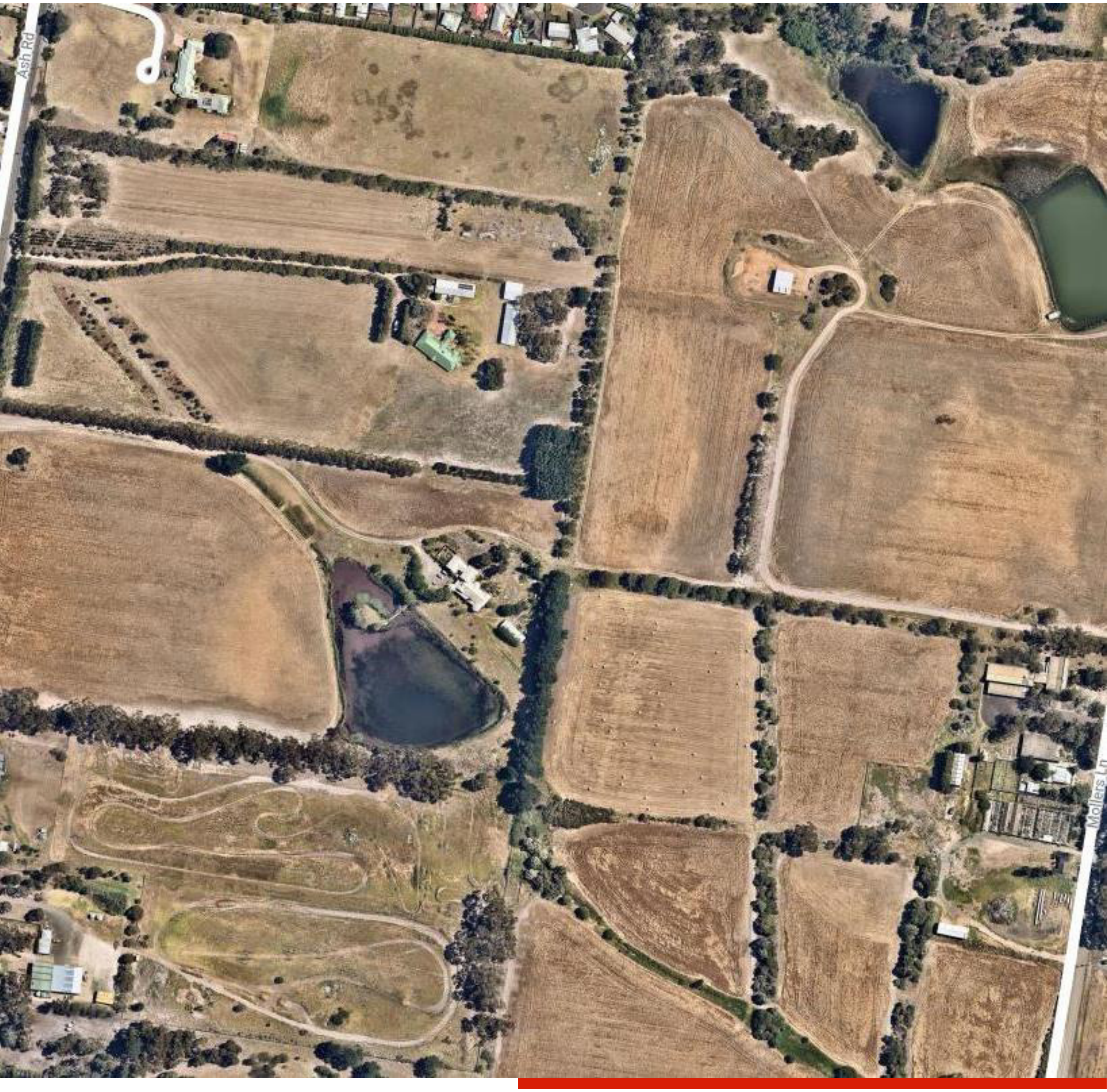

ASH ROAD EAST, LEOPOLD

STORMWATER MANAGEMENT PLAN REPORT
FEBRUARY 2020

PREPARED FOR EASTERN ASH PTY LTD

This report has been prepared by the office of Spiire
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TABLE OF ACRONYMS

SELGA	**South East Leopold Growth Area**
SMP	Stormwater Management Plan
CCMA	Corangamite Catchment Management Authority
CoGG	City of Greater Geelong
FIA	Flood Impact Assessment
WSUD	Water Sensitive Urban Design
AEP	Annual Exceedance Probability
EY	Exceedances per Year
EDD	Extended Detention Depth
NWL	Normal Water Level
EES	Environmental Effects Statement
ANCOLD	Australian National Committee on Large Dams
AHD	Australian Height Datum

1. INTRODUCTION

Spiire Australia Pty. Ltd. have been engaged by Eastern Ash Pty Ltd to undertake a Stormwater Management Plan (SMP) for a proposed residential development site at Ash Road East, Leopold. This report describes the SMP requirements for the proposed development site.

The proposed development (further referred to as the subject site) is positioned within the western portion of the South-East Leopold Growth Area (SELGA). The SELGA and the subject site cover approximately 79ha and 29ha, respectively.

Figure 1 presents a plan showing the various zones being considered as part of this assessment, as follows:

- The overall SELGA area, which includes the Mollers Lane development, within the eastern portion of the SELGA
- The Ash Road East area. This comprises 71-85 Ash Road, 87-101 Ash Road, 127 Ash Road, 129 Ash Road and 153 Ash Road, and represents the area being proposed for rezoning from Farming to General Residential
- The subject site area. This comprises 87-101 Ash Road and 103-127 Ash Road, and represents the area being considered as part of the Planning Permit Application.

1.1.1 LAKE CONNEWARRE

The SELGA is located within the catchment of Lake Connewarre, a RAMSAR listed wetland of international significance.

Figure 2 presents the location of the SELGA in relation to Lake Connewarre. The southeast corner of the SELGA, on Mollers Lane, lies approximately 900m upstream of the northern shoreline of Lake Connewarre.

To fully assess the impact to Lake Connewarre from the SELGA, Eastern Ash Pty Ltd engaged Venant Solutions to undertake a Lake Connewarre Impact Assessment. The findings of this study are discussed in Section 5 of this SMP.

1.1.2 MOLLERS LANE DEVELOPMENT

As presented in Figure 1 and Figure 2, the proposed Mollers Lane development lies immediately downstream and to the east of the subject site. As the Ash Road East and Mollers Lane developments will form part of the same urban drainage system, including a network of retarding basins and wetlands, connected by a constructed waterway, this SMP considers a developed scenario assuming full development of both the Ash Road East and Mollers Lane sites.

Planning and design for the Mollers Lane development is ahead of the subject site, with report *Site Stormwater Management Plan and Flood Impact Assessment* (TGM, 2018) for the Mollers Lane development already being endorsed by the Corangamite Catchment Management Authority (CCMA) and City of Greater Geelong Council (CoGG). This includes 2D flood modelling assessment of the relevant catchments.

The TGM (2018) assessment assumes that all of the SELGA, with the exception of the Mollers Lane site, is undeveloped. Therefore, this SMP can be viewed as building upon the

Mollers Lane SMP, by taking the concept drainage system developed as part of that study, and including with the Ash Road East SMP, to represent a catchment scale, holistic assessment.

To remain consistent with TGM (2018), this assessment uses the hydrologic and hydraulic modelling used in the TGM assessment as a basis.

Figure 1: Zoning Plan

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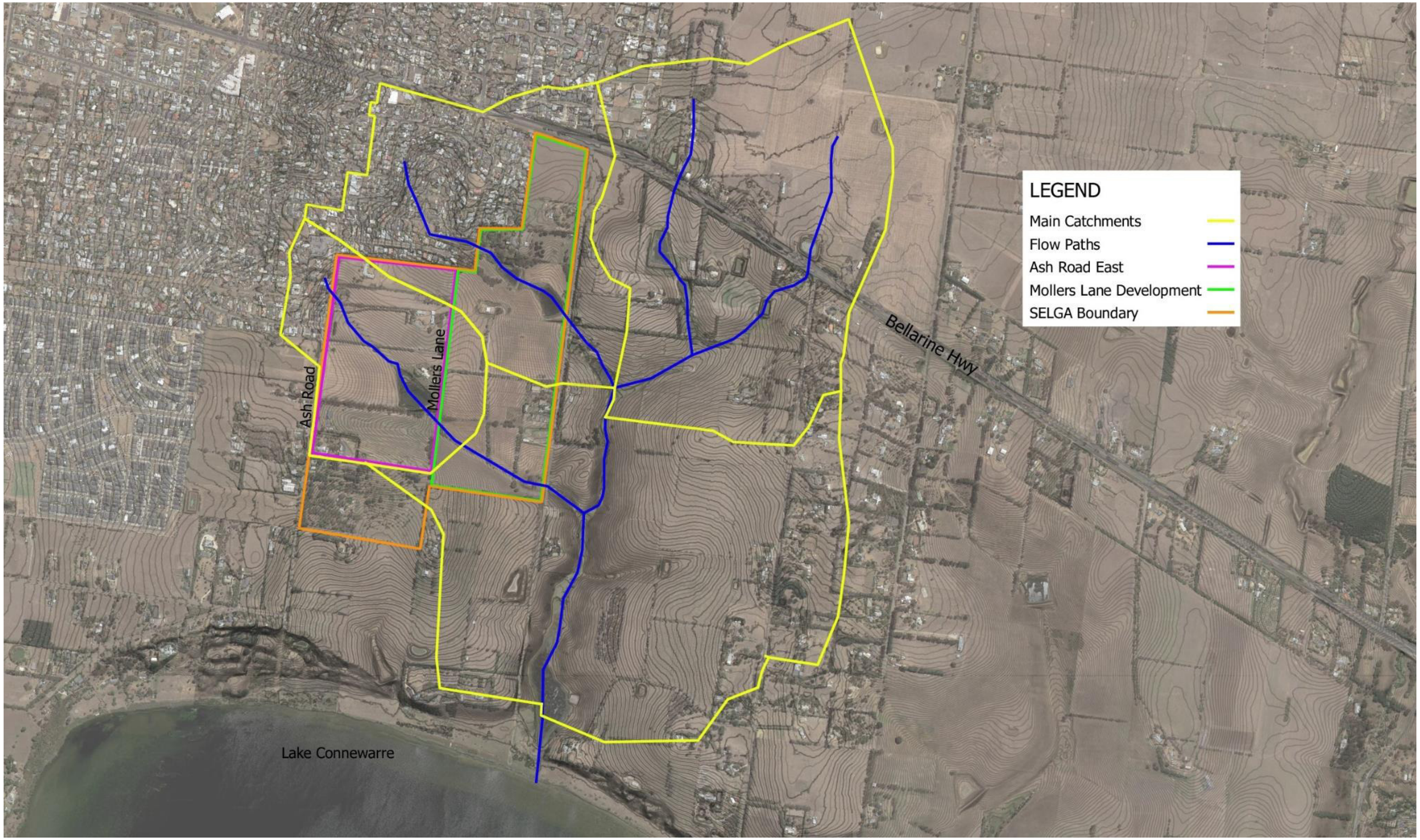

Figure 2: SELGA in relation to Lake Connewarre

1.2 SCOPE OF WORKS

The scope of works for the SMP are as follows:

- Undertake hydrological modelling, to understand magnitude of flows for a range of frequencies and durations, and for use as input to a flood impact assessment (FIA)
- Conceptual design of the urban drainage system, such that appropriate management of stormwater is provided, as follows:
  - Sufficient capacity is available for minor and major drainage systems
  - Water quality treatment measures are provided, through WSUD
  - Appropriate retardation of flows is provided, to protect the downstream environment (both built and natural) from flooding and erosion
- Undertake a FIA based on 2D hydrodynamic flood modelling, to understand existing and developed flood conditions, and validate design of retardation basins and constructed waterways.
- Undertake a Lake Connewarre Impact Assessment, to determine impact on Lake Connewarre, as a result of development of the SELGA.
- Report on the above (this report).

2. EXISTING SITE AND CATCHMENT CHARACTERISTICS

As shown in Figure 2, the SELGA is located to the southeast of the existing suburb of Leopold, and is currently comprised of farmland. Topography is relatively steep and undulating through the SELGA, with two small ephemeral waterways flowing northwest to southeast through the SELGA, being separated by a low ridge line (shown as dashed in orange in Figure 3). This ridge separates a southern catchment and a northern catchment within the Ash Road East site, (bounded in red, Figure 3).

Both northern and southern ephemeral waterways join another waterway downstream of Mollers Lane. This waterway flows north to south, before discharging to Lake Connewarre (see Figure 2).

Both the northern and southern waterway are recognised as waterways under the Water Act (1989).

The southern ephemeral waterway (approximately 310m long) is characterised as a low flow channel at the base of a small valley setting. There is approximately 6.4ha of existing residential catchment, west of Ash Road, which contributes to this waterway, which commences at the eastern side of Ash Road, then flows northwest to southeast, through the centre of the site. At the downstream end of the site, flows discharge into a large farm dam, located at the eastern site boundary.

Details of the construction and integrity of the existing large farm dam are unknown, and as such, it cannot be adopted as part of the ultimate urban drainage system. Therefore, this dam will be decommissioned, and replaced with a WSUD facility.

Refer to Appendix A for the existing conditions catchment plan, which shows further details on the main drainage features.

The northern ephemeral waterway lies to the north of the Ash Road East site, as shown in Figure 3.

Figure 3. Existing Site Conditions

A 20m wide service easement containing 600mm and 960mm Barwon Water Transfer Mains (servicing Leopold and the Bellarine Peninsula) bisects the subject site (refer to plans, Appendix A). The easement runs east-west through the site extending from Ash Road, into the Mollers Lane site immediately to the east.

2.1 EXISTING CONDITIONS HYDROLOGIC AND 2D HYDRODYNAMIC MODELLING

The existing catchment plan is presented as Figure 4 – refer to Appendix A for full details.

For the Mollers Lane development, a SMP and FIA have already been completed, and endorsed by authorities, as part of the planning application process for the Mollers Lane site. The documents which describe this work are as follows:

- Site Stormwater Management Plan and Flood Impact Assessment (TGM, 2018a)
- Mollers Lane, Leopold – Rezoning and Subdivision Memorandum – Site Stormwater Management Plan and Flood Impact Assessment – Consolidated Detention Basin for Southern Site (Mollers v4) (TGM, 2018b)

As part of these studies, hydrologic (XP RAFTS) and 2D hydrodynamic (TUFLOW) modelling has been undertaken, across the relevant catchments, down to the outlet to Lake Connewarre.

To remain consistent in approach with the Mollers Lane development studies, Eastern Ash Pty Ltd commissioned TGM to:

- Update the hydrologic model (XP STORM) to be fit for purpose for the Ash Road East site, and provide flow output locations appropriate for modelling and reporting.
- Re run the hydrologic model to obtain flows for the following:
  - Both existing conditions and fully developed conditions (Ash Road East and Mollers Lane sites developed)
  - Storm events comprising the 1% AEP, 2% AEP, and 5% AEP, 10% AEP, 0.2 EY and 0.5 EY. All durations considered for each frequency.
- Provide the modelled hydrograph data for the above scenarios, suitable for input to a 2D hydrodynamic flood model, and general use as part of this SMP.
- Provide a summary report describing the work undertaken, and presenting the results. This was provided as Technical Memorandum *Ash Road Development Site Hydrology Modelling* (TGM, 2019).For details of this memo, refer to Appendix J.
- Provide the catchment scale TUFLOW model (from Ash Road down to Lake Connewarre) used in the Mollers Lane FIA, for use as a basis for the Ash Road East modelling and SMP.

Subsequent to receipt of the above, Spiire rebuilt the flood model supplied by TGM, and then made appropriate modifications, to ensure the model was fit for purpose for the Ash Road East site. Refer to Appendix F for full description of the 2D flood model build and assumptions.

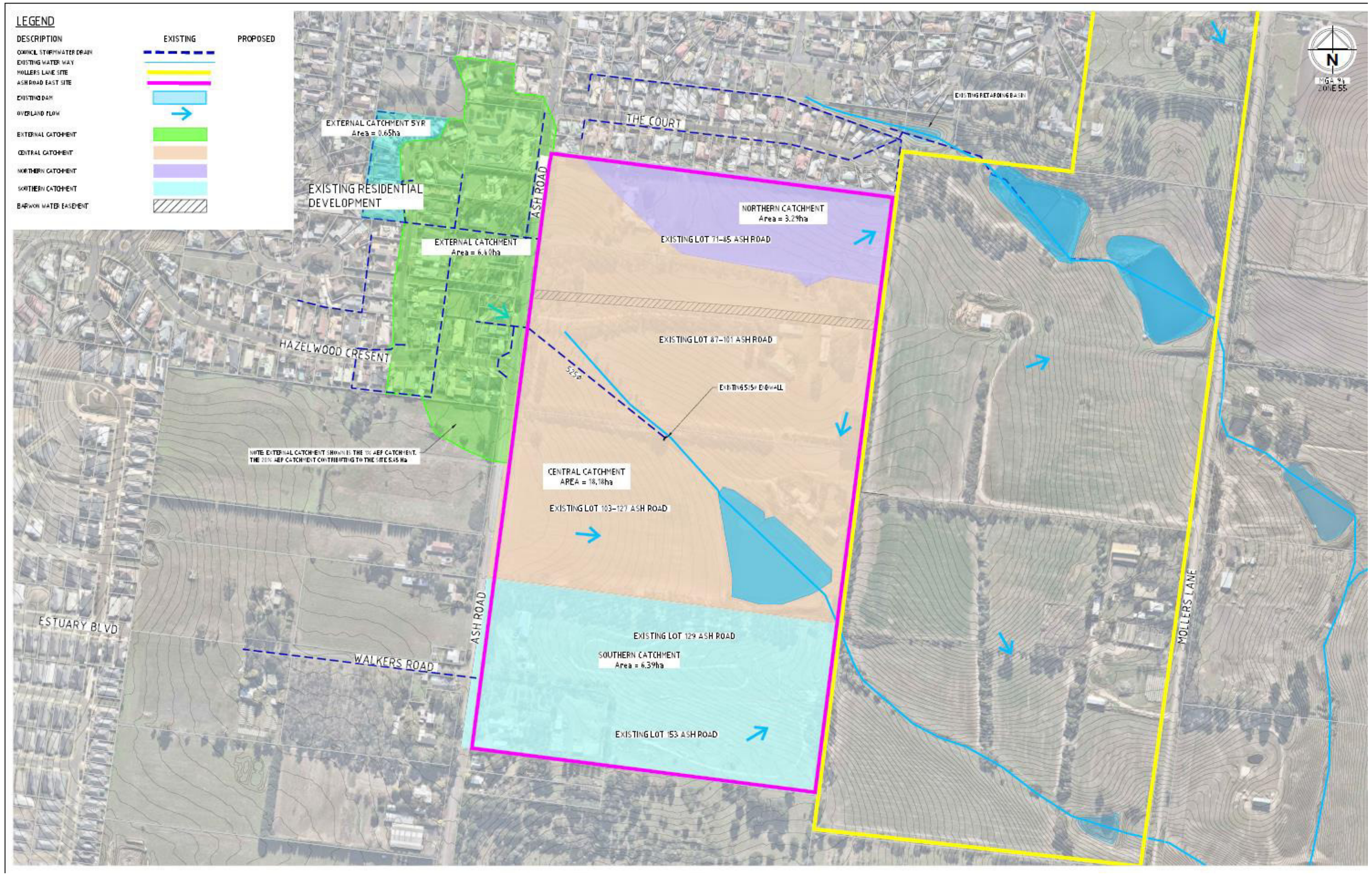

Figure 4: Existing conditions catchment plan

2.1.1 MODELLING RESULTS

Using the rebuilt, fit for purpose 2D flood model, the hydrology, for all frequencies and durations, was imported and simulated through the model.

Figure 5 and Figure 6 present maximum 1% AEP flood depths and extents, for the catchments extents, and SELGA extents, respectively.

Table 1 presents peak 1% AEP discharge rates across the catchment at key locations (refer and for location of flows within the catchment).

Existing conditions flood depth and extents mapping for the 1% AEP, 2% AEP, and 5% AEP, 10% AEP, 0.2 EY and 0.5 EY events are presented in Appendix D, together with velocity mapping for the 1% and 0.2 EY events.

Table 1. Modelled existing conditions peak flows

Event frequency	Location A (m^3/s)	Location B (m^3/s)*	Location C (m^3/s)	Location D (m^3/s)
1% AEP	1.5	0.2	2.4	8.2

*Design flows extracted from TGM 2018b and do not represent flows routed through TUFLOW model

Reporting Location A represents the point of confluence between the central and southern catchments of Ash Road East. Analysis here is important to understand how the future Ash Road East retarding basins (described in following sections) are performing in relation to existing conditions.

Reporting Location B represents stormwater flows from the small northern catchment (3.29ha), which grades to the north, and contributes to the waterway to the northeast of the Ash Road site.

Reporting Location C represents total discharge from the southern SELGA catchment, to the downstream environment, and is located at the southern outfall of the Mollers Lane development. As such, the existing 1% AEP peak discharge at Reporting Location C (2.39m^3/s) represents permissible discharge from the southern SELGA catchment.

Reporting Location D represents the confluence between the southern SELGA catchment, the northern SELGA catchment (the discharge from future Mollers Lane Basin AB) and catchments to the north.

Refer Figure 5 and Figure 6 for all Reporting Locations described above.

The developed scenario, under this SMP, will consider the proposed Ash Road East drainage assets, together with the endorsed Mollers Lane drainage assets (TGM, 2018b), and test the entire system using the 2D model. The proposed arrangement must allow 1% AEP peak discharge rates from the SELGA to be kept at or below existing conditions.

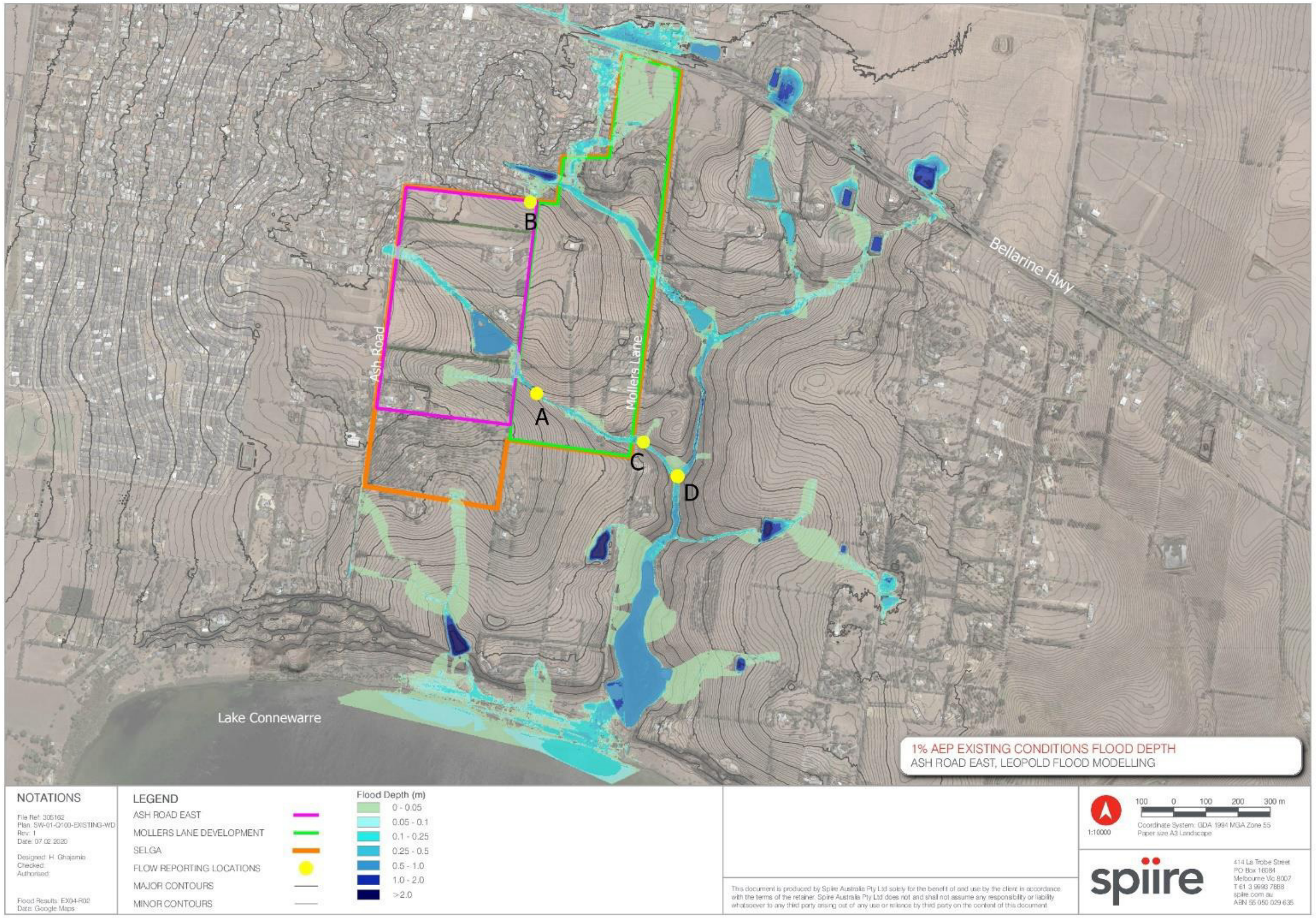

Figure 5: Existing conditions 1% maximum depth and extents – catchment map

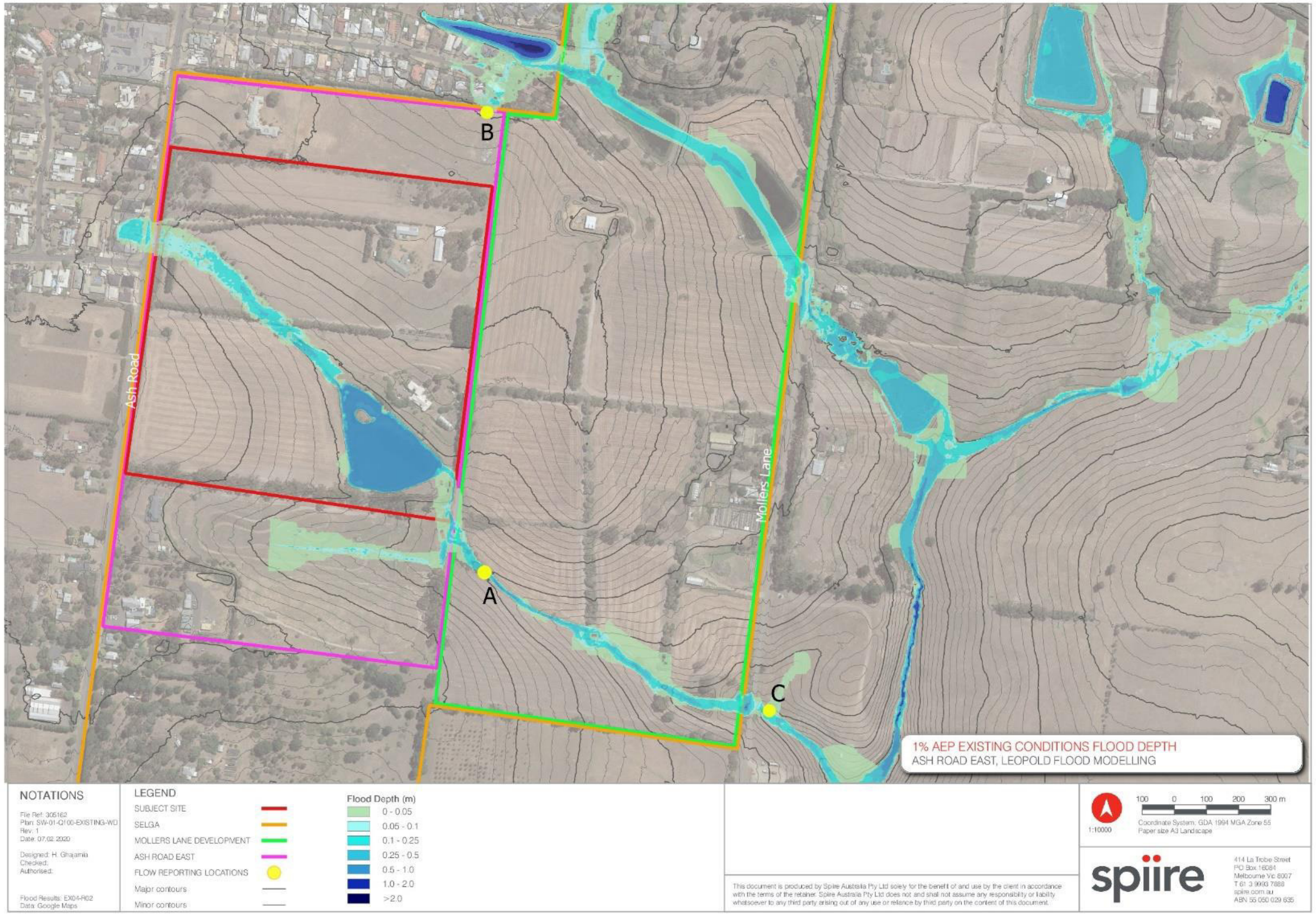

Figure 6: Existing conditions 1% maximum depth and extents – site map

3. PROPOSED DEVELOPMENT

3.1 URBAN DESIGN

The overall structure informing the urban design of the subject site is set out in the SELGA Framework Plan. The SELGA is bounded to the north by the Bellarine Highway, to the west by Ash Road, to the east by Mollers Lane, and to the south by agricultural land and rural residential, as presented in Figure 7.

Figure 7. Leopold Ash Rd East Site Location within SELGA Framework Plan

Tract have prepared and supplied an urban design for the subject site, based on the SELGA Framework plan, which is presented in Figure 8. The Tract urban design forms the basis for this SMP.

As shown, the proposed development includes a linear open space running northwest to southeast, through the centre of the site, which corresponds to the southern ephemeral waterway corridor. A drainage reserve will be located at the downstream (south east) end of the linear reserve, and is described in more detail in following sections.

The urban design (Figure 8) also indicatively includes the layout within the 129 and 153 Ash Road properties, (south of the subject site, which also includes a drainage reserve), and 71-85 Ash Road property (north of the subject site). Both properties are outside of the subject site, but within the Ash Road East site.

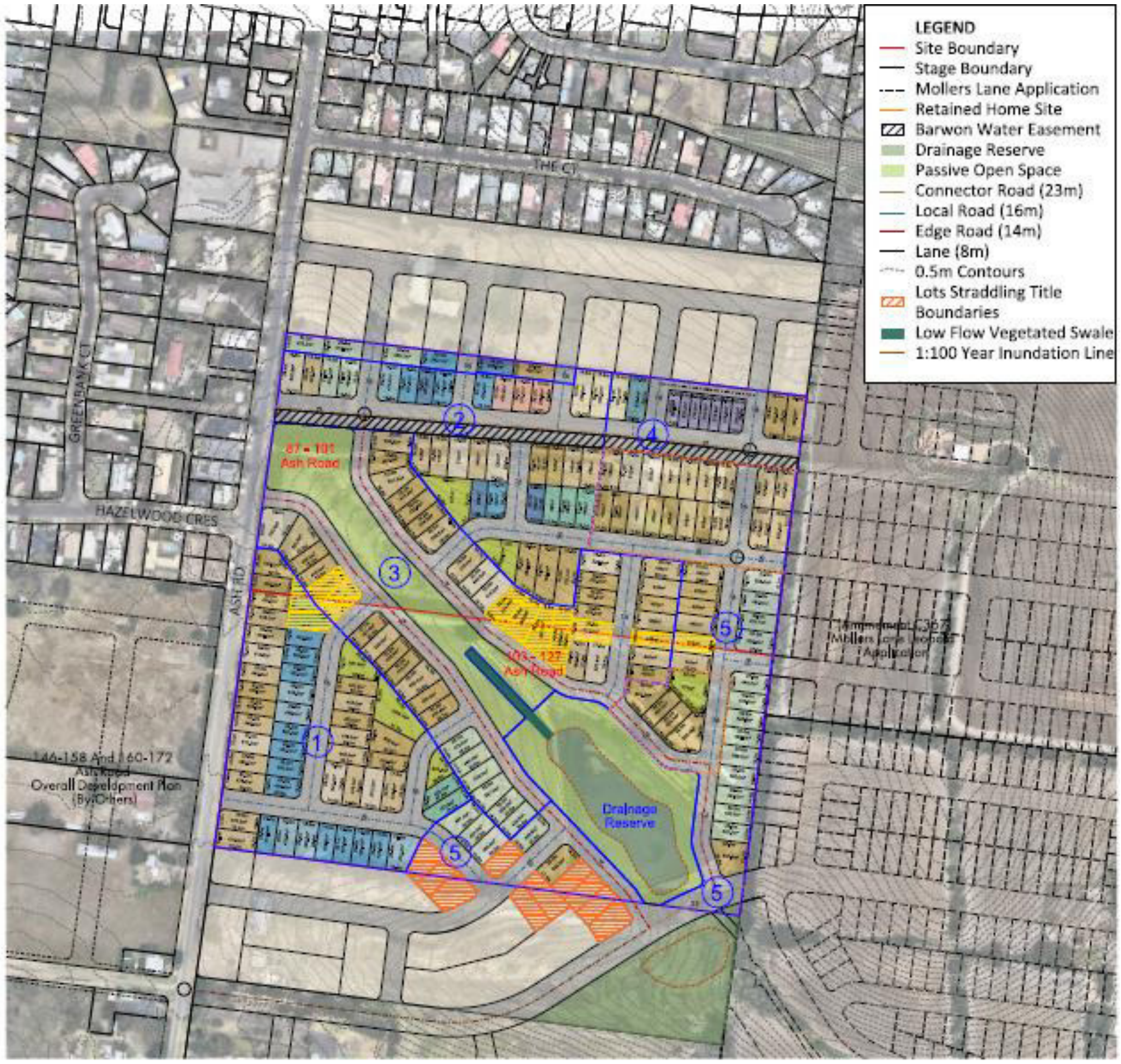

Figure 8. Proposed subdivision layout for the subject site (including staging plan and existing dwelling super lots)

3.2 DEVELOPED CATCHMENTS AND DRAINAGE RESERVES

The developed catchment layout for Ash Road East is presented in Figure 9, which also includes the Mollers Lane subdivision layout and drainage reserves. Refer to Appendix A for full details of the catchment plan.

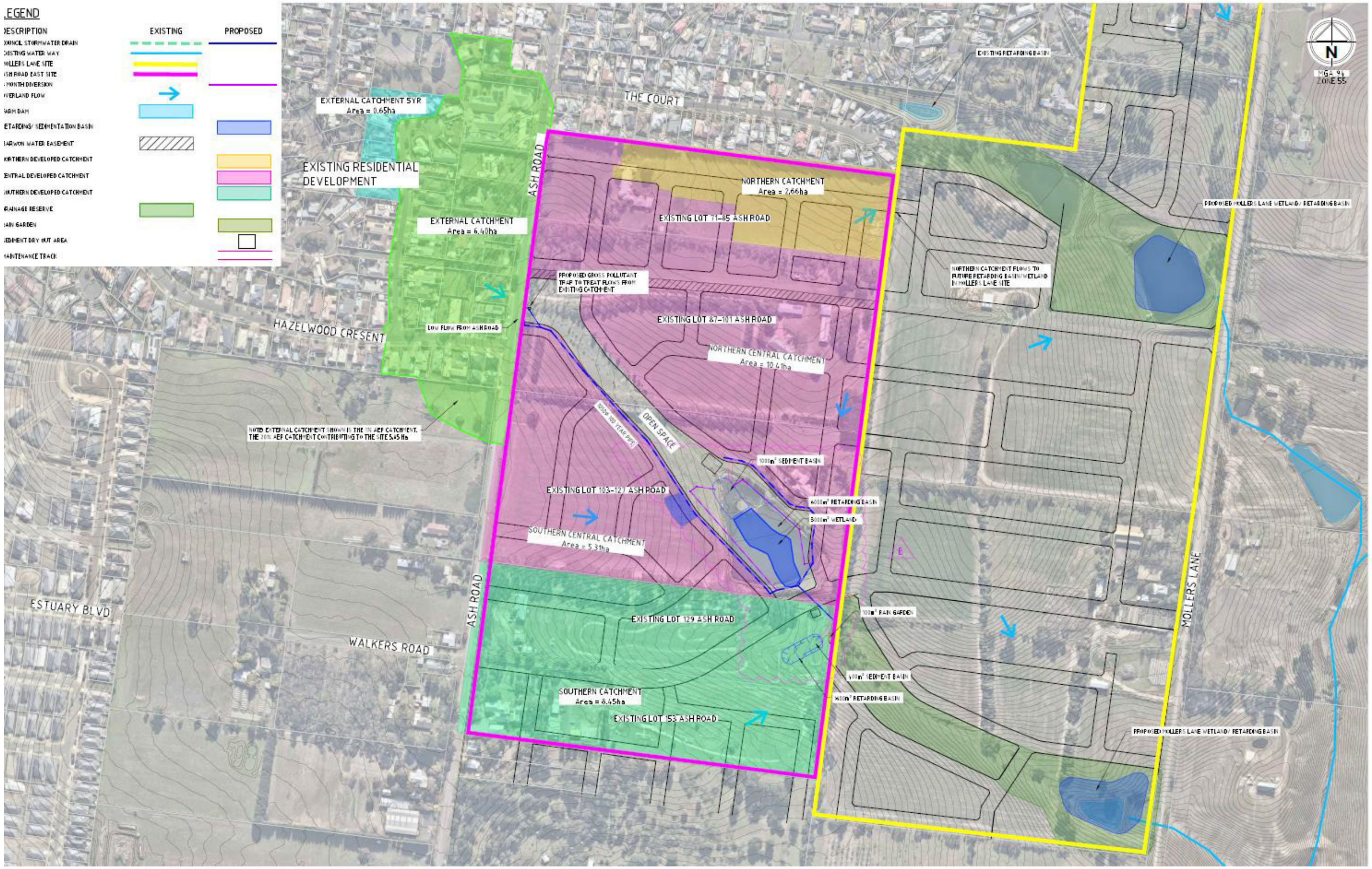

Figure 9: Developed conditions catchment plan

The main aspects of the proposed stormwater drainage system are summarised in the following sections.

3.2.1 NORTHERN CATCHMENT

The northern catchment of the Ash Road East site covers 2.66ha, and lies entirely within the 71-85 Ash Road property, immediately to the north of the subject site. Refer to the yellow catchment in Figure 9, above, and the catchment plans in Appendix A, for details.

The northern catchment drains eastwards, into the northern basin (Basin AB) catchment within the Mollers Lane development (TGM 2018a). As no allowance has been made for this catchment as part of Basin AB sizing, water quality and quantity provision will need to take place within the Northern Catchment. The requirement for this will be assessed as part of the Planning Permit application for development of this property.

3.2.2 CENTRAL CATCHMENT AND DRAINAGE RESERVE

A 6.4ha developed catchment, west of Ash Road (external to the site), together with a 15.7ha catchment of future lots and roads, within the proposed Ash Road development, discharge to a central drainage reserve. This is directly adjacent to the linear open space, within the southeast corner of the subject site (refer Figure 9 above, and Appendix A for details).

The central drainage reserve comprises:

- A 1,000m^2 sediment basin (NWL 35.4m AHD, EDD 0.35m)
- A 2,800m^2 wetland (NWL 35.3m AHD, EDD 0.35m)
- A 6,550m^3 retarding basin, with the sediment basin and wetland located at the base.
- A high flow piped bypass, around the sediment pond and wetland, to provide scour protection to the planting of these assets

Refer to Appendix B for a conceptual plan and long section through the central drainage reserve.

Topography through this area is relatively steep, with the waterway corridor forming a small valley setting. A 22m connector road (in accordance with the SELGA framework plan) forms the southern/downstream boundary of the drainage reserve, as shown in Figure 9. Where this connector road crosses the waterway corridor, a road embankment approximately 3-4m above existing surface will be formed. It should be noted that this structure will be subject to ANCOLD assessment and design.

Outlet pipes from the retarding basin will run through/under the connector road embankment, to discharge to a future constructed waterway, immediately downstream. This constructed waterway will be constructed as part of the Mollers Lane development, and convey flows to the Mollers Lane southern drainage reserve, located in the south eastern (downstream) corner. This drainage reserve comprises a wetland and retarding basin (Basin C) combination, and is described in TGM 2018a and TGM 2018b.A concept design of the central retarding basin was analysed and iterated in RORB, to arrive at suitable arrangements for storage volume, outlet controls and spillway levels. This basin design was then incorporated to the developed scenario 2D flood model, for analysis as part of the fully developed SELGA system. This analysis is discussed in later sections of this report. Details of the conceptual retarding basin are presented in Table 2.

Table 2: Conceptual central retarding basin details

Total volume (m^3)	Maximum depth (m)	1% AEP peak level (m AHD)	Concept piped outlet arrangement
6,550	1.2	36.5	300 dia low flow, set to NWL 35.30. 70m long at 4.4% 600 dia high flow set to EDD 35.65, 70m long at 4.9%

3.2.3 PROPOSED 1% AEP PIPE FOR EXTERNAL CATCHMENT FLOWS

As described in sections above, a 6.4ha external developed catchment, west of Ash Road, currently drains via a 600 dia pipe to the southern ephemeral waterway.

Previous advice received from Council's Open Space department was that it was preferable to keep open stormwater drainage separate from the linear open space to create a less encumbered, and usable space for the future community.

As a result, subsequent discussions with CCMA and Council were undertaken, to discuss the possibility of piping all flows from this external catchment, up to the 1% AEP, through the future road reserve of the subject site. The pipe is proposed to outlet to the central drainage reserve (refer proposed development plan in Appendix A for conceptual 1% pipe location). CCMA advised that in order to approve the piping of 1% AEP flows from this catchment, water quality treatment provided to the proposed development would need to "exceed" best practice. This was proposed with consideration of the presence of Lake Connewarre, downstream of the site.

A proposed treatment train for Ash Road East, inclusive of a 1% AEP pipe for external catchment flow conveyance, was sized to exceed best practice treatment performance. This was presented to CCMA in a Memorandum titled *Proposal to remove existing reach of ephemeral waterway* (Spiire, 20 December 2019), and detailed above. CCMA have subsequently provided In Principal support to adopt a 1% pipe for the external catchment (refer to Appendix C for CCMA letter).

Based on TGM hydrology (TGM 2019), 1% AEP peak flows from the external catchment are 1.63 m^3/s. A concept 1% AEP pipe design was developed in 12d, and simulated in Storm Analysis. A pipe diameter of 1050mm was found to be suitable to convey all flows, with the concept pipe details being summarised in Table 3.

Table 3: External catchment concept 1% AEP pipe design details

1% AEP peak flow (m^3/s)	Max grade (%)	Min grade (%)	Pipe dia (mm)
1.6	4.9	1.0	1050

3.2.4 SOUTHERN CATCHMENT AND DRAINAGE RESERVE

The southern drainage reserve is located in the southern portion of the Ash Road East, within the 153 Ash Road property. This represents 8.54ha of catchment, and is located immediately to the south of the subject site.

Refer to Appendix A and Appendix B, for catchment layout, and drainage reserve layout, respectively. Note that the northern boundary of the southern drainage reserve follows the property boundary. This will be refined through design development, and will respond to the urban design.

As both the southern drainage reserve, and contributing catchment, are outside the subject site, and will therefore be developed under separate planning permit, the southern drainage is not assessed and described to the same level of detail as the central drainage reserve, under this SMP.

The intent is to provide sufficient detail and analysis to demonstrate water quality and quantity can be appropriately managed, as part of the overall SELGA stormwater system.

Further concept details and information regarding the southern drainage reserve should be provided as part of a site specific SMP to support a planning permit application for the 153 Ash Road property.

The southern drainage reserve comprises:

- A 400m^2 sediment basin (EDD 0.50m)
- A 1,760m^3 retarding basin, with the sediment basin located at the base. Refer Table 4 for concept retarding basin details
- A 100m^2 biofilter (EDD 0.30m), positioned downstream of the retarding basin, to reduce inundation duration which is considered detrimental to plant health.

A concept design of the southern retarding basin was analysed and iterated in RORB, to arrive at a suitable arrangement, with regards to storage volume, outlet controls and spillway levels. This basin design was then imported to the developed scenario 2D flood model, for analysis as part of the fully developed SELGA system. This analysis is discussed in later sections of this report. Details of the concept retarding basin design are presented in Table 4.

Table 4: Conceptual southern retarding basin details

Total volume (m^3)	Maximum depth (m)	1% AEP peak level (m AHD)	Concept piped outlet arrangement
1,760	1.4	31.9	450 dia pipe, 44m long at 0.5%

3.3 MUSIC MODELLING OF PROPOSED TREATMENT TRAIN

Through preliminary discussions with CCMA it was advised that due to the presence of Lake Connewarre, a RAMSAR listed wetland, downstream of the SELGA, a water quality treatment performance that exceeded best practice was required. For details, refer to Appendix C for CCMA letter.

The treatment train for both the central catchment and southern catchment, presented above, was iterated and analysed in MUSIC, and found to produce water pollutant treatment which exceeds best practice. This is detailed in Table 5. For details of MUSIC model assumptions and layout, refer to Appendix H.

An inundation duration analysis was also undertake using Melbourne Water's online Wetland Analysis Tool. All criteria was shown to be met – refer to Appendix H for details.

Refer to Appendix A and Appendix B for catchment plans and conceptual WSUD design, respectively.

Table 5: Proposed treatment train results from Ash Road East MUSIC model

<table>
<tr><th>Scenario description</th><th>Gross Pollutants reduction (%)</th><th>Total Suspended Solids reduction (%)</th><th>Total Phosphorus reduction (%)</th><th>Total Nitrogen reduction (%)</th></tr>
<tr><td>State Environmental Protection Policy clause 56</td><td>70</td><td>80</td><td>45</td><td>45</td></tr>
<tr><td>Central catchment: 1,000m^2 sed pond, 2,800m^2 wetland</td><td rowspan="2">100</td><td rowspan="2">86</td><td rowspan="2">66</td><td rowspan="2">49</td></tr>
<tr><td>Southern catchment: 400m^2 sed pond, 100m^2 raingarden</td></tr>
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3.4 DEVELOPED CONDITIONS 2D MODELLING

Following development of the concept WSUD system, described above, the TUFLOW flood model was modified, to represent a developed SELGA. This comprised the concept drainage elements through the Ash Road East site, described above, together with concept drainage elements within the Mollers Lane site, supplied by TGM. This developed case model was subsequently simulated for all frequencies and durations, to test the Ash Road East and Mollers Lane drainage elements as a system.

Refer to Appendix F for TUFLOW model build and assumptions.

Table 6 presents a comparison between modelled existing and developed conditions peak discharges, at key locations.

Table 6. Modelled developed conditions peak flows, compared with existing conditions

Event frequency	Location A (m^3/s)	Location B (m^3/s)*	Location C (m^3/s)	Location D (m^3/s)
1% AEP Existing conditions	1.5	0.2	2.4	8.2
1% AEP Developed conditions	1.2	0.7	1.9	7.3

*Design flows extracted from TGM 2018b and do not represent flows routed through TUFLOW mode

Figure 10 and Figure 11 present modelled peak depths and extents, for the 1% AEP amd 0.2 EY, respectively.

Figure 12 and Figure 13 present afflux for the 1% AEP and 0.2 EY, respectively.

Developed conditions flood depth and extents mapping for the 1% AEP, 2% AEP, and 5% AEP, 10% AEP, 0.2 EY and 0.5 EY events are presented in Appendix E, together with velocity and afflux mapping for the 1% and 0.2 EY events.

Note that retardation of peak flows have focused on the 1% AEP event, and reported under this SMP. Afflux mapping to the downstream environment has focused on the 1% and 0.2 EY events, to demonstrate change under major and minor flood conditions.

A summary of the post development modelling is as follows:

- A combination of the central and southern retarding basins provide suitable retardation of flows. The developed 1% AEP peak flow at Flow Location A of $1.2m^3/s$ is 20% less than $1.5m^3/s$, under existing conditions.
- The 1% AEP peak developed flow of $0.7m^3/s$ (Flow Location B) from the northern catchment will be retarded within this northern property. This will be assessed as part of development applications for this property.

- The Ash Road East retarding basins are shown to function efficiently, in combination with Mollers Lane Basin C. Developed conditions 1% AEP modelled flows at reporting Location C, immediately downstream of Mollers Lane, are 1.9m^3/s, being 20% less than the existing conditions discharge of 2.4m^3/s.
- Reporting Location D represents the confluence between the southern SELGA catchment, the northern SELGA catchment (the discharge from future Mollers Lane Basin AB) and catchments to the north. Here, 1% AEP peak discharges are modelled to be 7.3m^3/s, or 12% less than the existing conditions discharge of 8.2m^3/s.
- Figure 12 presents afflux for the 1% AEP event. As shown, downstream of the southern SELGA catchment, peak 1% AEP flood levels are predicted to reduce by 20 – 50mm. Some larger afflux is shown through the basins of both developments, which is to be expected. Appropriate freeboard will be provided to all development adjacent to flood areas as part of the design process.
- Some minor increases in flood levels upstream and downstream of the Mollers Lane northern catchment is shown; note that modelling results as part of this SMP should be viewed as indicative for these areas. For accurate modelling results for these areas, refer to TGM 2018a.
- Figure 13 presents afflux for the 0.2 EY event. Downstream of the SELGA, analysis demonstrates no change in 1% AEP flood levels. This is with the exception of some small isolated areas, which are considered negligible.

The TUFLOW analysis presented here demonstrates that the concept retarding basins are appropriate, and work well as a system. No or very minor change in water levels through the downstream environment is predicted, which confirms suitability of basin design.

Changes to volumetric run off, from existing to developed conditions, is discussed in Section 5.

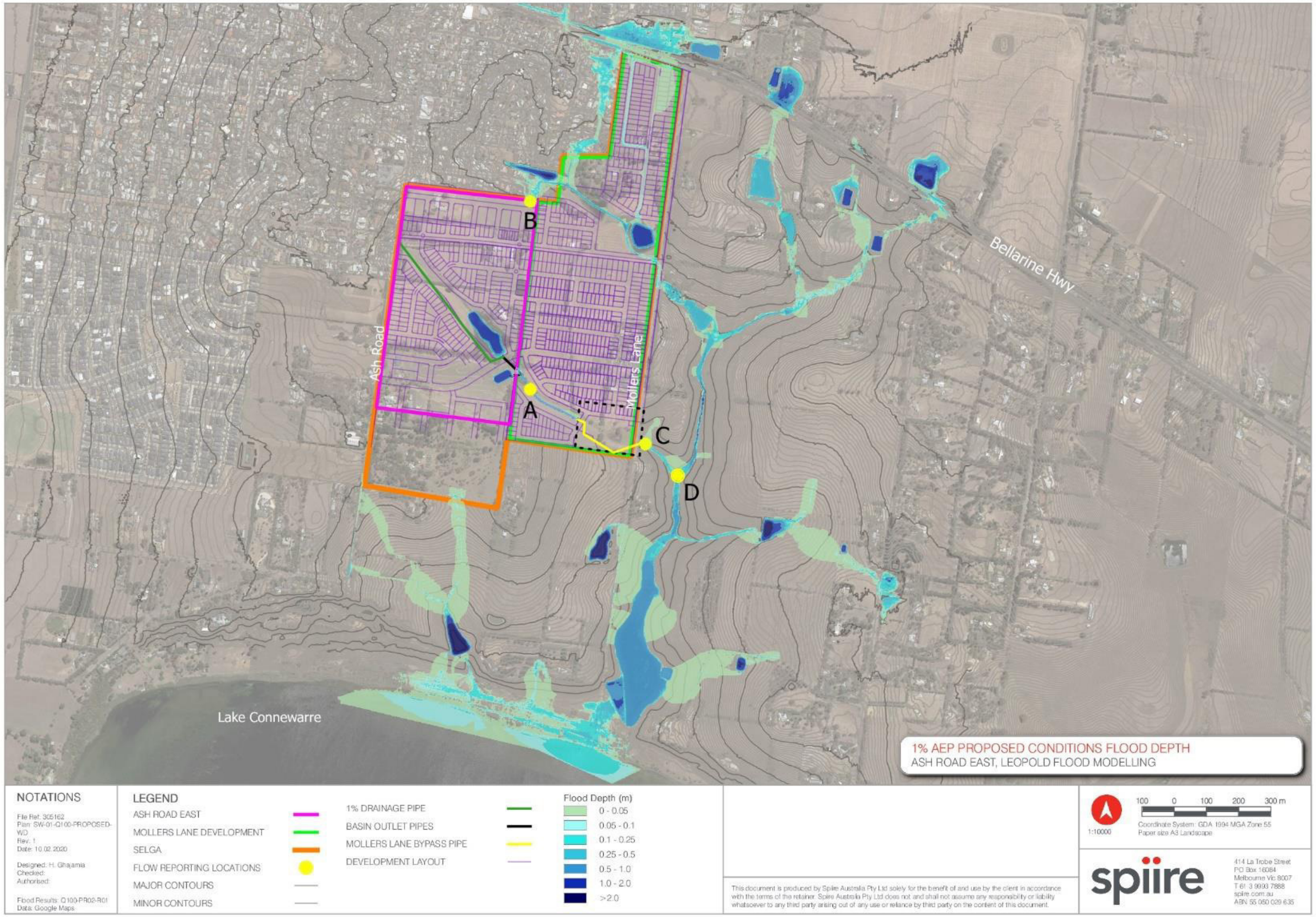

Figure 10: Developed conditions 1% maximum depth and extents – catchment map

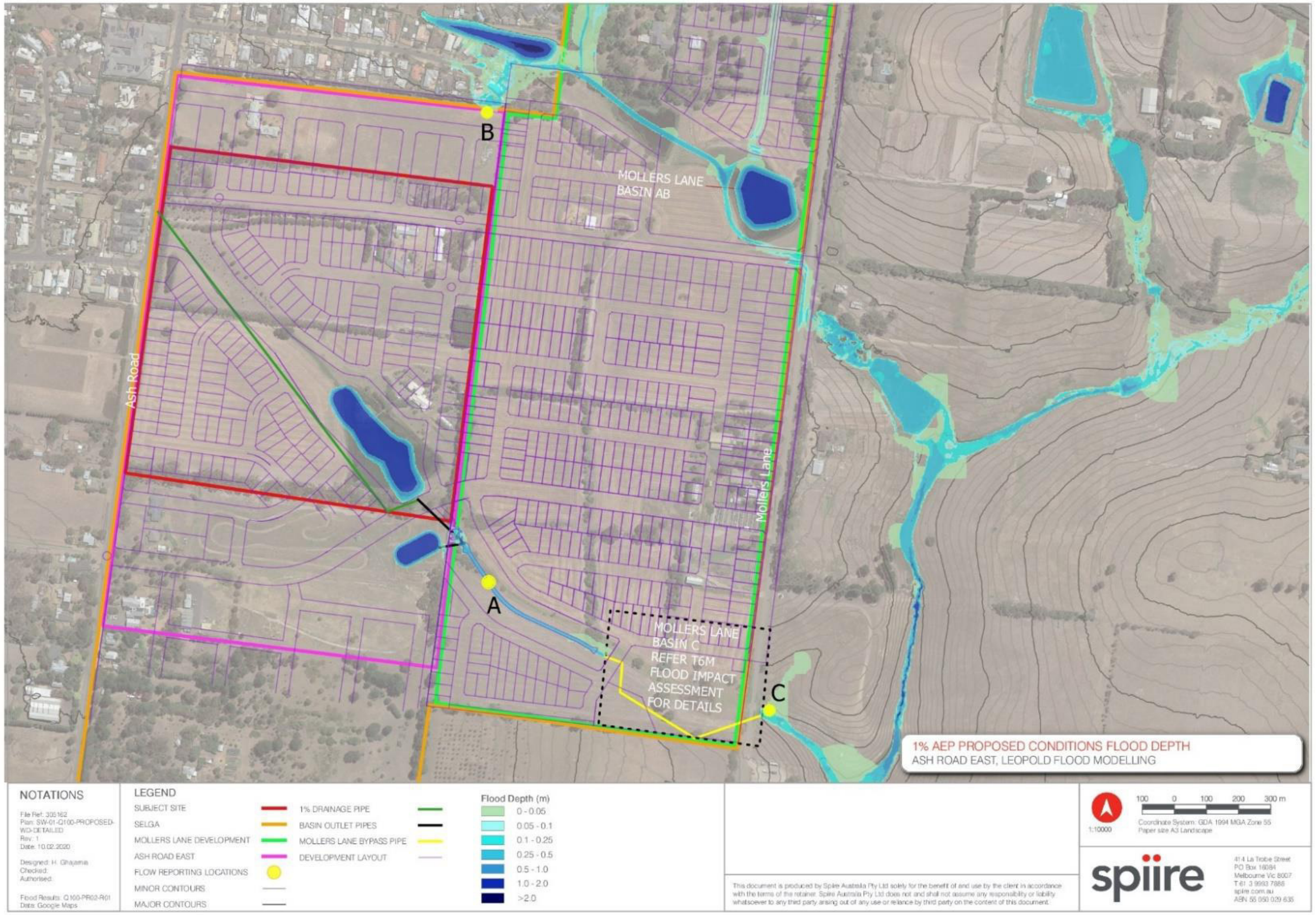

Figure 11: Developed conditions 1% maximum depth and extents – site map

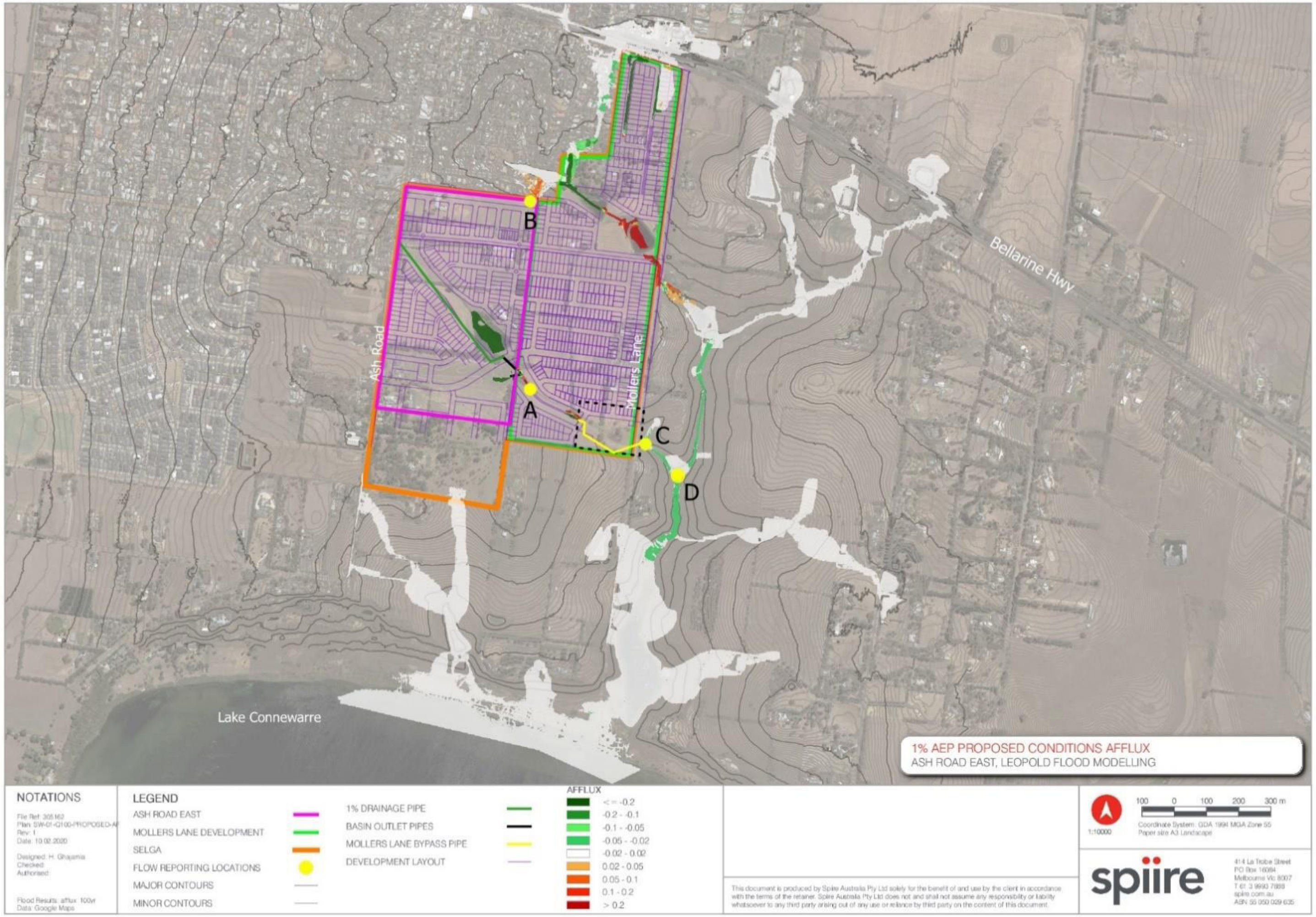

Figure 12: 1% AEP afflux

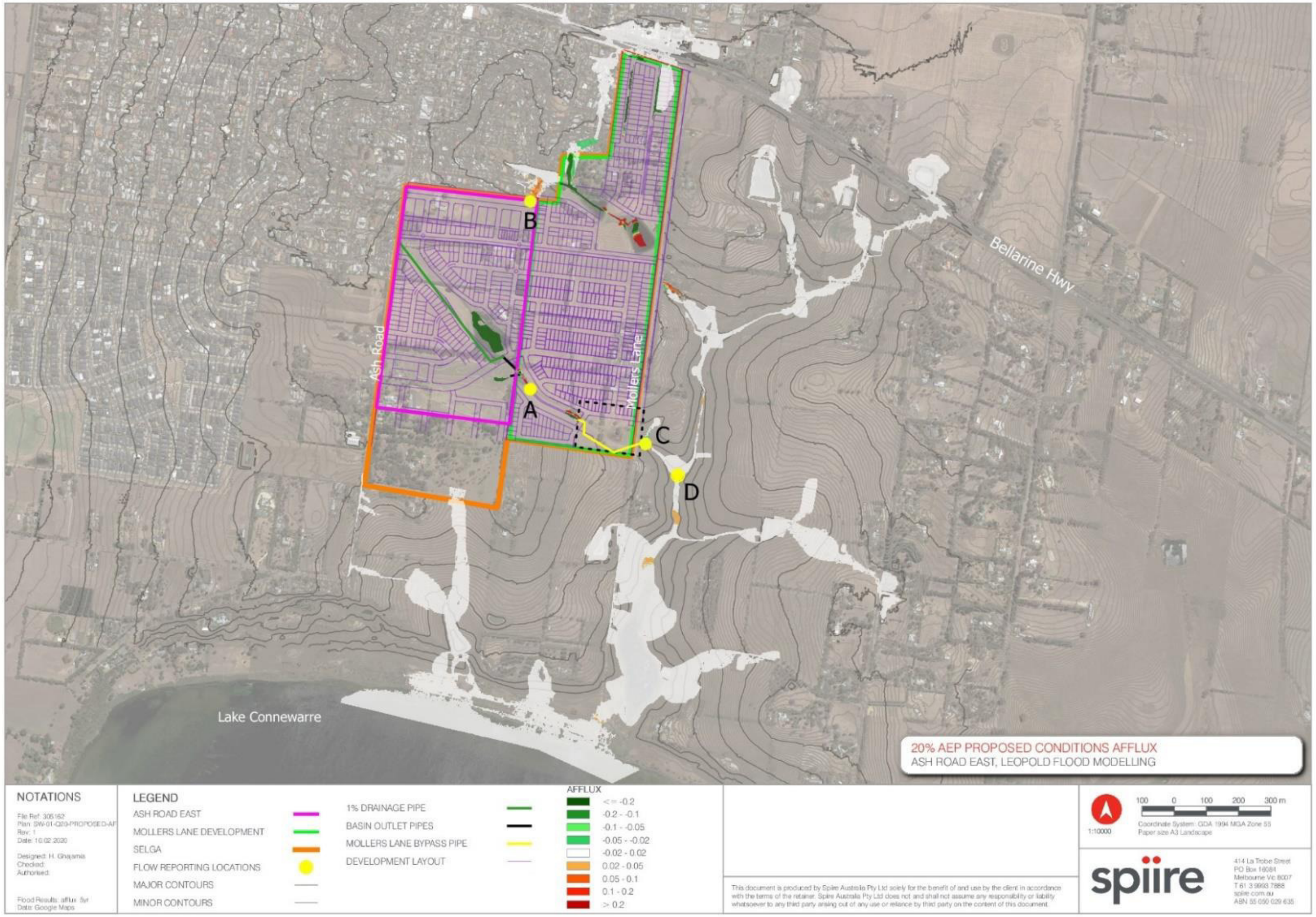

Figure 13: 20% AEP afflux

3.5 COVEYANCE OF FLOWS

Conveyance of stormwater flows up to 20% AEP will be provided through the piped system. Gap flows (generally 1% AEP flows – 20% AEP flows) will be conveyed through the road reserve network.

Hydrological modelling was undertaken by TGM, and presented in TGM 2019 (Appendix J). Figure 14 presents a catchment plan extracted from TGM 2019 which shows the north-central catchment (catchment E) and south-central catchment (catchment F1), which lie immediately to the north and south of the drainage reserve, respectively.

Topography is relatively steep through these catchments, and conceptually, major and minor flows will be conveyed to discharge points as black dots shown in Figure 14 as "hydrograph locations".

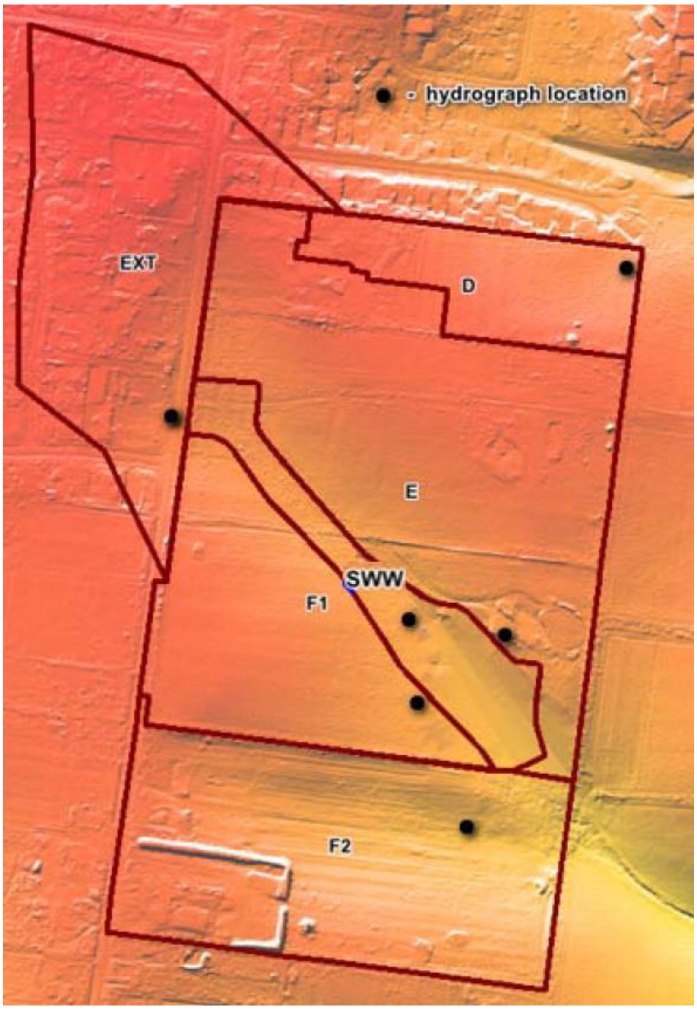

Figure 14: Ash Road East catchment showing design flow locations as black dots (TGM, 2019)

Table 1 presents 1% AEP, 20% AEP and gap flows for catchments E and F1 and the critical locations.

Using the Colebrook White formula, and assuming a 1:200 longitudinal grade, maximum pipe diameters of 750mm and 1050mm will be required for catchments F1 and E, respectively. Refer Appendix G for Colebrook White calculations.

Note that this pipe sizing is subject to change through design development, include Hydraulic Grade Line analysis.

Assuming a 16m road reserve, and 1:200 longitudinal grade, maximum conveyance capacity is approximately 1.5m^3/s (refer Appendix H for PC Convey calculations). Therefore, adequate capacities are available through both catchment F1 and E. Note that this is a conservative assumption as due to topography, road gradings are likely to be steeper than 1:200.

Table 7: Developed design flows for subject site

Catchment	1% AEP (m^3/s)	20% AEP (m^3/s)	Gap (m^3/s)
F1	1.5	0.8	0.7
E	2.8	1.5	1.3

4. STAGING

Works within the central drainage reserve will be staged in coordination with progressive development of the proposed subdivision stages.

It is possible that Phase 1 basin works will be designed and constructed, to provide drainage for initial stages of the development, with the ultimate basin being constructed towards the final stages of the development.

The staging of the basin works will be assessed and designed in conjunction with design progression of the overall development. This is anticipated to occur together with functional design of Stage 1.

5. LAKE CONNEWARRE IMPACT ASSESSMENT

5.1 MOLLERS LANE ASSESSMENT

As part of assessment for the proposed Mollers Lane development, Venant Solutions prepared report *Mollers Lane Development – Lake Connewarre Impact Assessmen*t (Venant Solutions, 2017). The scope of this assessment was:

- To assess the impact of additional runoff from the future Mollers Lane development on Lake Connewarre
- Assess impact to Lake Connewarre foreshore vegetation communities
- Assess impact to the broader Lake Connewarre environment

The findings of this assessment was that risk to Lake Connewarre was low with no mitigation measures required, other than best practice WSUD.

5.2 SELGA ASSESSMENT

As part of the Ash Road East assessment, Venant Solutions have updated their study, and produced report *Ash Rd Development – Flows to Lake Connewarre Impact Assessment – Stage 1* (Venant Solutions, 2019). This was necessary given the Venant Solutions 2017 assessment considered development of the Mollers Lane site in isolation. Given worst case impact to Lake Connewarre from the SELGA catchment corresponds with a fully developed SELGA, this updated assessment considered ultimate development of SELGA.

The scope of the updated assessment was the same as the Venant Solutions 2017 study.

Subsequent to Venant Solutions 2017, a bypass pipeline has been proposed by the Mollers Lane developer and TGM to convey excess flows (not base flows) from the outlet of SELGA (Basins AB and C at Mollers Lane) down to Lake Connewarre. The purpose of this pipeline is to protect the existing waterways between Mollers Lane and Lake Connewarre from increased erosion risk, due to increased volumetric runoff, and also negate the requirement for the acquisition of easements through downstream properties.

Currently, it is understood that the proposed bypass pipeline is still at the concept design stage, and hence no design information is available for assessment by Venant Solutions as part of the Lake Connewarre Impact Assessment update. Therefore, the updated Venant Solutions 2019 assessment assumes no bypass pipeline is in place, which is consistent with the approach taken in Venant Solutions 2017. This approach assumes all flows discharge to the waterway immediately downstream of Mollers Lane.

Note that it is understood that the bypass pipeline will be designed and constructed as part of future early stages of the Mollers Lane development. Once design of this pipeline and been developed, Venant Solutions will be commissioned to undertake an updated assessment (Stage 2), including the bypass pipe.

It is recommended that the assessment of this pipe is undertaken as part of a Condition of the Planning Permit. This was agreed at a meeting at Council offices between Ample, Spiire, CCMA and Council on 7th November 2019.

The findings of the Venant Solutions 2019 assessment are that impacts to Lake Connewarre will be limited and low, and unlikely to trigger Victoria's EES provisions. The report recommends mitigation of risks (all of which are low, due to changes in hydrology and water quality) through best practice WSUD.

6. SUMMARY

This SMP presents an appropriate plan for managing stormwater quality and quantity for the subject site and Ash Road East site. The key findings of this assessment are summarised as follows:

- The conceptual treatment train for the central catchment is proposed to be:
  - A 1,000m^2 sediment basin (NWL 35.3m, EDD 0.35m)
  - A 2,800m^2 wetland (NWL 35.3m, EDD 0.35m)
  - A 6,550m^3 retarding basin, with the sediment basin and wetland located at the base.
- The conceptual treatment train for the southern catchment is proposed to be:
  - A 400m^2 sediment basin (EDD 0.50m)
  - A 1,760m^3 retarding basin, with the sediment basin located at the base.
  - A 100m^2 biofilter (EDD 0.30m), positioned downstream of the retarding basin.
  - Note that the southern catchment is not part of the subject site, and will be delivered as part of a separate Planning Permit. Additional detail around the southern drainage reserve will be developed as part of a separate Planning Permit application.
- The currently developed 6.4ha catchment, immediately to the west of Ash Road, and external to the site, will be drained by a 1050 dia 1% AEP pipe. This will allow the removal of the existing low flow ephemeral channel through the site, and create a less encumbered, more useable open space for the future community.
- A 22m wide connector road forms the downstream boundary of the central catchment retarding basin. Given the existing (and future), topography through this area forms a small valley setting, the future 22m wide connector road will be positioned on a 3-4m high embankment to form the retarding basin outlet. This is a substantial structure and will be subject to ANCOLD assessment.
- A 2D flood modelling assessment has been undertaken, to assess performance of the proposed Ash Road East and Mollers Lane basins, as a system. Analysis has shown that the proposed system is appropriate, with suitable retardation of flows.
- Venant Solutions have updated the Lake Connewarre Impact Assessment, and conclude that there is low risk to the downstream environment, as a results of SELGA. This risk will be managed by suitable WSUD practices, defined in this SMP.
- A bypass pipe to Lake Connewarre may be required to protect waterways downstream of Mollers Lane from erosion, as a result of increased volumetric flows from SELGA. This will be designed and constructed as part of the Mollers Lane development, with assessment being conditioned as part of the Planning Permit.

7. REFERENCES

Tract, 2016, South East Leopold Framework Plan

Venant Solutions, 2017, Mollers Lane Development – Lake Connewarre Impact Assessment

TGM 2018a, Site Stormwater Management Plan and Flood Impact Assessment, Revision 02

TGM, 2018b, Mollers Lane, Leopold – Rezoning and Subdivision Memorandum – Site Stormwater Management Plan and Flood Impact Assessment – Consolidated Detention Basin for Southern Site, Version 04

TGM 2019, Ash Road Development Site Hydrology Modelling

Spiire, 2019, Memorandum - Proposal to remove existing reach of ephemeral waterway

Venant Solutions, 2019, Ash Rd Development – Flows to Lake Connewarre Impact Assessment – Stage 1

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

APPENDIX A – CATCHMENT PLANS

Rev	Amendments	Approved	Date
B	UPDATED NOTE	A.D	12-02-20
A	ISSUED AS APPENDIX TO SERVICING & SWMS STRATEGY	N.G	03-12-18

Scale
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SCALE @ A1
0 20 40 60 80 100

AS/NZS ISO 9001 certified · AS/NZS 4801 certified · AS/NZS ISO 14001 certified

spiire
10 MOORABOOL STREET GEELONG
VICTORIA 3220 AUSTRALIA T 61 3 5249 6888
spiire.com.au ABN 55 050 029 635

Designed: J.RAMSAY
Checked: J.HEDLEY
Authorised: N.GREEN
Date: 27-11-2018

ASH ROAD EAST STORMWATER MANAGEMENT PLAN
EXISTING CONDITIONS & CATCHMENT PLAN
ASH ROAD EAST PLAN
CITY OF GREATER GEELONG
AMPLE INVESTMENTS GROUP

PRELIMINARY
Drg No 305162CE101
Rev B

file name 305162CE100.dwg layout name CE101 plotted by Matthew DiSanto
file location G:\30\305162\Civil\ACAD plot date 12/02/2020 5:24 PM Sheet 2 of 4 Sheets

file name 305162CE100.dwg layout name CE103 plotted by Matthew DiSanto
file location G:\30\305162\Civil\ACAD plot date 12/02/2020 5:17 PM Sheet 4 of 4 Sheets

Rev	Amendments	Approved	Date
B	UPDATED ASSETS AND NOTATON AS SHOWN	A.D	12-02-20
A	ISSUED AS APPENDIX TO SERVICING & SWMS STRATEGY	N.G	03-12-18

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spiire.com.au ABN 55 050 029 635

Designed: J.RAMSAY
Checked: J.HEDLEY
Authorised: N.GREEN
Date: 09-11-18

ASH ROAD EAST STORMWATER MANAGEMENT PLAN

DEVELOPED CONDITIONS & CATCHMENT PLAN
ASH ROAD EAST PLAN

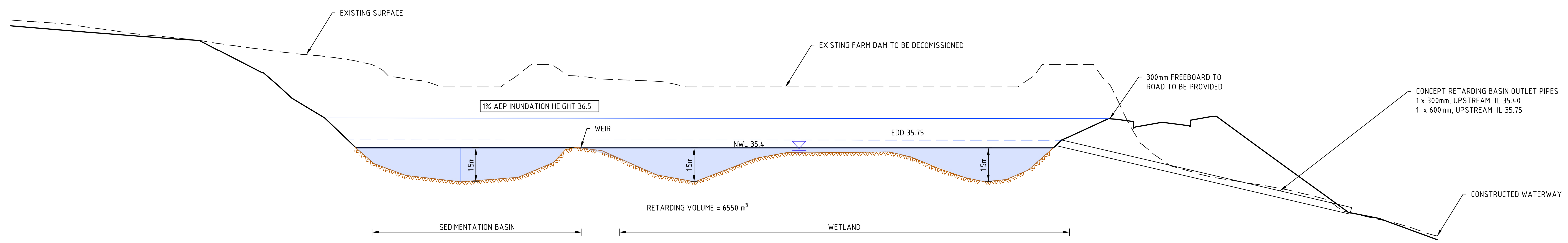
CITY OF GREATER GEELONG
AMPLE INVESTMENTS GROUP

PRELIMINARY

Drg No 305162CE103 Rev B

APPENDIX B – CONCEPT DRAINAGE RESERVE PLANS AND SECTION

CENTRAL DRAINAGE RESERVE DETAIL
NOT TO SCALE



SECTION A-B
NOT TO SCALE

Rev	Amendments	Approved	Date
A	PRELIMINARY ISSUE	J.H	12-02-20

Scale
NOT TO SCALE

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Designed: A.DAVIDSON
Checked: A.BROWN
Authorised: J.HEDLEY
Date: 12/02/2020

ASH ROAD EAST
AMPLE SITE
SERVICING REPORT
CENTRAL DRAINAGE RESERVE DETAIL
CITY OF GREATER GEELONG
AMPLE INVESTMENTS GROUP

PRELIMINARY
Drg No 305162CE104
Rev A

file name 305162CE100.dwg layout name CE104 plotted by Matthew DiSanto
file location G:\30\305162\Civil\ACAD plot date 19/02/2020 8:46 AM Sheet 5 of 5 Sheets

APPENDIX C – CCMA LETTER REGARDING 1% PIPE

CORANGAMITE CMA

CMA Reference No: CCMA-F-2018-00558
Document No: 4
File No.: STP/02-0002
Date: 17 January 2020

Mr Alan Davidson
Spiire Australia Pty Ltd - Geelong
Level 2, 10 Moorabool Street
Geelong Vic 3220

Alan.Davidson@spiire.com.au

Dear Alan

Property	**Street:**	**87-101 Ash Road Leopold Vic 3224**
	Cadastral:	**Lot 1 TP848680, Parish of Moolap**
Regarding:		**Proposed piping of ephemeral low flow channel, Ash Road East, Leopold**

Thank you for your correspondence and updated report dated 20 December 2019, received at the Corangamite Catchment Management Authority on 20 December 2019 in relation to the proposed piping of the approximately 80 metre ephemeral low flow channel on the abovementioned land. The report was prepared in response to the CMA's last correspondence on the matter (CCMA ref: CCMA-F-2019-01010 or CCMA-F-2018-00558-3). The CMA has reviewed the discussion paper received on the 20th December (Spiire ref: 305162).

Corangamite CMA is, in general, not supportive of piping waterways in our waterway management district. The planning provisions also promote the maintenance and enhancement of waterways, as detailed in our last correspondence. This instance has required consideration of a combination of factors, most notably:

- City of Greater Geelong's preference for unencumbered open space
- The small (~6.5 ha), entirely urbanised and untreated waterway catchment
- The fact that the waterway is currently piped with around 80 meters of "daylight" waterway between the pipe outlet and dam (future wetland if developed)
- The willingness of the developers to exceed the Best Practice Environmental Management Guidelines (BPEMG) for stormwater, providing an enhanced outcome for downstream receptors (i.e. Lake Connewarre, part of the RAMSAR listed Port Philip Bay (Western Shoreline) and Bellarine Peninsula site)

MUSIC Modelling

It appears the MUSIC model was set up to include the waterway as an 80m long swale, then added a sedimentation pond and wetland (800m^2 and 2600m^2 respectively) to meet the BPEMG for stormwater. Nitrogen was the limiting factor in this set up. Removing the swale and increasing the wetland size to 2800m^2 wetland still met the BPEMG with nitrogen as the limiting factor, however resulted in a decrease in removal of Total Suspended Solids (TSS) and Total Phosphorus (TP) when compared to the "swale included" scenario. As

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e: info@ccma.vic.gov.au w: www.ccma.vic.gov.au

the BPEMG are required to be met regardless of whether the waterway is piped (i.e. through the planning provisions), this represented an overall decrease in stormwater treatment as a consequence of piping the waterway and required addressing.

The report submitted on 20 December 2019 has revised the sedimentation pond and wetland sizing to 1000m^2 and 2800m^2 respectively, representing an increase in pollutant reduction for TSS, TP, Total Nitrogen (TN) and Gross Pollutants (GP). Furthermore, the report has detailed that further increasing the size of these assets has diminishing returns on pollutant reduction.

Hydraulic effect of upstream catchment

At the CMA's request, the updated report identifies the hydraulic effect of the upstream catchment on the wetland detention time and water level exceedance. The MUSIC Auditor results presented suggest the upstream catchment will not negatively impact the hydraulic function of the wetland.

Peak flow retardation

The report has not addressed peak flow rate retardation. The CMA appreciates that this will occur during detailed design however it should be noted this will be a significant consideration in any planning permit application for the development. *Preliminary* designs indicate flow retardation will likely be possible but will need to be satisfactory demonstrated before approval is provided from the CMA.

Waterway replacement summary

Modelling presented to the CMA indicates that the current preliminary design results in an increase in water quality treatment beyond the BPEMG. More importantly, treatment asset sizes have been manipulated to ensure that the "piped waterway" scenario both meets the BPEMG *and* represents an increase in treatment over the "retain waterway" scenario. The modelling also demonstrated that further increases to asset sizes produce diminishing returns.

With this in mind, the **Corangamite CMA can give its in-principle support for the planned piping of the short ephemeral waterway** in the context of a stormwater management strategy resembling that presented in the discussion paper, provided that the BPEMG are exceeded and piping of the waterway does not represent a decrease in stormwater treatment.

Volume increases

The draft Venant Solutions report *Ash Rd Development Flows to Lake Connewarre Impact Assessment Draft Report* quantifies the increase in flow volumes to Lake Connewarre. Based on information provided to the CMA, there does not appear to have been any attempt to reduce freshwater volumes flowing into the lake. The potential impact of increased volumes and the need to preserve the natural hydrological regime has been raised by the CMA in multiple past correspondences to the developers (or their representatives) of Ash Road East and in preliminary advice to Council in preparation for the potential planning scheme amendment.

The CMA strongly recommends volume reduction options (i.e. mitigation) are explored further as the development progresses through the planning stages.

The Corangamite CMA has provided this advice as preliminary information only and has been based on the information you have provided. This advice is not to be taken as final support or approval of any development on the subject land.

The Authority can provide further information regarding any proposed development of the property in response to a planning permit application referred by the City of Greater Geelong in accordance with the Planning and Environment Act 1987.

This document contains flood level **advice only** and does not constitute approval or otherwise of any development at this location. The Authority recommends you seek further advice from the City of Greater Geelong.

Should you have any queries, please do not hesitate to contact our office on (03) 5232 9100 or floodinfo@ccma.vic.gov.au. To assist the CMA in handling any enquiries please quote **CCMA-F-2018-00558** in your correspondence with us.

Yours sincerely,

Dr Geoff Taylor
Floodplain Statutory Manager

The information contained in this correspondence is subject to the disclaimers and definitions attached.

Definitions and Disclaimers

1. The area referred to in this letter as the 'proposed development location' is the land parcel(s) that, according to the Authority's assessment, most closely represent(s) the location identified by the applicant. The identification of the 'proposed development location' on the Authority's GIS has been done in good faith and in accordance with the information given to the Authority by the applicant(s) and/or Council.

2. While every endeavour has been made by the Authority to identify the proposed development location on its GIS using VicMap Parcel and Address data, the Authority accepts no responsibility for or makes no warranty with regard to the accuracy or naming of this proposed development location according to its official land title description.

3. **AEP** as Annual Exceedance Probability – is the likelihood of occurrence of a flood of given size or larger occurring in any one year. AEP is expressed as a percentage (%) risk and may be expressed as the reciprocal of ARI (Average Recurrence Interval).

   Please note that the 1% probability flood is not the probable maximum flood (PMF). There is always a possibility that a flood larger in height and extent than the 1% probability flood may occur in the future.

4. **AHD** as Australian Height Datum - is the adopted national height datum that generally relates to height above mean sea level. Elevation is in metres.

5. **ARI** as Average Recurrence Interval - is the likelihood of occurrence, expressed in terms of the long-term average number of years, between flood events as large as or larger than the design flood event. For example, floods with a discharge as large as or larger than the 100 year ARI flood will occur on average once every 100 years.

6. **LiDAR** (**Li**ght **D**etection **A**nd **R**anging) is an optical remote sensing technology which measures the height of the ground surface using pulses from a laser. LIDAR can be used to create a topographical map of the land and highly detailed and accurate models of the land surface.

7. No warranty is made as to the accuracy or liability of any studies, estimates, calculations, opinions, conclusions, recommendations (which may change without notice) or other information contained in this letter and, to the maximum extent permitted by law, the Authority disclaims all liability and responsibility for any direct or indirect loss or damage which may be suffered by any recipient or other person through relying on anything contained in or omitted from this letter.

8. This letter has been prepared for the sole use by the party to whom it is addressed and no responsibility is accepted by the Authority with regard to any third party use of the whole or of any part of its contents. Neither the whole nor any part of this letter or any reference thereto may be included in any document, circular or statement without the Authority's written approval of the form and context in which it would appear.

9. The flood information provided represents the best estimates based on currently available information. This information is subject to change as new information becomes available and as further studies are carried out.

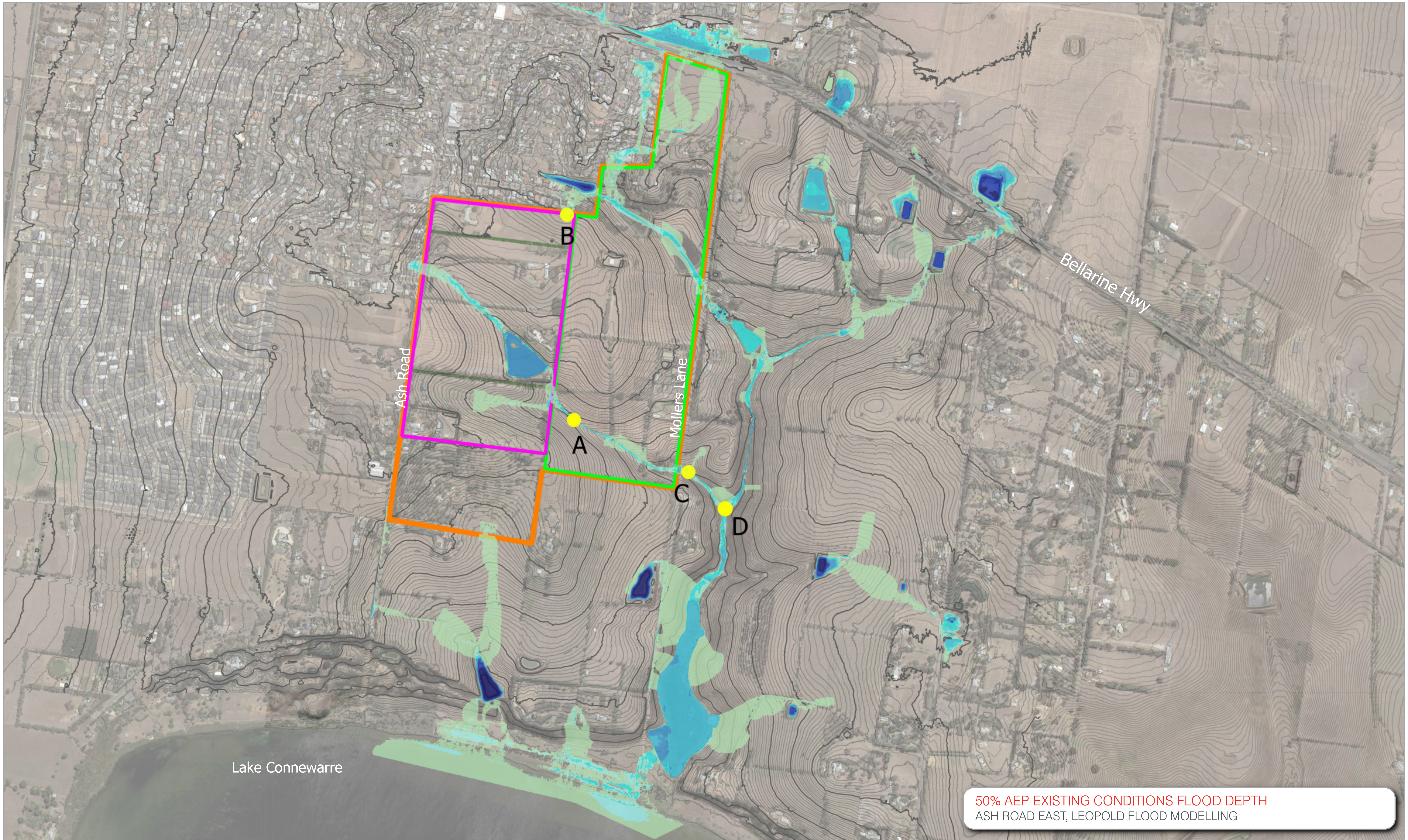
References

1. Guidelines for Development in Flood-prone areas. Melbourne Water 2007.
   http://www.melbournewater.com.au/content/planning_and_building/information_for_developers/guidelines_for_developers.asp?bhcp=1

2. Australian Rainfall and Runoff Revision Project 10 – Appropriate Safety Criteria for People April 2010.
   http://www.arr.org.au/wp-content/uploads/2013/Projects/ARR_Project_10_Stage1_report_Final.pdf

3. Australian Rainfall and Runoff Revision Project 10 – Appropriate Safety Criteria for Vehicles February 2011.
   http://www.arr.org.au/wp-content/uploads/2013/Projects/ARR_Project_10_Stage2_Report_Final.pdf

APPENDIX D – EXISTING CONDITIONS FLOOD MAPPING



50% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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414 La Trobe Street
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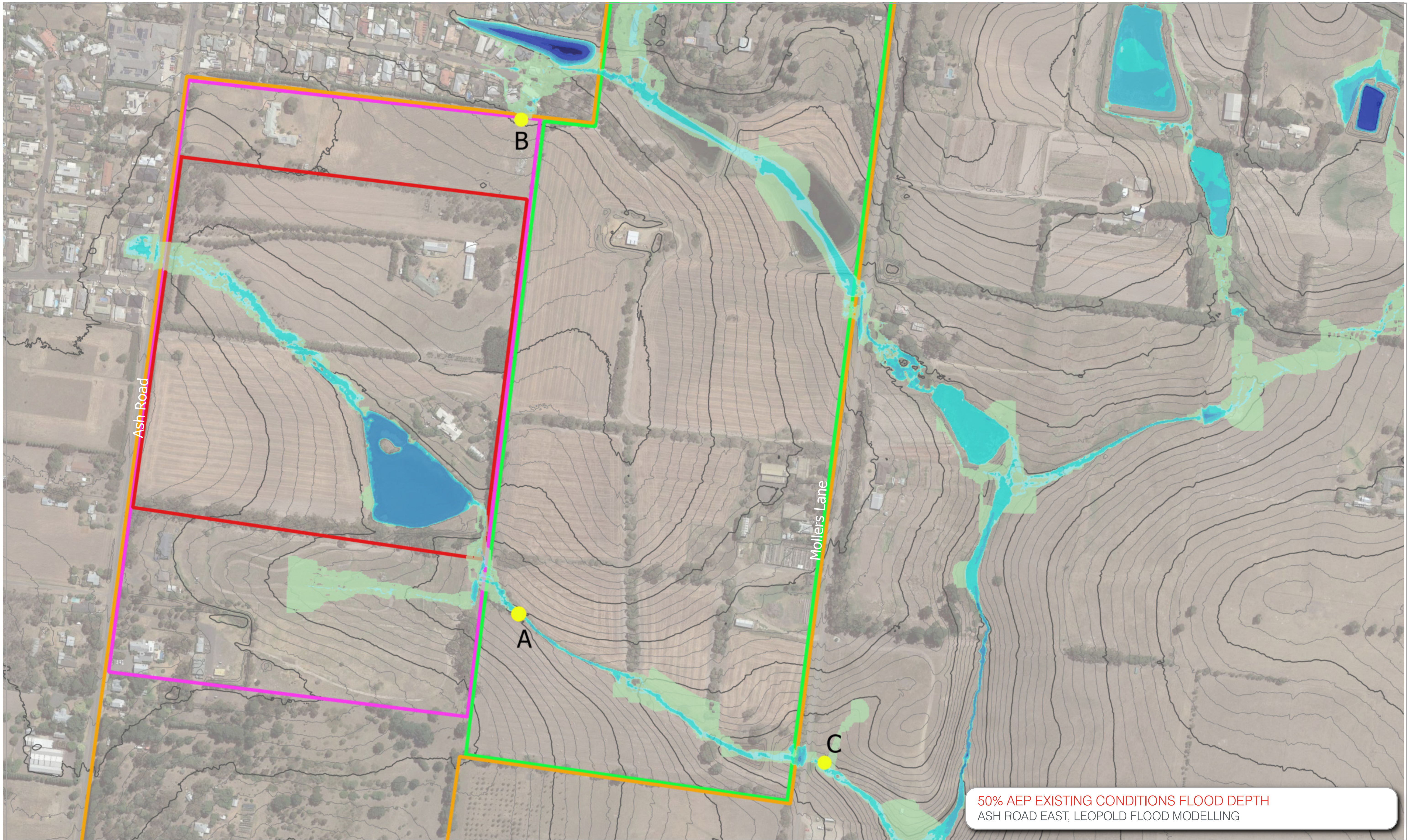
ABN 55 050 029 635



50% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

SUBJECT SITE
SELGA
MOLLERS LANE DEVELOPMENT
ASH ROAD EAST
FLOW REPORTING LOCATIONS
Major contours
Minor contours

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
>2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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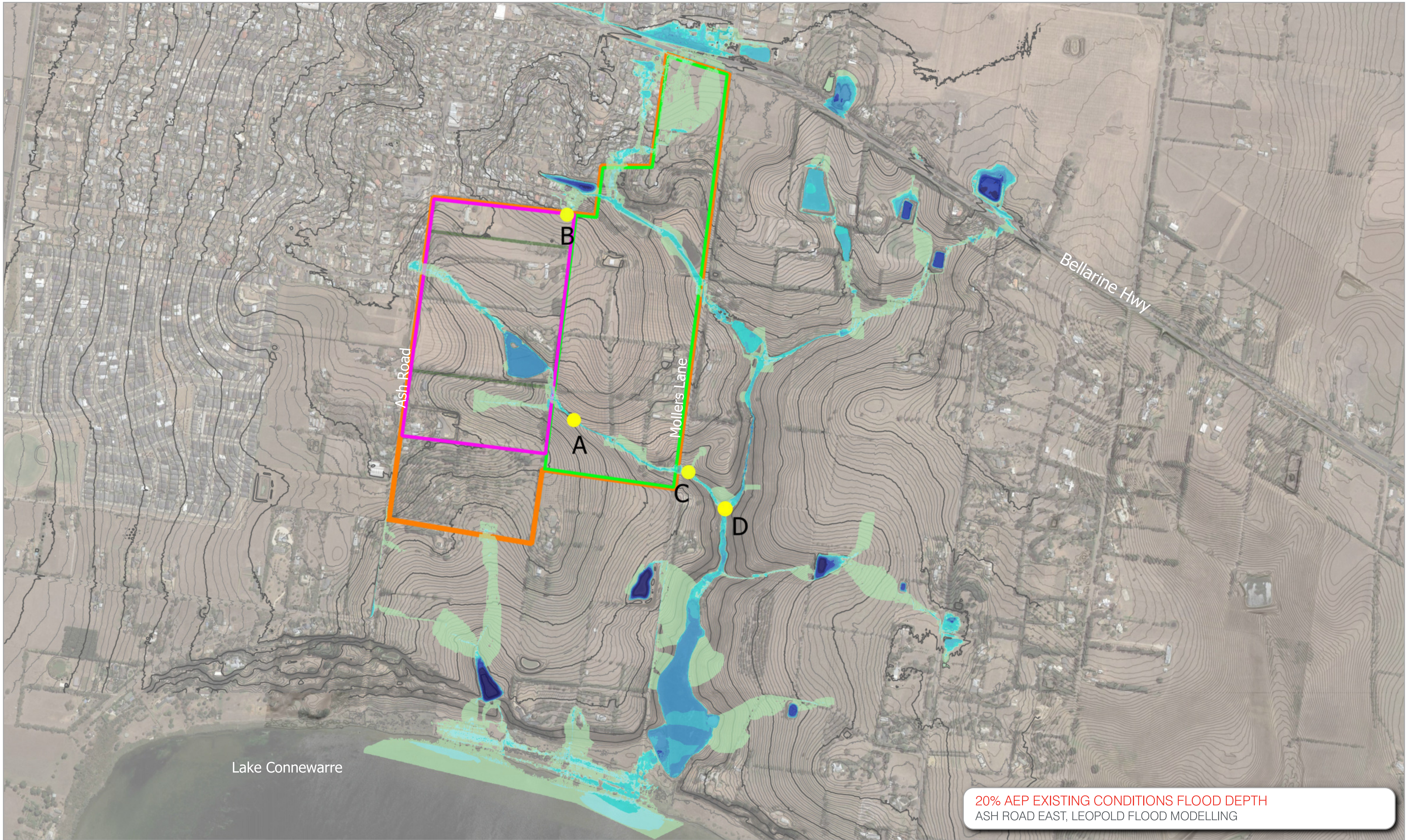

20% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS

Flood Depth (m)
- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000
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Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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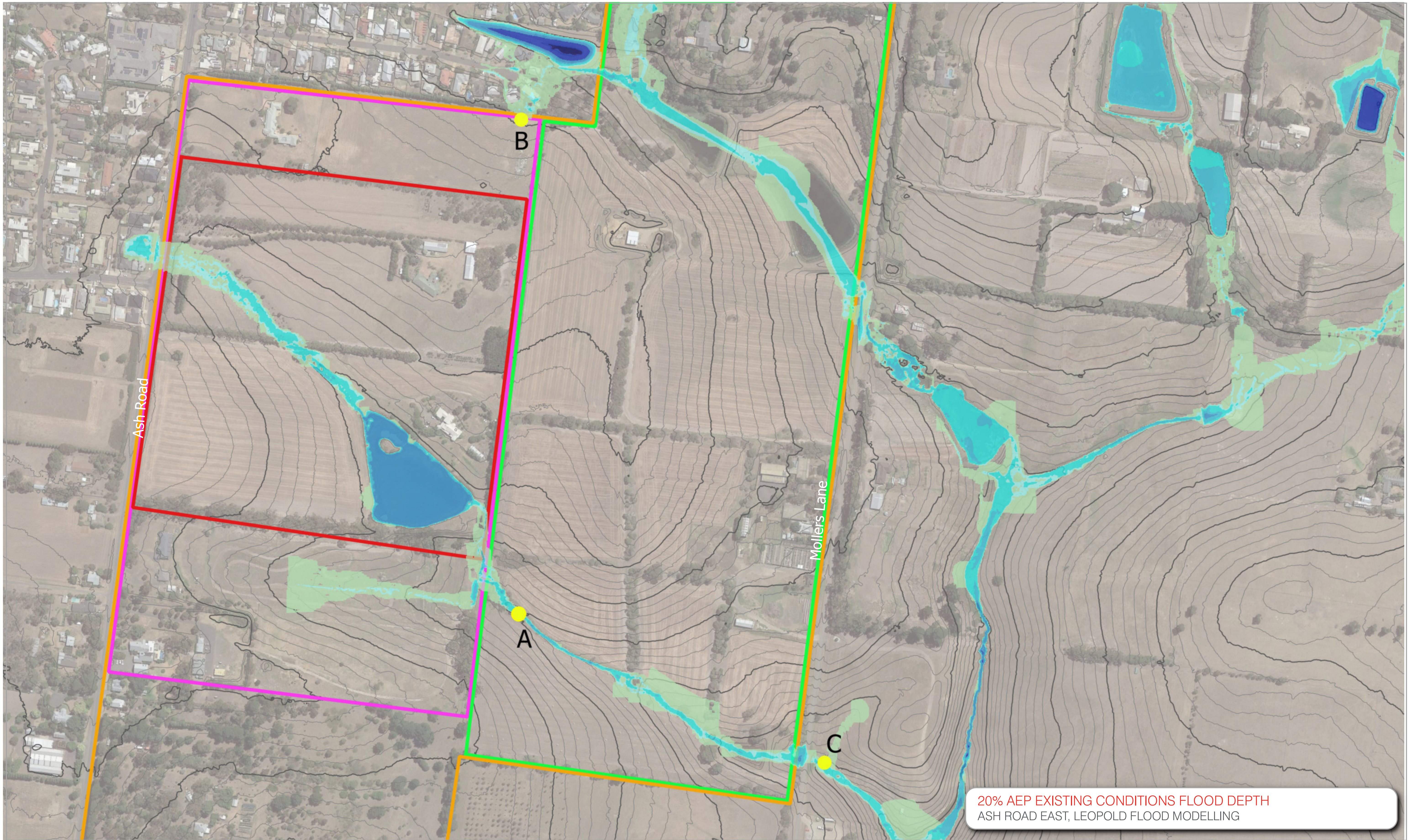

20% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- Major contours
- Minor contours

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

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Coordinate System: GDA 1994 MGA Zone 55
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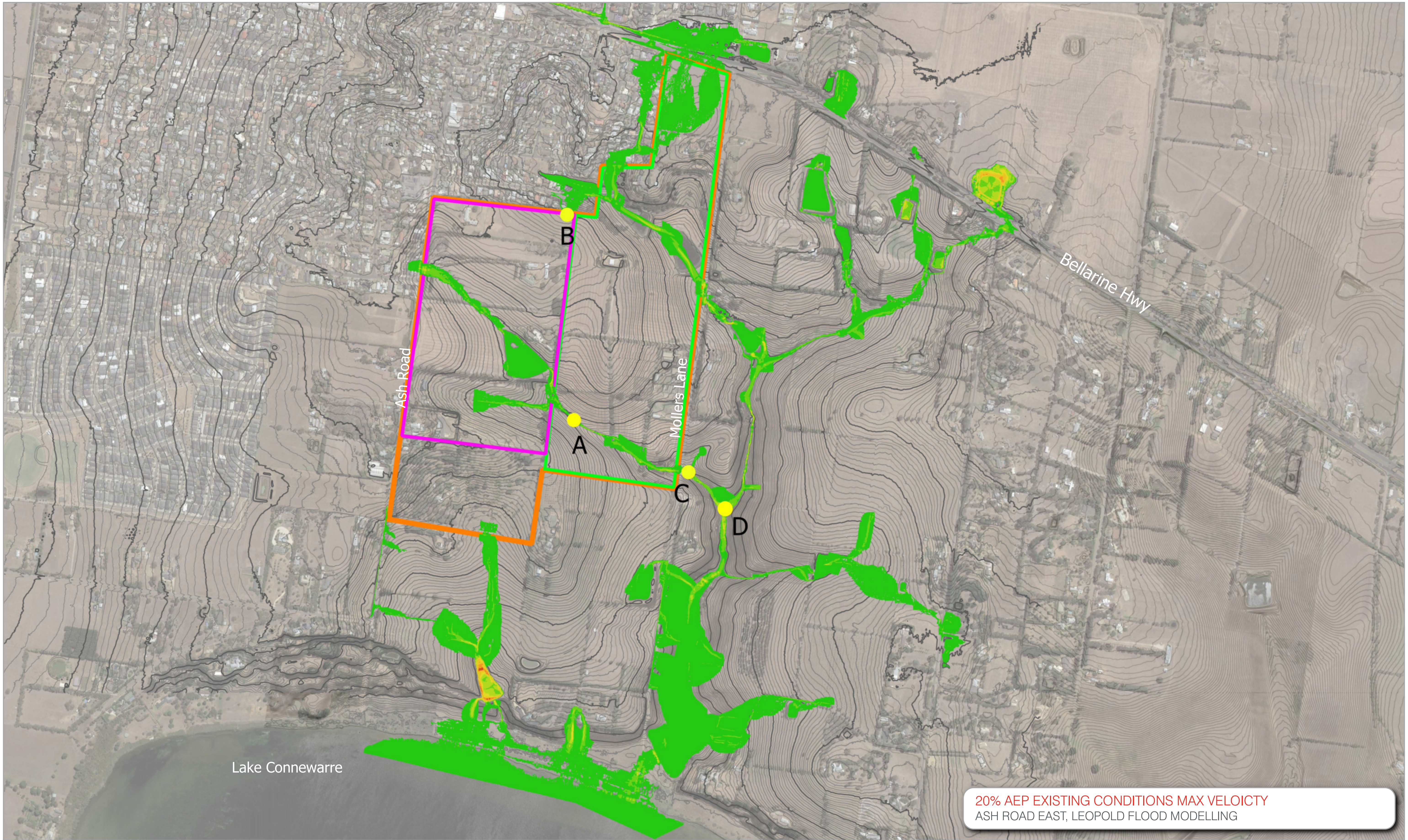

20% AEP EXISTING CONDITIONS MAX VELOICTY
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-EXISTING-VEL
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS

MAX VELOCITY (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

100 0 100 200 300 m

1:10000

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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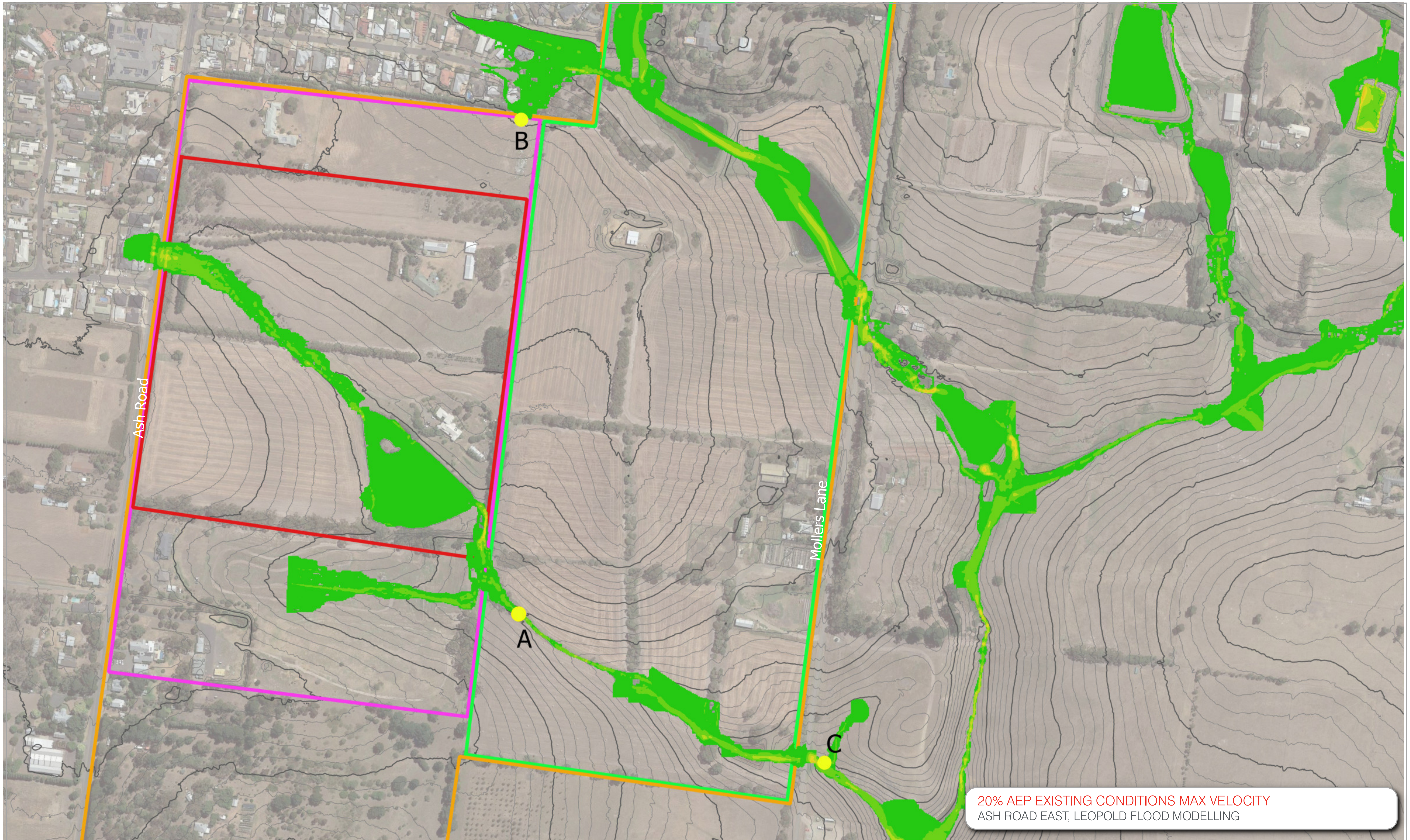
ABN 55 050 029 635



NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-EXISTING-VEL-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02-
Data: Google Maps

LEGEND

SUBJECT SITE	red line
SELGA	orange line
MOLLERS LANE DEVELOPMENT	green line
ASH ROAD EAST	magenta line
FLOW REPORTING LOCATIONS	yellow dot
Major contours	dark line
Minor contours	light line

Max Velocity (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

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1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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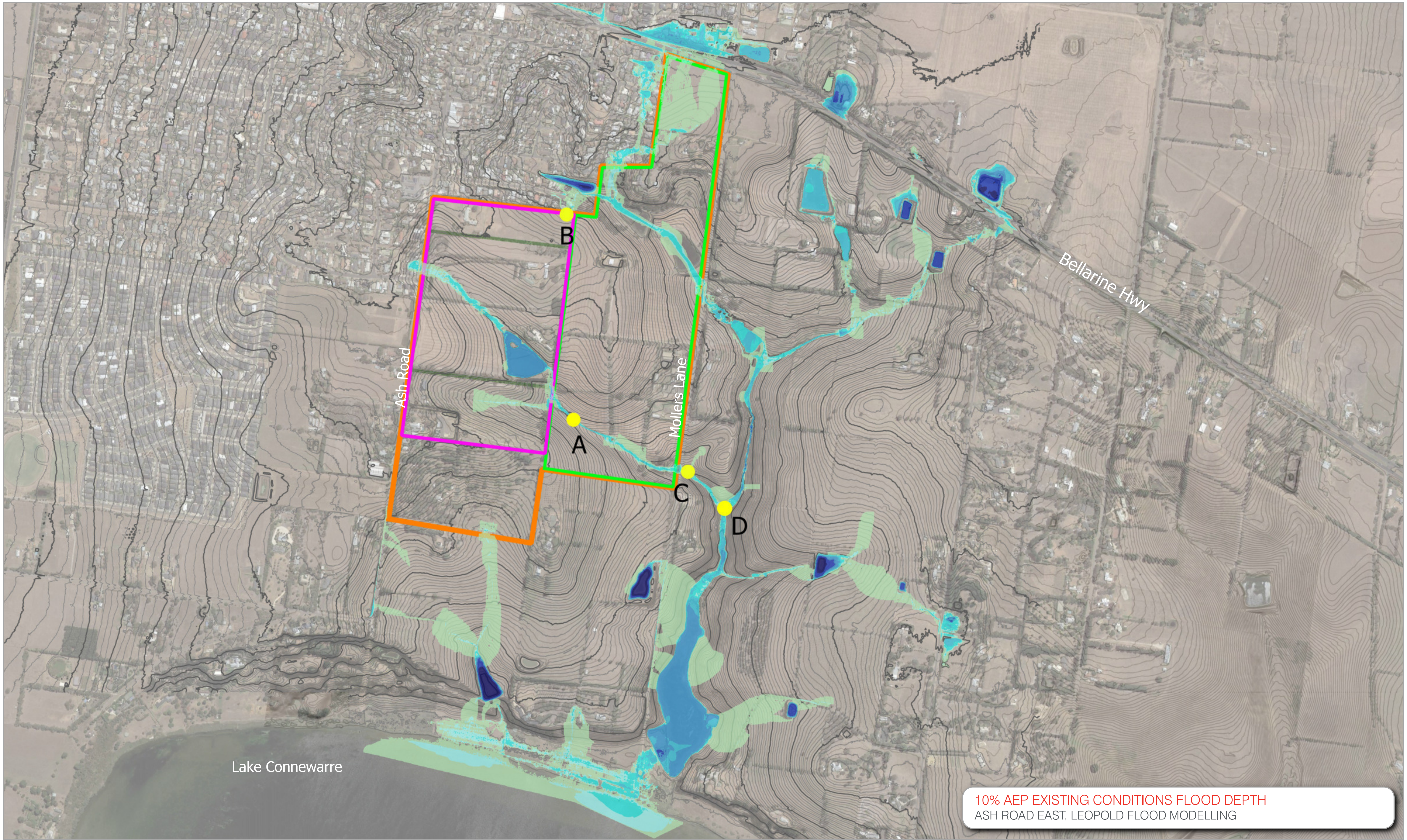
spiire.com.au
ABN 55 050 029 635



10% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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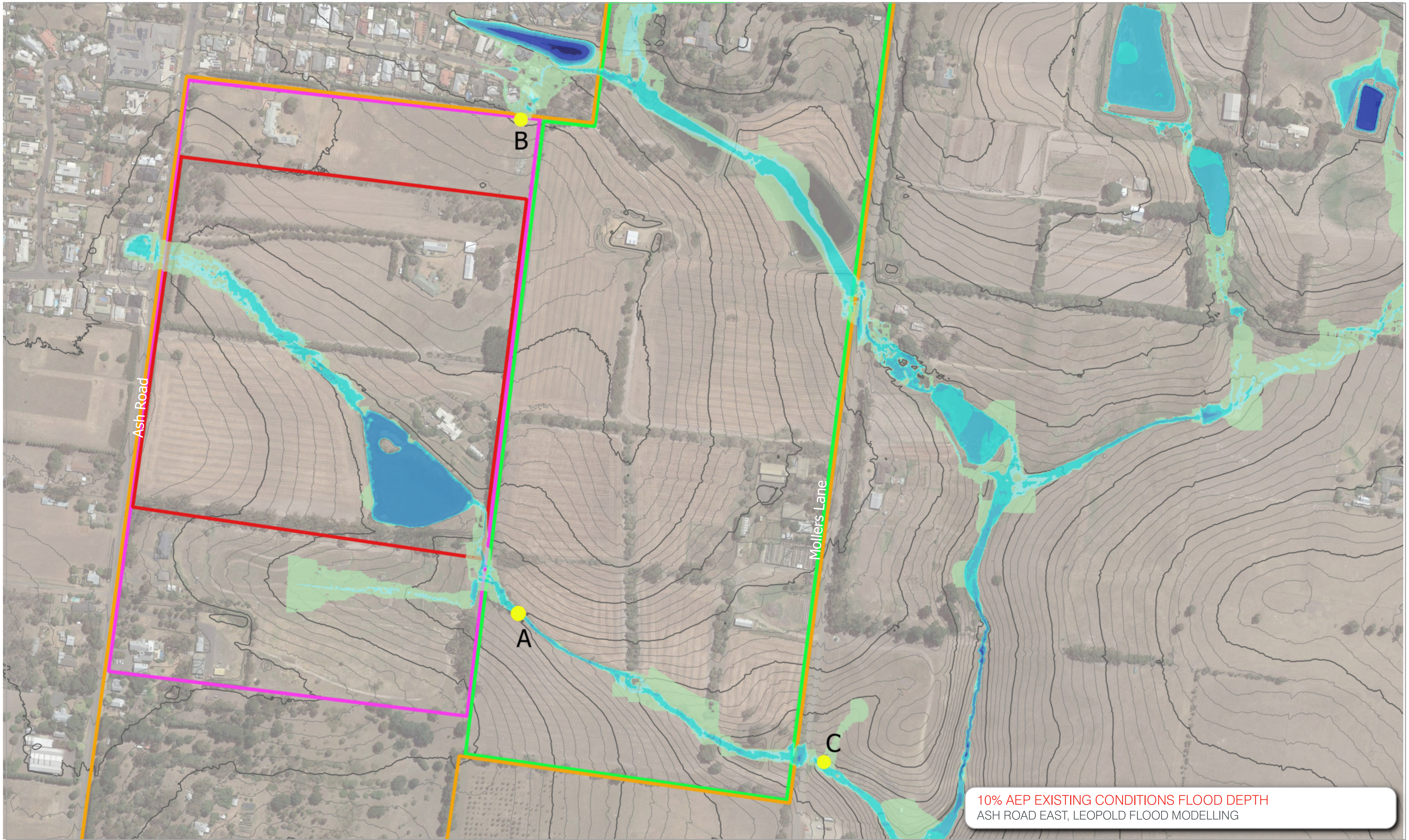

10% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- Major contours
- Minor contours

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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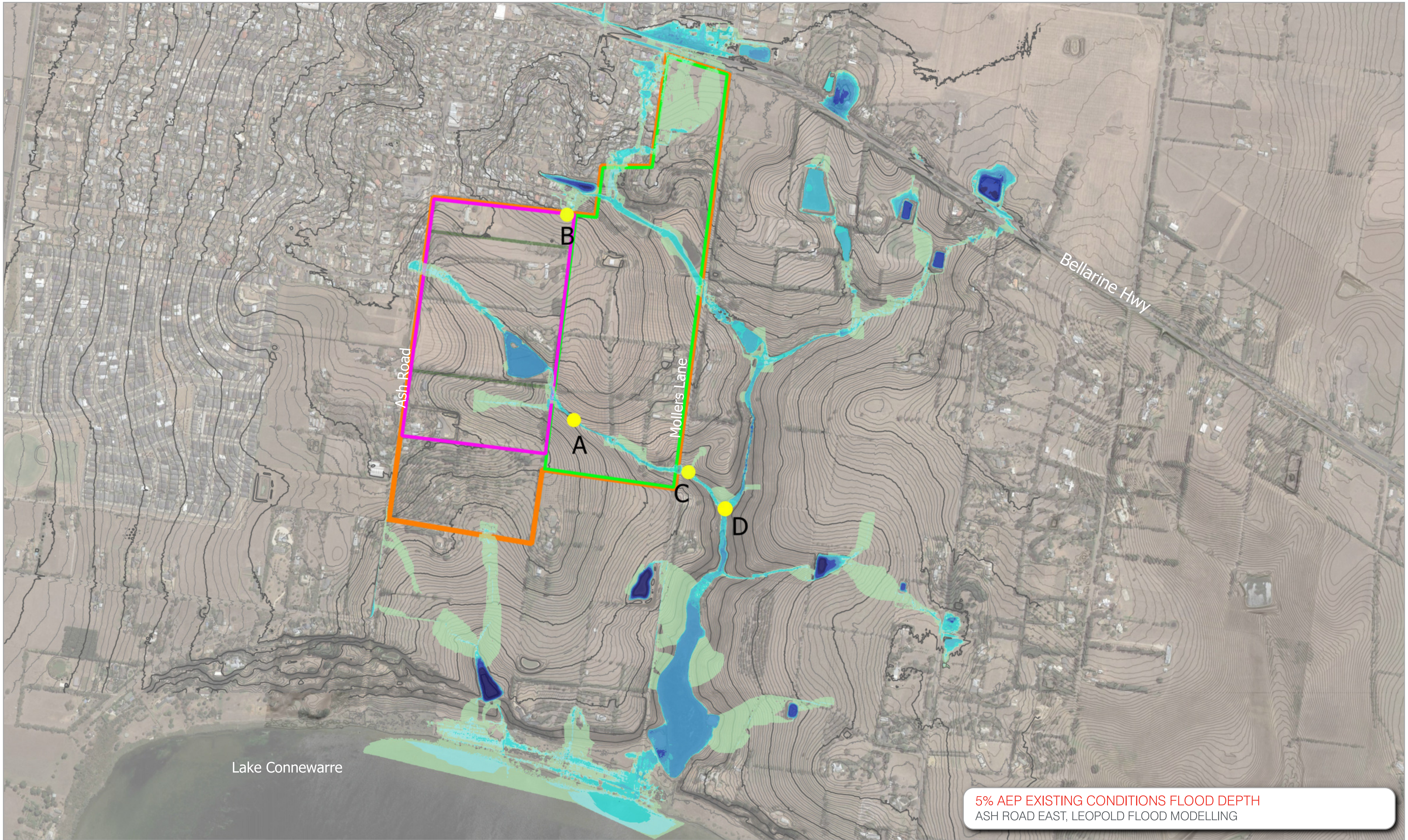

5% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS

Flood Depth (m)
- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000
100 0 100 200 300 m
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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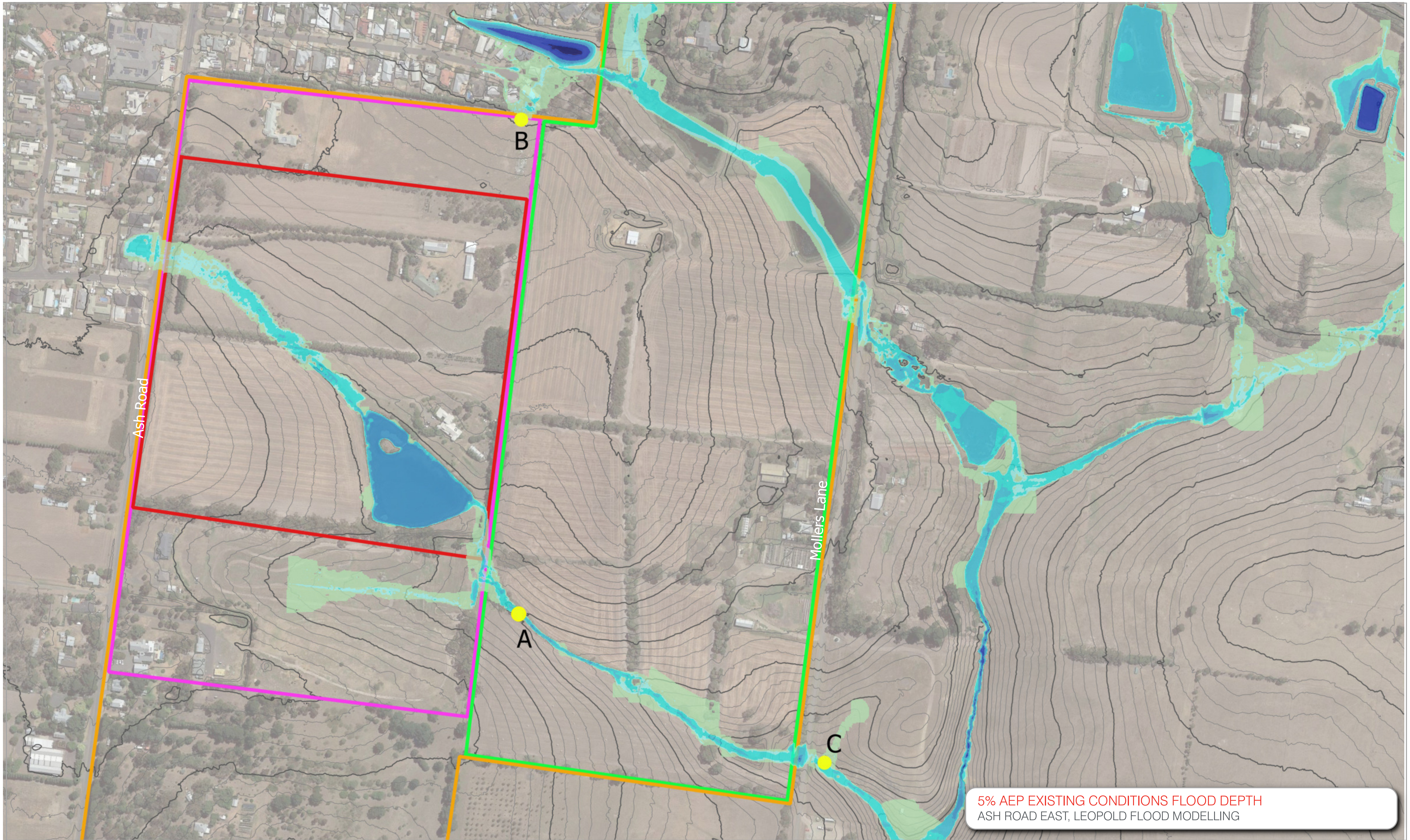

5% AEP EXISTING CONDITIONS FLOOD DEPTH

ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

SUBJECT SITE
SELGA
MOLLERS LANE DEVELOPMENT
ASH ROAD EAST
FLOW REPORTING LOCATIONS
Major contours
Minor contours

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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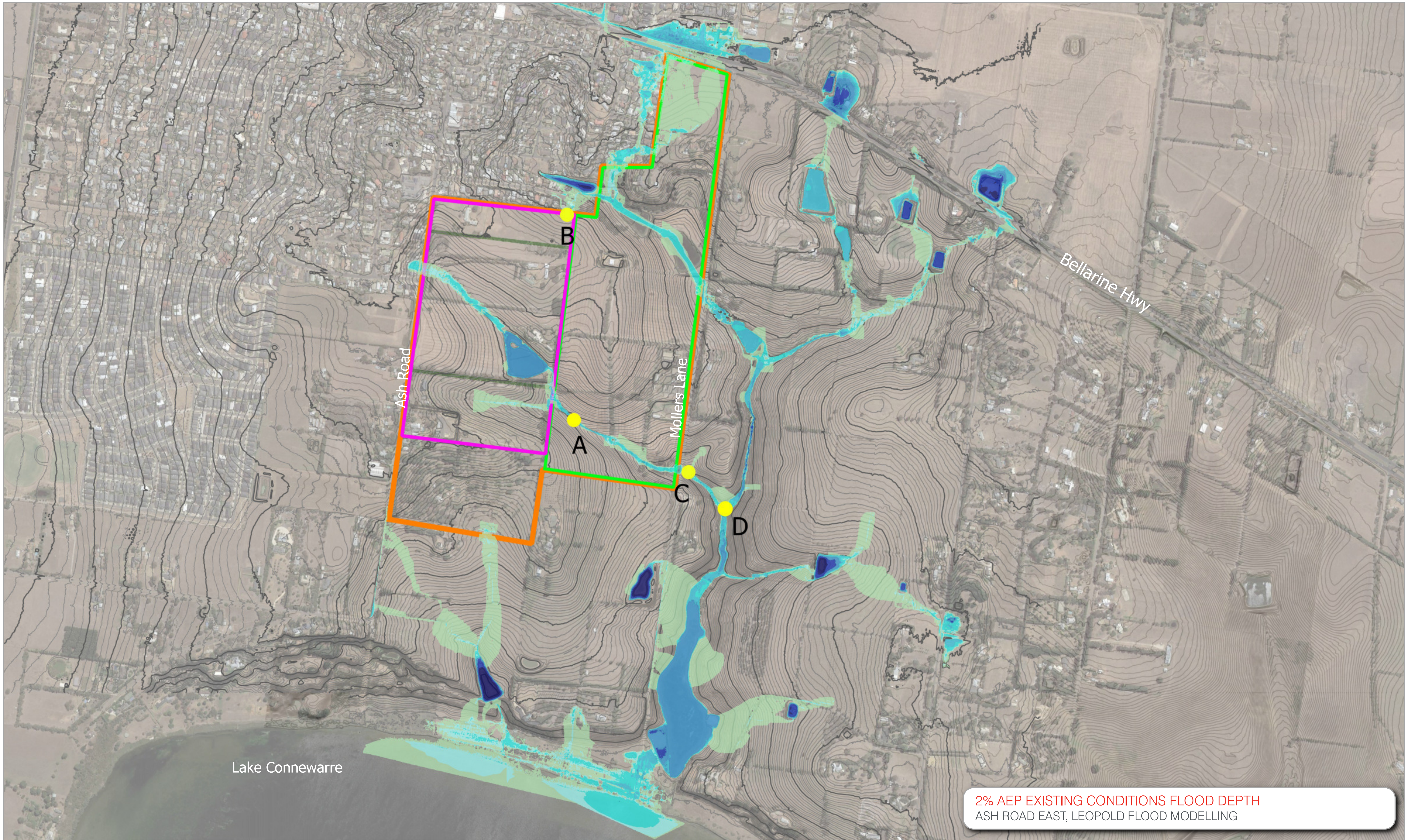

2% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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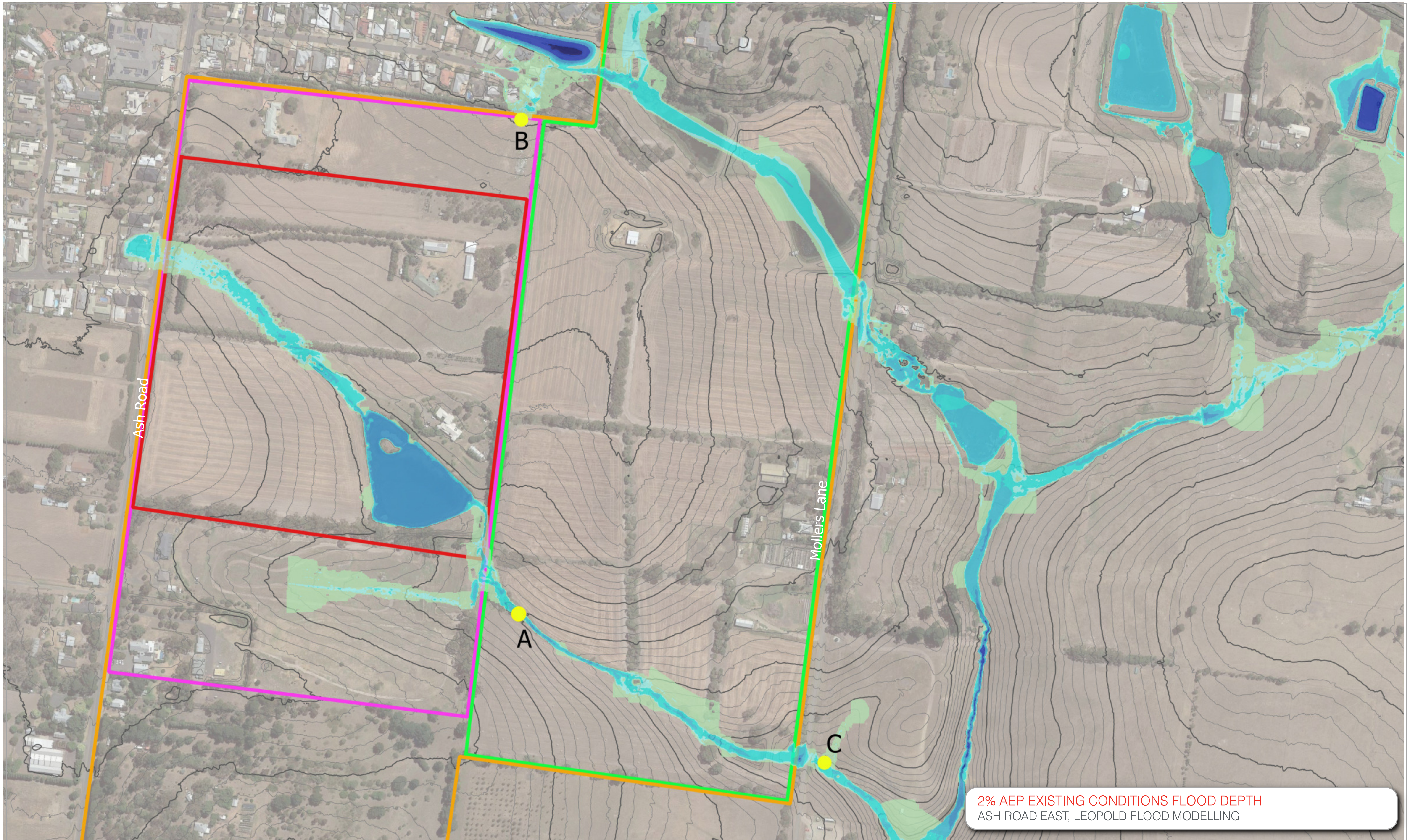

2% AEP EXISTING CONDITIONS FLOOD DEPTH

ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- Major contours
- Minor contours

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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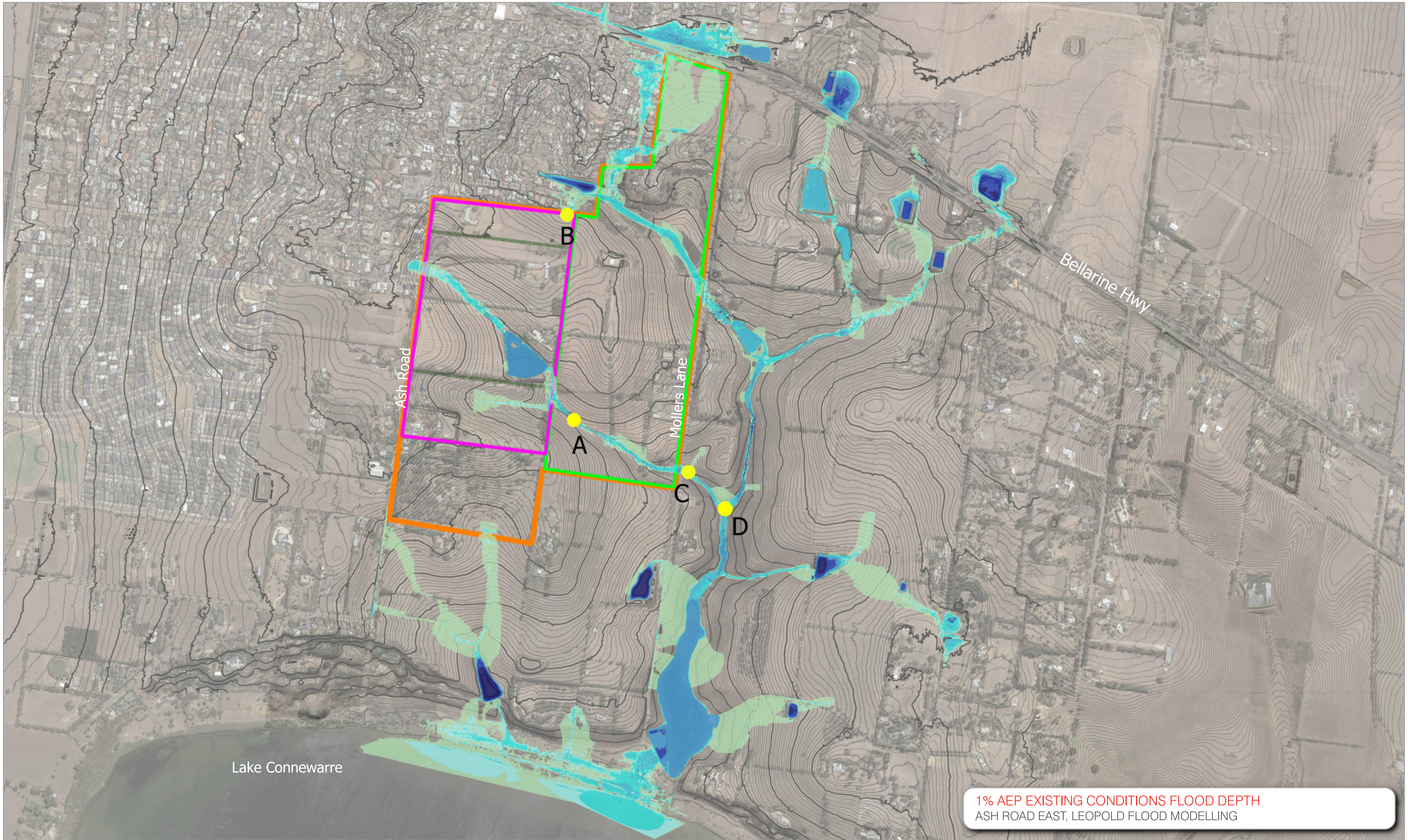

1% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
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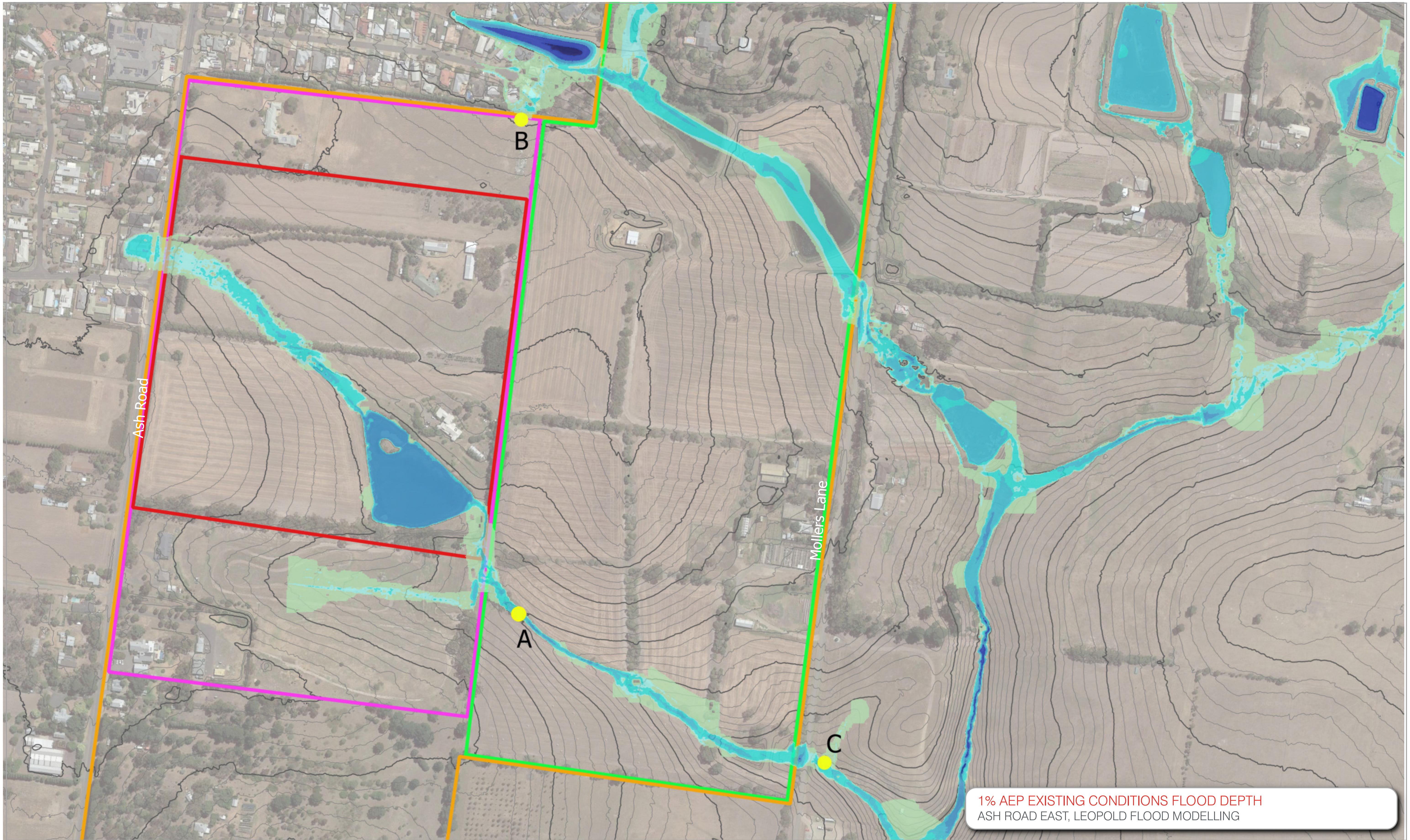

1% AEP EXISTING CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-WD
Rev: 1
Date: 07.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- Major contours
- Minor contours

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

100 0 100 200 300 m

1:10000

Coordinate System: GDA 1994 MGA Zone 55
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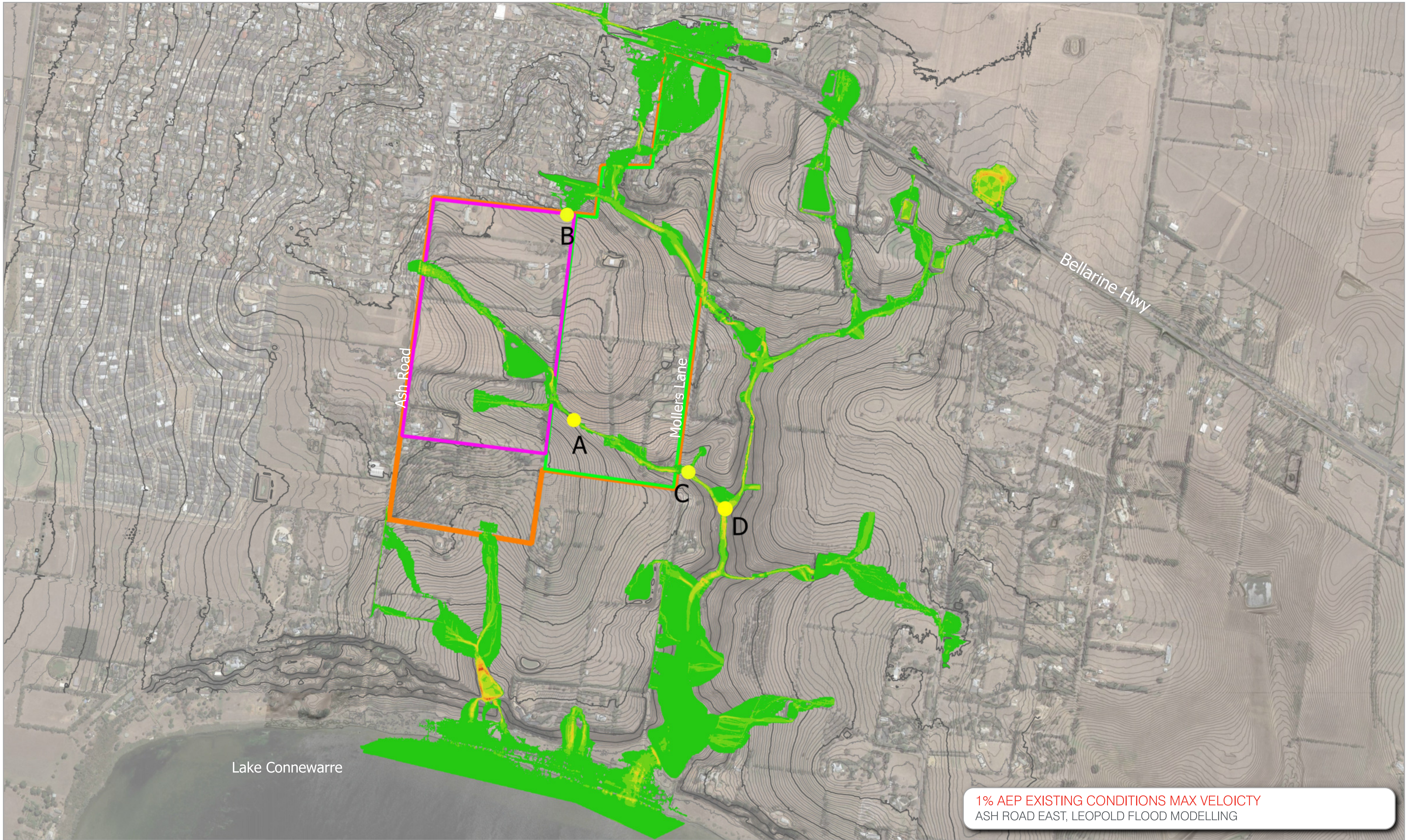

1% AEP EXISTING CONDITIONS MAX VELOICTY
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-EXISTING-VEL
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
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Flood Results: EX04-R02
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS

MAX VELOCITY (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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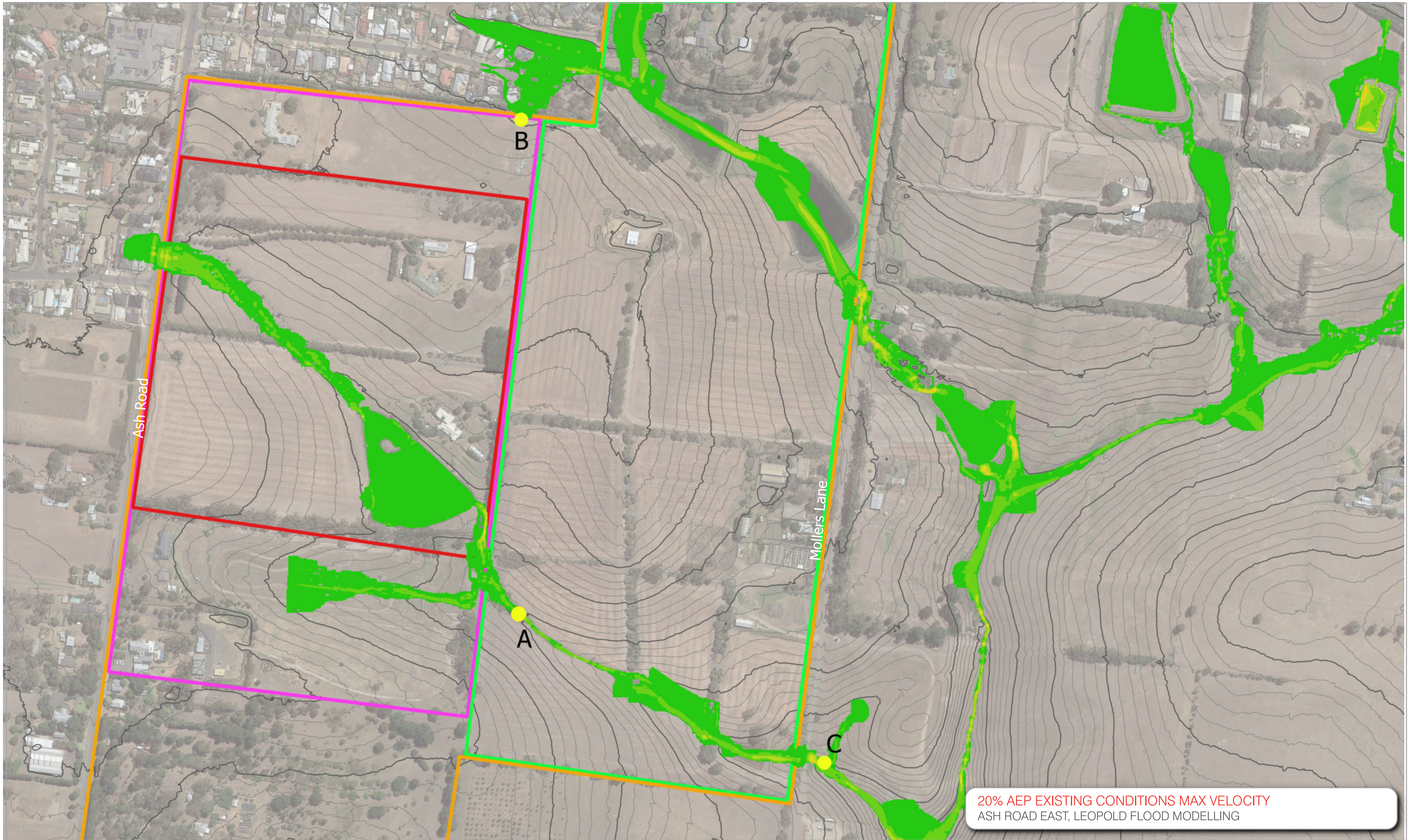
ABN 55 050 029 635



NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-EXISTING-VEL-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: EX04-R02-
Data: Google Maps

LEGEND

SUBJECT SITE	red line
SELGA	orange line
MOLLERS LANE DEVELOPMENT	green line
ASH ROAD EAST	magenta line
FLOW REPORTING LOCATIONS	yellow dot
Major contours	dark line
Minor contours	light line

Max Velocity (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

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1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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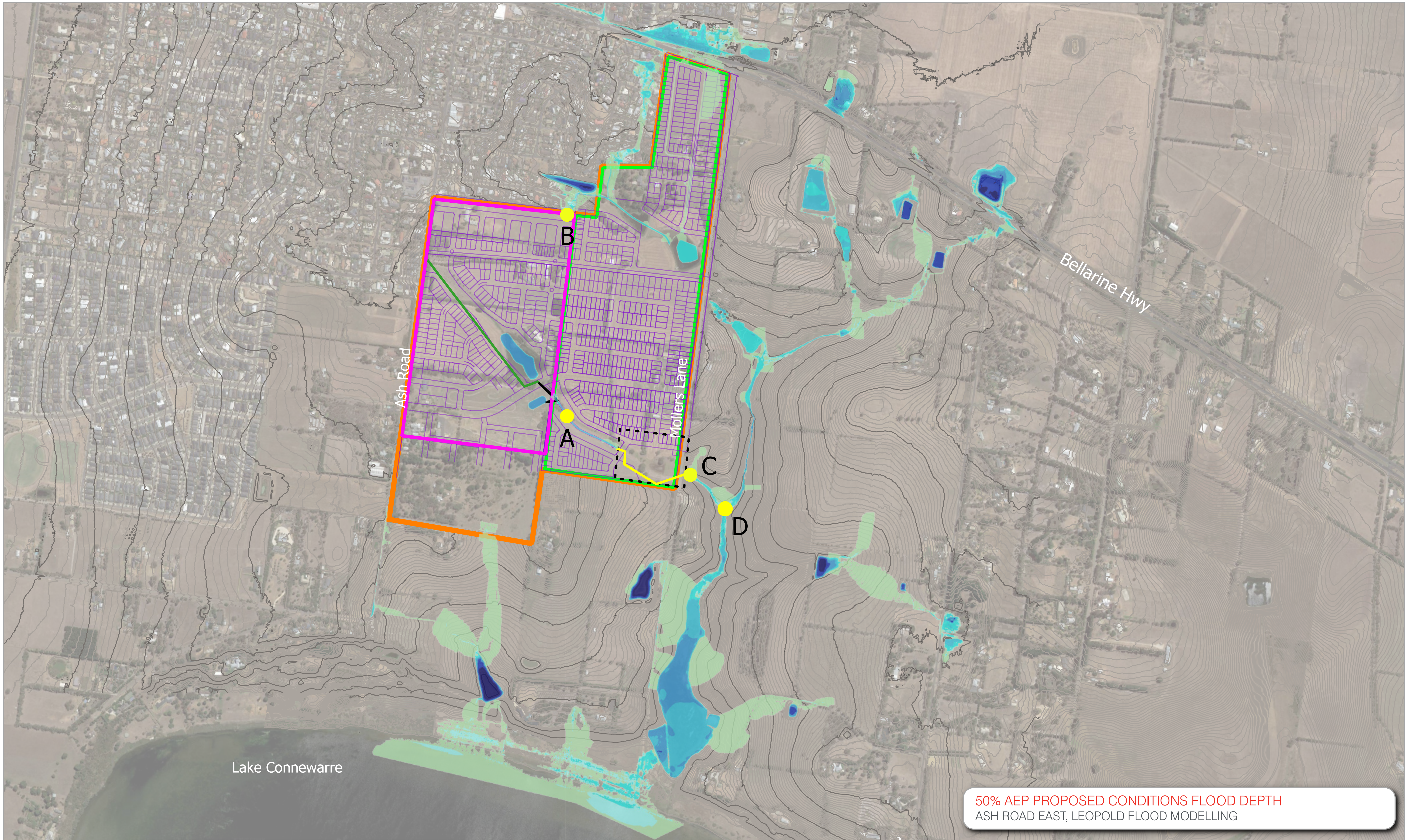
APPENDIX E – POST DEVELOPMENT FLOOD MAPPING



50% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q2-PROPOSED-WD
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
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Authorised:

Flood Results: Q2-PR02-R01
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
>2.0

1:10000
100 0 100 200 300 m
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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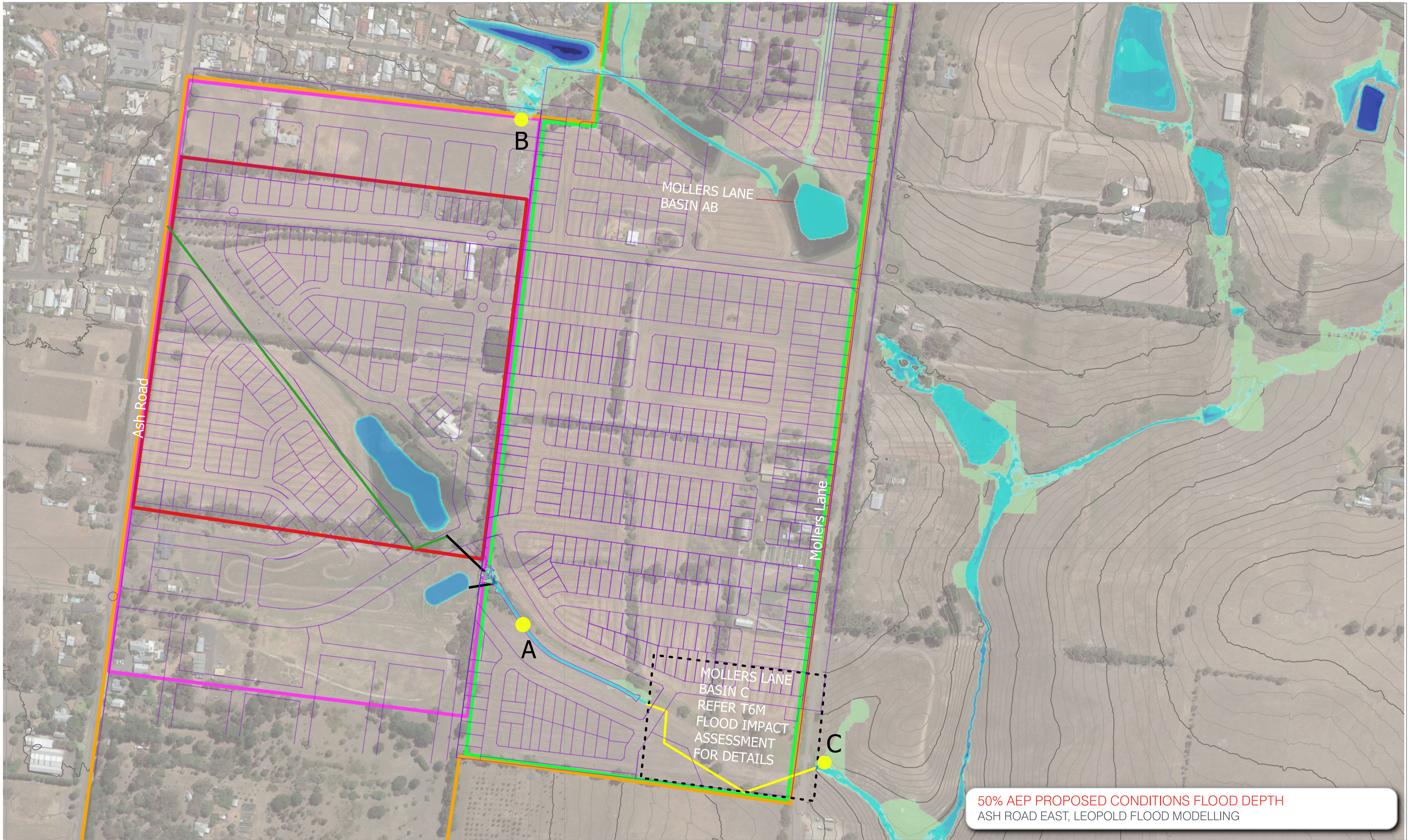
spiire.com.au
ABN 55 050 029 635



50% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q2-PROPOSED-WD-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q2-PR02-R01
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- MINOR CONTOURS
- MAJOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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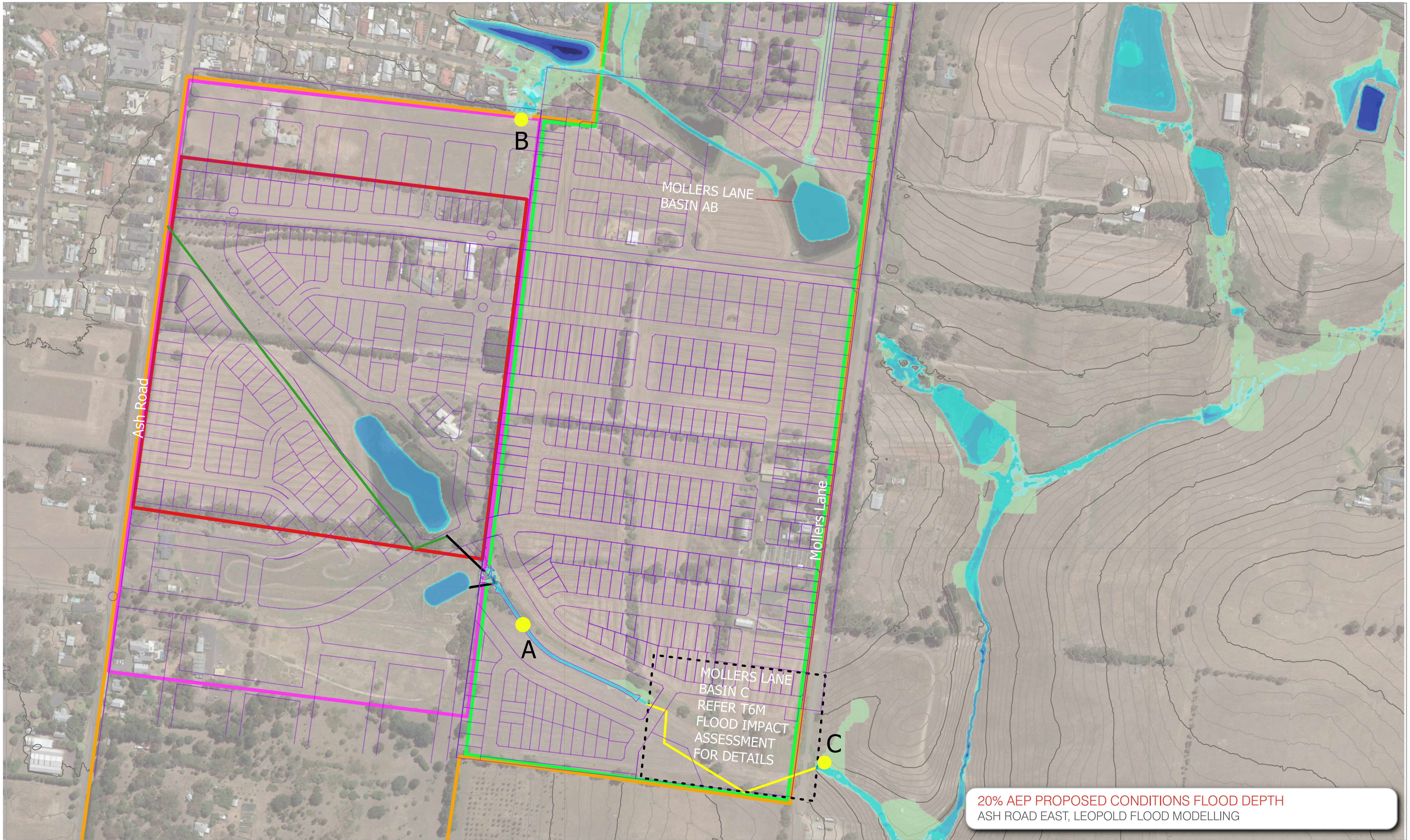

20% AEP PROPOSED CONDITIONS FLOOD DEPTH

ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-PROPOSED-WD-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q5-PR02-R01
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- MINOR CONTOURS
- MAJOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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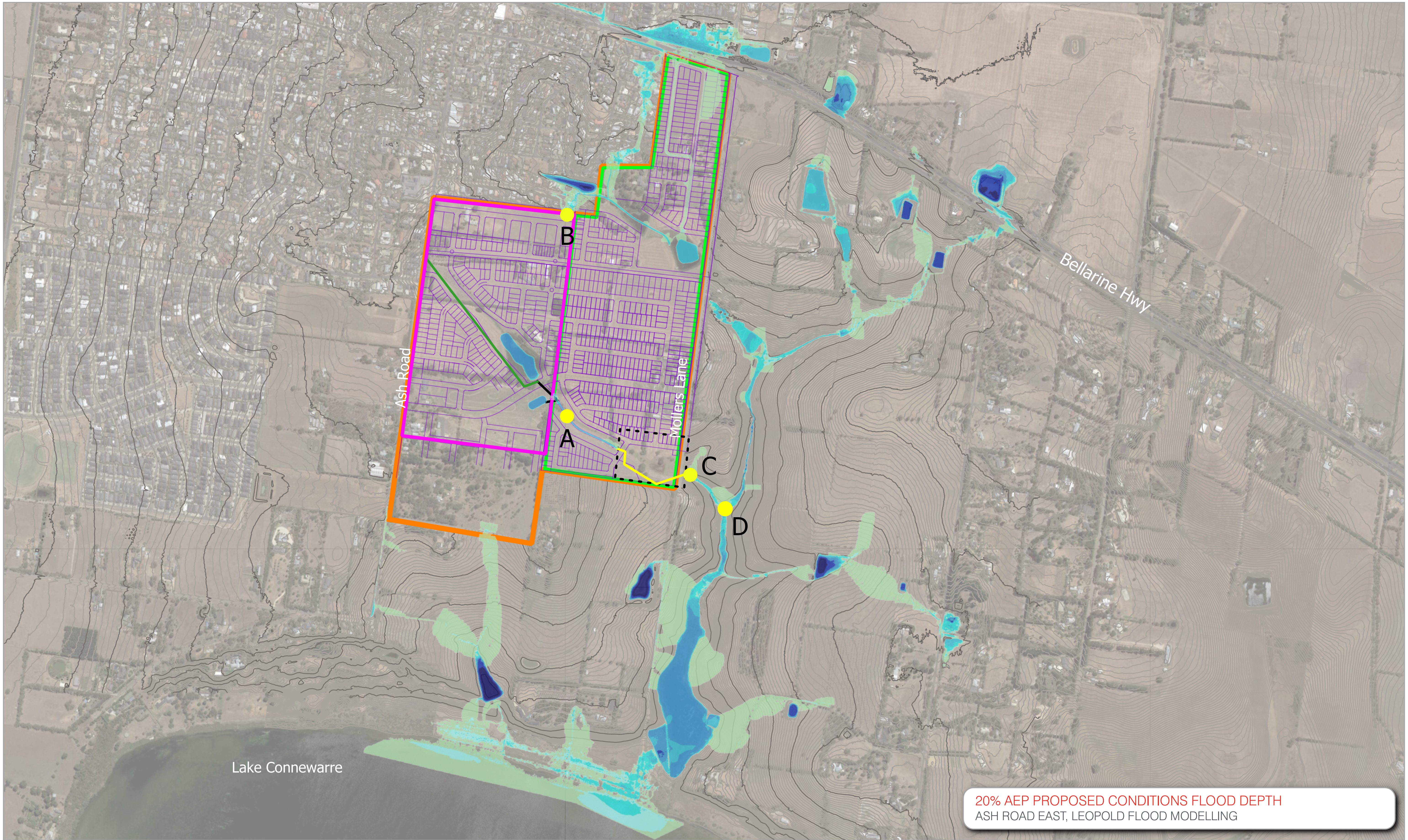

20% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-PROPOSED-WD
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q5-PR02-R01
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
>2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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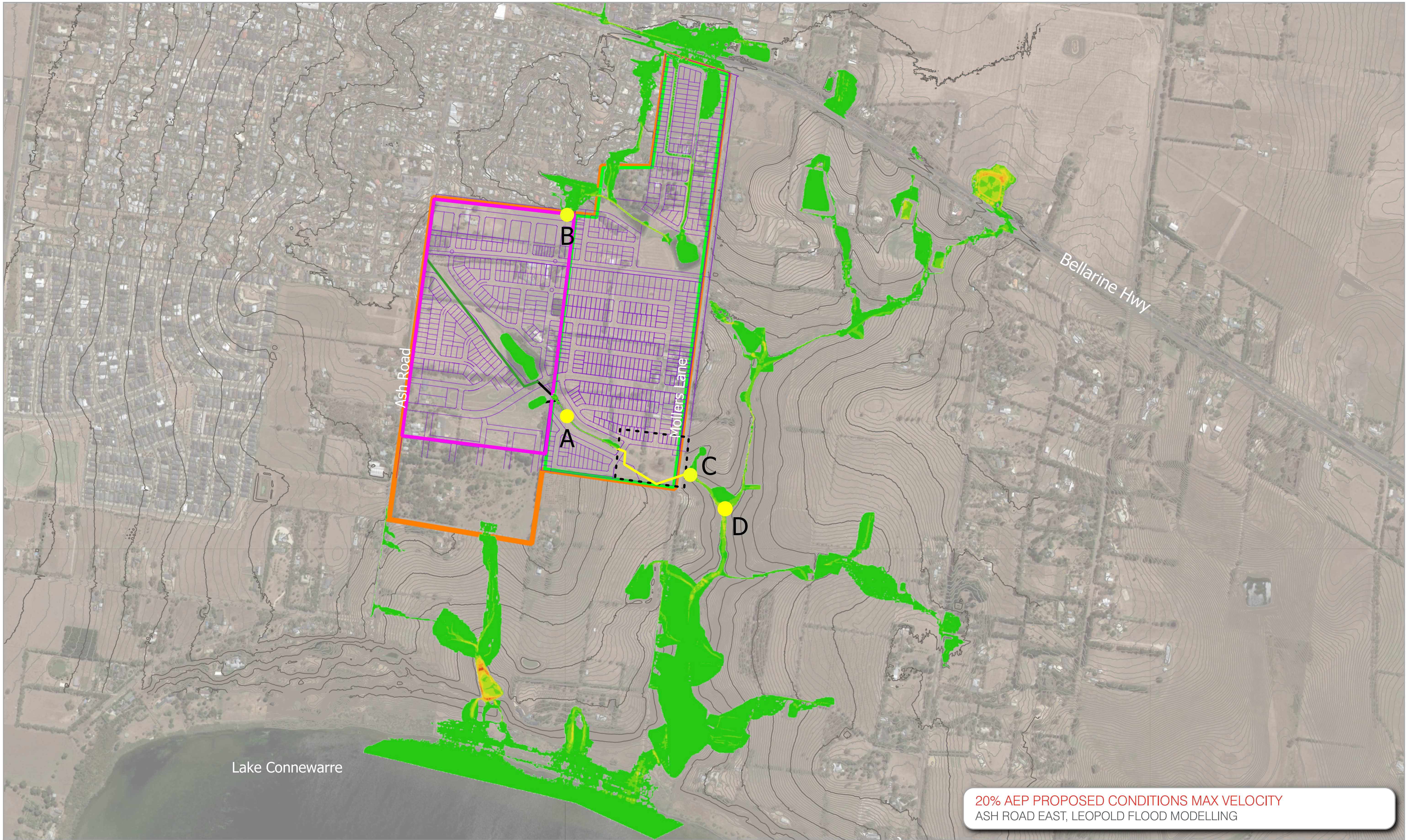

20% AEP PROPOSED CONDITIONS MAX VELOCITY
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q20-PROPOSED-VEL
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
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Authorised:

Flood Results: Q5-PR02-R01-
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Max Velocity (m/s)
- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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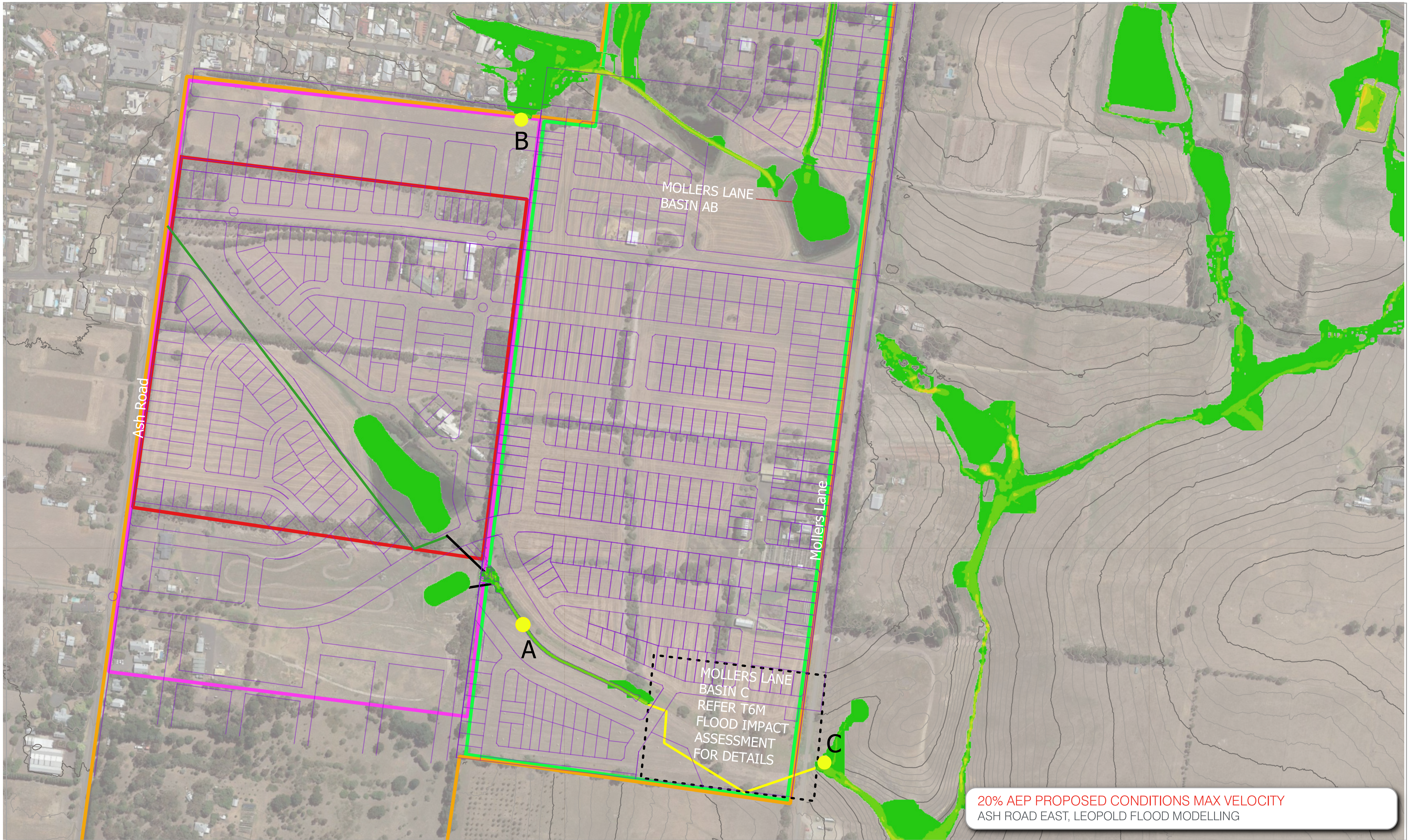

20% AEP PROPOSED CONDITIONS MAX VELOCITY
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-PROPOSED-VEL-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results:
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- MINOR CONTOURS
- MAJOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Max Velocity (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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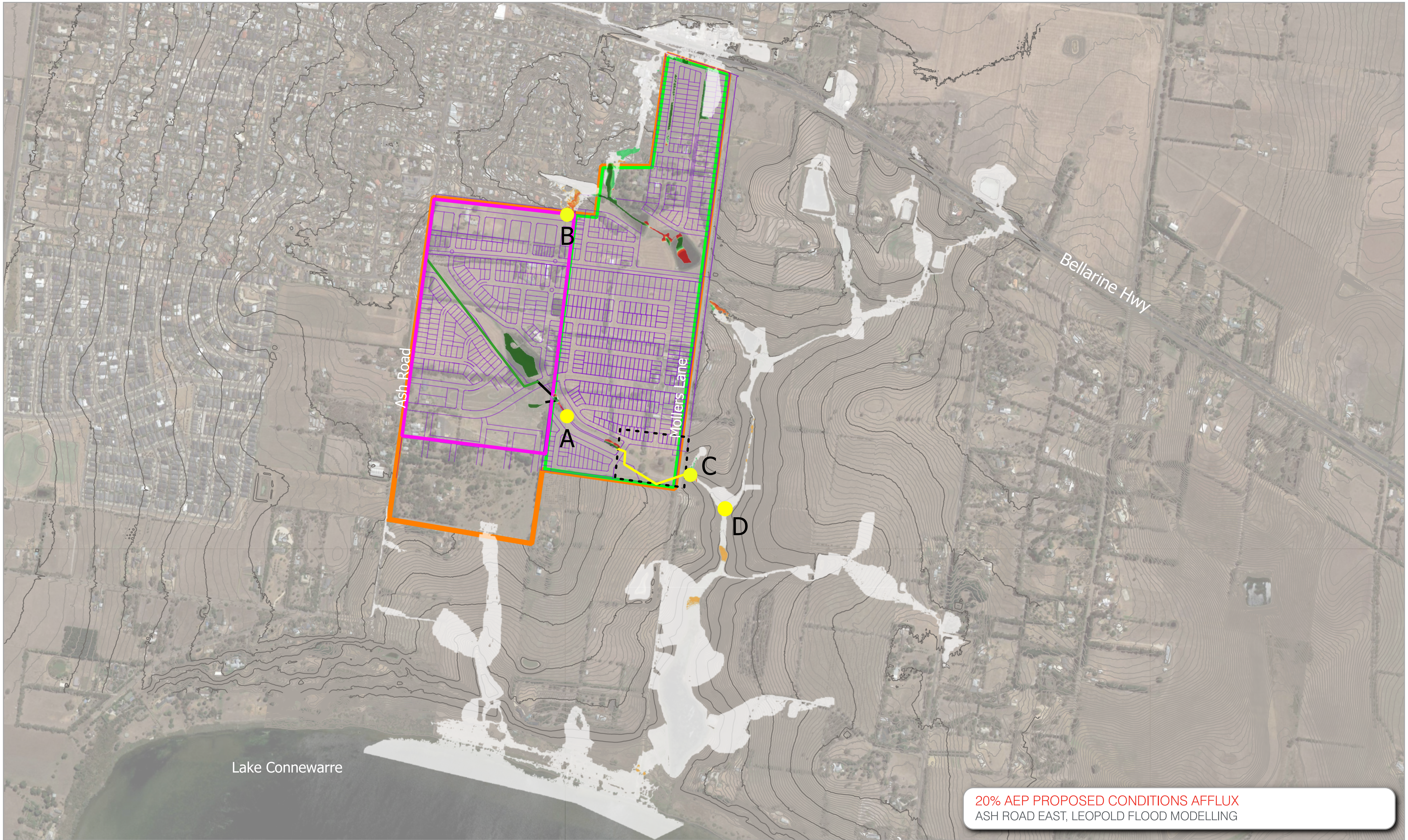

20% AEP PROPOSED CONDITIONS AFFLUX
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q20-PROPOSED-AF
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: afflux 5yr
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

AFFLUX

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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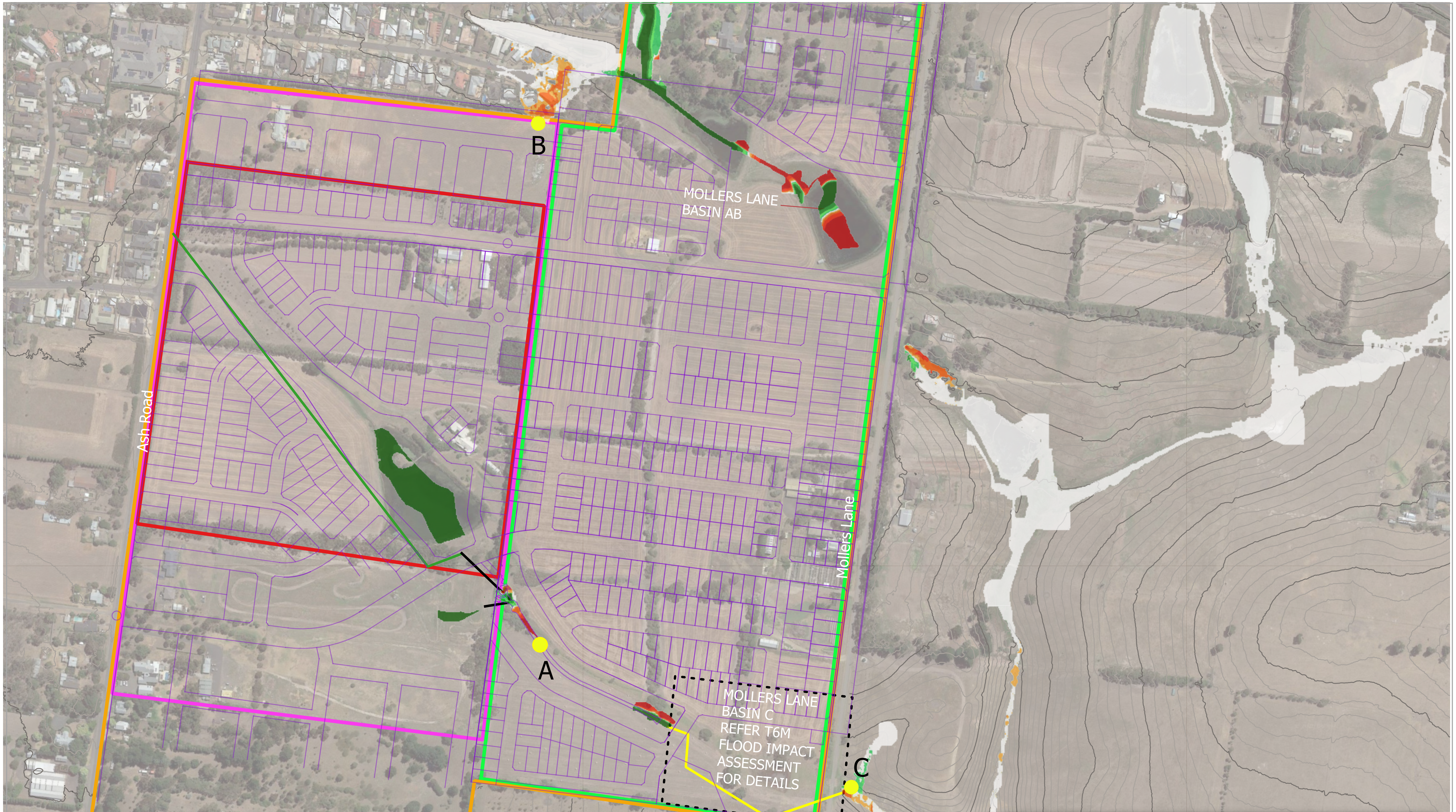

20% AEP PROPOSED CONDITIONS AFFLUX
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q5-PROPOSED-AF-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: afflux 5yr
Data: Google Maps

LEGEND

SUBJECT SITE
SELGA
MOLLERS LANE DEVELOPMENT
ASH ROAD EAST
FLOW REPORTING LOCATIONS
MINOR CONTOURS
MAJOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

AFFLUX

<= -0.2
-0.2 - -0.1
-0.1 - -0.05
-0.05 - -0.02
-0.02 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
> 0.2

1:10000
100 0 100 200 300 m
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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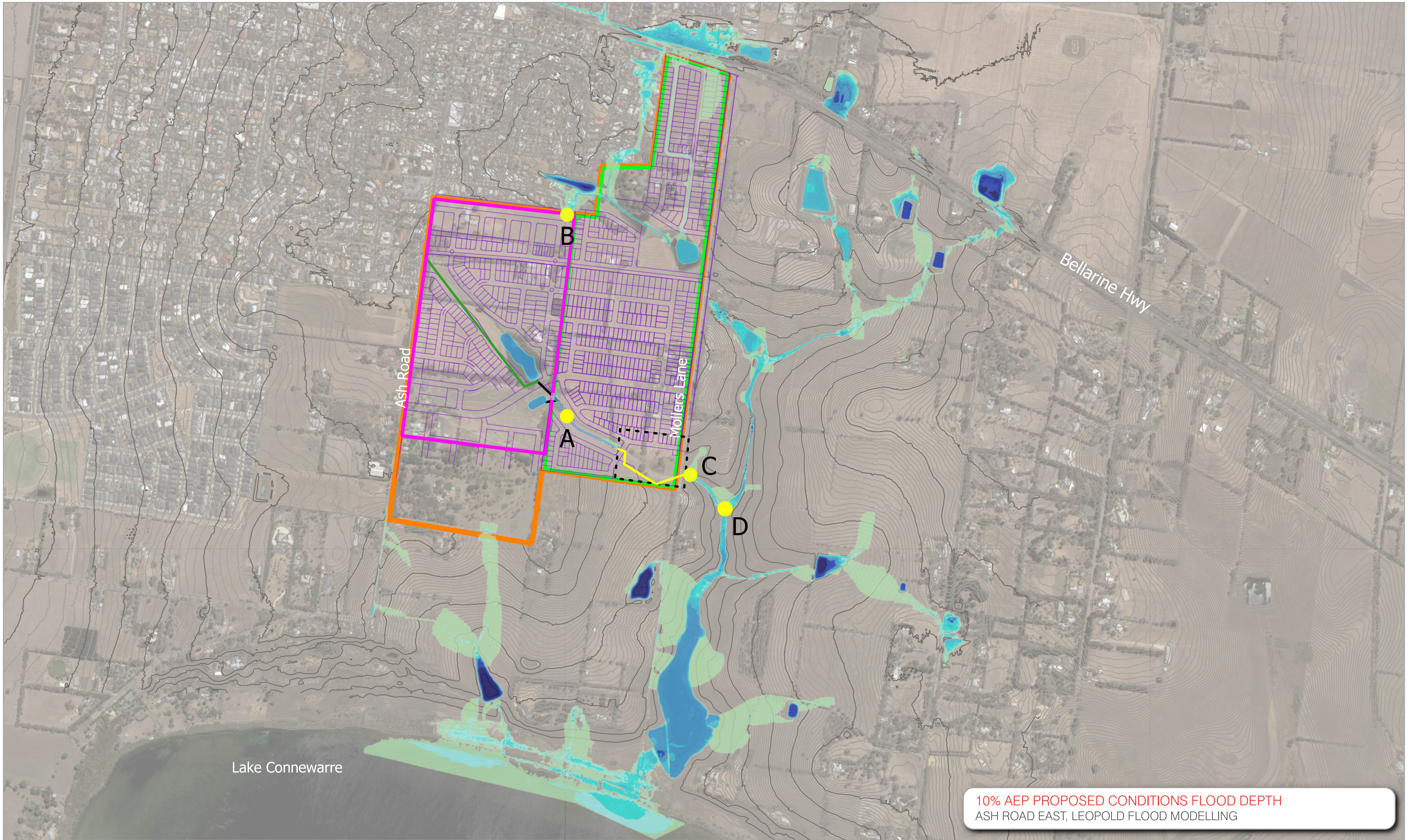

10% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q10-PROPOSED-WD
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q10-PR02-R01
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

Flood Depth (m)

0 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
>2.0

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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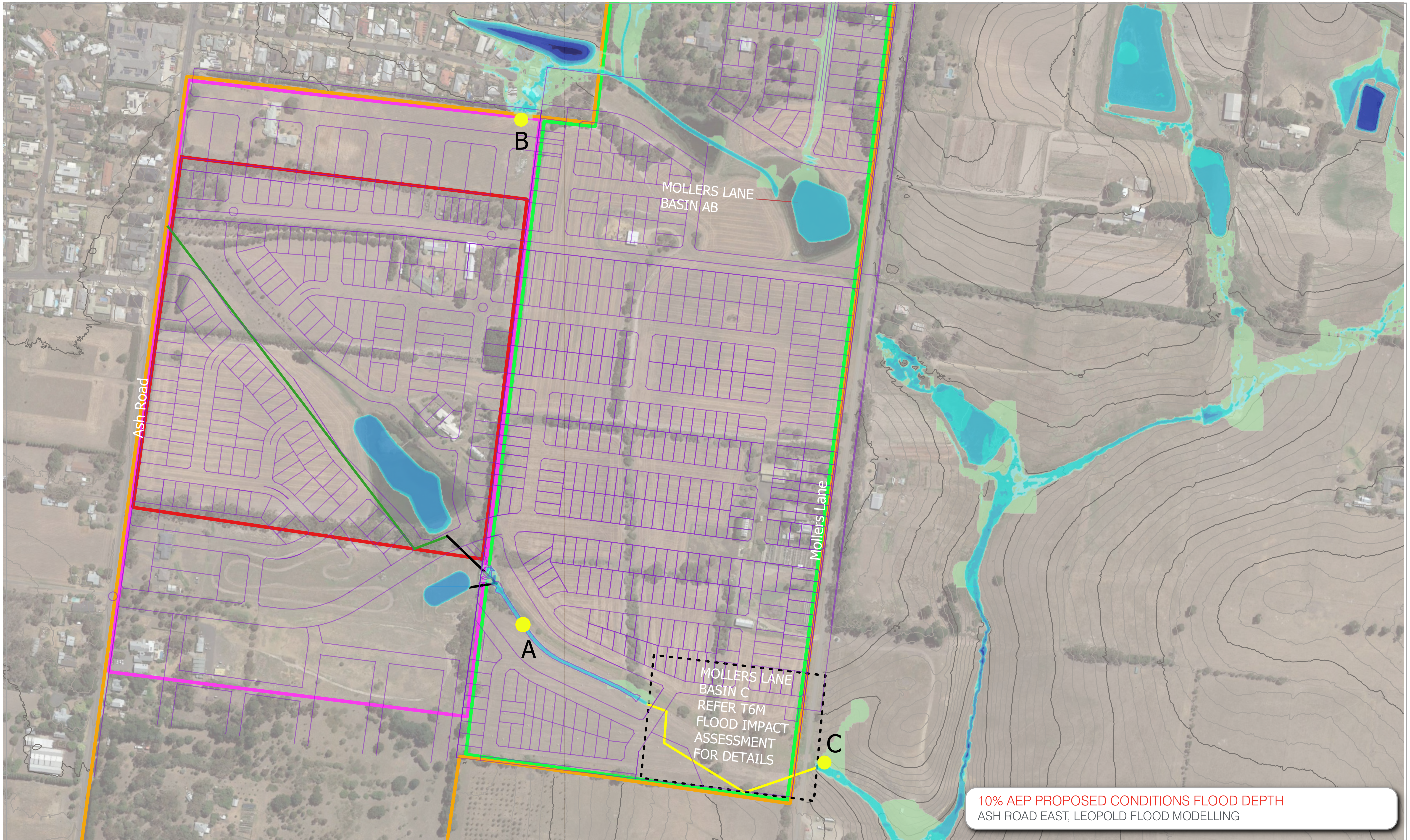

10% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q10-PROPOSED-WD-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q10-PR02-R01
Data: Google Maps

LEGEND

SUBJECT SITE
SELGA
MOLLERS LANE DEVELOPMENT
ASH ROAD EAST
FLOW REPORTING LOCATIONS
MINOR CONTOURS
MAJOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
>2.0

1:10000
100 0 100 200 300 m
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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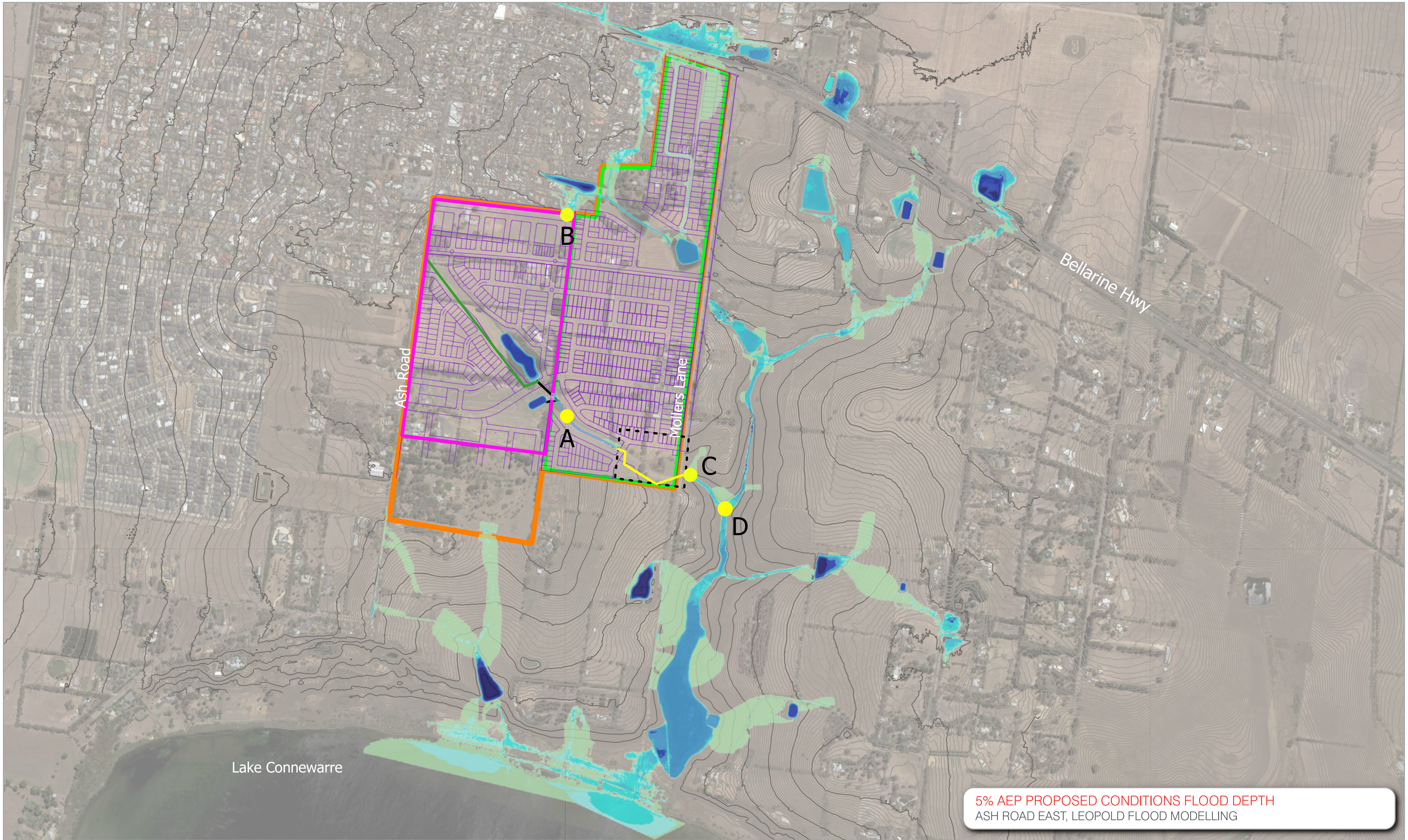

5% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q20-PROPOSED-WD
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q20-PR02-R01
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.0
>2.0

1:10000
100 0 100 200 300 m
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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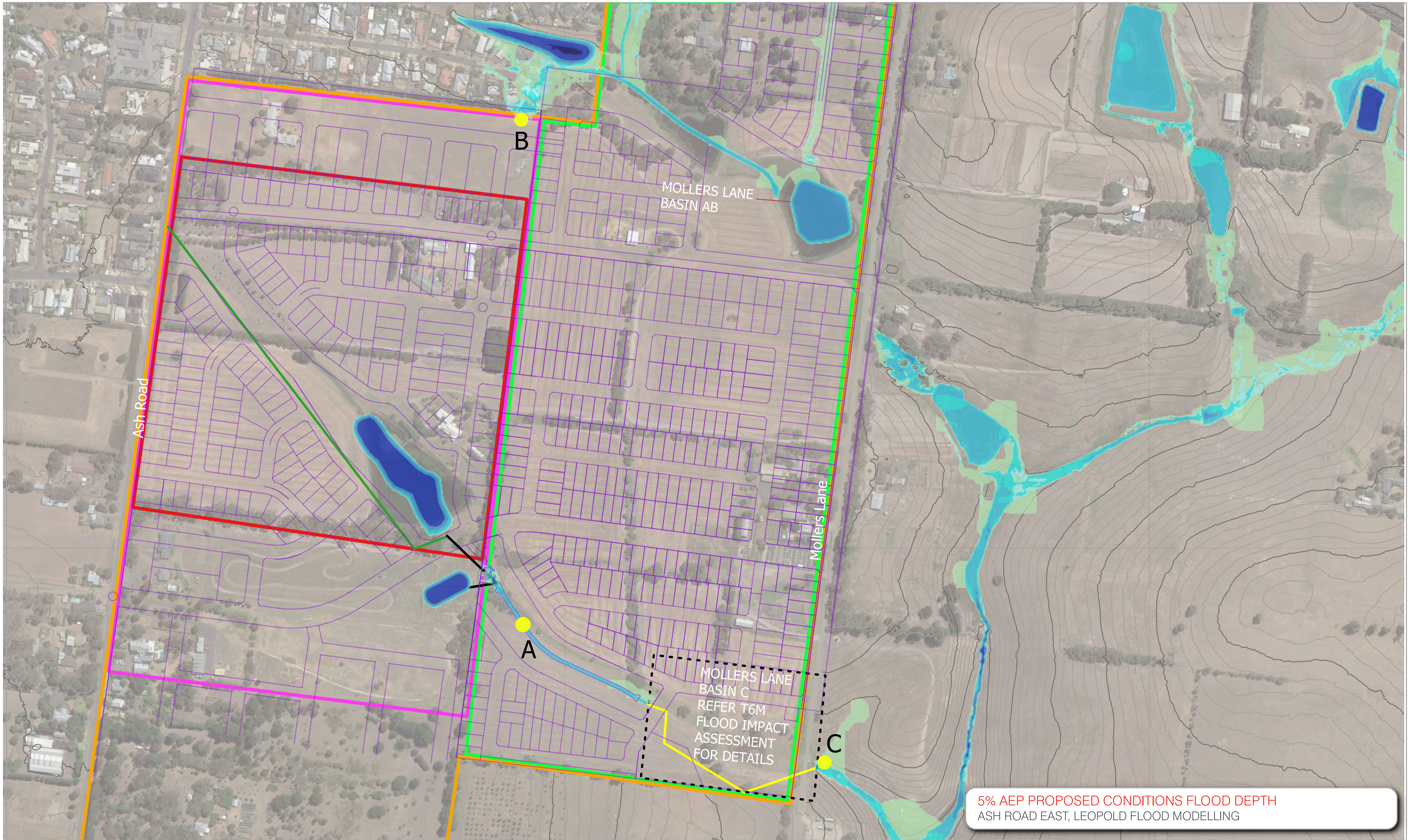

5% AEP PROPOSED CONDITIONS FLOOD DEPTH

ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q20-PROPOSED-WD-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q20-PR02-R01
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- MINOR CONTOURS
- MAJOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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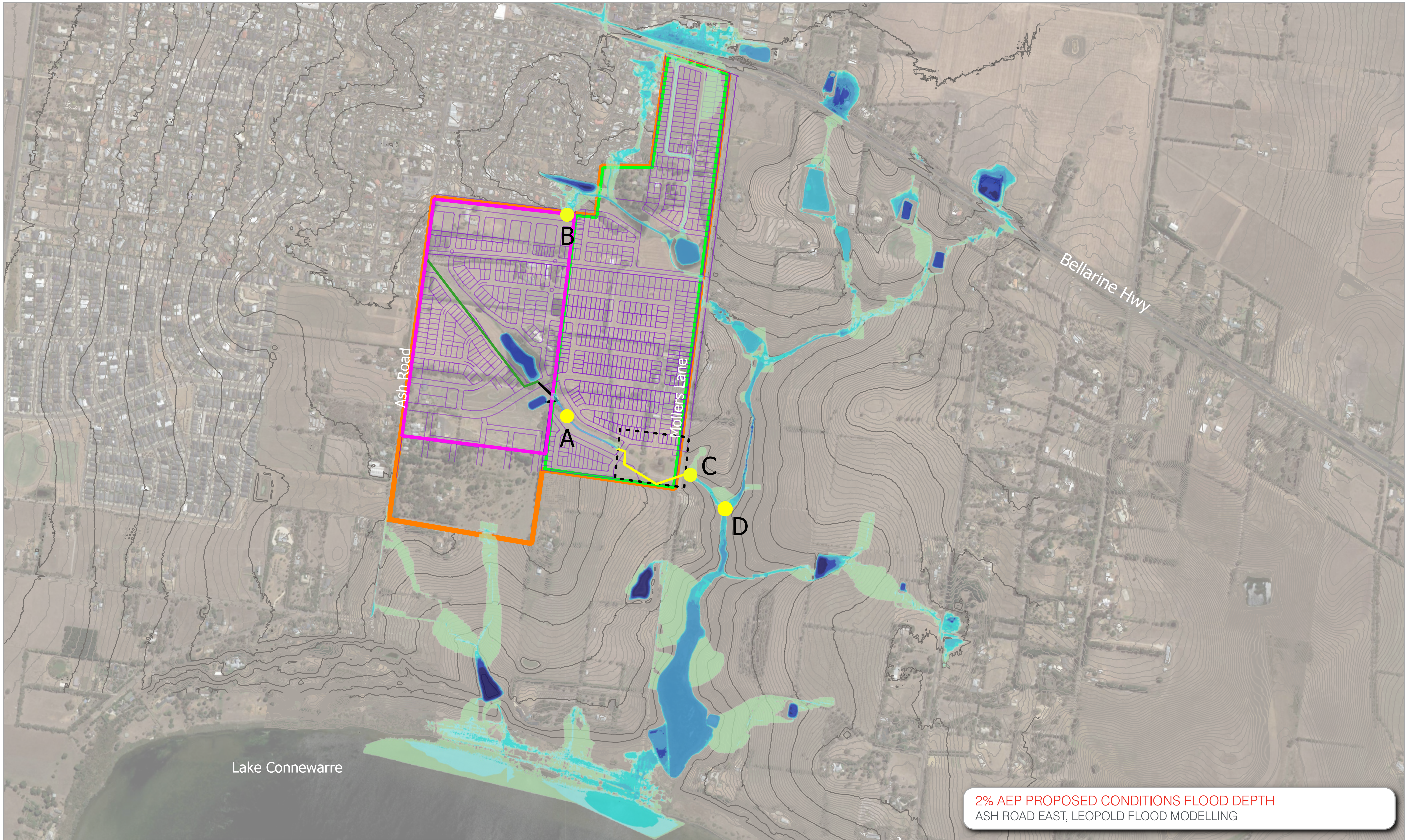

2% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q50-PROPOSED-WD
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q50-PR02-R01
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

100 0 100 200 300 m

1:10000

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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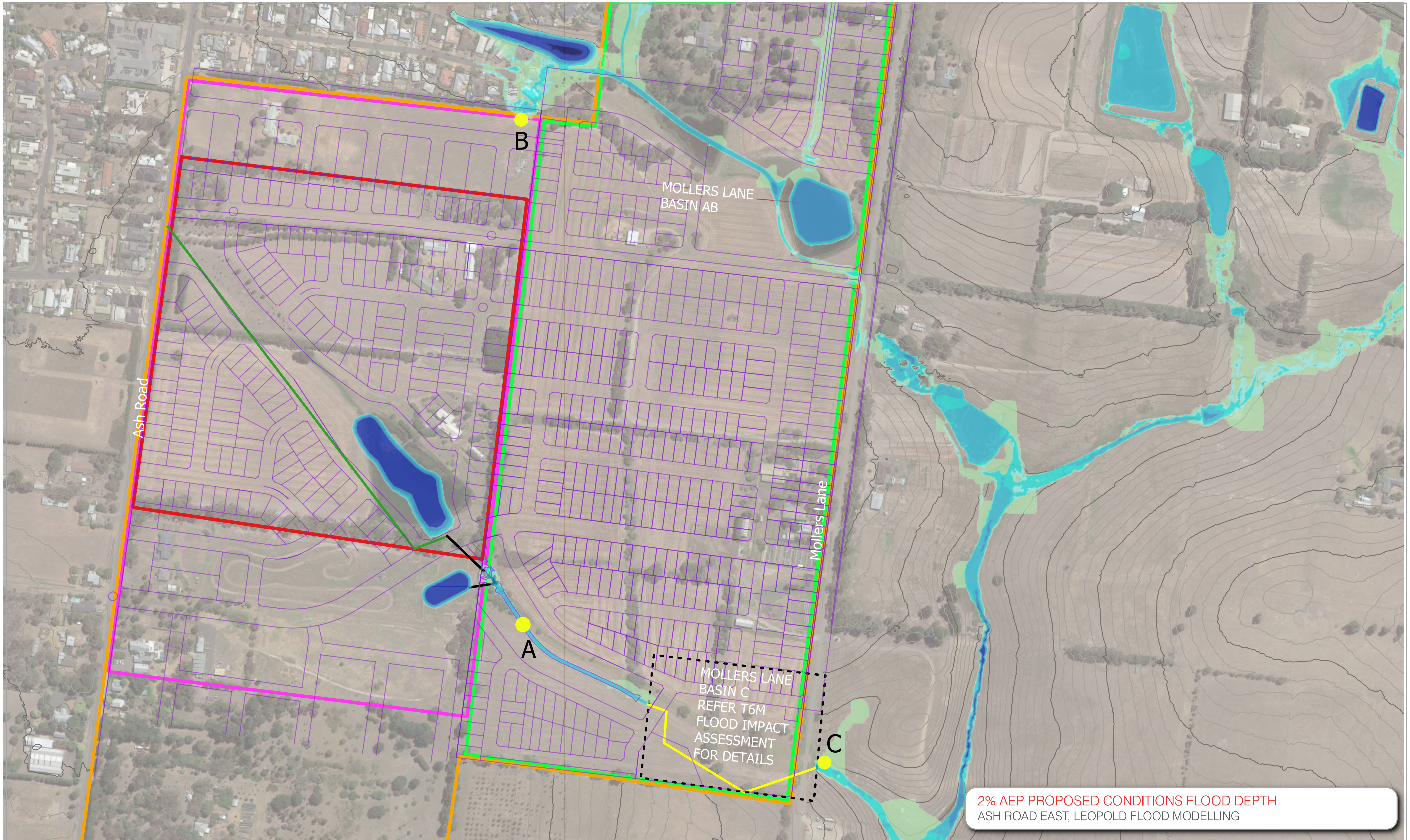

2% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q50-PROPOSED-WD-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q50-PR02-R01
Data: Google Maps

LEGEND

SUBJECT SITE	1% DRAINAGE PIPE
SELGA	BASIN OUTLET PIPES
MOLLERS LANE DEVELOPMENT	MOLLERS LANE BYPASS PIPE
ASH ROAD EAST	DEVELOPMENT LAYOUT
FLOW REPORTING LOCATIONS	
MINOR CONTOURS	
MAJOR CONTOURS	

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

100 0 100 200 300 m

1:10000

Coordinate System: GDA 1994 MGA Zone 55
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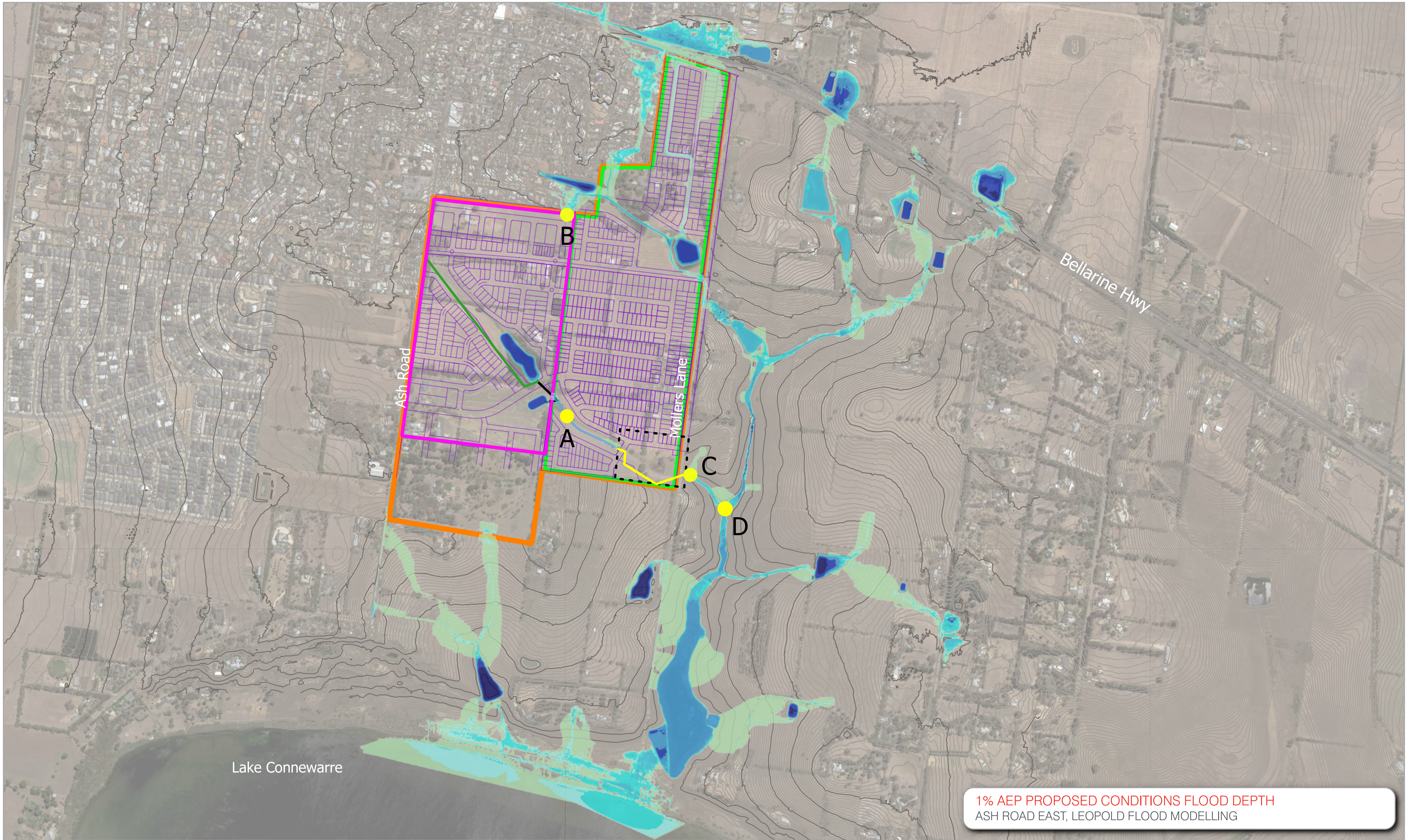

1% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-PROPOSED-WD
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q100-PR02-R01
Data: Google Maps

LEGEND

- ASH ROAD EAST
- MOLLERS LANE DEVELOPMENT
- SELGA
- FLOW REPORTING LOCATIONS
- MAJOR CONTOURS
- MINOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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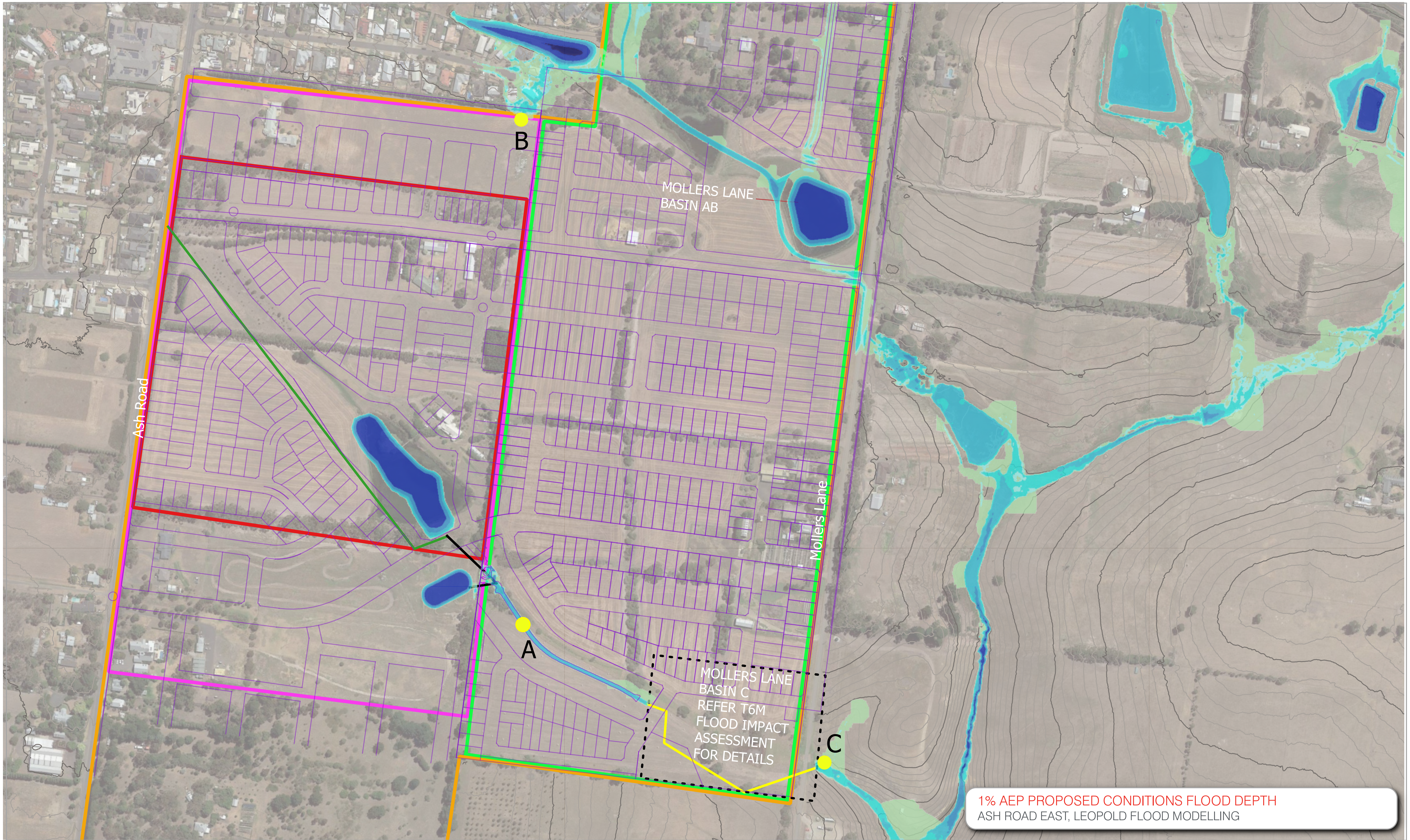

1% AEP PROPOSED CONDITIONS FLOOD DEPTH
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-PROPOSED-WD-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q100-PR02-R01
Data: Google Maps

LEGEND

SUBJECT SITE		1% DRAINAGE PIPE	
SELGA		BASIN OUTLET PIPES	
MOLLERS LANE DEVELOPMENT		MOLLERS LANE BYPASS PIPE	
ASH ROAD EAST		DEVELOPMENT LAYOUT	
FLOW REPORTING LOCATIONS			
MINOR CONTOURS			
MAJOR CONTOURS			

Flood Depth (m)

- 0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- >2.0

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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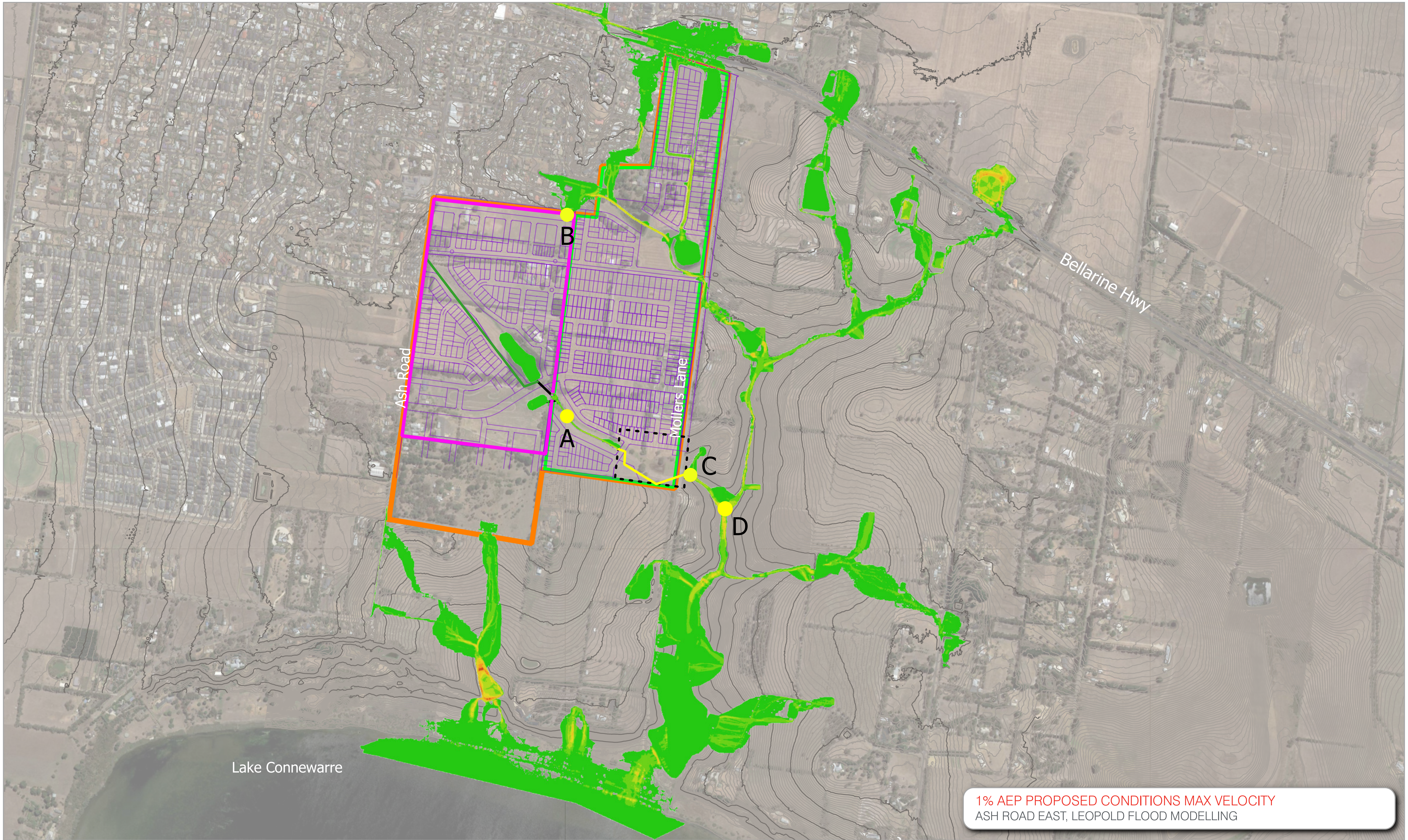

1% AEP PROPOSED CONDITIONS MAX VELOCITY
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-PROPOSED-VEL
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: Q100-PR02-R01-
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

Max Velocity (m/s)
<= 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 3
3 - 4
4 - 5
> 5

1:10000
100 0 100 200 300 m
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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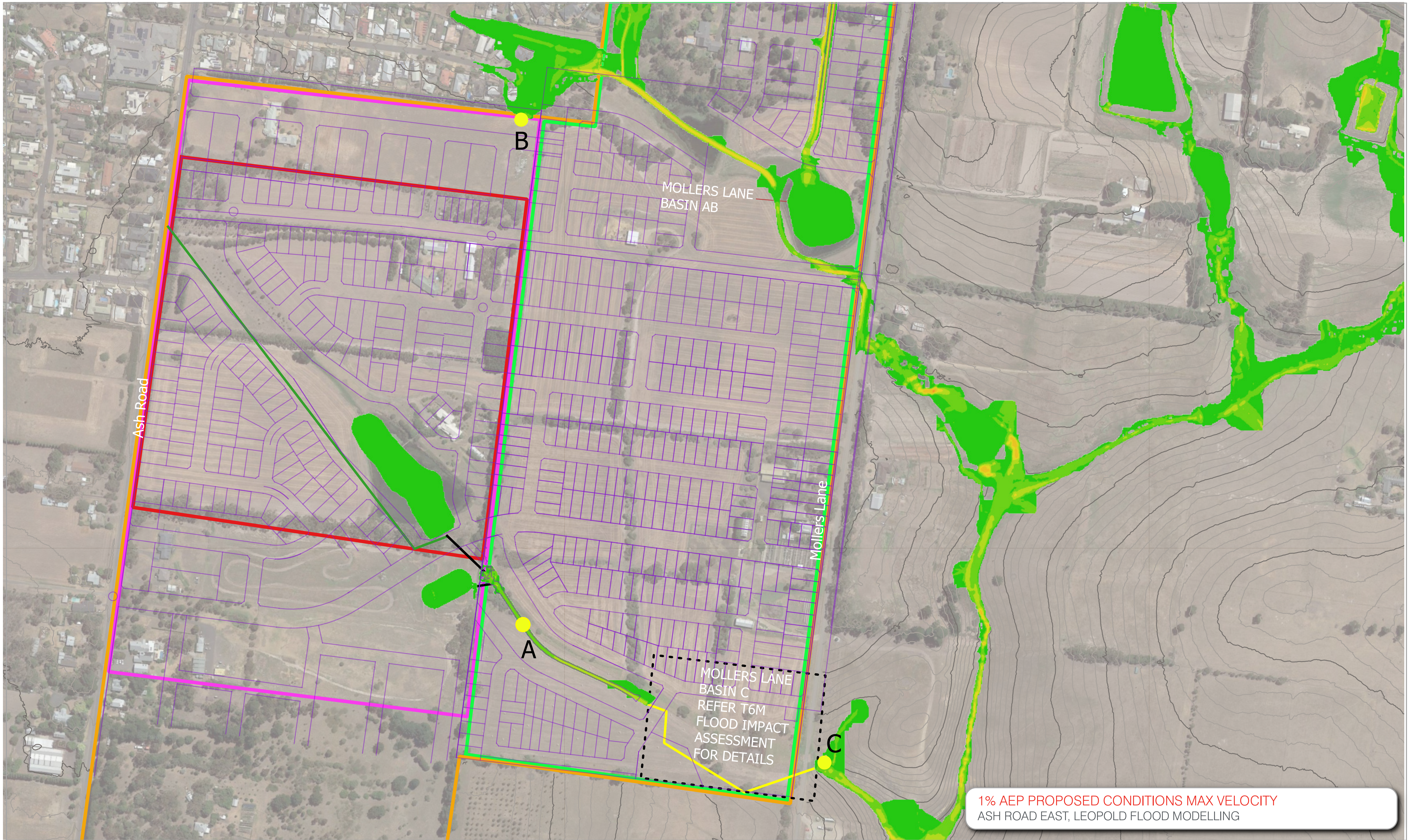

1% AEP PROPOSED CONDITIONS MAX VELOCITY
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-PROPOSED-VEL-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results:
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- MINOR CONTOURS
- MAJOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

Max Velocity (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- > 5

1:10000

100 0 100 200 300 m

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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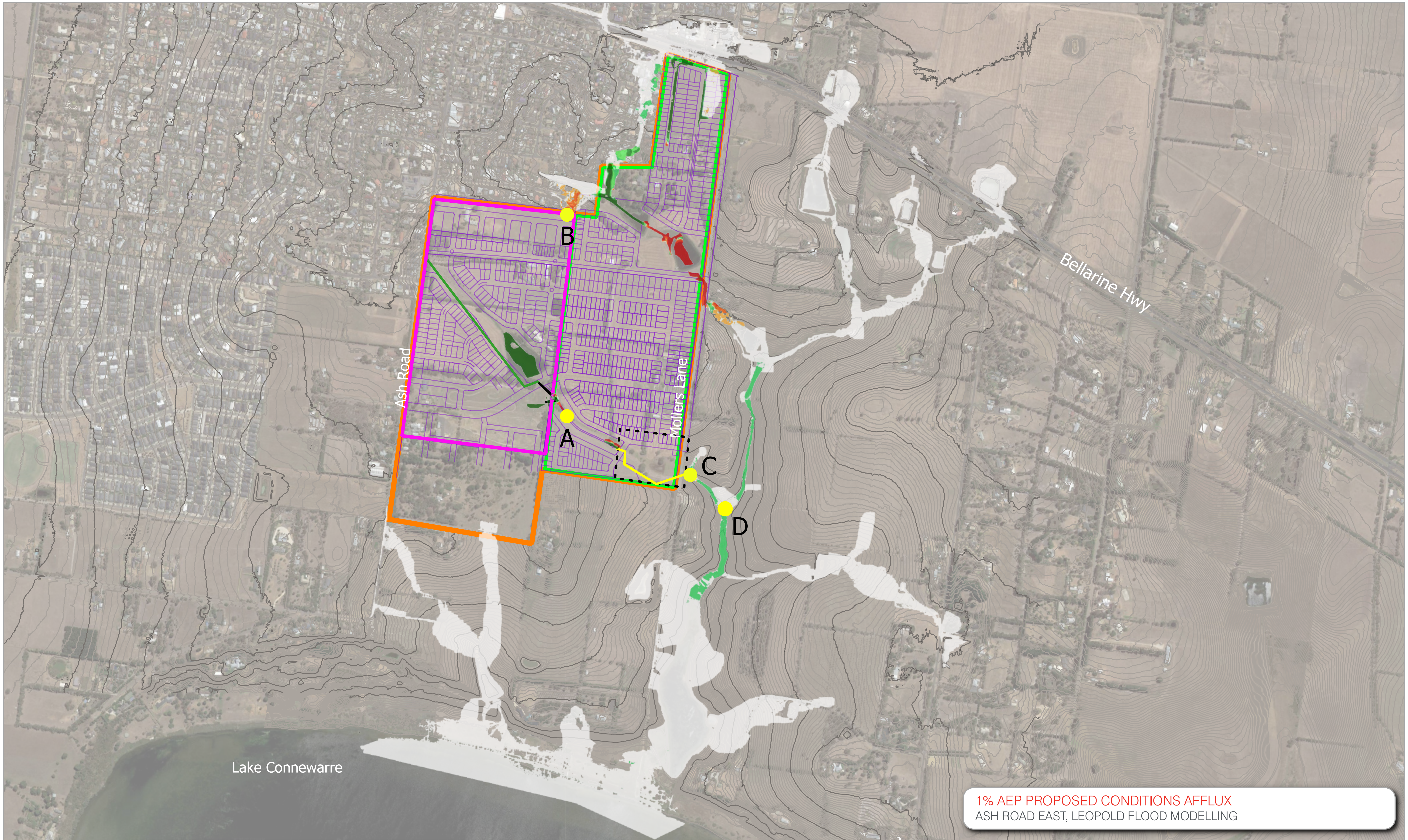

1% AEP PROPOSED CONDITIONS AFFLUX
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-PROPOSED-AF
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: afflux 100yr
Data: Google Maps

LEGEND

ASH ROAD EAST
MOLLERS LANE DEVELOPMENT
SELGA
FLOW REPORTING LOCATIONS
MAJOR CONTOURS
MINOR CONTOURS
1% DRAINAGE PIPE
BASIN OUTLET PIPES
MOLLERS LANE BYPASS PIPE
DEVELOPMENT LAYOUT

AFFLUX
<= -0.2
-0.2 - -0.1
-0.1 - -0.05
-0.05 - -0.02
-0.02 - 0.02
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
> 0.2

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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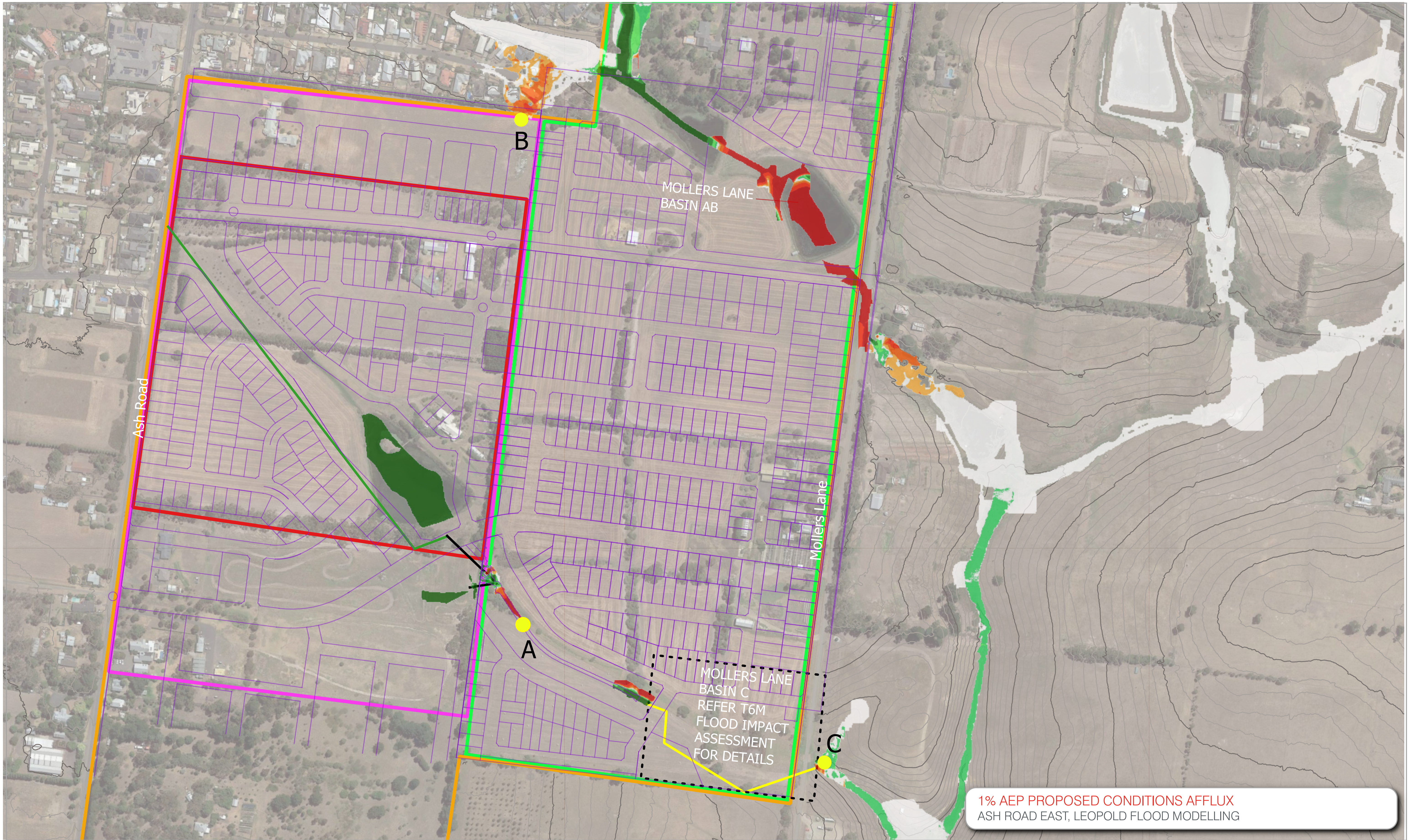

1% AEP PROPOSED CONDITIONS AFFLUX
ASH ROAD EAST, LEOPOLD FLOOD MODELLING

NOTATIONS

File Ref: 305162
Plan: SW-01-Q100-PROPOSED-AF-DETAILED
Rev: 1
Date: 10.02.2020

Designed: H. Ghajarnia
Checked:
Authorised:

Flood Results: afflux 100yr
Data: Google Maps

LEGEND

- SUBJECT SITE
- SELGA
- MOLLERS LANE DEVELOPMENT
- ASH ROAD EAST
- FLOW REPORTING LOCATIONS
- MINOR CONTOURS
- MAJOR CONTOURS
- 1% DRAINAGE PIPE
- BASIN OUTLET PIPES
- MOLLERS LANE BYPASS PIPE
- DEVELOPMENT LAYOUT

AFFLUX

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- -0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2

100 0 100 200 300 m
1:10000
Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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APPENDIX F – TUFLOW MODEL BUILD AND ASSUMPTIONS

INTRODUCTION

In October 2018, TGM completed a flood impact assessment for the Mollers Lane Development, immediately east of the proposed Ash Road Development. The extent of this assessment was taken at a regional level, to the outlet into Lake Connewarre (Figure 1).

Following discussions between Spiire, CCMA and the City of Greater Geelong, it was agreed that the modelling of the Ash Road development should assess both existing and proposed conditions and that it should consisder both:

- The local scale to assess the functionality of designed retarding basins; and,
- The regional scale to determine any environmental impacts of flooding on Lake Connewarre

Throughout this memo, modelling regarding the Ash Road site and surrounds will be referred to as the 'local scale' with the greater Lake Connewarre catchment being referred to as the 'regional scale'.

TGM provided hydrographs for flows from 0.5 EY (2-year ARI) to 1% AEP (100-year ARI) with 12 different durations at the full catchment scale for the existing and proposed conditions. For each AEP, the 10 min through to 12 hour storm duration was provided.

Figure 1: The Regional Scale Modelling Extent

The local scale modelling extent (Figure 2) shows the location of the Ash Road East northern and southern retarding basins. These assets are positioned upstream of the drainage reserve and retarding basin within the Mollers Lane development (denoted asTGM design in Figure 2).

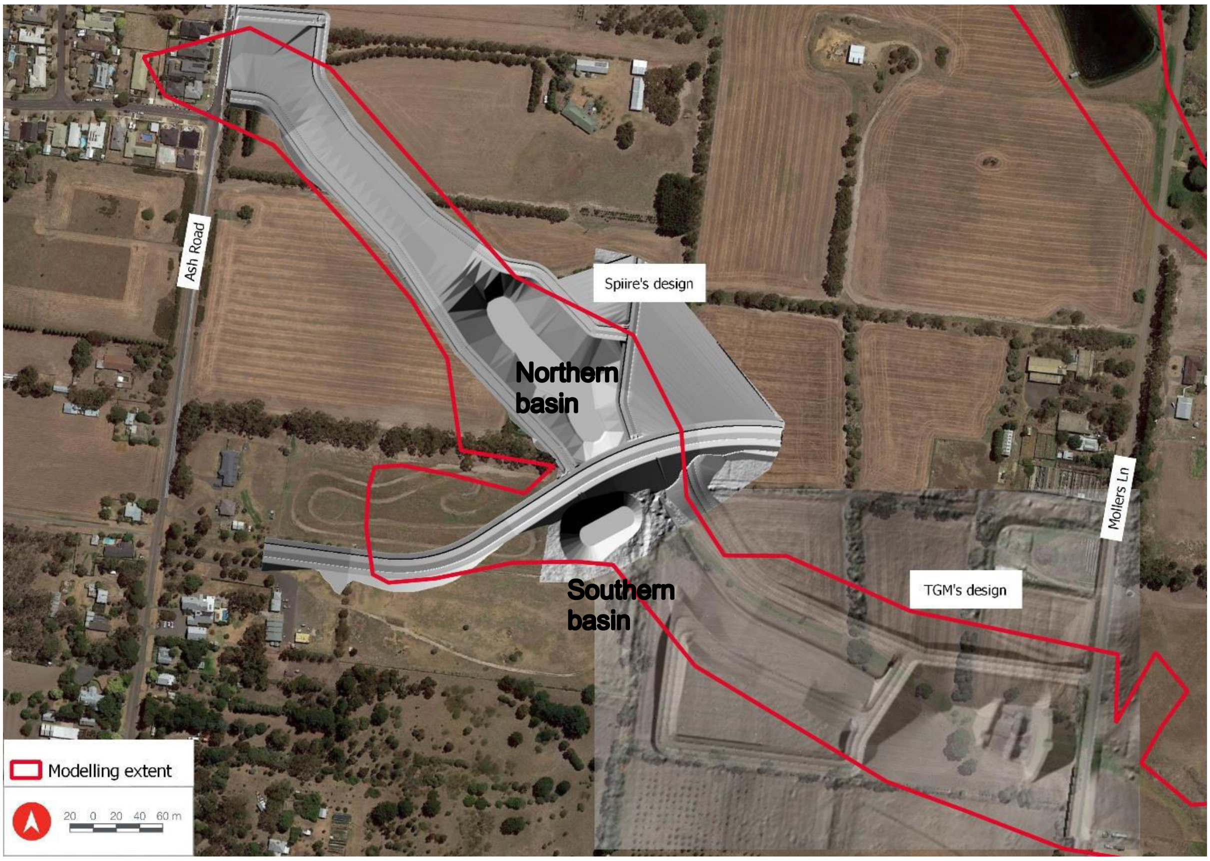


Figure 2: The Local Scale Modelling Extent

HYDROLOGIC ANALYSIS

TGM provided Spiire with hydrographs for existing and proposed conditions for the whole catchment (regional scale) as well as for the external catchment flows from the developed area west of Ash Road (local scale). As such, no further hydrologic analysis was performed by Spiire. The location of hydrograph inflows and downstream boundary conditions are shown in Figure 4 and Figure 5 for the regional scale and local scale models respectively.

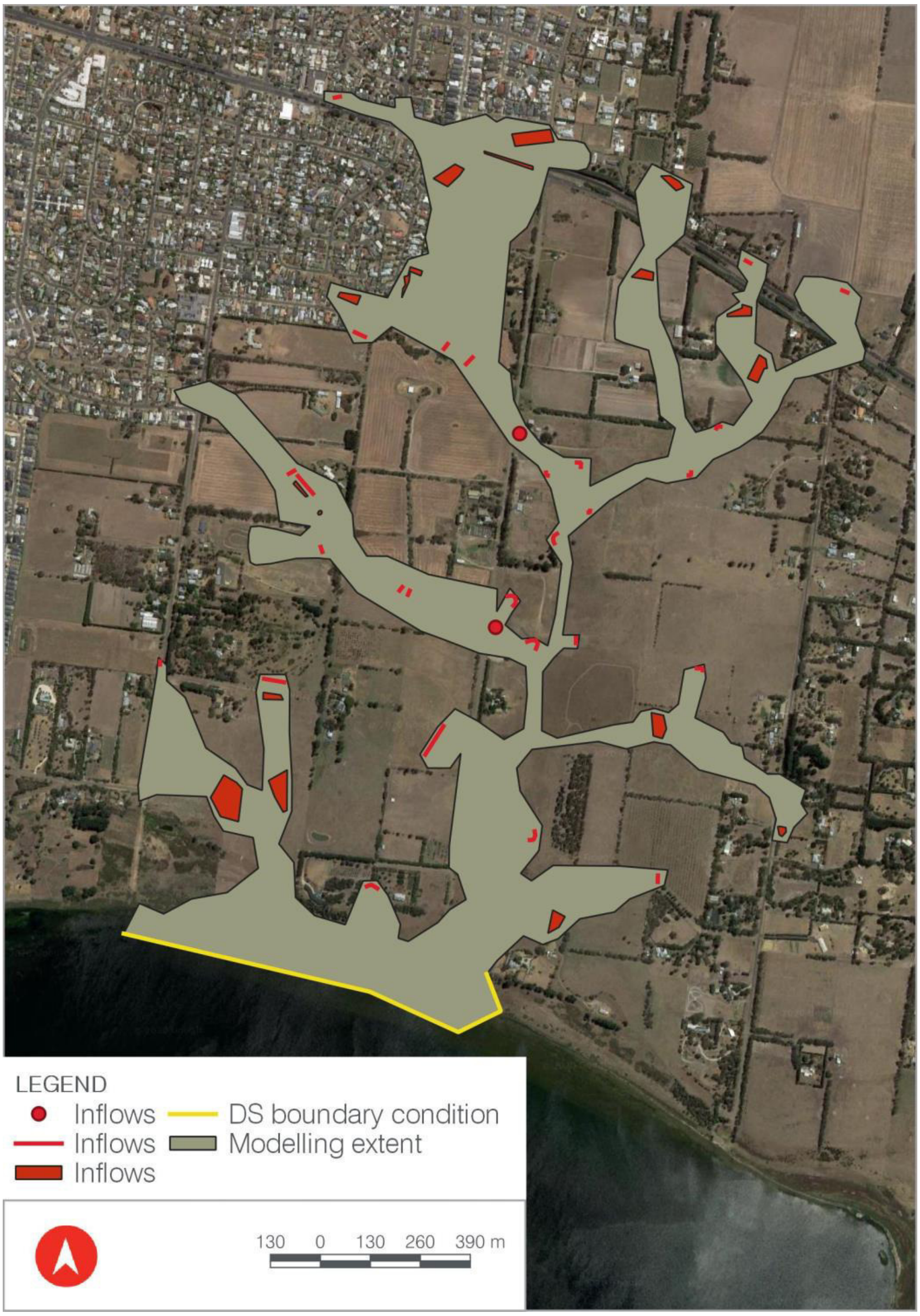


Figure 3: Boundary Conditions - Regional Scale

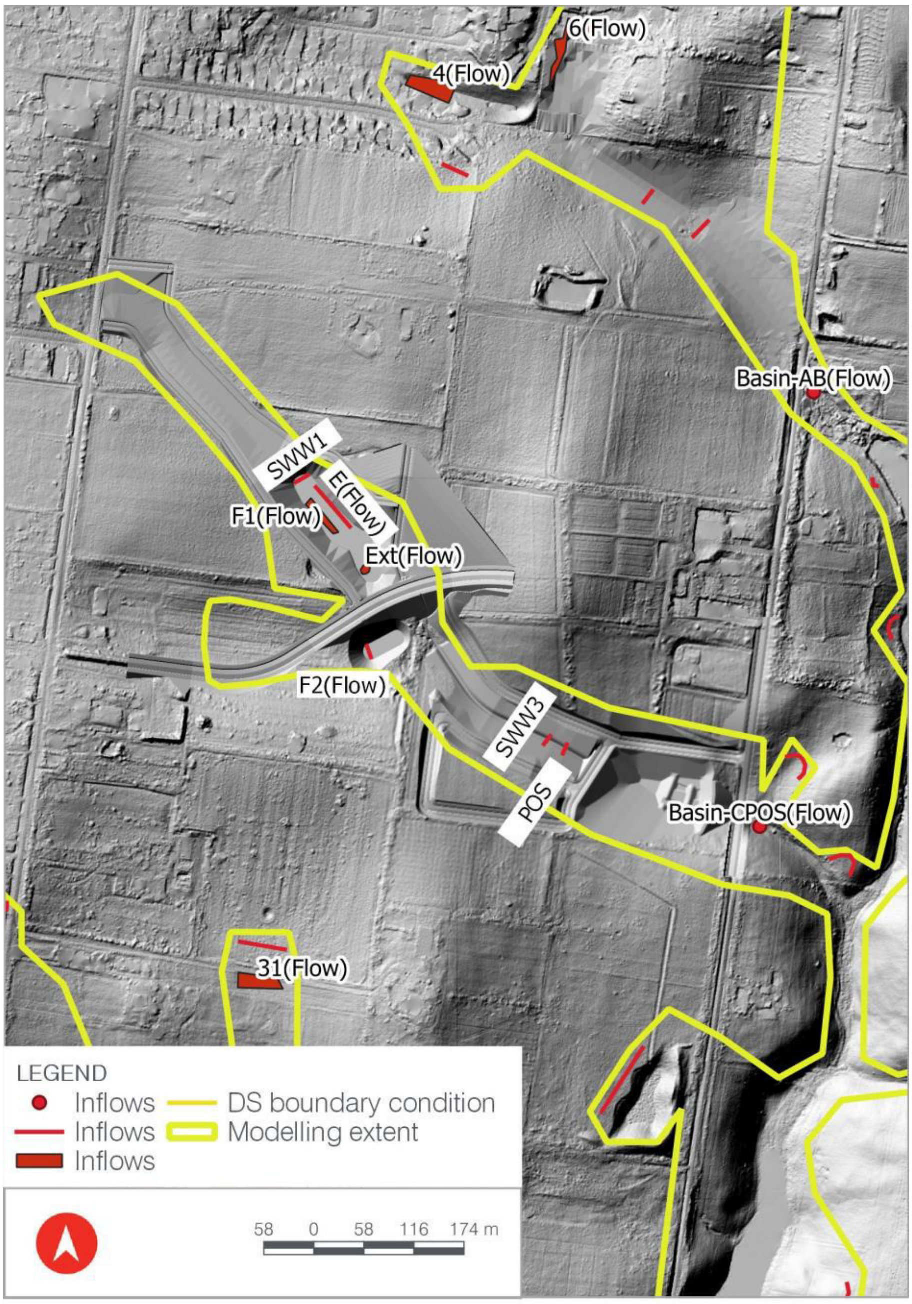


Figure 4: Boundary Conditions - Local Scale

HYDRAULIC ANALYSIS

With the provided input hydrographs, a hydraulic (TUFLOW) analysis was undertaken to determine flood depths, extents, flood velocities, and flood hazard. The TGM pre-developed condition inflows were adopted for the existing condition. The proposed conditions were developed based on the existing conditions model and incorporated various changes to represent the ultimate design conditions for the site. The following additions to the existing conditions modelling were made to represent proposed development conditions:

- Geometry for a TUFLOW model was created. For this purpose, two types of raster files and Tuflow Z-shape files were used, as summarised below:

  - Raster files:
    - LiDAR data as the base map;
    - Two rasters to simulate the designed conditions. This included the proposed urban development footprints, drainage reserves and retarding basins designed by TGM; and,
    - A raster representing the basins for Ash Road
  - Z-shape files
    - Z shape files to remove unusual features on existing LiDAR data; and,
    - Z shape files to adjust the invert level of pipe outlets to match in with the proposed surface at the Spiire retarding basins.
- The adopted TUFLOW run parameters are summarised below:
  - The modelling extent is demonstrated in **Error! Reference source not found.**;
  - Hydrograph and downstream boundaries are shown in Figure 4;
    - The downstream boundary condition at Lake Connewarre was modelled with a hydraulic grade of 0.01 m/m to allow water to freely exit the model; and,
    - Upstream boundary conditions are the inflow hydrographs that are shown in Figure 3 and Figure 4.
  - Grid size = 1 metre x 1 metre;
  - The TGM Manning's n layer was utilised in the catchment scale modelling. A more detailed Manning's n layer, based on land use, was created for the local model from Ash Road to downstream of TGM's retarding basin;
  - Calculation time step = 0.5 seconds (initial setting only; time step is automatically adjusted with GPU solver); and,
  - TUFLOW's GPU solver was used.

A drainage pit located at the low point on Ash Rd will capture flows (up to the 1% AEP) from the external catchment (west of Ash Road), hydrograph "Ext(Flow)" and convey it directly to the base of the Spiire retarding basin. This pipe will be sized in detailed design to prevent any surface flow between Ash Road and retarding basin. As such, the hydraulic modelling of this section was unnecessary and the Ext(Flow) was applied directly to the base of the basin.

The 9-hour storm event was recognised as the critical storm duration for the design of the retarding basin which was consistent for all AEPs.

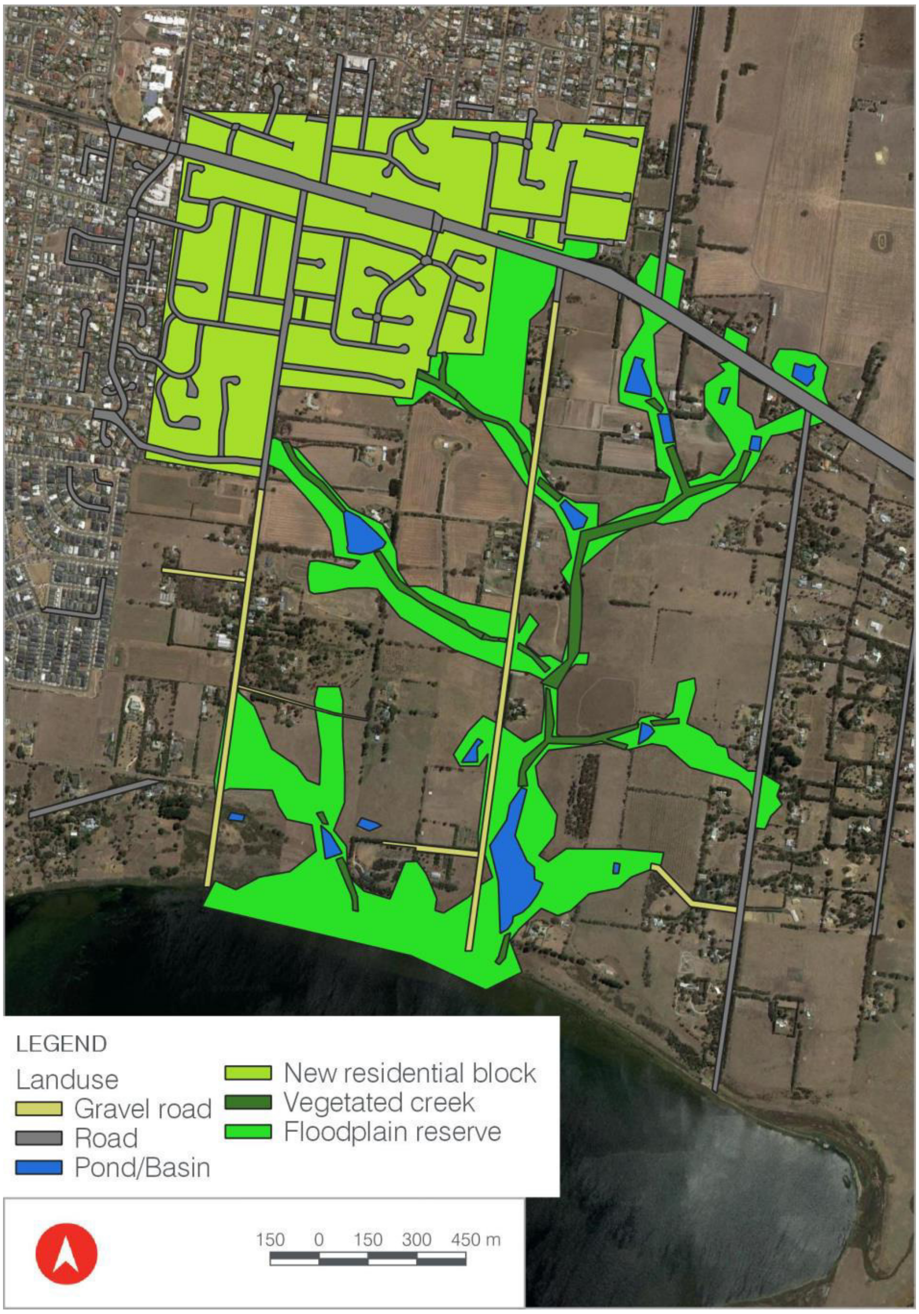


Figure 5: Existing Conditions Manning's n

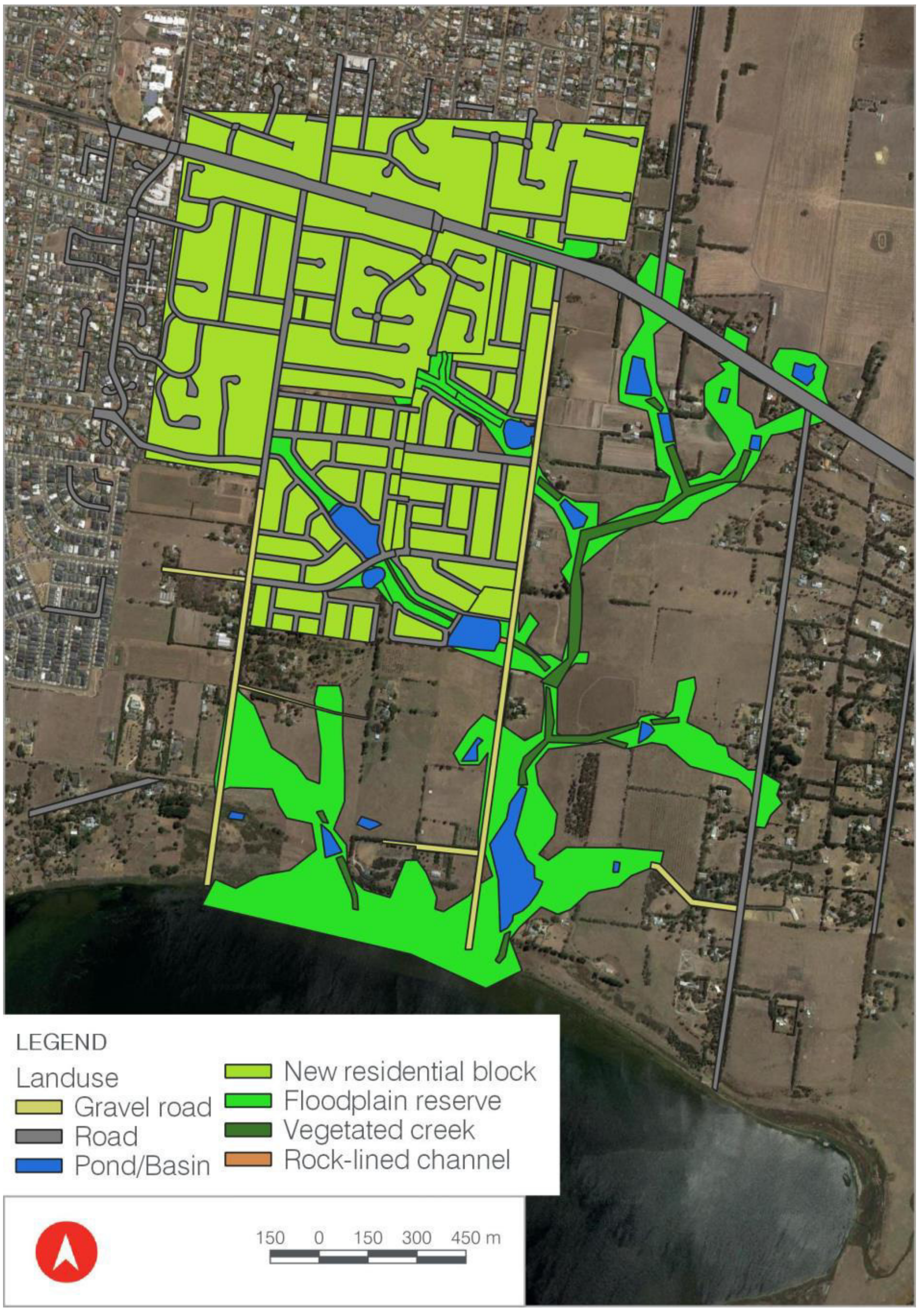


Figure 6: Proposed Conditions Manning's n

Two outlets were set for the northern retarding basin with the aim of reducing peak 100-year ARI flow in the proposed condition to the 100-year existing condition flows (refer to Figure 7 for the location of northern basin).

For the southern basin, a single outlet pipe was shown to be adequate (refer to Figure 7 for the location of southern basin). The size and invert level of outlet pipes for each basin are shown in Table 1 and Figure 7.

Table 1: The specifications of outlet pipes for the designed retarding basin

Retarding basin	Pipe size	US IL (m)	DS IL	Length (m)
Northern retarding basin	600 mm	35.65	32.15	70
Northern retarding basin	300 mm	35.30	32.15	70
Southern retarding basin	450 mm	30.50	30.28	40

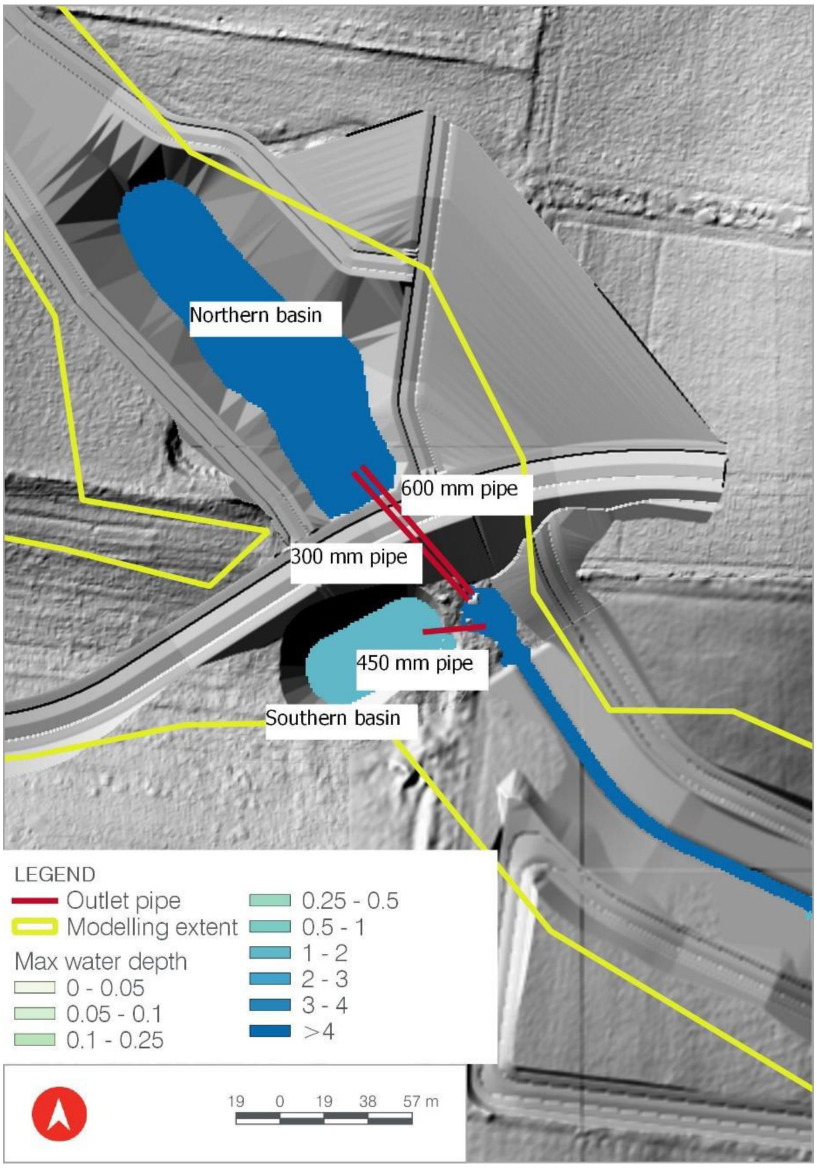


Figure 7: the location and size of outlet pipes

Existing and proposed conditions models were run for the above ARIs and durations. Results for flood depth, flood velocity and flood hazard were mapped. 100-year ARI existing and proposed flood depths are shown in Figure 8 and Figure 9.

From the TUFLOW runs, it was verified that the critical duration for all flows is the 9-hour storm for the design of the Spiire retarding basins.

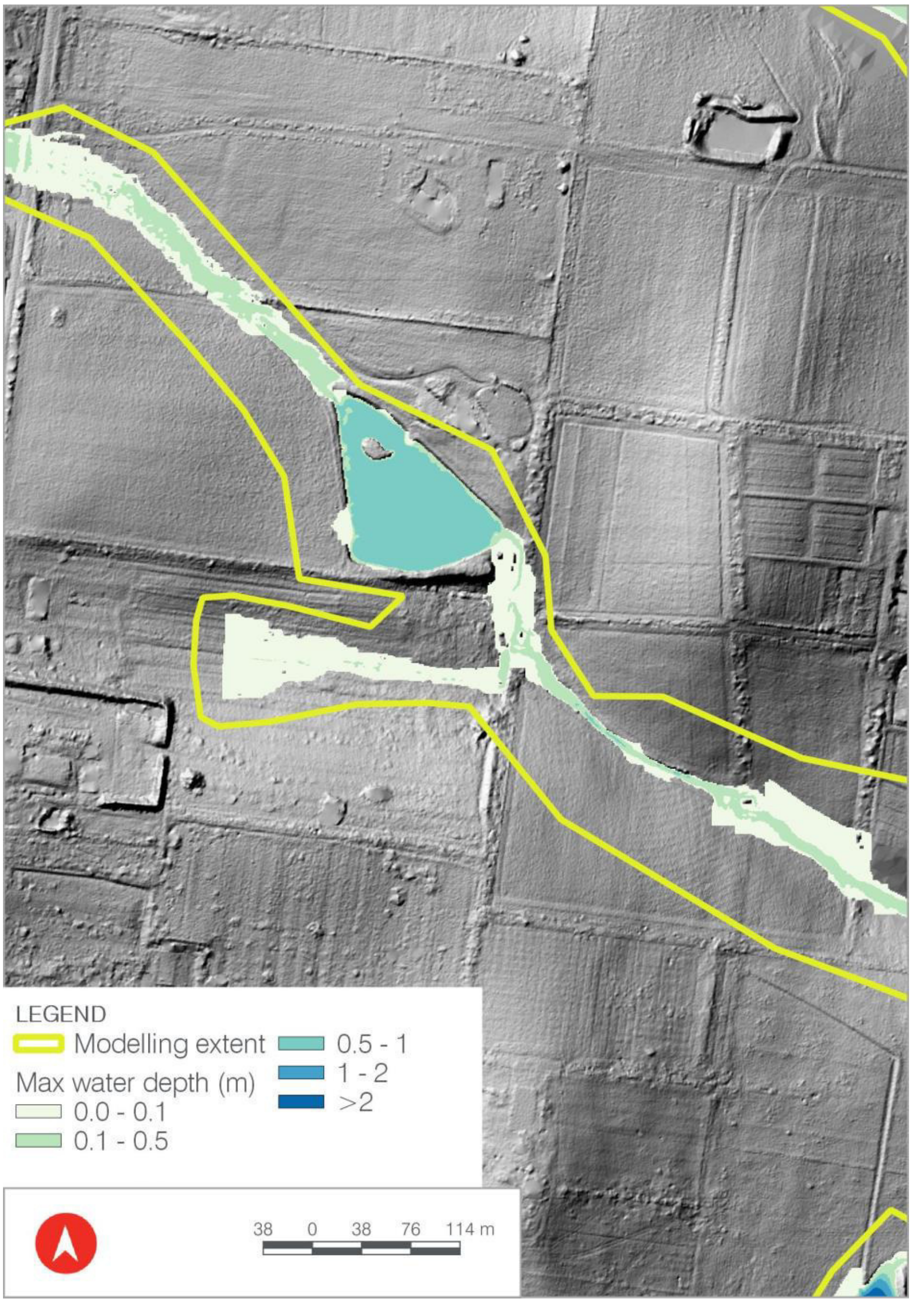


Figure 8: 100-year ARI Existing Conditions Flood Depth

Figure 9: 100-year ARI Proposed Conditions Flood Depth

CONCLUSION

This document describes the TUFLOW model build and assumptions used for the Ash Road East flood study. For details of model build for the Mollers Lane Flood Impact Assessment, please refer to *Site Stormwater Management Plan and Flood Impact Assessment* (TGM, 2018).

For full details of the Ash Road East stormwater management plan, including detailed flood modelling analysis, please refer to *Ash Road East, Leopold Stormwater Management Plan* (Spiire, 2020).

APPENDIX G – COLEBROOK WHITE CALCULATIONS

Colebrook-White Calculations

Project: Ash Rd East
Reference: 305162
Client: Eastern Ash Pty Ltd

INPUT DATA	
Pipe Type	RCP
Diameter	750 mm
Slope	1 in 200
k	0.6000 mm
OUTPUT DATA (complete formula)	
v	1.975 m/s
Qcap	0.872 m3/s

Comments: pipe flows for catchment F1

INPUT DATA	
Pipe Type	RCP
Diameter	1,050 mm
Slope	1 in 200
k	0.6000 mm
OUTPUT DATA	
v	2.433 m/s
Qcap	2.106 m3/s

Comments: pipe flows for catchment E

APPENDIX H – PC CONVEY OUTPUT

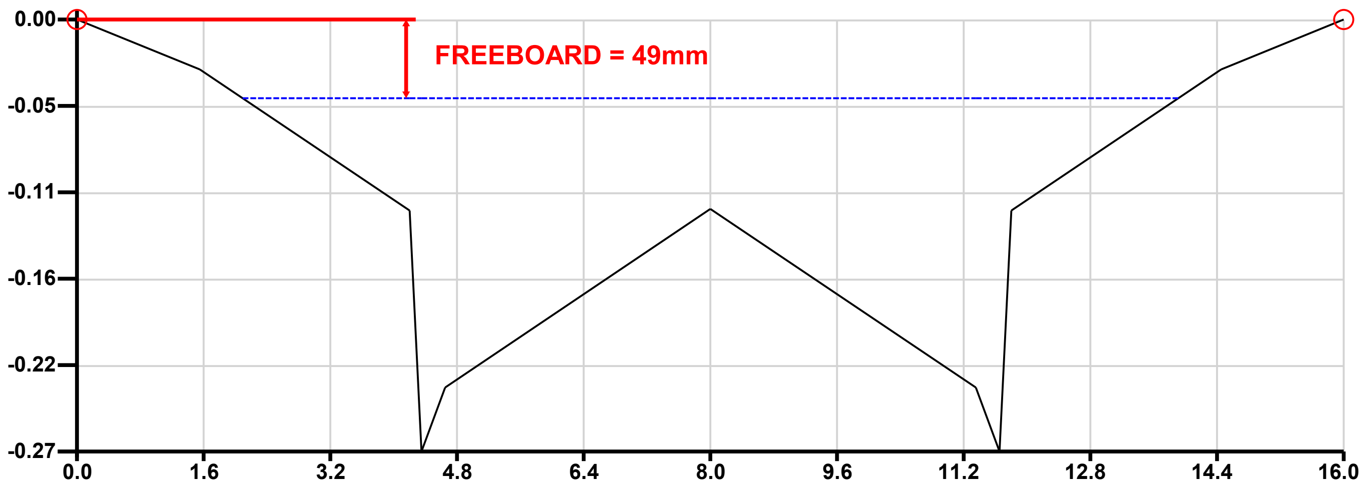
PROJECT: Ash Road East

Gap flow analysis

Print-out date: 12/02/2020 - Time: 12:07

Data File: \\spiire.com.au\geedata\Data\30\305162\Water\Stormwater and Flooding\PC CONVEY\1 in 200.dat

1. CROSS-SECTION:



2. DISCHARGE INFORMATION:

100 year (1%) storm event

Total discharge = 1.5 cumecs

There is no pipe discharge
Overland / Channel / Watercourse discharge = 1.500 cumecs

3. RESULTS: Water surface elevation = -0.049m

Grade = 1 in 200

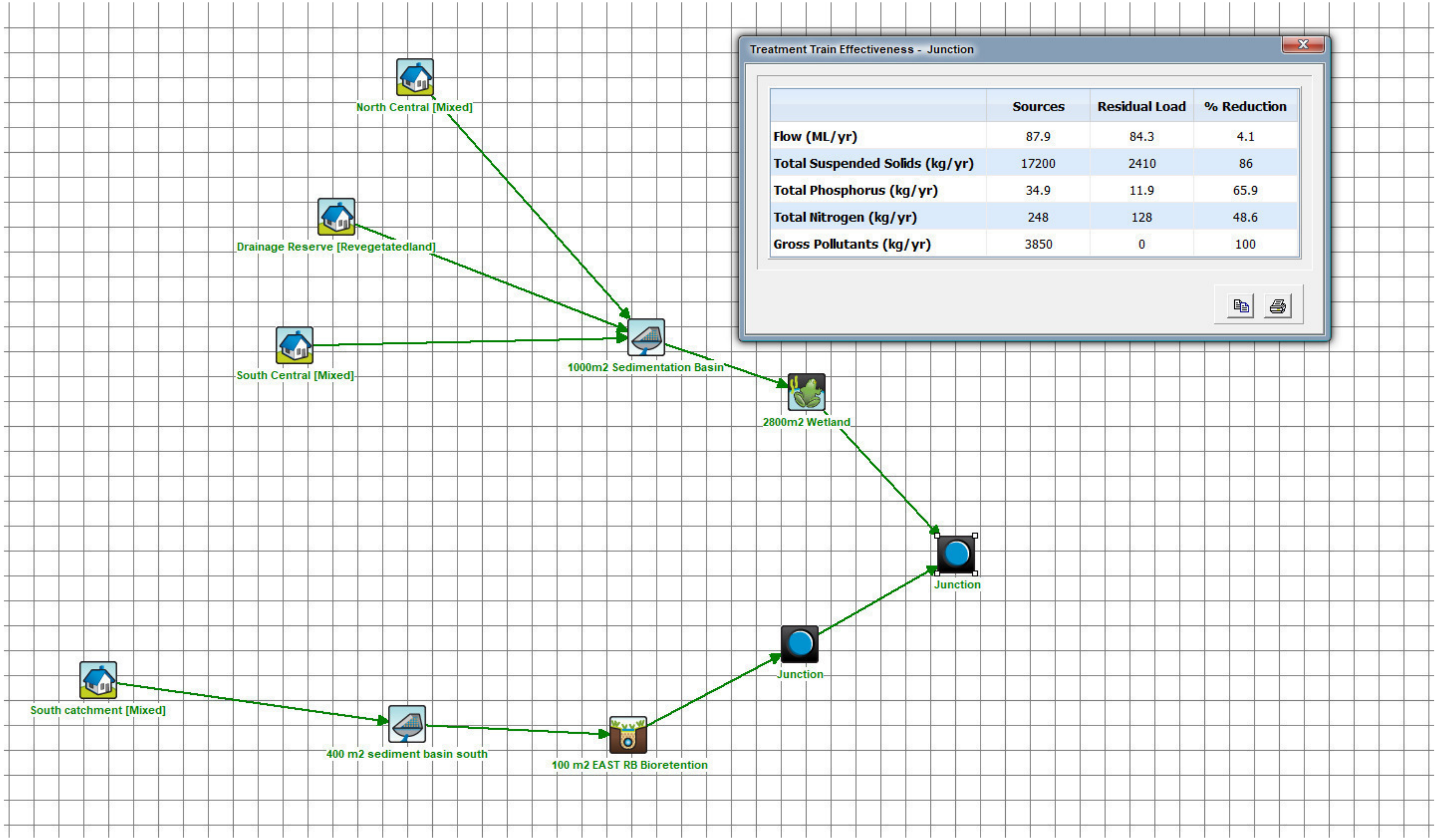
	LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK	TOTAL CROSS-SECTION
Discharge (cumecs):	0.00	1.58	0.00	1.58
D(Max) = Max. Depth (m):	0.00	0.22	0.00	0.22
D(Ave) = Ave. Depth (m):	0.00	0.10	0.00	0.10
V = Ave. Velocity (m/s):	0.00	1.38	0.00	1.38
D(Max) x V (cumecs/m):	0.00	0.30	0.00	0.30
D(Ave) x V (cumecs/m):	0.00	0.13	0.00	0.13
Froude Number:	0.00	1.42	0.00	1.42
Area (m^2):	0.00	1.15	0.00	1.15
Wetted Perimeter (m):	0.00	11.95	0.00	11.95
Flow Width (m):	0.00	11.82	0.00	11.82
Hydraulic Radius (m):	0.00	0.10	0.00	0.10
Composite Manning's n:	0.000	0.011	0.000	0.011
Split Flow?	-	-	-	No

4. CROSS-SECTION DATA:

	LEFT HAND POINT		RIGHT HAND POINT		
SEGMENT NO.	CHAINAGE (m)	R.L. (m)	CHAINAGE (m)	R.L. (m)	MANNING'S N
1	0.000	0.000	1.550	-0.031	0.002
2	1.550	-0.031	4.200	-0.119	0.002
3	4.200	-0.119	4.350	-0.269	0.002
4	4.350	-0.269	4.650	-0.229	0.002
5	4.650	-0.229	8.000	-0.118	0.020
6	8.000	-0.118	11.350	-0.229	0.002
7	11.350	-0.229	11.650	-0.269	0.002
8	11.650	-0.269	11.800	-0.119	0.002
9	11.800	-0.119	14.450	-0.031	0.002
10	14.450	-0.031	16.000	0.000	0.002

APPENDIX I – MUSIC MODEL AND ASSUMPTIONS

ASH ROAD EAST LEOPOLD: MUSIC MODEL PARAMETER SETTINGS



	Sources	Residual Load	% Reduction
Flow (ML/yr)	87.9	84.3	4.1
Total Suspended Solids (kg/yr)	17200	2410	86
Total Phosphorus (kg/yr)	34.9	11.9	65.9
Total Nitrogen (kg/yr)	248	128	48.6
Gross Pollutants (kg/yr)	3850	0	100

- Climatic data used: Geelong North 1971 – 1990
- Catchment parameters: Soil Storage Capacity – 120mm, Field Capacity = 50mm
- Fraction Impervious values: residential = 0.7, open space = 0.1

WSUD element	**Central drainage reseve**	**Southern drainage reserve**
Sediment Pond NWL area/volume/EDD	1,000m^2, 1,000m^{3-}, 0.35m	400m^2, 400m^3, 0.50m
Wetland NWL area/volume/EDD	2,800m^2, 1,120m^3, 0.35m	NA
Raingarden area/EDD	NA	100m^2, 0.3m

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the 'Shallow marsh zone planting depth' and 'Deep marsh zone plating depth'.

Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

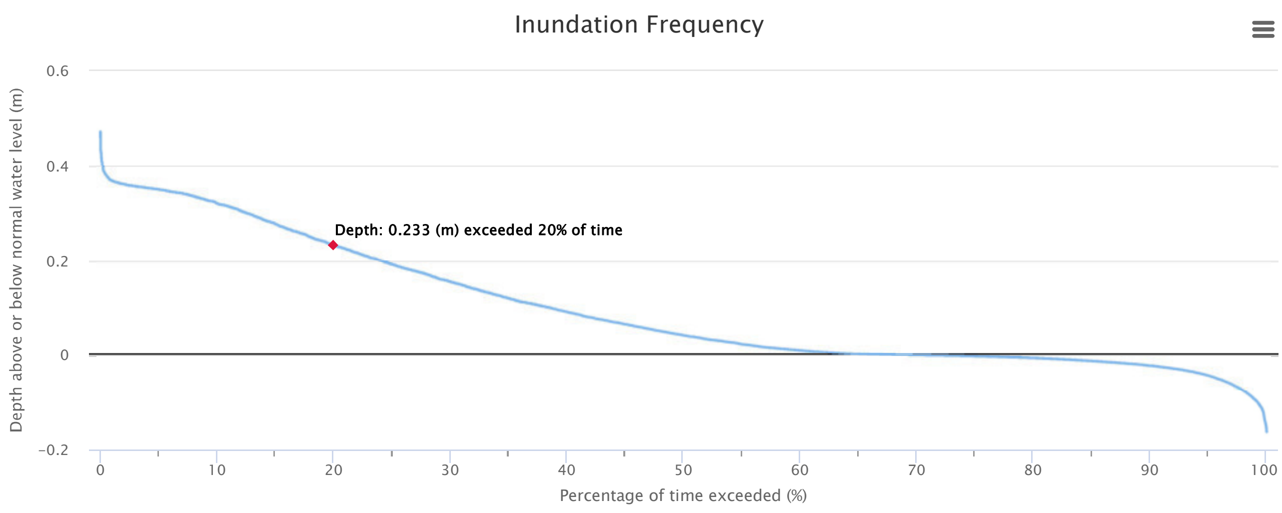
Please enter the permanent pool volume.

Permanent Pool Volume 1120 m�

Please select the daily flux file generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Browse...

FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
	1	☑		Shallow Only

Sea Club-rush *Bolboschoenus caldwellii*				
Water Ribbons *Triglochin procerum*	1	☑	☐	
Jointed Club-rush *Baumea articulata*	1.8	☑	☐	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☐	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☐	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☐	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☐	☐	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☐	Deep Only
Common reed *Phragmites australis*	2.5		☐	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

+ Add user defined plant

Report

File: Ash Rd wetland flux file.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.233 m

Water level exceeded for 50% of time: 0.0425 m
·Effective water level is within 50 mm of normal water level and is acceptable.

90th Percentile Residence Time: 3 days

☐ Spells Analysis?

APPENDIX J – TGM HYDROLOGY MEMO

Technical Memorandum

Title	**Ash Road Development** **Site Hydrology Modelling**		
Client	Eastern Ash Pty Ltd	**Project No**	19984-01
Date	21/10/2019	**Status**	Final
Office	Geelong	**Discipline**	Civil

1.1 BACKGROUND

Cardno TGM has been engaged by Eastern Ash Pty Ltd to undertake hydrological modelling and provision of hydrological catchment flow data to aid in the preparation of a Flood Impact Assessment (FIA) and catchment scale Stormwater Management Plan (SMP), in response to City of Greater Geelong (CoGG) and Corangamite Catchment Management Authority (CCMA) comments, relating to a planning permit application for the proposed development site at Ash Road East, Leopold.

Cardno TGM have previously submitted and received subsequent approval for the Mollers Lane, Leopold – Rezoning and Subdivision FIA and SMP at the adjacent site in which the Ash Road Development forms an upper sub catchment. Given the previous works undertaken by CardnoTGM for the adjacent Mollers Lane, Leopold developments, CoGG and the CCMA have requested that the modelling for the site be directly comparable to the earlier mapping undertaken.

To allow the creation of a comparable 2D hydraulic model CardnoTGM have provided to Spiire all boundary conditions utilised in the endorsed FIA *Mollers Lane, Leopold – Rezoning And Subdivision Memorandum – Site Stormwater Management Plan and Flood Impact Assessment - Consolidated Detention Basin for Southern Site (Mollers V4).* Hydrograph information provided consisted of local catchment existing and developed hydrograph information for the 1% AEP, 2% AEP, 5% AEP, 10% AEP 0.2 EY and 0.5 EY for the local and regional catchments. The 540-minute critical event for the full range of AEP's was provided as per '*Mollers V04'* for the regional catchments and 10minutes to 720minutes durations for the local catchments as determined through this investigation.

The subject land is comprised of properties 73-85, 87-101, 103-127 & 129-141 Ash Road, Leopold. The combined land parcels are currently zoned as Farming Zone (FZ) under the Greater Geelong Planning Scheme.

An external sub catchment west of Ash Road zoned General Residential Zone Schedule 1 (GRZ1) is also included in the study as per *Mollers Lane, Leopold – Rezoning And Subdivision Site Stormwater Management Plan And Flood Impact Assessment Revision 02*, *(Mollers V02)* and *(Mollers V04).*

This report and the referenced reports nominated provide an explanation and background to the hydrological assessment of the subject site and its sub catchment and details expected critical flowrates and hydrographs for the required 2d hydraulic assessment to further aid in the preparation of a site-specific FIA and catchment scale SMP for the Ash Road development site.

1.2 STUDY AREA

The subject site currently comprises a rural holding of approximately 29 hectares and is generally located to the south/east of the established urban area of Leopold.

The subject site has a frontage onto Ash Road and provides a logical extension to the previously approved Mollers Lane Development located to the east.

1.2.1 Existing Site Conditions

The subject site has an elevation ranging from 52 m AHD in the north sector to 34 m AHD in the southern sector. There is a distinct gully that collects and conveys stormwater flows from within and external to the site in a south easterly direction.

A smaller sub-catchment also exists in the northern portion of the site separated by a minor ridgeline. Flows from the northern catchment discharge east towards the adjacent Mollers Lane site.

The existing site contours can be seen in Figure 1-1.

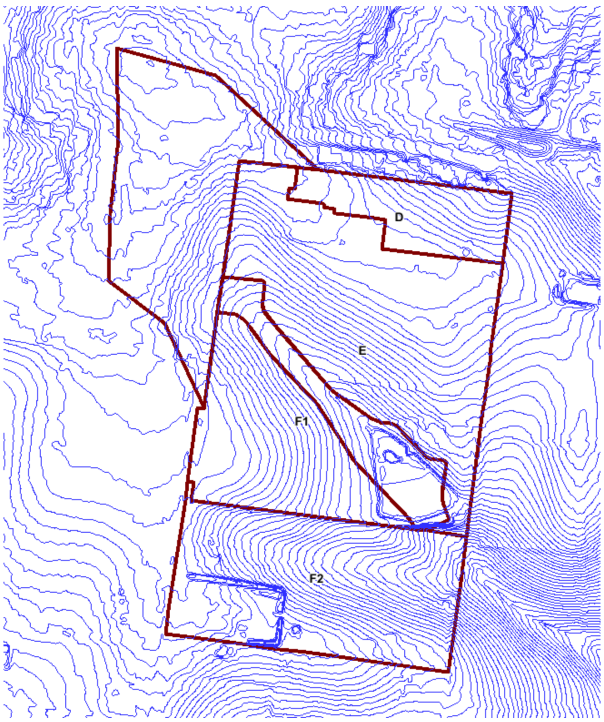


Figure 1-1 Existing Site Contours

The site currently comprises a rural holding of approximately 29 hectares of pervious area with a contributing upstream developed catchment on the western side of Ash Road of approximately 6.9Ha (As discussed with council and subsequently nominated in Mollers V02 and Mollers V04).

Catchment outflow hydrographs have undergone slight amendment to better represent the exact sizer and slope of the catchments but are fundamentally as per Mollers V04 and Mollers V02 with the exception of catchment F. Catchment F has been separated into two sub catchments to allow separation of catchment flows and provide additional input locations for hydraulic modelling and subsequent detail design of the Ash Road Development.

The Ash Road Development existing sub catchments are provided in Figure 1-2 and Table 1-1;

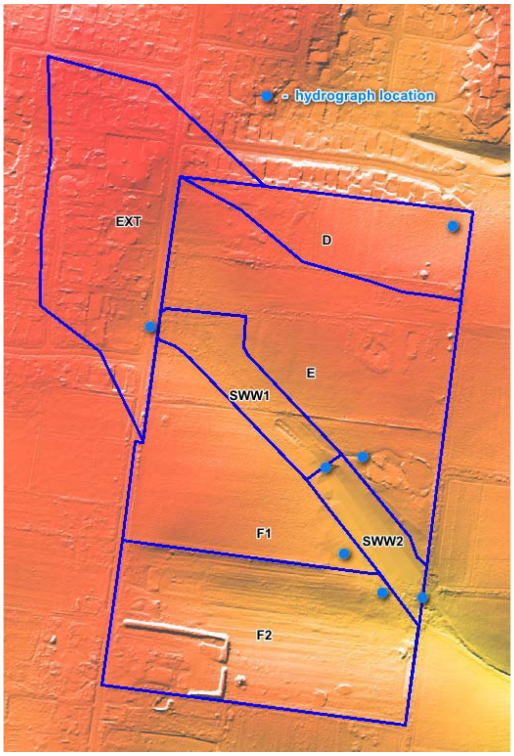


Figure 1-2 Existing Site Catchments and Hydrograph Input Locations

Catchment	Area (ha)	Fraction Impervious	Pervious Area (ha)	Impervious Area (ha)	Pervious Slope (%)	Impervious Slope (%)
D	3.30	0	3.30	0.00	2.50	1.80
E	8.95	0.15	7.61	1.34	2.80	2.50
F1	5.53	0	5.53	0.00	3.85	3.85
F2	8.24	0.1	7.42	0.82	1.40	4.25
SWW1	1.92	0	1.92	0.00	2.50	0
SWW2	1.36	0	1.36	0.00	2.50	0
Ext	6.90	0.6	2.76	4.14	2.50	2.50

Table 1-1 Existing Catchment Properties

1.2.2 Developed Site Conditions

The indicative development plan proposes creation of approximately 300 conventional residential housing lots within the developable site with a varying range of sizes between 210 and 1000m^2.

The proposed subdivision will increase impervious surfaces within the developed site. To account for this an impervious fraction of 70% has been adopted as per *Mollers V02* and the subsequently approved *Mollers V04.*

The Ash Road Development developed sub catchments are provided in Figure 1-3and Table 1-2 ;

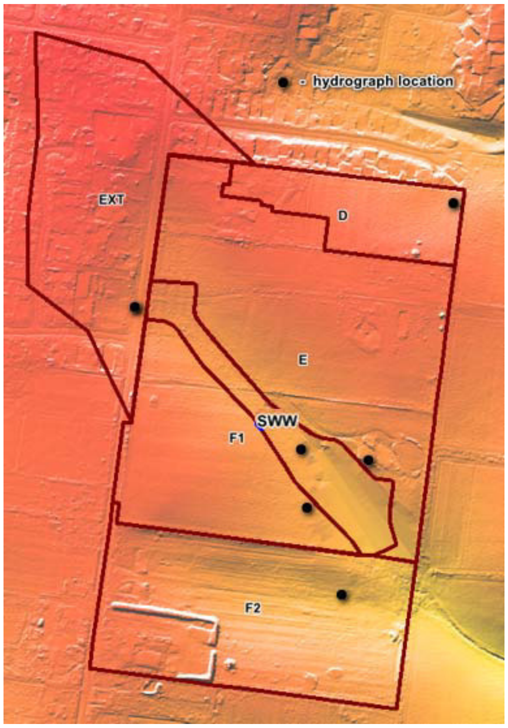


Figure 1-3 Developed Catchment Plan and Proposed Location of Boundary Conditions

Catchment	Area (ha)	Fraction Impervious	Pervious Area (ha)	Impervious Area (ha)	Slope (%)
D	2.66	0.7	0.80	1.86	2.4
E	10.40	0.7	3.12	7.28	2.6
F1	5.24	0.7	1.57	3.67	3.2
F2	8.48	0.7	2.54	5.94	4.1
SWW	2.51	0	2.51	0.00	1.9
Ext	6.90	0.6	2.76	4.14	2.9

Table 1-2 Developed Catchment Properties

1.3 HYDROLOGY

1.3.1 Site Loss Parameters

The hydrological modelling has been undertaken in line with the methodologies described within Mollers V02 All calibration factors utilised within the aforementioned report have been adopted for this analysis.

1.4 RESULTS

1.4.1 Local Catchments Critical Storm Duration - Existing

The critical duration for each design event probability and each sub-catchment may vary depending on a number of conditions. Therefore, consideration of a number of storm durations is important to ascertain the critical storm duration impacting the site and study area.

Outflow hydrographs for the !% AEP rainfall event for the various sub catchments are defined in the below figures. Table 1-3 identifies the various critical events for the full range of AEP's investigated.

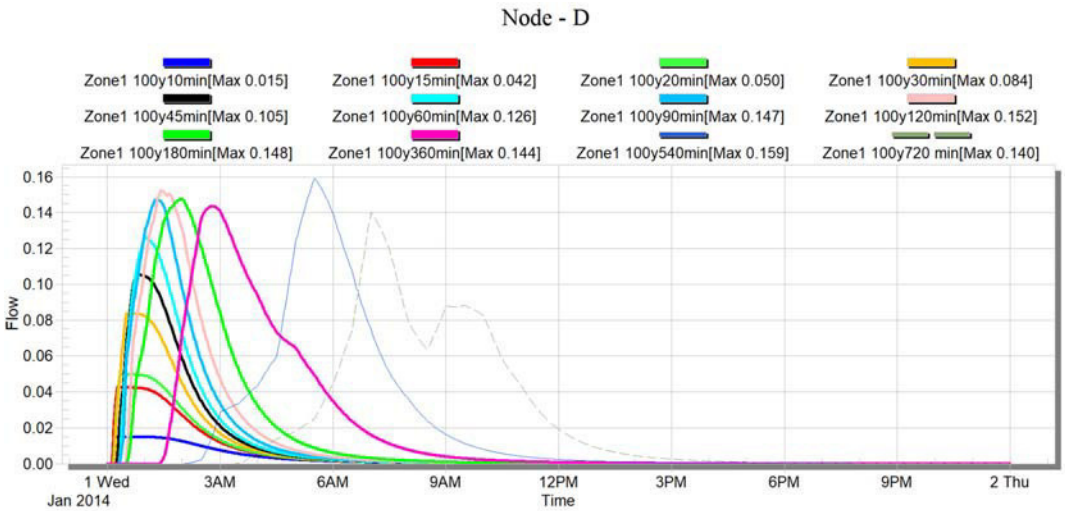


Figure 1-4 Existing Catchment D 1% AEP

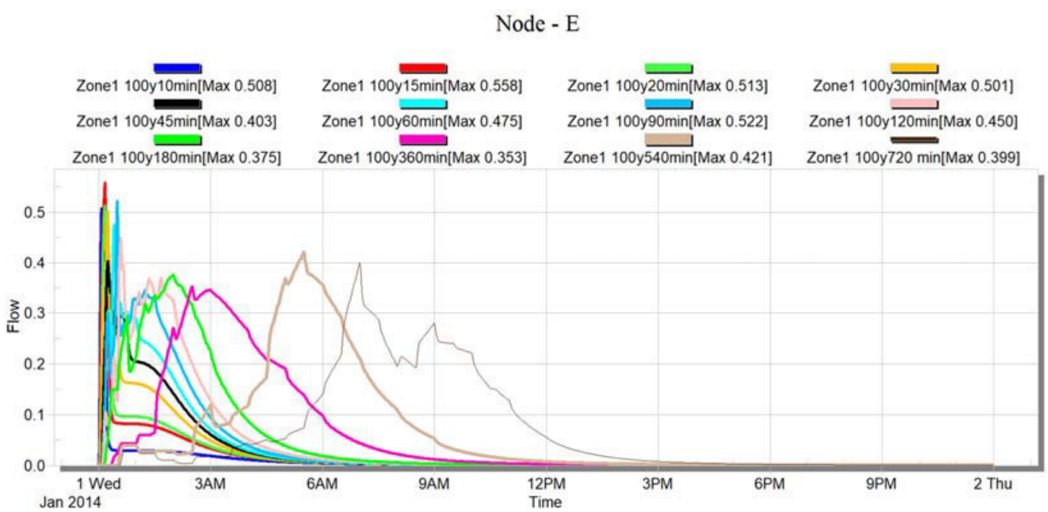


Figure 1-5 Existing Catchment E 1% AEP

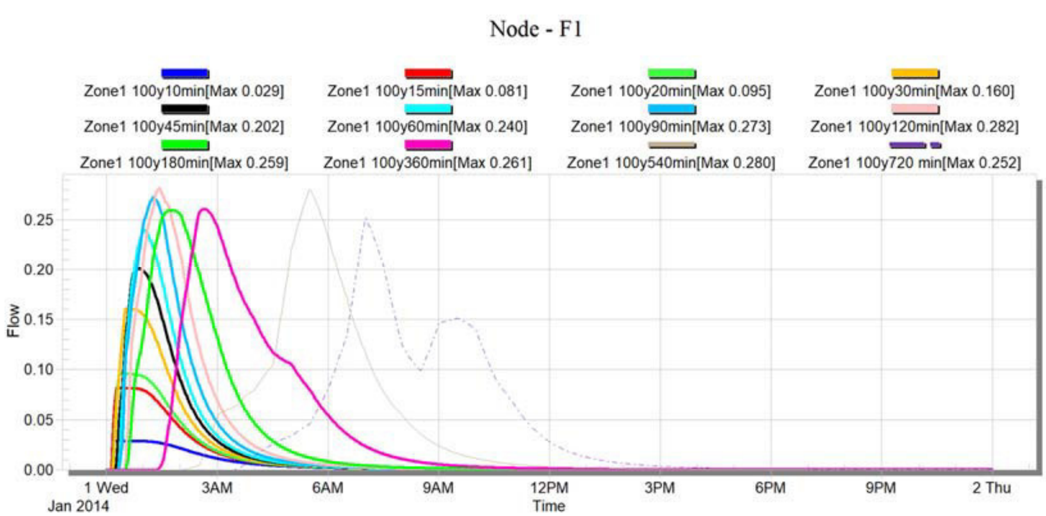


Figure 1-6 Existing Catchment F1 1% AEP

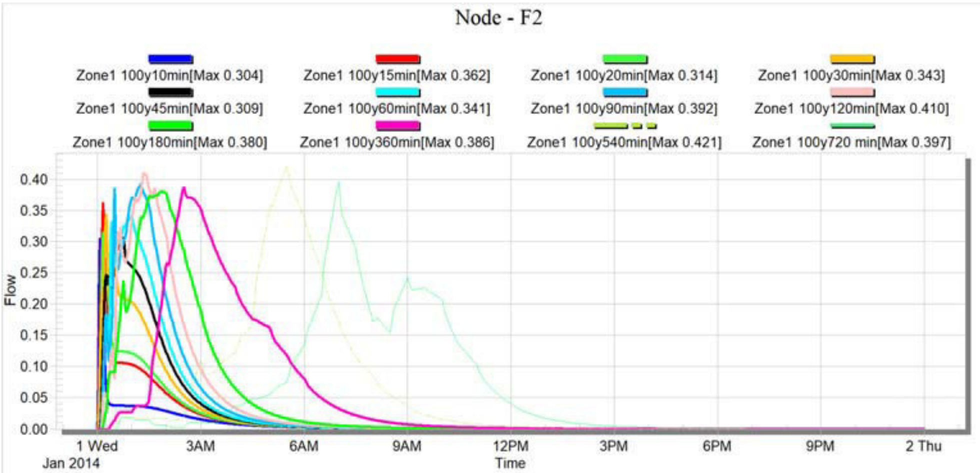


Figure 1-7 Existing Catchment F2 1% AEP

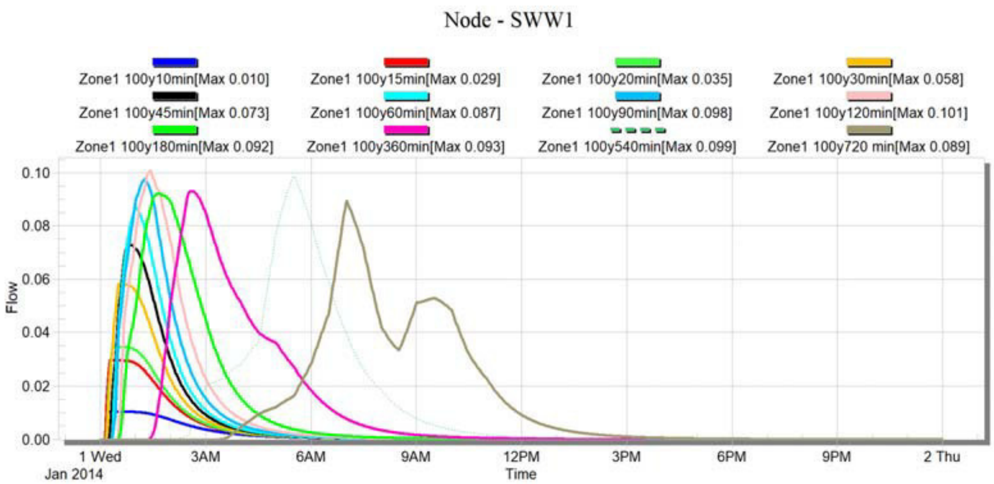


Figure 1-8 Existing Catchment SWW1 1% AEP

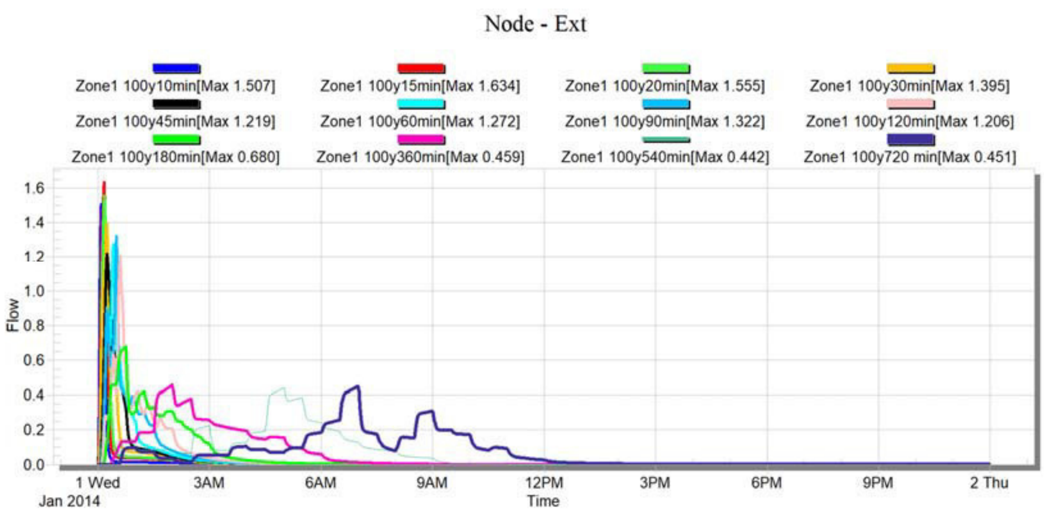


Figure 1-9 Existing Catchment Ext 1 1% AEP

No	1%	Dur (min)	2%	Dur (min)	5%	Dur (min)	10%	Dur (min)	0.2EY	Dur (min)	0.5EY	Dur (min)
D	0.16	540	0.13	540	0.11	540	0.08	540	0.07	540	0.04	540
E	0.56	15	0.47	15	0.39	15	0.33	15	0.28	15	0.21	15
F1	0.28	120	0.24	540	0.20	540	0.15	540	0.12	540	0.08	540
F2	0.42	540	0.36	540	0.30	540	0.24	540	0.19	540	0.13	15
SWW1	0.10	120	0.08	540	0.07	540	0.06	540	0.04	540	0.03	540
SWW2	0.08	120	0.06	120 & 540	0.05	540	0.04	540	0.03	540	0.02	540
Ext 1	1.63	15	1.40	15	1.20	15	1.00	15	0.85	15	0.62	15

Table 1-3 Existing Catchment Peak Outflows for various AEP rainfall events

1.4.2 Local Catchments Critical Storm Duration – Developed

Outflow hydrographs for the 1% AEP rainfall event for the various sub catchments are defined in the below figures. Table 1-4 identifies the various critical events for the full range of AEP's investigated;

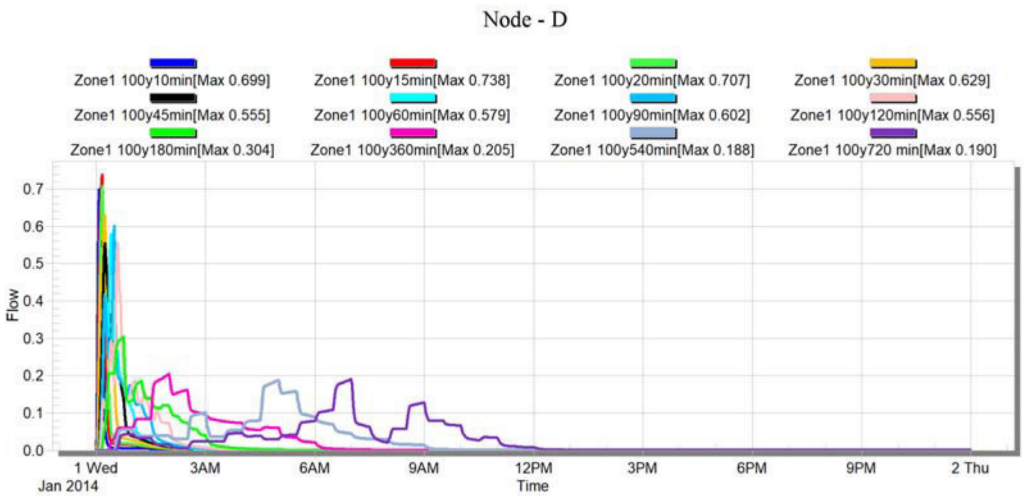


Figure 1-10 Developed Catchment D 1% AEP

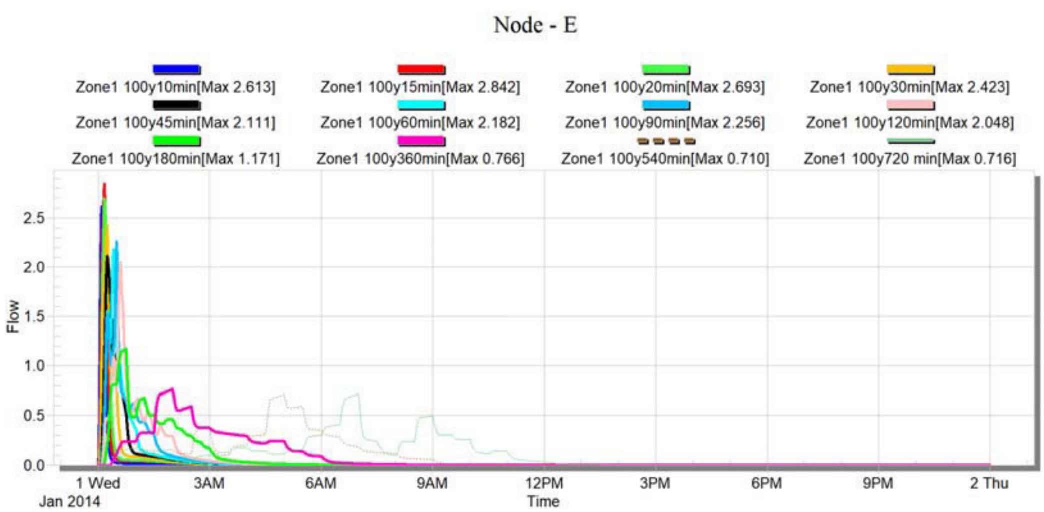


Figure 1-11 Developed Catchment E 1% AEP

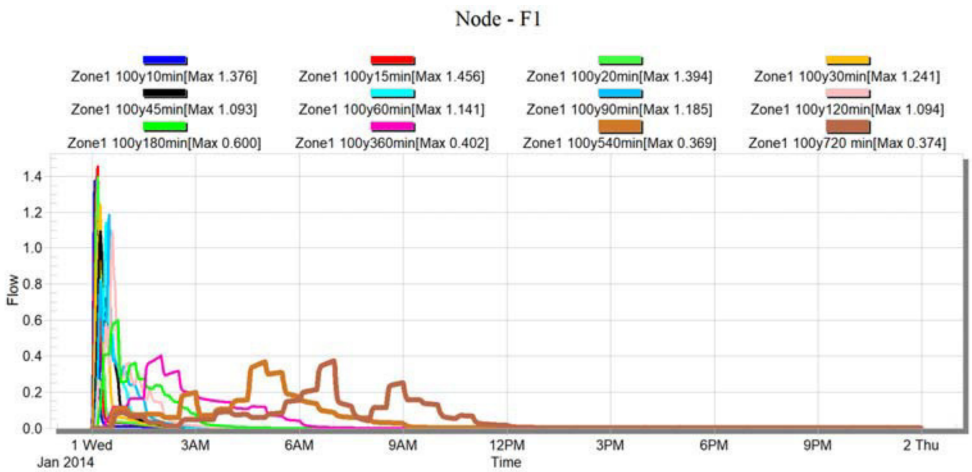


Figure 1-12 Developed Catchment F1 1% AEP

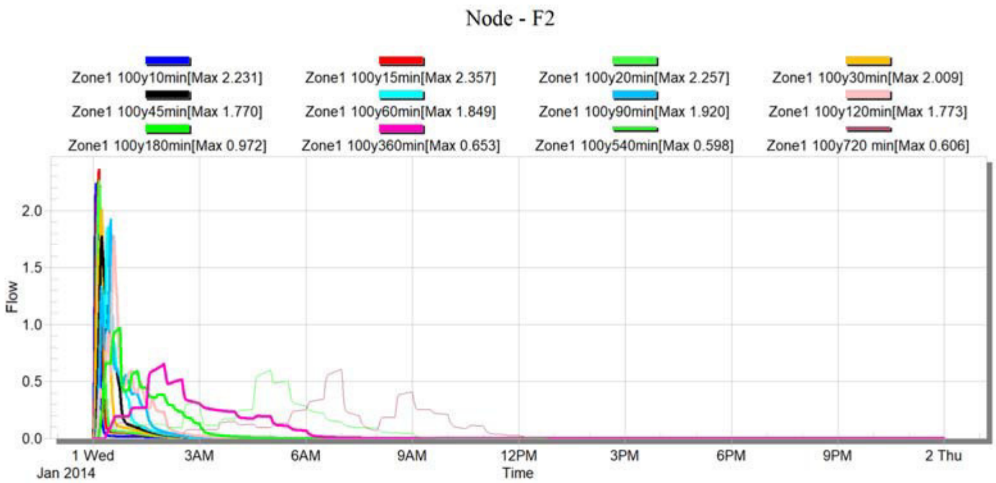


Figure 1-13 Developed Catchment F2 1% AEP

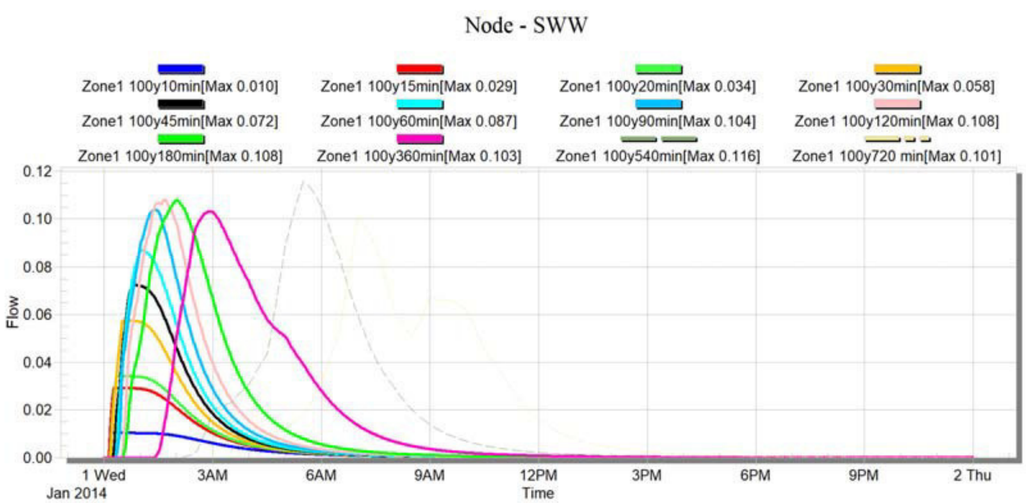


Figure 1-14 Developed Catchment SWW1 1% AEP

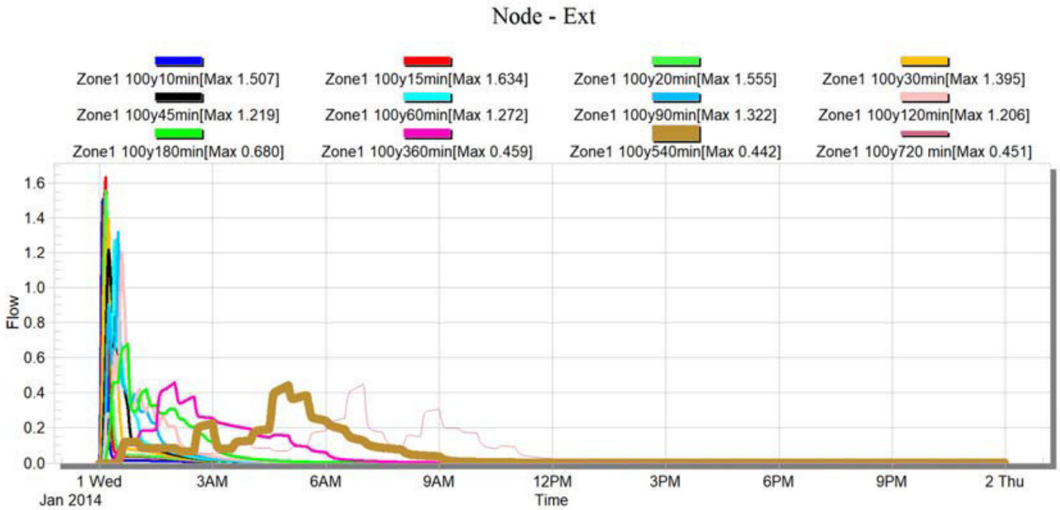


Figure 1-15 Developed Catchment Ext 1 1% AEP

Table 1-4 Developed Catchment Peak Outflows for various AEP rainfall events

No	1%	Dur (min)	2%	Dur (min)	5%	Dur (min)	10%	Dur (min)	0.2EY	Dur (min)	0.5EY	Dur (min)
D	0.74	15	0.63	15	0.54	15	0.45	15	0.39	15	0.29	15
E	2.84	15	2.44	15	2.08	15	1.72	15	1.46	15	1.03	15
F1	1.46	15	1.25	15	1.07	15	0.89	15	0.76	15	0.57	15
F2	2.36	15	2.03	15	1.74	15	1.45	15	1.23	15	0.9	15
SWW1	0.17	540	0.10	540	0.09	540	0.06	540	0.05	540	0.03	540
Ext 1	1.63	15	1.52	15	1.30	15	1.08	15	0.92	15	0.68	15

Flow hydrographs have been provided to Spire in *.csv format for 1% AEP, 2% AEP, 5% AEP, 10% AEP 0.2 EY and 0.5 EY flood frequencies and durations ranging from 10minutes to 720minutes. Peak flows from all reported catchments are presented above in Table 1-3 and Table 1-4

1.4.3 Regional Catchments Critical Storm Duration

Flow hydrographs utilised in Mollers V02 & Mollers V04 regional modelling have been provided to Spire in *.csv format for 1% AEP, 2% AEP, 5% AEP, 10% AEP 0.2 EY and 0.5 EY flood frequencies for the 540minute duration event to allow input into the relevant hydraulic models for assessment.

1.5 CONCLUSION

To allow the creation of a comparable 2D hydraulic model CardnoTGM have provided relevant Hydrograph information of the local and regional catchments for the 1% AEP, 2% AEP, 5% AEP, 10% AEP 0.2 EY and 0.5 EY rainfall events.

The hydrological modelling has been undertaken in line with the methodologies described within *Mollers V02* and all calibration factors utilised within Mollers V02 have been adopted for this analysis.