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Toral Drive and Jorl Court, Buderim

Master Drainage Study

Date: 31 May 2016

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1. INTRODUCTION

SMEC Australia was commissioned by the Sunshine Coast Council (SCC) to prepare a Master Drainage Study for Toral Drive and Jorl Court, Buderim. In conjunction with this study SCC is seeking guidance on the management of drainage related issues compounded by ongoing development in the catchment.

The properties which currently gain access to Toral Drive and Jorl Court have traditionally been larger rural residential style allotments. However, the majority of this land is currently zoned as either low or medium density residential. In recent years, a number of properties have intensified the use with unit and small lot housing projects having been approved and constructed. With the likely on-going pressure of intensification within this catchment, Council have identified the need to address drainage issues that are known within this catchment and take a holistic and equitable approach in implementing a drainage strategy.

SCC have identified that in formulating the drainage strategy for the catchment roads flows within Toral Drive and Jorl Court should be QUDM compliant, lots achieve the desired level of flood immunity and the strategy does not result in a loss of flood plain storage.

1.1. Study Objectives

The objectives of this investigation are as follows:

1. Development of a contemporary surface and drainage 1D / 2D model (rain on cell) representing the existing stormwater drainage networks and surface flow within the study catchment area;
2. Identify and collect any additional survey data required to assist the study;
3. Development of an ultimate development model which accounts for:
    a. future development based on zoning,
    b. augmentation of the drainage network to facilitate safe functioning of Toral Drive and Jorl Court
    c. Preservation of flood plain storage
    d. Mitigation of offsite impacts using onsite detention volume
4. Undertake sensitivity assessment on key parameters such as temporal pattern, boundary conditions, channel roughness and fraction impervious.
5. Undertake a serve storm impact assessment to ensure the proposed mitigation strategy does not introduce new hazards in an extreme storm event.
6. Prepare brief report, concept design and flood mapping (2, 10, 100 and 2000yr ARI) in hard copy and in an electronic GIS format, suitable for incorporation into SCC's Geospatial database

1.2. Study Area

The Toral Drive and Jorl Court catchment can be described as rural residential, with a mix of low and medium density residential as well as open space. The catchment area is spilt by the Sunshine Motorway and Tanawha Tourist Drive. There are two main catchments, one which drains from south to north to Mountain Creek, while the other drains from west to east and contributes to the Mooloolah River.

The catchment is relatively steep upstream of Sunshine Motorway and Tanahwa Tourist Drive, however, becomes quite flat in the downstream portion where the potential for development intensification occurs. Catchment elevations range from 15m to 72m AHD. A locality plan of the general study area is provided below in **Figure 1**.

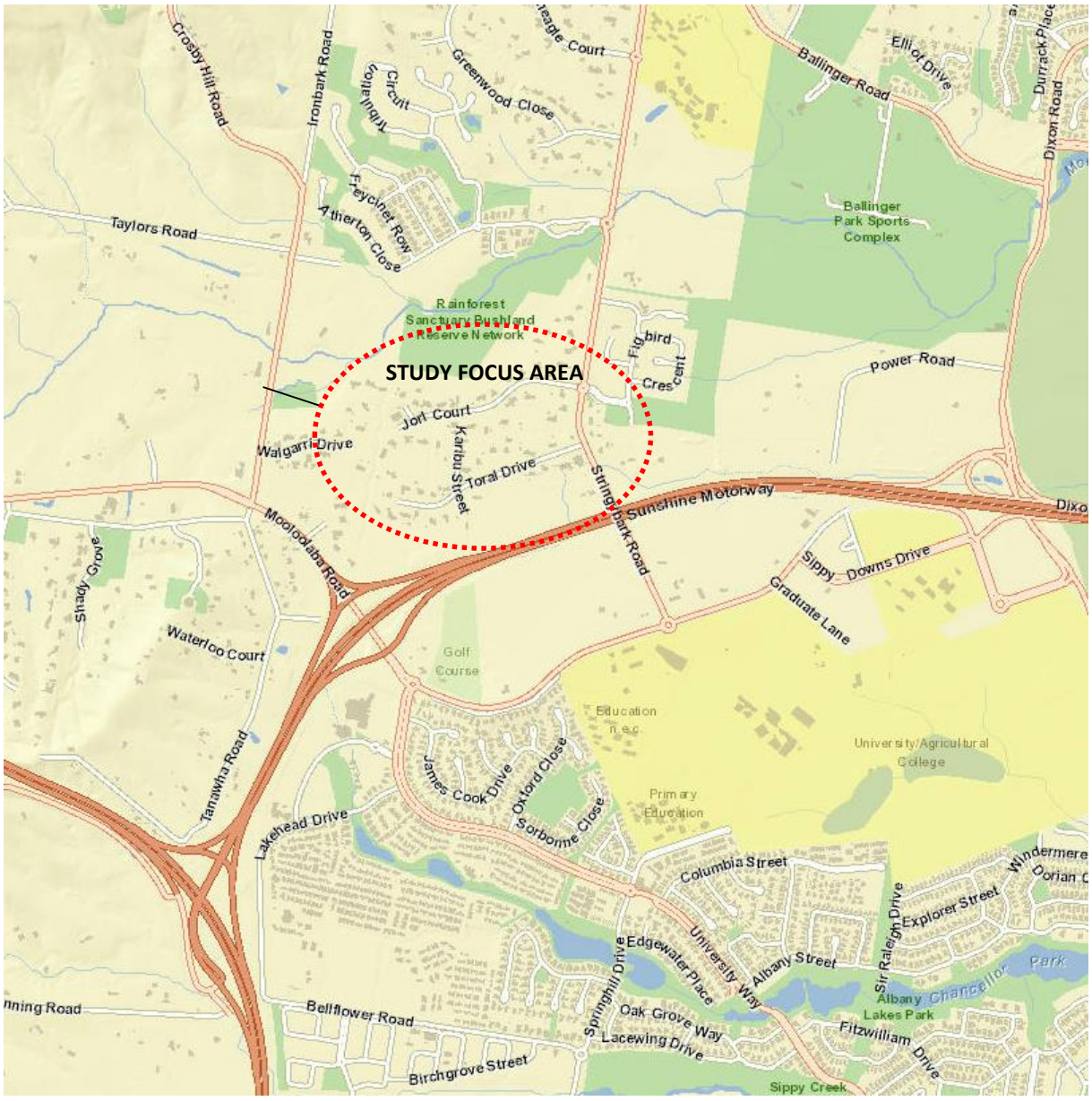


Figure 1: Locality Plan

2. DATA

The following data detailed in **Table 1** was reviewed and used in this assessment:

Table 1: Summary of Study Data

Item No	Data Description
1	1 metre resolution digital elevation model (DEM) based on Aerial LiDAR survey captured by DERM in 2014 (vertical accuracy of +/- 200mm (2 sigma error rate)
2	Aerial photography captured by NearMap (26 October 2015).
3	Stormwater pipe, pit and infrastructure GIS information supplied by SCC.
4	Detailed survey commissioned as part of this project undertaken by LSD Surveys of drain contributing to Jorl Drive.
5	Duration Independent Storm (DIS) rainfall intensity data for design event simulation has been provided by SCC.

3. MODEL SETUP

3.1. Hydrology

The study area of this investigation was assessed using the "direct rainfall" or "rain on cell" method within the TUFLOW model. In the direct rainfall approach, rainfall is directly applied to every cell in the 2D model domain and the rainfall-runoff processes that generate stormwater runoff flows throughout the catchment are simulated by the flood model. From within the hydraulic model, catchment loss parameters were applied as outlined in **Table 2**.

Table 2: Direct Rainfall Catchment Loss Parameters

ID	Type	Initial Loss (mm/hr)	Continuing Loss (mm/hr)
1	Road Pavement	0	0
2	Road Reserve	0	0
3	Rural Residential	0	0
4	Water	0	0
5	Medium Density Residential	0	0
6	Environmental / Forest	0	2.5
7	Concrete / Grassed Channel	0	0
8	Thick Vegetation / Covenant	0	0
9	Medium Vegetation	0	0
10	Low Density Residential	0	0

3.2. Hydraulics

3.2.1. Model Software

Hydraulic modelling has been carried out using the TUFLOW software developed by BMT WBM in Brisbane. TUFLOW is a suite of numerical engines primarily used in hydraulic studies involving waterways, floodplains, estuaries and coastlines. It is suited to the investigation of flood behaviour in complex flow scenarios where there is interaction between flow paths that occur in both small and large flooding scenarios.

TUFLOW contains a 2d hydrodynamic model with dynamically linked 1D computations. The 2d element solves the depth averaged shallow water equations, representative of flood wave propagation, through mass and momentum continuity. The 1D element, consisting of the unsteady St Venant fluid flow equations, allows for a full dynamic link between modelled 1D elements and the free surface.

TUFLOW version 2013-12-AD-w64 has been used for this investigation.

3.2.1. Model Extents

The TUFLOW model has been developed as a 'rain on cell' model of the catchment which contributes to Toral Drive and Jorl Court. An overview of the key model features, along with the thematic mapping of the topography is provided in **Appendix A**.

3.2.2. Topography

The catchment topography has been defined using a 2D grid model using a 2m cell size. The underlying topography layer used in the model is based on the 2014 aerial LiDAR DEM supplied by SCC.

Terrain modification to represent modification to future allotments, and road and drainage upgrades has been performed within TUFLOW using zshape files (2d_zsh).

3.2.3. Pit and Pipe Network

All known pit, manhole and pipe infrastructure (>300mm) within the model extent has been represented within the TUFLOW model as 1D structures. The initial pit and pipe data was sourced from SCC GIS layers provided at the start of the project. This data was transferred to the relevant 1d_nwk (pit and pipe) and 1d_mh (manhole) layers for use within TUFLOW. Pit locations and sizes were verified through a combination of site visits and google street view. Some pipe invert and dimension details were missing from the GIS data set provided by SCC. Missing values were interpolated based on the upstream and downstream invert levels, and pipe lengths.

Road pits were represented using 1d_nwk files within model. Each pit was assigned an inlet curve based of the pit inlet type and longitudinal grade of the road (derived from HEC-22). The combination of inlet types applied within the model area outlined below in **Table 3**. Inlet curves are provided in **Appendix B**.

Table 3: Pit Inlet Types

Inlet Type	Inlet Size
Sag Inlet	Grate only or constrained lintel (VS)
	1.2m lintel no grate (S)
On-Grade Inlet	1.2m lintel with grate (S)
	2.4m lintel with grate (M)
	3.6m lintel with grate (L)

Inlet Type	Inlet Size
Field Inlet	900x900mm grate

3.2.4. Structures

All significant hydraulic structures (i.e. culverts) within the model extent have been included in the TUFLOW model. These are limited to the culvert (1d_nwk structures that are located along the waterway that runs north-south into Mountain Creek and channel that run west-east under Stringybark Road. The details of these structures were supplied by SCC or sourced from design drawings.

3.2.1. Hydraulic Roughness

Hydraulic roughness values and areas have been provided by SCC for use within this investigation. The hydraulic roughness values presented in **Table 4** were applied to the model setup.

Table 4: Hydraulic Roughness Values

ID	Type	Manning's n
1	Road Pavement	0.015
2	Road Reserve	0.022
3	Rural Residential	0.060
4	Water	0.020
5	Medium Density Residential	0.040
6	Environmental / Forest	0.140
7	Concrete / Grassed Channel	0.030
8	Thick Vegetation / Covenant	0.150
9	Medium Vegetation	0.080
10	Low Density Residential	0.050

3.2.1. Boundaries

The study area has been represented as a direct rainfall model (2d_rf). This method allows a rainfall hyetograph to be applied directly to each cell.

The outflow boundary to the model has been represented as a Height versus Flow (HQ) (2d_bc), which has been applied as a normal depth rating curve.

With direct rainfall models, rainfall is applied to each cell within the model defining the respective flow paths and catchments. The area in which rainfall is applied is generally slightly larger than the actual catchment. Because of this, runoff will flow away from the main outlet boundary. To ensure these flows have an outlet boundary to leave the model, a Height versus Flow (HQ) has been applied around the remaining model extent (2d_bc). This has been applied as a normal depth rating curve.

3.3. Existing Scenario

The existing case scenario forms the base case of the study. In the existing scenario all roads, topography and stormwater infrastructure has been setup to represent what is exhibited in the catchment at the time this investigation was prepared. There are three developments which have

recently been approved and under construction have been included as part of the existing scenario. The following development sites have been included:

- 11 Toral Drive
- 16 Toral Drive
- 148-150 Stringybark Road

Details of the existing scenario TUFLOW model are presented in **Appendix A**.

3.4. Proposed Scenario

A proposed scenario has been developed which builds on the existing scenario to represent applications which are currently in the approval process. These sites have been represented to reflect the development layouts currently lodged with Council. The following development sites have been included within proposed scenario:

- 18-20, 22-24 and 26-28 Toral Drive
- 47-19 and 53 Toral Drive
- 60 Toral Drive
- 14-16 Jorl Drive

This scenario was conducted to gain an understanding of the flooding in relation to these proposed developments, however, whilst these results were not specifically used to guide a mitigation solution, this scenario may be used to guide or assess the flood immunity requirements for individual development application (prior to flood mitigation being installed).

3.5. Mitigation Scenario

The mitigation scenario has been developed to improve flooding conditions based on the ultimate development potential within the catchment. The ultimate development potential has been based upon the current land-use zonings within Council's Planning Scheme (refer **Appendix C**). Mitigation measures have been developed to include:

- Create lots which are flood free in the 1% AEP (2100) – On sites which were affected by flooding in the existing scenario, the lot levels were raised within the model to create a flood free area. In doing this consideration was given to limiting offsite impacts and maintaining flow paths and flood storage.
- Ensure Toral Drive and Jorl Court are QUDM compliant (road flow depths <250mm) in the 1% AEP (2100) – Generally, road flow depths were reduced through the placement of additional drainage infrastructure within the road reserves. In Toral Drive, this was achieved through reducing backwater levels, raising a sag in the road and modification of the verge.
- Maintain flood storage in 100 year ARI (2100) – Lots at 2-28 Toral Drive had a significant amount of flood storage in the existing scenario. To maintain flood storage volumes, an area of cut on each lot was provided to offset the placement of fill located to achieve flood immunity requirements.
- Implementation of on-site detention for future developments – Runoff from each site was collected and routed through an on-site detention node which throttled back flows entering the piped network within Toral Drive and Jorl Court. Different rates of detention were applied to Low and Medium Density Residential.

Details of these features are represented in the design scenario TUFLOW model, which are presented in **Appendix A**.

4. DESIGN FLOOD EVENTS

4.1. What is a Design Flood

A design flood (or design event flood) is a hypothetical flood which is used for planning, design and floodplain management. A design flood is typically defined by a probability of occurrence which, in Australia, is commonly defined using 'Average Recurrence Interval' (ARI) or 'Annual Exceedance Probability' (AEP). By way of example, the 1% AEP flood is equivalent to a 100 year ARI flood and these represent a best estimate for a flood size that has 1 chance in 100 of being exceeded in any given year.

It is important to note that the probability of a particular design flood occurring is not related to how long it has been since a similar size flood has occurred. This is pointed out to dispel the common misconception by the public that, for example, a 100 year ARI flood occurs every 100 years.

4.2. Hydrology Methodology

4.2.1. Duration Independent Storm (DIS)

Design event hydrology has been carried out using SCC's preferred method which utilises the concept of the 'Duration Independent Storm' (DIS). This method has been commonly applied to other flooding investigations within Council's local government area.

Using a DIS design event approach negates the need to run numerous design flood durations for a single ARI in order to determination the critical storm duration.

The DIS is an artificial rainfall event, which for this investigation has a total duration of 24 hours. It has a peak rainfall intensity halfway through the event (at 12 hours) which is based upon a 5 minute duration rainfall intensity (IFD) calculated using Bureau of Meteorology (BoM) 2013 IFD. The rainfall intensity either side of this peak then reduces at a rate which ensures that BoM 2013 IFD intensities are achieved for all standard rainfall event durations up to 24 hours.

The DIS rainfall intensity data has been supplied by SCC and the following design events have been simulated for this project.

- 2 Year ARI (39.35% AEP)
- 10 Year ARI (9.5% AEP)
- 20 Year ARI (5% AEP)
- 50 Year ARI (2% AEP)
- 100 Year ARI (1% AEP)
- 500 Year ARI (0.2% AEP)
- 2000 Year ARI (0.05% AEP)
- Probable Maximum Flood (PMF). This is the flood resulting from a Probable Maximum Precipitation (PMP) event.

4.2.2. Design Event Loss Rates

As no calibration of the runoff model took place, no rainfall proportional loss rates have been applied.

4.2.1. Climate Change

Design event modelling has been carried out based on both the current climate (40%, 10% and 0.05% AEP) and future climate scenarios (1% AEP).

To simulate climate change design events, DIS rainfall intensities have been increased by 20%. This figure was recommended by SCC and was based upon the Queensland Government 2010 publication "Increasing Queensland's resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study".

The 20% increase in rainfall intensity is associated with a 4 degree Celsius increase in temperature by 2100 (5% per degree).

4.3. Hydraulics Methodology

4.3.1. Culvert and Pit Blockage

There are a number of cross-road culvert structures within the catchment. These are mainly in association with the Sunshine Motorway. The culverts within the model are located along the south-north waterway and these culverts have been modelled assuming a 20% blockage.

The pipes within the underground stormwater network have been modelled assuming a 0% blockage; however, blockage factors have been applied to the inlet pits. The blockage factors for inlet pits are based on those recommended in QUDM and have been applied to the storage curves. A summary of the blockage factors is presented below in **Table 5**.

Table 5: Blockage Factors

Type	Inlet	Blockage
Design Event Runs		
Sag	Lintel only	20%
	Grate only	50%
	Lintel with grate	Capacity of lintel
On-grade	Lintel only	20%
	Lintel with grate	27%
	Grate only	50%
Field Inlet	Grate only	50%

4.3.1. TUFLOW Simulation

In order to reduce TUFLOW runtimes, noting that the DIS storm runs for 24 hours, the model was run from 10 hour to 13 hour to ensure that the peak at 12 hour is adequately represented. Review of the pipe and surface flows through the catchment shows that the peak flows are reached within this timeframe.

A 1 second time step has been applied to the model 2m grid.

4.4. Mapping

In utilising the direct rainfall method, every cell within the 2D model extent will become wet with flowpaths forming according to the model terrain. As a result of this method, when processing results the entire model extent will report a flow depth. To ensure that results and mapping are presentable, filtering of the model outputs needs to occur in line with grid size and accuracy of survey.

The 2m grid is mostly represented from the LiDAR DEM which contains a vertical accuracy of +/- 200mm (2 sigma error rate). As such the mapping extents within the 2m grid section of the model have only been reported where flow depths are greater than 50mm.

5. RESULTS

5.1. Existing Scenario

The Existing Scenario model has been setup and run to provide an understanding of the existing flooding characteristics within the catchment in order to identify areas where flooding issues are occurring. This information will then be used to identify mitigation measures that could be installed to achieve the design objectives of this study.

Flood mapping indicating the inundation extents and overland flow paths throughout the catchment during the 40%, 10%, 1% (2100) and 0.05% year AEP events are included in **Appendix D**. These maps show peak flood depths that currently occur within the catchment under existing conditions.

The assessment of the existing conditions results shows that there are a number of flooding issues within the catchment which are described below. A locality plan highlighting these areas are depicted in **Figure 2**, with numbering shown on plan as per below.

1. Drainage network is generally under capacity within Toral Drive and Jorl Court resulting in road flow depths greater than 250mm.
2. Break out flows existing flow path downstream of Sunshine Motorway on-ramp through properties at 46 to 58 Toral Drive. This break out is shown to cause flooding issues to properties fronting Honeysuckle Court as well as exacerbating drainage problems in Toral Drive.
3. Break out flows from north-south flowing waterway into Jorl Court.
4. Large areas of inundation within properties at 2 to 28 Toral Drive and 18 Jorl Court.
5. Overland flow path affecting north-western boundary of existing development at 13 to 21 Toral Drive (Toral Park Terraces).

A number of flow reporting locations have been created (refer **Figure 3**) to capture an understanding of the flow rates within the different flow paths within the catchment. The peak flow rates at each of the reporting locations are discussed further below in **Section 5.2.2**.

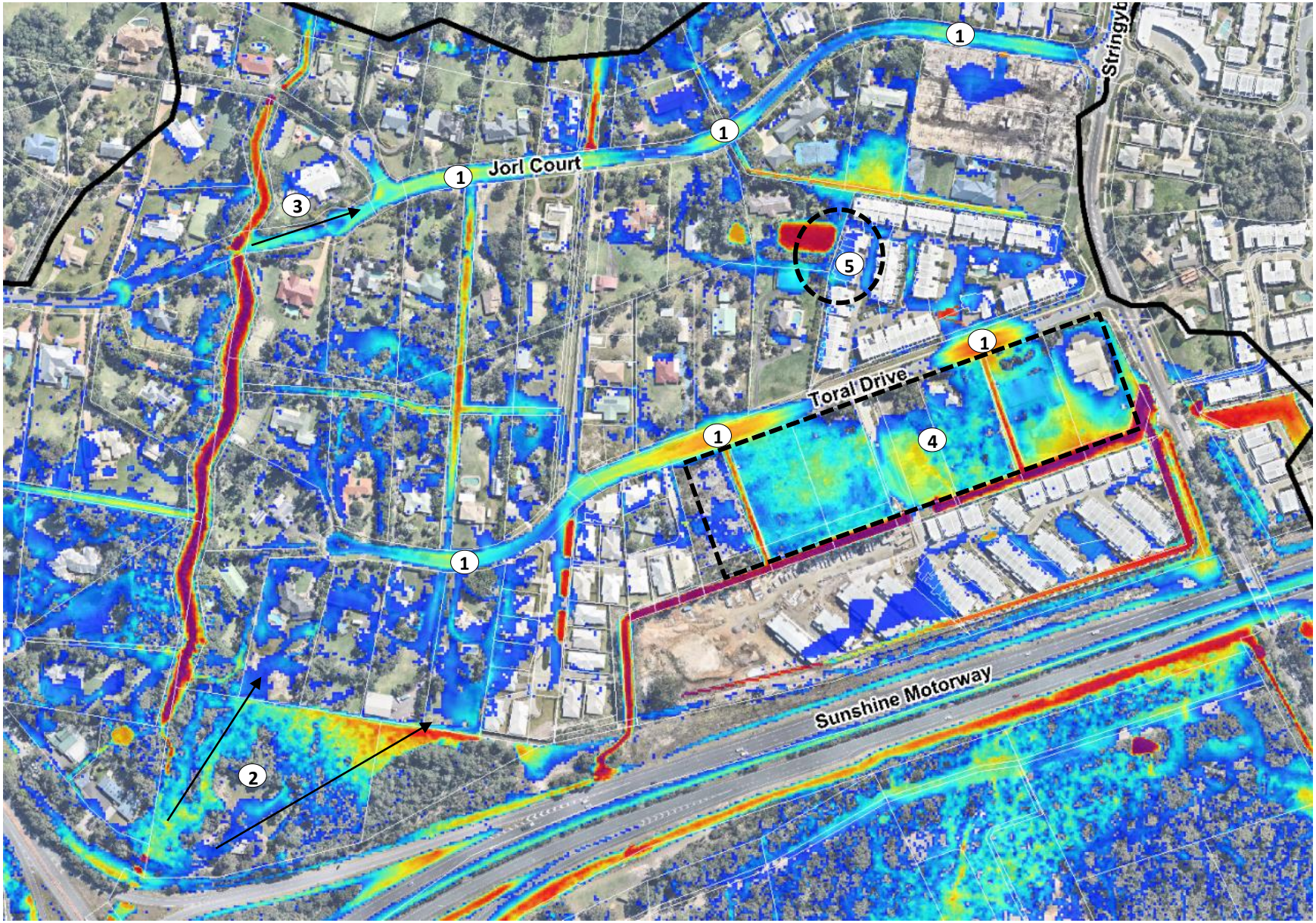


Figure 2: Locality Plan

5.2. Mitigation Scenario

The objective of the Mitigation Scenario was to identify an appropriate strategy to manage runoff in relation to Toral Drive and Jorl Court to demonstrate:

- Lots zoned with development potential graded to legal point of discharge, filled to achieve flood immunity requirements and imperviousness increased to represent developed conditions.
- Augmentation of the drainage network to facilitate safe functioning of Toral Drive and Jorl Court in minor and major design event (QUDM Criteria used to determine safe functioning).
- Mitigation of offsite impacts using onsite detention volume. The acceptability of impacts within the Toral Drive and Jorl Court area as discussed at inception meeting (proposed drainage solutions cannot adversely impact on existing development).

From this an assessment of the design has also been undertaken to:

- Detail the design solution to be implemented.
- Change in flows.
- Highlight areas where afflux occurs.

These items are discussed further below.

5.2.1. Mitigation Strategy

In developing the drainage mitigation solution for the study area, a number of iterations were undertaken in formulating a solution which both optimised the drainage system and the construction costs. The proposed solution has aimed to adequately manage drainage within both Toral Drive and Jorl Court whilst minimising the amount of infrastructure that needs to be installed.

The infrastructure upgrades required to manage the areas of interest involved include:

- Upgrade of stormwater pipes and pits (particularly in relation to sags / outlets)
- Upgrade of private access culverts and downstream channel to prevent break flows occurring.
- Raising of private bund at rear of properties at 44 to 58 Toral Drive. A drain is also required below the bund to direct ponded waters back to the south-north waterway.
- Bund along waterway from 59 to 60 Jorl Court.
- Widen channel downstream of entry culverts at 16 Toral Drive
- Provide balance of flood storage at properties on 2 to 28 Toral Drive
- Grade verge back from top of kerb along 18 to 28 Toral Drive to reduce road flow depths.
- Raise road sag at frontage of 8 Toral Drive
- Formalise flow paths at 22-26 Joral Court / 23-32 Toral Drive and 40-59 Toral Drive
- Implementation of on-site detention for future developments. On-site detention is not proposed at 2-28 Toral Drive due its location at the downstream end of the catchment and the fact that regional flood storage / detention is being provided by these sites.

The concept mitigation strategy for the catchment is provided in **Appendix E**.

Flood mapping indicating the inundation extents and overland flow paths throughout the catchment during the 40%, 10%, 1% (2100) and 0.05% year AEP events are included in **Appendix F**. These maps show peak flood depths that are anticipated as a result of the mitigation measures proposed.

5.2.2. Change in Flow

With the mitigation solution proposed to be implemented changes to the amount of overland flow directed through Toral Drive and Jorl Court has been reduced. This is attributed to a number of measures including increased capacity of underground drainage, diverting of break out flows back into waterways, maintaining flood storage and on-site detention. A comparison of flow rates in the 1% (2100) AEP event is provided below in **Table 6** between the existing and mitigated scenarios. The reporting locations are the same as those presented in **Figure 3**.

Table 6: Existing 1% (2100) AEP Flows at Nominated Flow Lines

Line	Existing Flow Rate (m^3/s)	Mitigated Flow Rate (m^3/s)
1	3.75	4.28
2	0.54	0.30
3	3.54	4.85
4	6.76	7.50
5	0.47	0.08
6	1.90	0.11
7	4.93	4.92
8	5.14	2.40
9	11.07	6.38
10	4.65	0.16
11	2.67	7.55
12	6.74	1.46
13	7.80	5.25
14	1.38	0.53

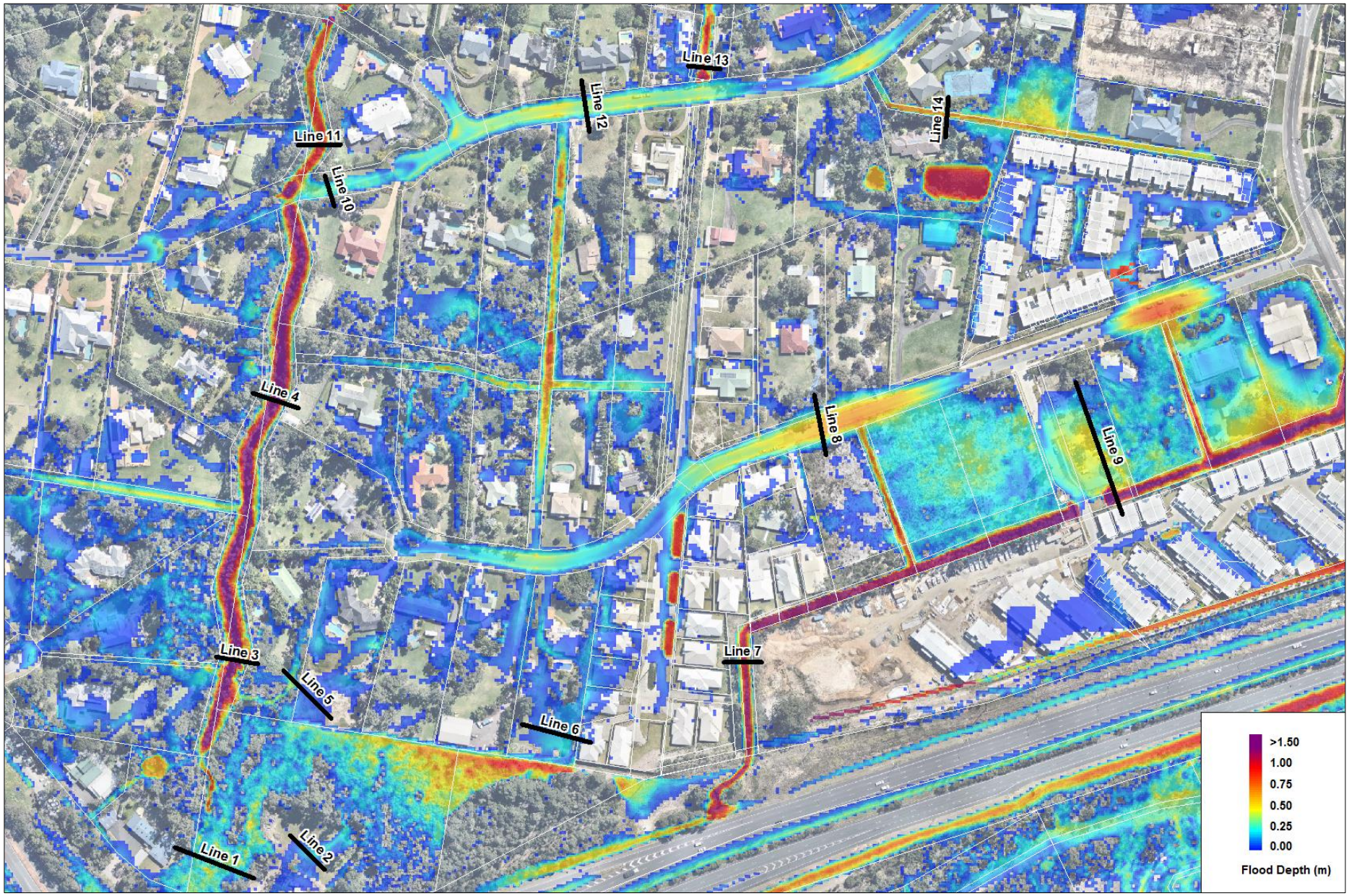


Figure 3: Flow Reporting Locations – Existing 1% (2100) AEP Depth Map

5.2.3. Afflux

An assessment has been made comparing the water surface levels in the Existing and Mitigation Scenarios to identify locations where afflux has occurred. Afflux maps (impact in flood levels in comparison to existing conditions) for all the subject AEP events are also shown in **Appendix G.** These maps highlight changes in the flooding levels noted within the catchment.

In considering afflux, it is important to note the main increases in flood levels result from the containment of flows within the south-north waterway. This was achieved through formalising part of the waterway downstream of the Sunshine Motorway and installing bunds to manage the break out of flows into Toral Drive and Jorl Court. Whilst there are increases in flood levels noted along this waterway, the increases are largely confined to the drainage reserve and do not impact of any private residences. There is a large area of impact immediately to the south of 44-58 Toral Drive, where the bund has been raised to prevent flows entering Toral Drive. These impacts are located within undeveloped bushland and do not impact any existing houses.

From this, it is considered that afflux has been managed in a practical manner so as to better manage drainage and flood immunity requirements within Toral Drive and Jorl Court, without causing significant issues to properties located adjacent to where runoff has been directed. A clear benefit can be seen in the flooding and drainage outcome within Toral Drive and within the channel conveying runoff across Stringybark Road.

5.2.4. Floodplain Storage

A requirement of the Sunshine Coast Council's *Flood Overlay Code* and the previous Maroochy Plan 2000 *Integrated Water Management Code* is to ensure development does not directly, indirectly or cumulatively alter the flooding characteristics external to the development site. An acceptable outcome in achieving this requirement is to ensure there is no reduction in the flood storage capacity of the waterway. Within this catchment, the properties located at 2 – 28 Toral Drive are heavily affected by flood inundation as highlighted below in **Figure 4**

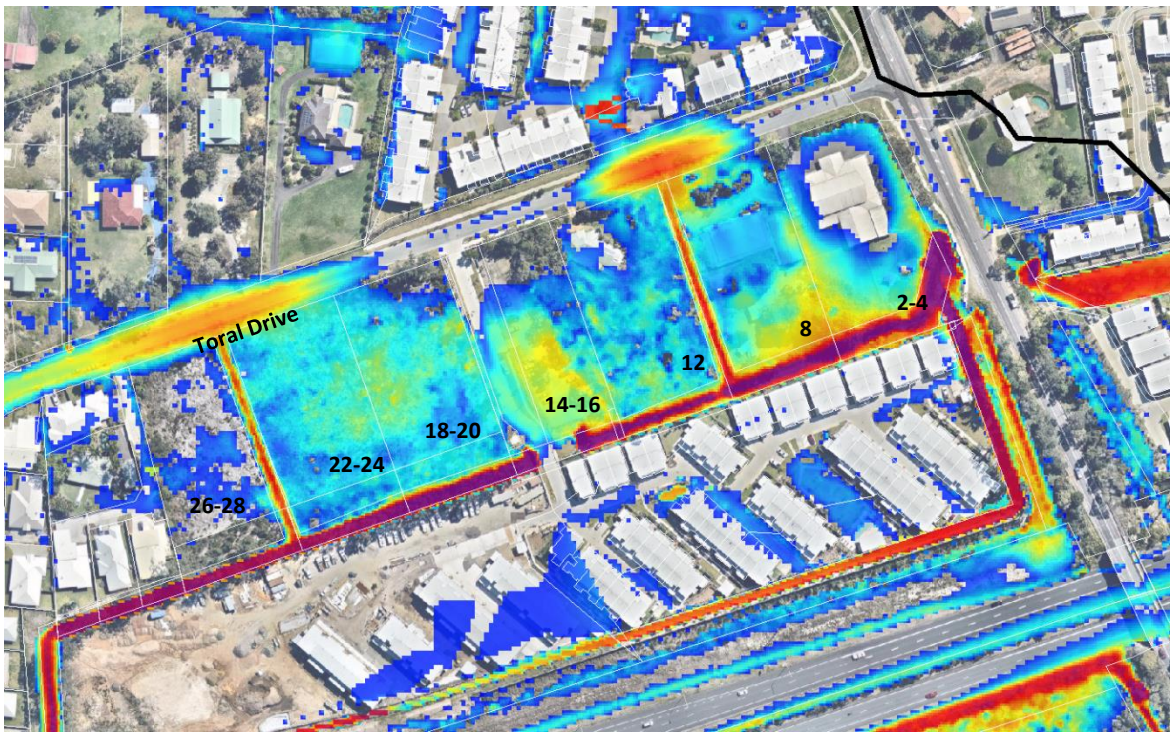


Figure 4: Properties Heavily Affected by Flooding

In formulating the mitigation strategy it was identified that these properties should be developed so that the amount of flood plain storage does not reduce. The strategy for 18- 28 Toral Drive was developed to address two outcomes; those being to balance flood storage and to ensure the major road flow depths are QUDM compliant (<250mm). In developing these properties it is acknowledged that there may be alternative earthworks solution that could be implemented to achieve the same outcome and may need further refinement to suit preliminary and detailed design of these lots. If the strategy is altered then the following limitations should be confirmed:

- The amount of flood plain storage provided should be confirmed by each site as they develop an earthworks strategy for their site.
- The channel / storage area needs to extend up to the sag in Toral Drive (fronting 18-28 Toral Drive) and connect to the main channel as far east as possible. This important in achieving trafficability of this sag and reduction in channel width must ensure the trafficability outcomes are not impacted.
- Maintain relief overland flow path between 8 and 12 Toral Drive.
- A minimum 6m base width of the channel running west-east along southern boundary of 2-28 Toral should be achieved with an appropriate grade to connect the culverts under Stringybark Road and the entry culvers to 16 Toral Drive.
- Alterations result in no off-site impacts

Figure 5 details the location of where flood storage and channel areas have been provided in order to compensate for the placement of fill required to enhance the development opportunity of the site andto achieve flood immunity requirements.

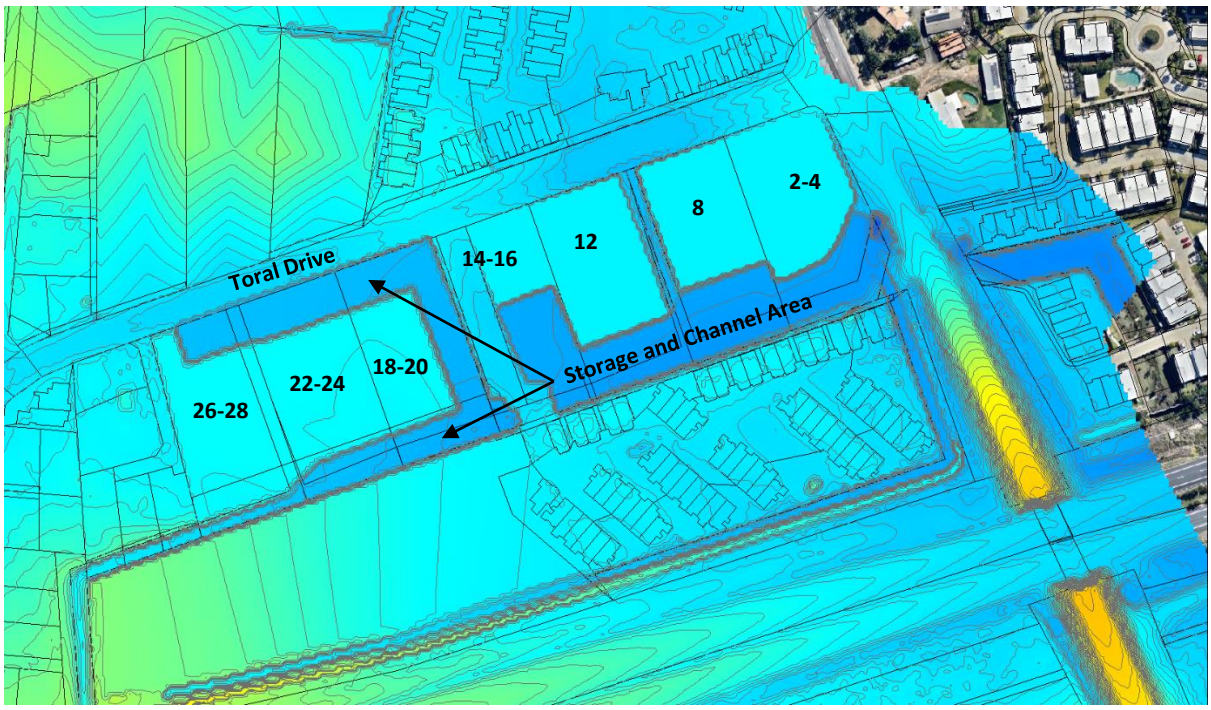


Figure 5: Channel and Storage Area Provided to 2-28 Toral Drive

Outlined below in **Table 7** is an assessment of floodplain storage over these properties in the existing and mitigated scenarios.

Table 7: Comparison of Flood Storage over Affected Properties in Existing and Mitigated Scenarios

Line	Existing Scenario Storage (m^3)	Mitigated Scenario Storage (m^3)
2-4 Toral Drive	1,930	1,990
8 Toral Drive	2,070	2,090
12 Toral Drive	1,310	1,370
14-16 Toral Drive	1,430	1,430
18-28 Toral Drive*	3,870	3,900

* A current development application exists over 18-28 Toral Drive and this has been treated as one site in determining an earthworks strategy.

5.2.5. On-Site Detention

In developing the mitigation strategy for the catchment the use of on-site detention applied to properties zoned either low density or medium density residential. The land-use plan of the area as detailed in the Sunshine Coast Planning Scheme is provided in **Appendix C**. As a guide to setting detention volume for each site, the deemed-to-comply solutions detailed within the Brisbane City Council "*Infrastructure Design Planning Scheme Policy – 7 Stormwater Drainage*" was applied. A detention node was setup in TUFLOW (1d_tab) and drained via 300mm RCP. Two rates of detention volume were applied are detailed in **Table 8** below.

Table 8: Deemed to Comply Detention Volumes

Line	% Impervious	Detention Volume
Low Density Residential	<70%	320m^3/ha
Medium Density Residential	>95%	350m^3/ha

Sensitivity testing was conducted on the detention volume by both increasing and decreasing the volume, and is discussed further in **Section 5.3.1**.

5.2.6. Severe Storm Assessment

In conjunction with the development of the mitigation strategy, consideration has been given to how the catchment will perform in a severe storm. The magnitude of the severe storm chosen for this assessment was the 0.05% AEP or 2,000 year ARI. In representing this scenario, no modelling parameters were altered except for the rainfall intensity to reflect the 0.05% AEP. Flood depth mapping for the severe storm assessment is provided in **Appendix F**. Whilst the majority Toral Drive and Jorl Courth areas manage the larger flows well, it can be seen that in a severe storm that overtopping of the south-north waterway occur and inundates through these properties. The extent of this inundation has increased in the mitigation scenario compared to existing. The flow depth is relatively shallow (<250mm), however, further mitigation of these flows should be achieved by installing a bund or raising the height of lots backing on to this channel so that flows are contained to the waterway.

5.3. Sensitivity Assessment

A sensitivity assessment has been undertaken on the proposed mitigation strategy works by assessing the solution in relation to effects of temporal pattern, channel roughness, changes in catchment imperviousness and detention volume. The outcome of these sensitivity tests are discussed below.

5.3.1. Temporal Pattern

This drainage investigation has been completed by applying the Duration Independent Storm (DIS) temporal pattern to the catchment. The first sensitivity testing that was completed was to assess what impact the application of Australian Rainfall and Runoff (ARR) temporal patterns has on flood levels within the catchment. To assess this, temporal patterns for the 25, 30, 45, 60, 90 and 120 minute duration storms were developed and applied to the model to determine the critical storm duration for the catchment. It was found that the 60 minute storm was the critical duration when applying the ARR temporal patterns. This rainfall pattern correlates well to the results achieved using the DIS temporal pattern, particularly in relation to road flows in Toral Drive and Jorl Court. Within these two roads the 60 minute ARR rainfall produced flow depths that were only up to 20mm higher than the DIS storm. Within the main south-north waterway and west-east channel, where there are greater flows conveyed, the ARR rainfall was up to 50mm lower than the DIS storm. This assessment would indicate that this catchment is not sensitive to the use of either the ARR or DIS temporal patterns.

5.3.2. Increase in Catchment Imperviousness

The next sensitivity that was conducted was to assess what effect increasing the imperviousness of the catchment within Toral Drive and Joral Court has on flow depths. To represent this, the catchment roughness of those properties zoned either low or medium density residential was lowered to 0.03, which is reduced from 0.05 and 0.04, for low and medium density, respectively. This has resulted in a 0.2m^3/s increase in surface flows within Toral Drive (1.4m^3/s to 1.6m^3/s) and 0.1m^3/s increase in Jorl Court (1.6m^3/s to 1.7m^3/s). This increase only translated to a minor increase in flow depth of between 10 to 20mm. With respect to the modelling approach utilised for this investigation, it is considered that the model is not overly sensitive to a reduction in catchment roughness within the future low and medium density areas.

5.3.3. Channel Roughness

The next sensitivity that has been performed was to assess the impact that increasing channel roughness to 0.15. This increase in Manning's was applied to the south-north waterway reporting to Mountain Creek and west-east channel reporting to Stringybark Road, which resulted in a water level increase of up to 100mm within the channel. However, these increases appear to be contained within the waterway and did not propagate up to cause impacts to the road network or properties. Whilst the model does appear to have some sensitivity to a change in channel roughness, the current channel capacity and catchment layout has resulted in this not influencing any lots or infrastructure.

5.3.1. Detention Volume

The final sensitivity that was completed was to assess what affect both an increase and reduction to the applied detention volume would have on flood depths in the catchment. To assess this, the applied volume was either increased or decreased by 50%. **Table** 9 details the adjustments that were made to the application of detention volume for low and medium density residential area. All other modelling parameters, including outlet pipe configuration remained the same across each option.

Table 9: Sensitivity Testing of Detention Volumes

Line	Detention Volume	Reduced Volumed	Increased Volume
Low Density Residential	320m^3/ha	215m^3/ha	480m^3/ha
Medium Density Residential	350m^3/ha	235m^3/ha	525m^3/ha

A number of flow depths have been assessed along Toral Drive and Jorl Court at locations detailed in **Figure 6**. **Table 10** details a comparison of the flow depths taken at each of the reporting locations. From these results it can be seen that there is a significant reduction in flow depths when comparing the deemed-to-comply sceanrio to that of no detention, with flow depth decreases of up to 260mm. Increasing the amount of detention does not appear to improve flow depth signifincantly with further reductions of up to 50mm noted but generally in the 0 to 20mm range. Reducing the amount of detention generally results in a slight increase in flow depths of up to 20mm, with increases of up to 50mm noted at reporting locations D and E, which are sags, known to have ponding issues. It is recommended that the deemed-to-comply solution be adopted, however, further refinement to this may be achievable when detention type and configuration is known.

Table 10: Sensitivity Testing of Detention Volumes on Catchment Flow Depths

Detention Scenario	A	B	C	D	E	F	G	H	I	J	K
Deemed-to-comply	0.16	0.19	0.18	0.10	0.22	0.08	0.21	0.58	0.93	1.11	1.34
Decreased	0.16	0.20	0.19	0.15	0.27	0.10	0.21	0.60	0.94	1.12	1.35
Increased	0.16	0.19	0.18	0.08	0.17	0.06	0.21	0.57	0.92	1.10	1.33
No Detention	0.17	0.25	0.26	0.36	0.34	0.11	0.26	0.66	0.98	1.15	1.38

Figure 6: Reporting Locations to Assess Effect of Detention Volume

6. STAGING OF WORKS

In consideration of staging the deliverables proposed as part of this mitigation strategy, the staging (and priorities) presented in **Table 11** and identified in **Figure 7**, may be considered in implementing the works. It should be noted that the progression of development within the catchment, for which Council has no control, may dictate or restrict the staging program and as such may, in the interim, influence the intended performance of the strategy. Of particular note in the staging, is the formalisation of channel and associated bunds to the south-west of Toral Drive which are considered the first priority in ensuring flood immunity and drainage capacities can be managed in line with the final strategy.

It is expected that the responsibility for delivering the infrastructure identified in this report will be shared between Council and Developers. A practical outcome in implementing the strategy would be for infrastructure associated with a given development to be delivered as part of that development and be a condition requirement of the development.

It should also be noted that the timings of Council delivered infrastructure will be affected by Council's ability to schedule the relevant study outcomes in capital works planning (which is subject to competitive regional prioritisation process).

Table 11: Potential Staging of Works

Staging / Priority	Description	Land Holding	Comment
A	Install required drainage traversing site at 47-53 Toral Drive and orifice plate to achieve non-worsening pending installation of Stage 8.	Private	To be installed as part of as part of Development Works (OPW15/0560)
B	Install required drainage at 16 Jorl Court (from rear of site through to Jorl Court)	Private	To be installed as part of as part of Development Works (REC15/0082)
1	Raising sag near entry to Toral Drive	Road Reserve	Constructed by future developments within Toral Drive or Council. Some mechanism to share cost of road construction should be devised.
2	Increase channel size to contain flows and private culverts, and raising of bund and drain at rear of 44-58 Jorl Court	Private	Is an import part of managing break out flows into Toral Drive in Major event. Will need to be constructed in association with private entry culverts / bund and channel bund to prevent flows entering Jorl Court and property at 60 Jorl Court
3	Duplicate drainage capacity in Jorl Court	Road Reserve	Downstream drainage works to main stormwater system. If missing link (Stage 8) isn't constructed prior to works commencing additional inlet works will be required to capture overland flow. Could be constructed as part of development at 44-46 Jorl Court

Staging / Priority	Description	Land Holding	Comment
4	Increase drainage capacity in Jorl Court	Road Reserve and Easement	Downstream drainage works to main stormwater system. Needed to drain works installed as part of Stage B. Could be constructed as part of development at 18 or 26 Jorl Court
5	Drainage works at end of Toral Drive connects into Stage A	Road Reserve	Constructed as part of developments at 44 to 55 Toral Drive. Consideration to be given to inlet capacity within development or within Toral Drive to limit surface flow in major event.
6	Drainage works at beginning Jorl Court	Road Reserve	No future development front this section of works. Consideration of contribution from future developments within Jorl Court
7	Drainage at end of Jorl Court connects into Stage 3	Road Reserve	Only 50 Jorl Court has development potential, and last link of works may need to be constructed by Council.
8	Missing link connection of drainage from Toral Drive to Jorl Court and removal of orifice plate installed in Stage A.	Private	If completed by future development need to ensure inlet and road flow criteria are achieved.
9	Re-shaping of verge to lower flow depth in Toral Drive, channel construction through to Stringybark Road and balance of flood storage at 18-28 Toral Drive	Road Reserve	To be provided by development at 18 to 28 Toral Drive and flowpath from Toral Drive to main East-West channel must be provided if lots developed individually
10	Channel construction and balance of flood storage at 2-16 Toral Drive	Private	To be provided by future developments and managed to ensure conveyance and flood storage objectives are achieved over time.
11	Private drainage works	Private	Future drainage (overland flow) works required to manage overland flow paths. Consideration to be given to the management of any impacts and mitigate any existing flooding issues.

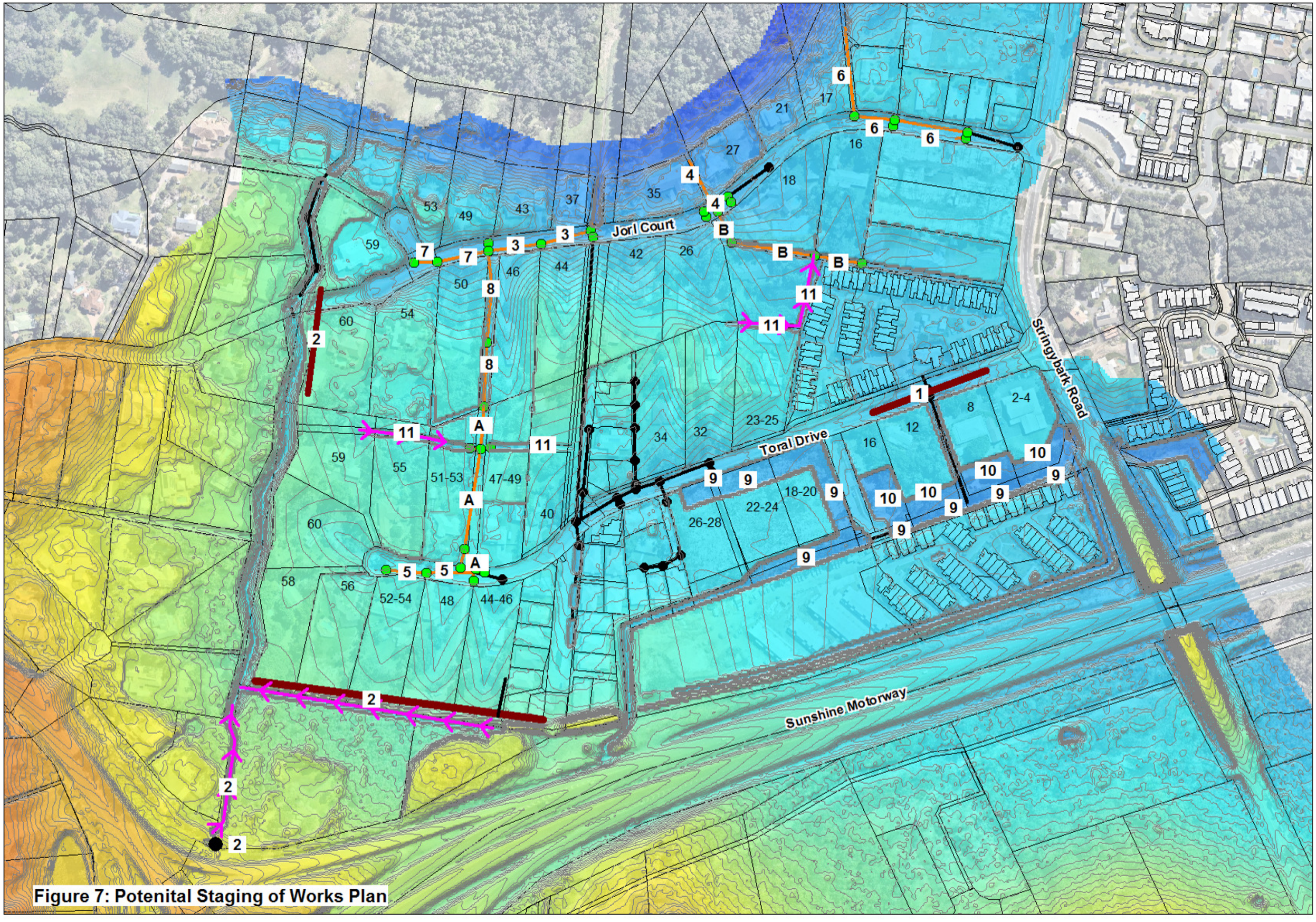


Figure 7: Potenital Staging of Works Plan

7. CONCLUSION AND RECOMMENDATIONS

SMEC has completed the Toral Drive and Jorl Court Master Drainage Study for Sunshine Coast Council. Detailed hydraulic and hydrological modelling using TUFLOW has been completed to represent the flow paths within the contributing catchment, with a specific focus on management of flows associated with Toral Drive and Jorl Drive.

Design event modelling has been carried for the existing and design scenarios for a range of events including the 40%, 10%, 1% (2100) and 0.05% AEP. The mitigation scenario has focused on the works to provide trafficability and flood immunity to future intensification within Toral Drive and Jorl Court.

The mitigation scenario detailed in **Appendix E** incorporated a number of drainage upgrades required to manage the areas of interest involved and included:

- Upgrade of stormwater pipes and pits (particularly in relation to sags / outlets)
- Upgrade of private access culverts and downstream channel to prevent break flows occurring.
- Raising of private bund at rear of properties at 44 to 58 Toral Drive. A drain is also required below the bund to direct ponded waters back to the south-north waterway.
- Bund along waterway from 59 to 60 Jorl Court.
- Widen channel downstream of entry culverts at 16 Toral Drive
- Provide balance of flood storage at properties on 2 to 28 Toral Drive
- Grade verge back from top of kerb along 18 to 28 Toral Drive to reduce road flow depths.
- Raise road sag at frontage of 8 Toral Drive
- Formalise flow paths at 22-26 Joral Court / 23-32 Toral Drive and 40-59 Toral Drive
- Implementation of on-site detention for future developments

This sensitivity testing was completed in relation to effects of temporal pattern, channel roughness, changes in catchment imperviousness and detention volume. These four sensitivity tests highlighted that the proposed design arrangement can effectively manage runoff without inundating adjoining properties.

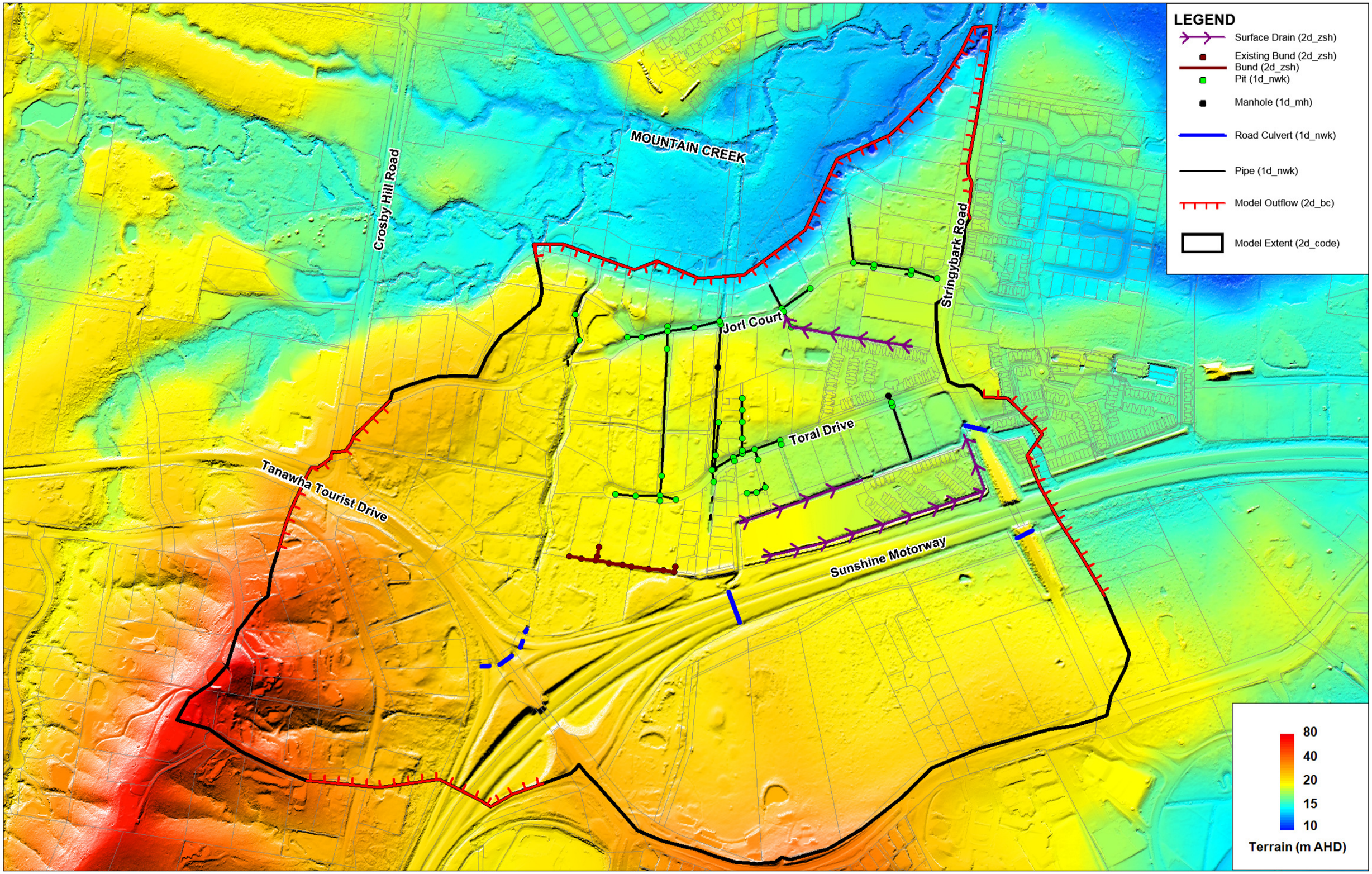
Design flood maps have been developed for the peak flood depth and flood afflux has been prepared for a range of events from the 40% to 0.05% AEP and are detailed in **Appendix D, F** and **G**.

In implementing of staging the deliverables proposed as part of this mitigation strategy, the staging (and priorities) presented in **Table 11** and identified in **Figure 7**, may be considered in implementing the works

8. REFERENCES

- http://earthsci.org/flooding/unit4/u4-03-01.html, date accessed 10 June 2015;
- BMT WBM (2010), "TUFLOW User Manual".
- Queensland Government (2010), "*Increasing Queensland's resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study*";
- IEAust (2003), "*The Institution of Engineers, Australia. Australian Rainfall and Runoff, A Guide to Flood Estimation, Volume 1, 2003*";
- IEAust (1987), "*The Institution of Engineers, Australia. Australian Rainfall and Runoff, A Guide to Flood Estimation, Volume 2, 1987*";
- QUDM (2013), "*Natural Resources and Water, Queensland Urban Drainage Manual – Third Edition, 2013*";
- Sunshine Coast Council (2014), "*SC6.9 Planning scheme policy for the flood hazard overlay code*";
- Maroochy Shire Council (2006), *"Maroochy Plan 2000 – Code for Integrated Water Management"*.
- Federal Highway Administration (2009), "*HEC-22 Urban Drainage Design Manual".*

APPENDIX A TUFLOW MODEL LAYOUT



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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

DRAWING NO. APPENDIX REVISION A STATUS DRAFT

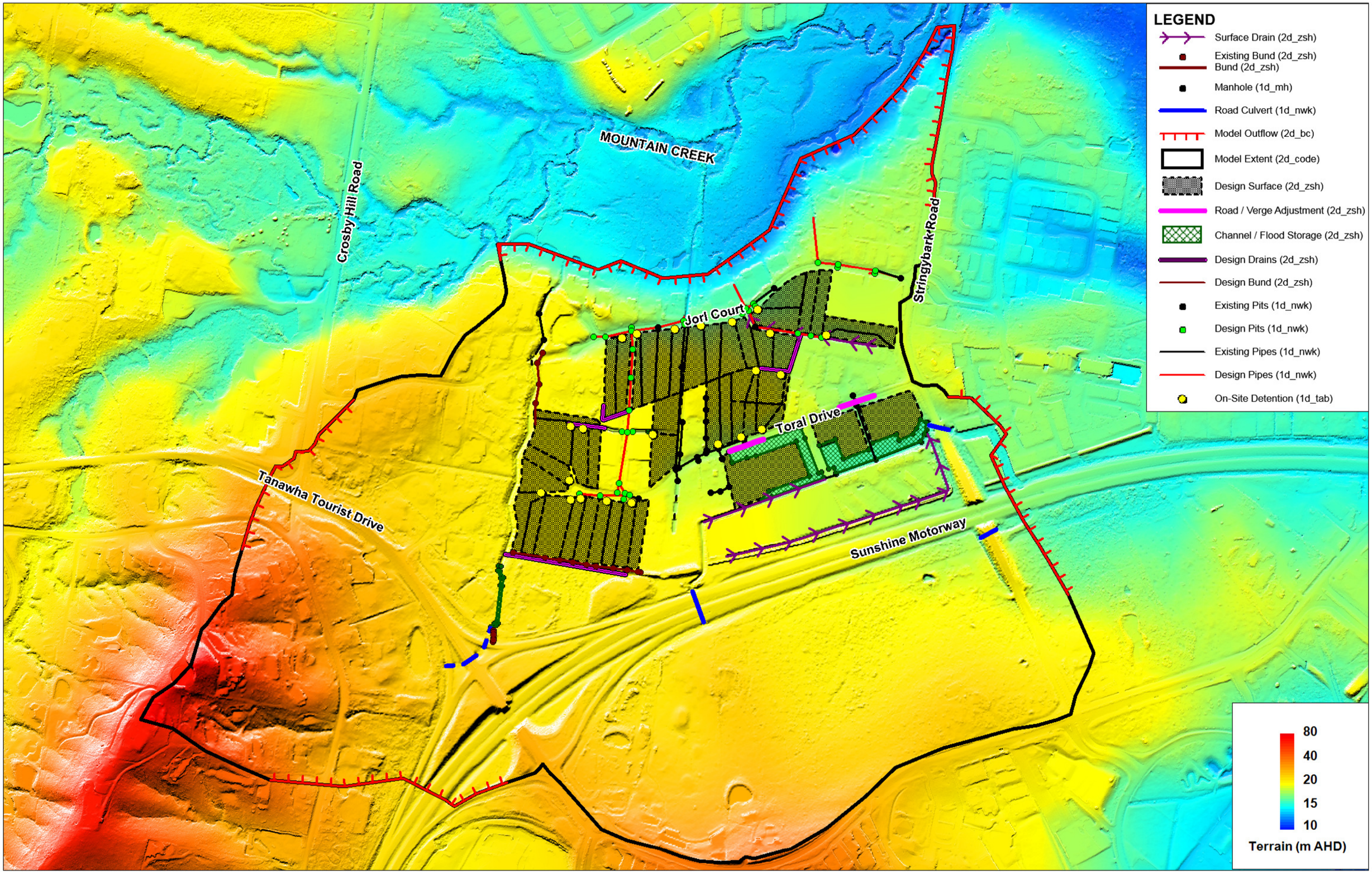
CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **TUFLOW MODEL SETUP - EXISTING**

CLIENT Sunshine Coast Council

CONSULTANT SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101



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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

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TITLE **TUFLOW MODEL SETUP - MITIGATED**

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South Brisbane QLD 4101

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APPENDIX B INLET CURVES

Sag Inlet

Flow Depth (m)	VS	S	M	L
0	0	0	0	0.000
0.010	0.001	0.002	0.004	0.006
0.020	0.003	0.005	0.011	0.016
0.030	0.008	0.010	0.020	0.030
0.040	0.014	0.015	0.031	0.046
0.050	0.021	0.021	0.043	0.064
0.060	0.029	0.028	0.056	0.085
0.070	0.038	0.036	0.071	0.107
0.080	0.047	0.043	0.087	0.130
0.090	0.057	0.052	0.104	0.156
0.100	0.068	0.061	0.121	0.182
0.120	0.092	0.080	0.160	0.239
0.140	0.118	0.101	0.201	0.302
0.160	0.146	0.123	0.246	0.369
0.180	0.113	0.147	0.293	0.440
0.200	0.119	0.165	0.330	0.495
0.250	0.134	0.193	0.385	0.578
0.300	0.147	0.217	0.434	0.651
0.350	0.159	0.239	0.477	0.716
0.400	0.170	0.258	0.517	0.775
0.450	0.181	0.277	0.554	0.831
0.5	0.191	0.294	0.589	0.883
0.55	0.200	0.311	0.621	0.932
0.6	0.209	0.326	0.652	0.979

VS 900x600 grate (50% blockage)
S 1.2m lintel 125mm high (lintel only)
M 2.4m lintel 125mm high (lintel only)
L 3.6m lintel 125mm high (lintel only)

Field Inlet (900x900)

Flow Depth (m)	Capacity (m3/s)
0	0.000
0.010	0.003
0.020	0.008
0.030	0.016
0.040	0.024
0.050	0.033
0.060	0.044
0.070	0.055
0.080	0.068
0.090	0.081
0.100	0.094
0.120	0.124
0.140	0.157
0.160	0.191
0.180	0.228
0.200	0.267
0.250	0.360
0.300	0.395
0.350	0.426
0.400	0.456
0.450	0.484
0.5	0.510
0.55	0.535
0.6	0.558

50% Blocakge

On-Grade Inlet Curves (adjusted for Blockage)

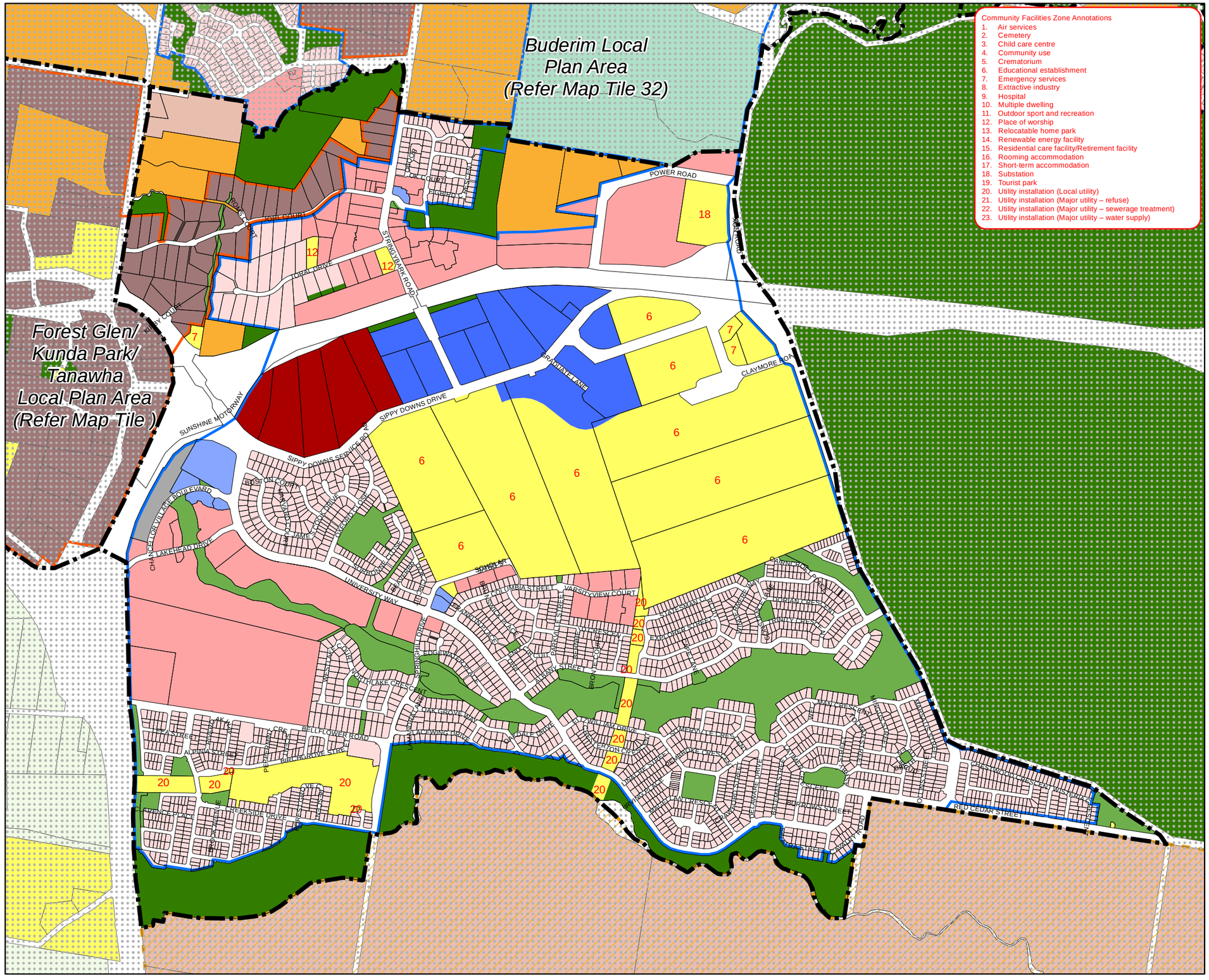
	VERY SMALL	SMALL	MEDIUM	LARGE
	Capture (m3/s) based on Longnitudinal Grade of Road			
Flow Depth (m)	0.5%	0.5%	0.5%	0.5%
0	0.000	0.000	0.000	0.000
0.01	0.001	0.001	0.001	0.001
0.02	0.002	0.002	0.002	0.002
0.03	0.003	0.004	0.004	0.004
0.04	0.005	0.008	0.008	0.008
0.05	0.008	0.013	0.013	0.014
0.06	0.010	0.020	0.021	0.022
0.07	0.013	0.028	0.030	0.032
0.08	0.016	0.037	0.040	0.044
0.09	0.020	0.047	0.052	0.057
0.1	0.023	0.058	0.065	0.072
0.11	0.027	0.070	0.079	0.088
0.12	0.031	0.082	0.094	0.105
0.13	0.035	0.095	0.109	0.124
0.14	0.039	0.108	0.124	0.142
0.15	0.043	0.121	0.140	0.160
0.16	0.047	0.134	0.155	0.179
0.17	0.051	0.146	0.170	0.198
0.18	0.055	0.159	0.186	0.216
0.19	0.059	0.171	0.201	0.235
0.2	0.063	0.184	0.216	0.253
0.21	0.067	0.196	0.231	0.272
0.22	0.071	0.208	0.245	0.290
0.23	0.075	0.219	0.260	0.308
0.24	0.080	0.231	0.274	0.326
0.25	0.084	0.243	0.289	0.344
0.26	0.088	0.254	0.303	0.361
0.27	0.092	0.265	0.317	0.379
0.28	0.096	0.276	0.331	0.396
0.29	0.100	0.287	0.345	0.413
0.3	0.104	0.298	0.358	0.431
0.31	0.108	0.309	0.372	0.448
0.32	0.112	0.320	0.385	0.465
0.33	0.116	0.330	0.399	0.481
0.34	0.120	0.341	0.412	0.498
0.35	0.124	0.351	0.425	0.515
0.36	0.128	0.361	0.438	0.531
0.37	0.132	0.372	0.451	0.548
0.38	0.136	0.382	0.464	0.564
0.39	0.140	0.392	0.476	0.580
0.4	0.144	0.401	0.489	0.596

VS 1.2m lintel 125mm high (lintel only)
S 1.2m lintel 125mm high and grate
M 2.4m lintel 125mm high and grate
L 3.6m lintel 125mm high and grate

Assumes 27% blockage

APPENDIX C LAND-USE PLAN

Sunshine Coast **Planning Scheme 2014**
Sippy Downs Local Plan Area



Community Facilities Zone Annotations

1. Air services
2. Cemetery
3. Child care centre
4. Community use
5. Crematorium
6. Educational establishment
7. Emergency services
8. Extractive industry
9. Hospital
10. Multiple dwelling
11. Outdoor sport and recreation
12. Place of worship
13. Relocatable home park
14. Renewable energy facility
15. Residential care facility/Retirement facility
16. Rooming accommodation
17. Short-term accommodation
18. Substation
19. Tourist park
20. Utility installation (Local utility)
21. Utility installation (Major utility – refuse)
22. Utility installation (Major utility – sewerage treatment)
23. Utility installation (Major utility – water supply)

Zone Map

Residential Zones Category
- Low Density Residential Zone
- Precinct LDR1 (Protected Housing Area)
- Medium Density Residential Zone
- High Density Residential Zone
- Tourist Accommodation

Centre Zones Category
- Principal Centre Zone
- Major Centre Zone
- District Centre Zone
- Local Centre Zone

Recreation Zones Category
- Sport and Recreation Zone
- Open Space Zone

Environmental Zones Category
- Environmental Management and Conservation Zone

Industry Zones Category
- Low Impact Industry Zone
- Medium Impact Industry Zone
- High Impact Industry Zone
- Waterfront and Marine Industry Zone

Other Zones Category
- Community Facilities Zone
- Emerging Community Zone
- Limited Development (Landscape Residential) Zone
- Rural Zone
- Precinct RUR1 (Meridan Plains Extractive Resource Area)
- Rural Residential Zone
- Specialised Centre Zone
- Tourism Zone

Other Elements
- Urban Growth Management Boundary
- Rural Residential Growth Management Boundary
- Local Plan Area Boundary
- Declared Master Planned Area (see Part 10 - Other Plans)
- Land within Development Control Plan 1 - Kawana Waters which is the subject of the Kawana Waters Development Agreement (see Section 1.2 - Planning Scheme Components)
- Priority Development Area (subject to the *Economic Development Act 2012*)
- DCDB 28 January 2013 © State Government

Note – Where a zone map provides an annotation for land included in the Community Facilities Zone, the annotation refers to the corresponding use set out in **Table SC2.1.1 (Community facilities zone annotations)**.

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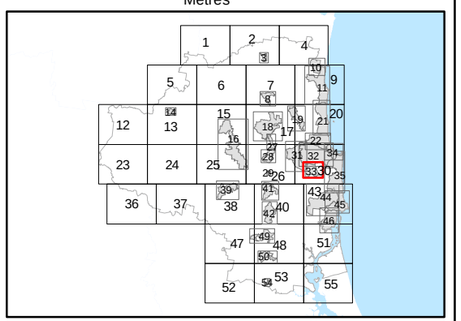
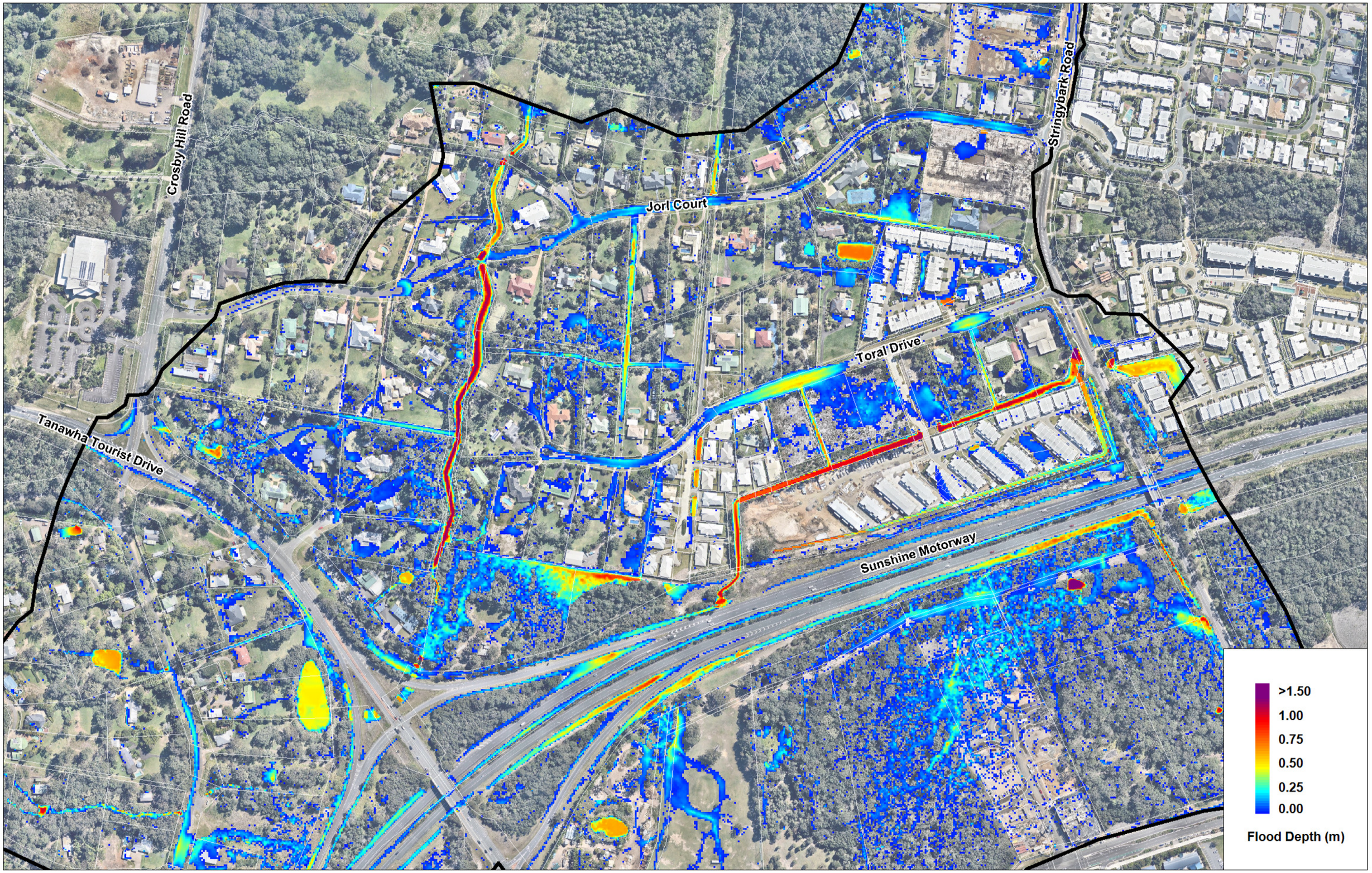
Metres



Zone Map ZM33

APPENDIX D PEAK FLOOD DEPTH MAPS - EXISTING



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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

DRAWING NO. APPENDIX REVISION A STATUS DRAFT

CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD DEPTH MAP - EXISTING SCENARIO - 40% AEP**

CLIENT

Sunshine Coast Council

CONSULTANT

SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101

Crosby Hill Road

Jorl Court

Stringybark Road

Toral Drive

Tanawha Tourist Drive

Sunshine Motorway

>1.50
1.00
0.75
0.50
0.25
0.00

Flood Depth (m)

COORDINATE SYSTEM Datum: GDA94 Projection: MGA Zone 56

NORTH

PAGE SIZE A3 SCALE 1:4,000

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TITLE **FLOOD DEPTH MAP - EXISTING SCENARIO - 10% AEP**

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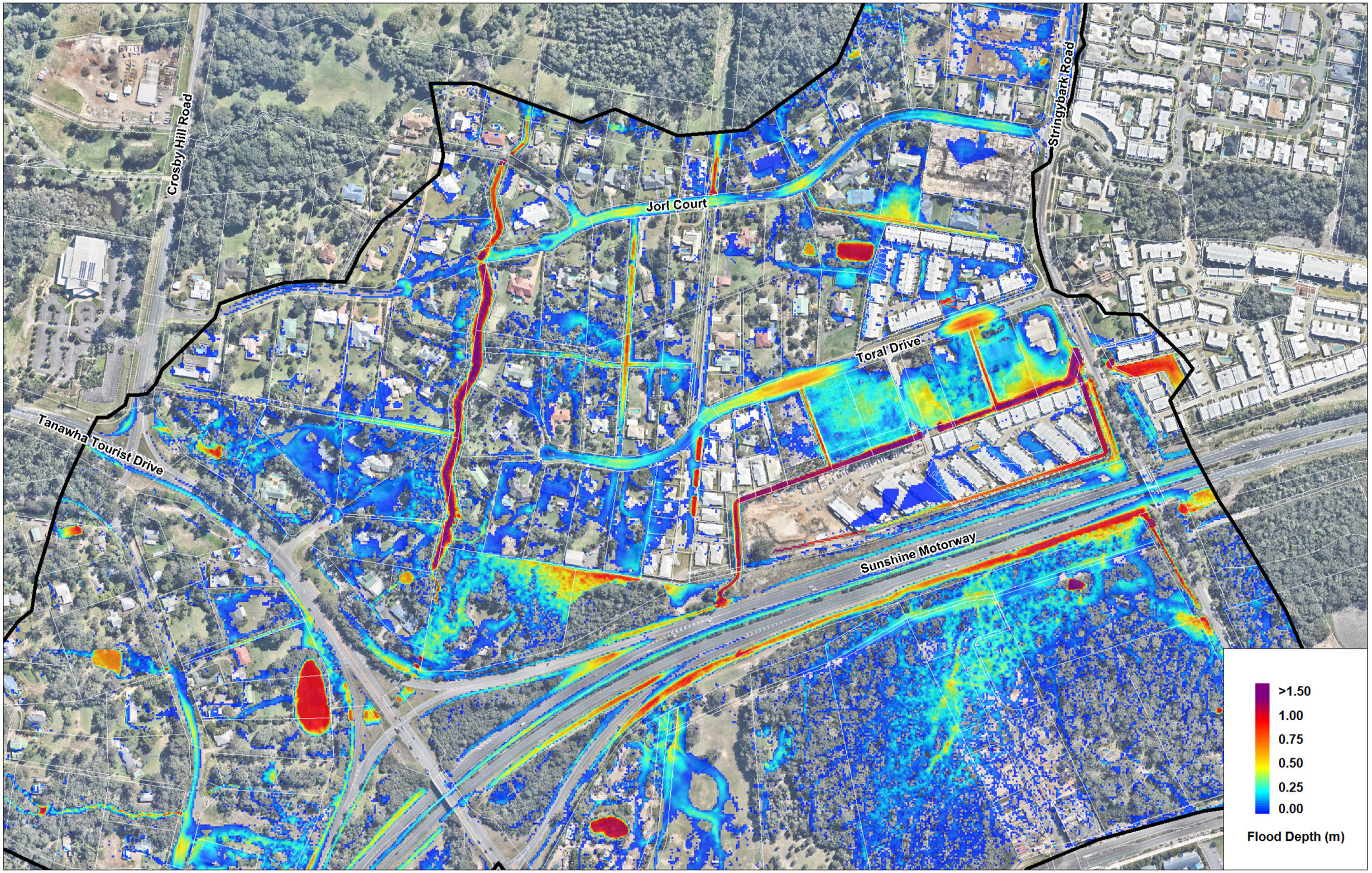

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TITLE **FLOOD DEPTH MAP - EXISTING SCENARIO - 1% AEP (2100)**

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Level 1, 154 Melbourne Street
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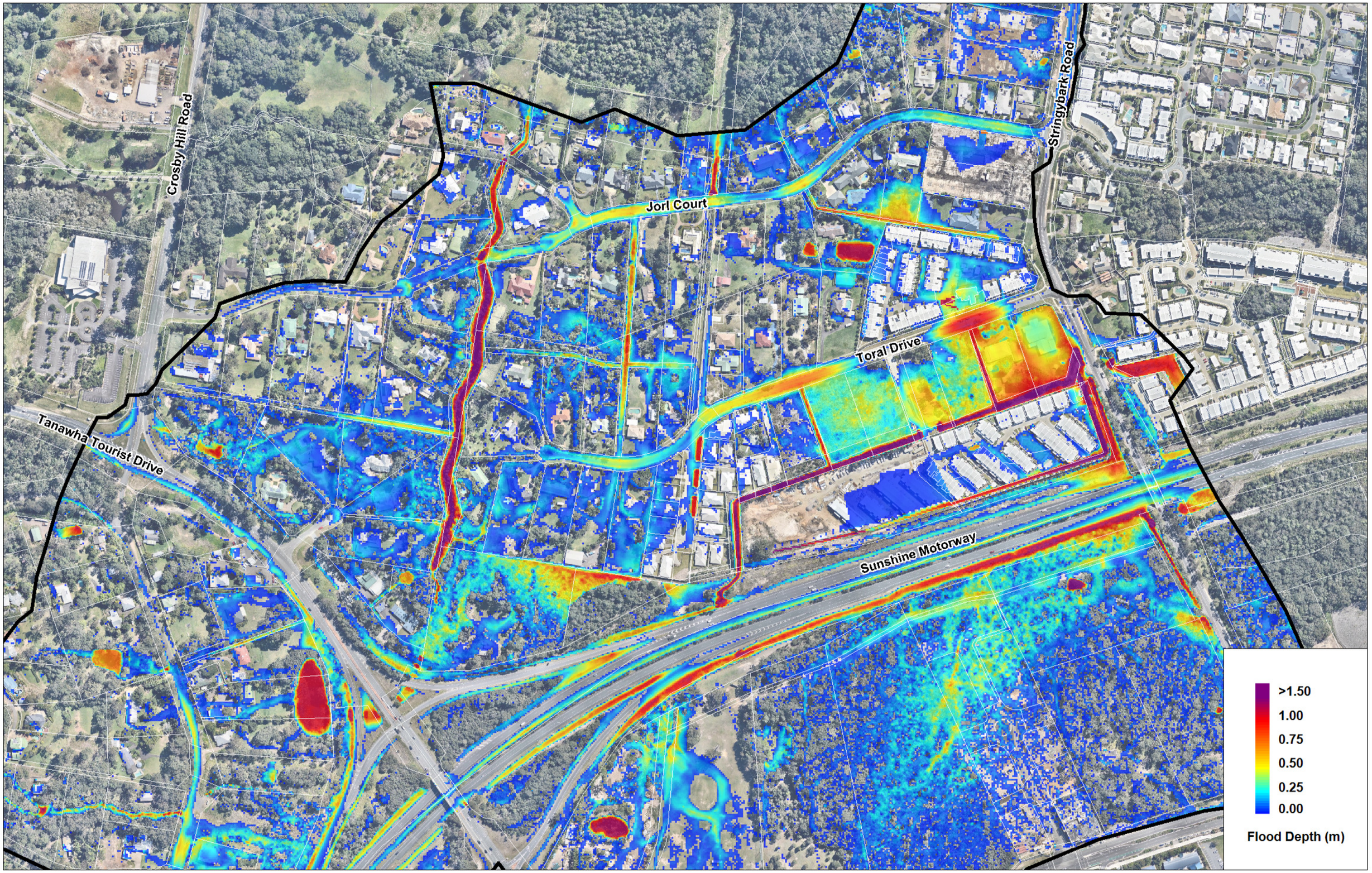

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CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD DEPTH MAP - EXISTING SCENARIO - 0.05% AEP**

CLIENT

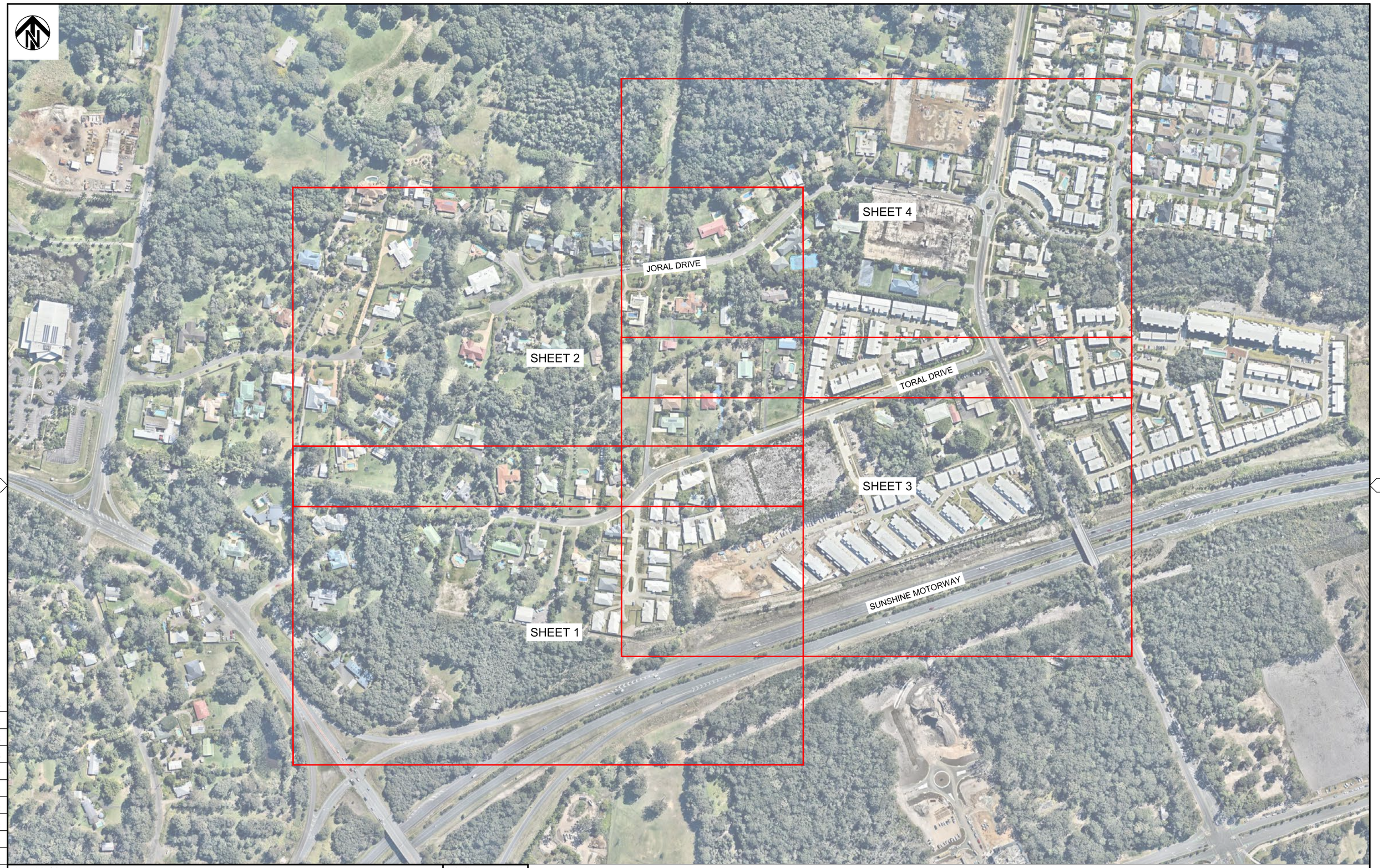
Sunshine Coast COUNCIL

CONSULTANT

SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101

APPENDIX E CONCEPT MITIGATION STRATEGY LAYOUT



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PLOT DATE 13 Jan 2016 TIME 14:32:55

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X_30031546_A1 X_30031546_DESIGN	A	13/01/2016	ISSUE FOR CLIENT REVIEW	001	APP 01

TITLE	NAME
DRAFTER	S ROY
DRAFTING CHECK	
DESIGNER	B BOLT
DESIGN CHECK	
PROJECT MANAGER	
PROJECT DIRECTOR	

SCALES AT A1 SIZE DRAWING
SCALE 1:2000 20 0 20 40 60 80 100

DESIGNER
SMEC
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BIRTINYA QLD. 4575
PH 07 3029-6700 FAX 07 5437-6625
SMEC PROJECT No 30031546

CLIENT
Sunshine Coast Council

PROJECT TITLE
TORAL DRIVE & JORL COURT, BUDERIM FLOOD MITIGATION STRATEGY SHEET LAYOUT

SCALE	PHASE	PROJECT / DRAWING No.	REVISION
		30031546-C-000	0

LEGEND

- UPGRADED / NEW PIPES
- EXISTING PIPES
- NEW CHANNEL OR DRAIN
- NEW ROAD OR BUND
- TOP OF BATTER
- BOTTOM OF BATTER
- 250mm DESIGN CONTOURS
- UPGRADED / NEW PITS
- EXISTING PITS

OSD REQUIREMENTS FOR NEW DEVELOPMENT

ZONING	VOLUME
LOW DENSITY	320 m³/ha
MEDIUM DENSITY	350 m³/ha

NOTE:
EARTHWORKS ARRANGEMENTS MAY BE ALTERED TO SUIT FUTURE DESIGN PROVIDING FLOOD STORAGE AND FLOODING OUTCOMES ARE ACHIEVED

REFER DRAWING 002

Ø1050mm RCP @ 0.5%

Ø1050mm RCP @ 0.74%

INCREASE PIPE AND PIT CAPACITY AT SAG OUTLET

Ø825mm RCP @ 0.25%

Ø825mm RCP @ 0.6%

TORAL DRIVE

GRADE VERGE DOWN FROM TOP OF KERB

LOW FLOW DRAIN (0.5%)

RL 17.40

RL 17.40

RL 17.52

RL 17.50

CHANNEL 16

EXISTING

RL 18.90

RL 22.55

INCREASE HEIGHT OF BUND TO PREVENT FLOW THROUGH LOTS

RL 22.55

TIE INTO ACCOUSTIC BUND

INCREASE CHANNEL SIZE TO CONTAIN FLOWS WITHIN CHANNEL (3m BASE) @ 2.36%

CONSTRUCT NEW CHANNEL TO DRAIN AREA BACK TO WATERWAY (0.5m BASE)
CONSTRUCT NEW COLLECTION DRAIN TO DIRECT PONDED RUNOFF BACK TO WATERWAY

SUNSHINE MOTORWAY

UPGRADE PRIVATE CULVERTS
5 x Ø675mm RCP

BUND
RL 25.30

REFER DRAWING 003

150 mm ON ORIGINAL
A1

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PLOT DATE 22 Dec 2015 TIME 16:07:15

EXTERNAL REFERENCE FILES
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X_30031546_DESIGN
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REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
A	22/12/2015	ISSUE FOR CLIENT REVIEW	001	APP 01

TITLE	NAME
DRAFTER	S ROY
DRAFTING CHECK	
DESIGNER	B BOLT
DESIGN CHECK	
PROJECT MANAGER	
PROJECT DIRECTOR	

SCALES AT A1 SIZE DRAWING
SCALE 1:750 5 0 10 20 30

DESIGNER
SMEC
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LEVEL 1, BLDG C, 6 INNOVATION PARKWAY
BIRTINYA QLD. 4575
PH 07 3029-6700 FAX 07 5437-6625
SMEC PROJECT No 30031546

CLIENT
Sunshine Coast Council

PROJECT TITLE
TORAL DRIVE & JORL COURT, BUDERIM FLOOD MITIGATION STRATEGY SHEET 1 OF 4

SCALE	PHASE	PROJECT / DRAWING No.	REVISION
		30031546-C-001	0

LEGEND

- UPGRADED / NEW PIPES
- EXISTING PIPES
- NEW CHANNEL OR DRAIN
- NEW ROAD OR BUND
- TOP OF BATTER
- BOTTOM OF BATTER
- 250mm DESIGN CONTOURS
- UPGRADED / NEW PITS
- EXISTING PITS

OSD REQUIREMENTS FOR NEW DEVELOPMENT

ZONING	VOLUME
LOW DENSITY	320 m³/ha
MEDIUM DENSITY	350 m³/ha

NOTE:
EARTHWORKS ARRANGEMENTS MAY BE ALTERED TO SUIT FUTURE DESIGN PROVIDING FLOOD STORAGE AND FLOODING OUTCOMES ARE ACHIEVED

INCREASE PIPE AND PIT CAPACITY AT SAG OUTLET

JORAL COURT

Ø900mm RCP @ 0.60%

Ø450mm RCP @ 2.92%

Ø900mm RCP @ 2.78%

Ø675mm RCP @ 0.10%

2 x Ø900mm RCP @ 0.11%

2 x Ø900mm RCP @ 0.28%

Ø525mm RCP @ 0.78%

Ø525mm RCP @ 1.04%

Ø1200mm RCP @ 0.89%

Ø1200mm RCP @ 1.30%

Ø1200mm RCP @ 1.18%

INCREASE PIPE AND PIT CAPACITY

RL 21.90

BUND TO PREVENT FLOWS ENTERING JORL COURT AND PRIVATE PROPERTY

RL 21.10

LOCAL DRAIN TO TIE INTO EXISTING (6m WIDE)

Ø1050mm RCP @ 0.38%

Ø1050mm RCP @ 0.50%

REFER DRAWING 001

REFER DRAWING 004

GRADE VERGE DOWN FROM TOP OF KERB

LOW FLOW DRAIN (0.5%)

RL 17.40

RL 17.40

150 mm ON ORIGINAL

A1

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TITLE	NAME
DRAFTER	S ROY
DRAFTING CHECK	
DESIGNER	B BOLT
DESIGN CHECK	
PROJECT MANAGER	
PROJECT DIRECTOR	

SCALES AT A1 SIZE DRAWING
SCALE 1:750 5 0 10 20 30

DESIGNER
SMEC
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LEVEL 1, BLDG C, 6 INNOVATION PARKWAY
BIRTINYA QLD. 4575
PH 07 3029-6700 FAX 07 5437-6625
SMEC PROJECT No 30031546

CLIENT
Sunshine Coast Council

PROJECT TITLE
TORAL DRIVE & JORL COURT, BUDERIM FLOOD MITIGATION STRATEGY SHEET 2 OF 4

SCALE	PHASE	PROJECT / DRAWING No.	REVISION
		30031546-C-002	0

LEGEND

- UPGRADED / NEW PIPES
- EXISTING PIPES
- NEW CHANNEL OR DRAIN
- NEW ROAD OR BUND
- TOP OF BATTER
- BOTTOM OF BATTER
- 250mm DESIGN CONTOURS
- UPGRADED / NEW PITS
- EXISTING PITS

OSD REQUIREMENTS FOR NEW DEVELOPMENT

ZONING	VOLUME
LOW DENSITY	320 m³/ha
MEDIUM DENSITY	350 m³/ha

NOTE:
EARTHWORKS ARRANGEMENTS MAY BE ALTERED TO SUIT FUTURE DESIGN PROVIDING FLOOD STORAGE AND FLOODING OUTCOMES ARE ACHIEVED

REFER DRAWING 001

150 mm ON ORIGINAL

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PLOT DATE 08 Jan 2016 TIME 15:17:19

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
A	22/12/2015	ISSUE FOR CLIENT REVIEW	001	APP 01

TITLE	NAME
DRAFTER	S ROY
DRAFTING CHECK	
DESIGNER	B BOLT
DESIGN CHECK	
PROJECT MANAGER	
PROJECT DIRECTOR	

SCALES AT A1 SIZE DRAWING
SCALE 1:750 5 0 10 20 30

DESIGNER
SMEC
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BIRTINYA QLD. 4575
PH 07 3029-6700 FAX 07 5437-6625
SMEC PROJECT No 30031546

CLIENT
Sunshine Coast Council

PROJECT TITLE
TORAL DRIVE & JORL COURT, BUDERIM
FLOOD MITIGATION STRATEGY
SHEET 3 OF 4

SCALE	PHASE	PROJECT / DRAWING No.	REVISION
		30031546-C-003	0

LEGEND

- UPGRADED / NEW PIPES
- EXISTING PIPES
- NEW CHANNEL OR DRAIN
- NEW ROAD OR BUND
- TOP OF BATTER
- BOTTOM OF BATTER
- 250mm DESIGN CONTOURS
- UPGRADED / NEW PITS
- EXISTING PITS

OSD REQUIREMENTS FOR NEW DEVELOPMENT

ZONING	VOLUME
LOW DENSITY	320 m³/ha
MEDIUM DENSITY	350 m³/ha

NOTE:
EARTHWORKS ARRANGEMENTS MAY BE ALTERED TO SUIT FUTURE DESIGN PROVIDING FLOOD STORAGE AND FLOODING OUTCOMES ARE ACHIEVED

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PLOT DATE: 22 Dec 2015 TIME: 16:07:52

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
A	22/12/2015	ISSUE FOR CLIENT REVIEW	001	APP 01

TITLE	NAME
DRAFTER	S ROY
DRAFTING CHECK	
DESIGNER	B BOLT
DESIGN CHECK	
PROJECT MANAGER	
PROJECT DIRECTOR	

SCALES AT A1 SIZE DRAWING: SCALE 1:750 (5 0 10 20 30)

DESIGNER
SMEC
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© ABN 47 065 475 149
LEVEL 1, BLDG C, 6 INNOVATION PARKWAY
BIRTINYA QLD. 4575
PH 07 3029-6700 FAX 07 5437-6625
SMEC PROJECT No 30031546

CLIENT: Sunshine Coast Council

PROJECT TITLE: TORAL DRIVE & JORL COURT, BUDERIM FLOOD MITIGATION STRATEGY SHEET 4 OF 4

SCALE	PHASE	PROJECT / DRAWING No.	REVISION
		30031546-C-004	0

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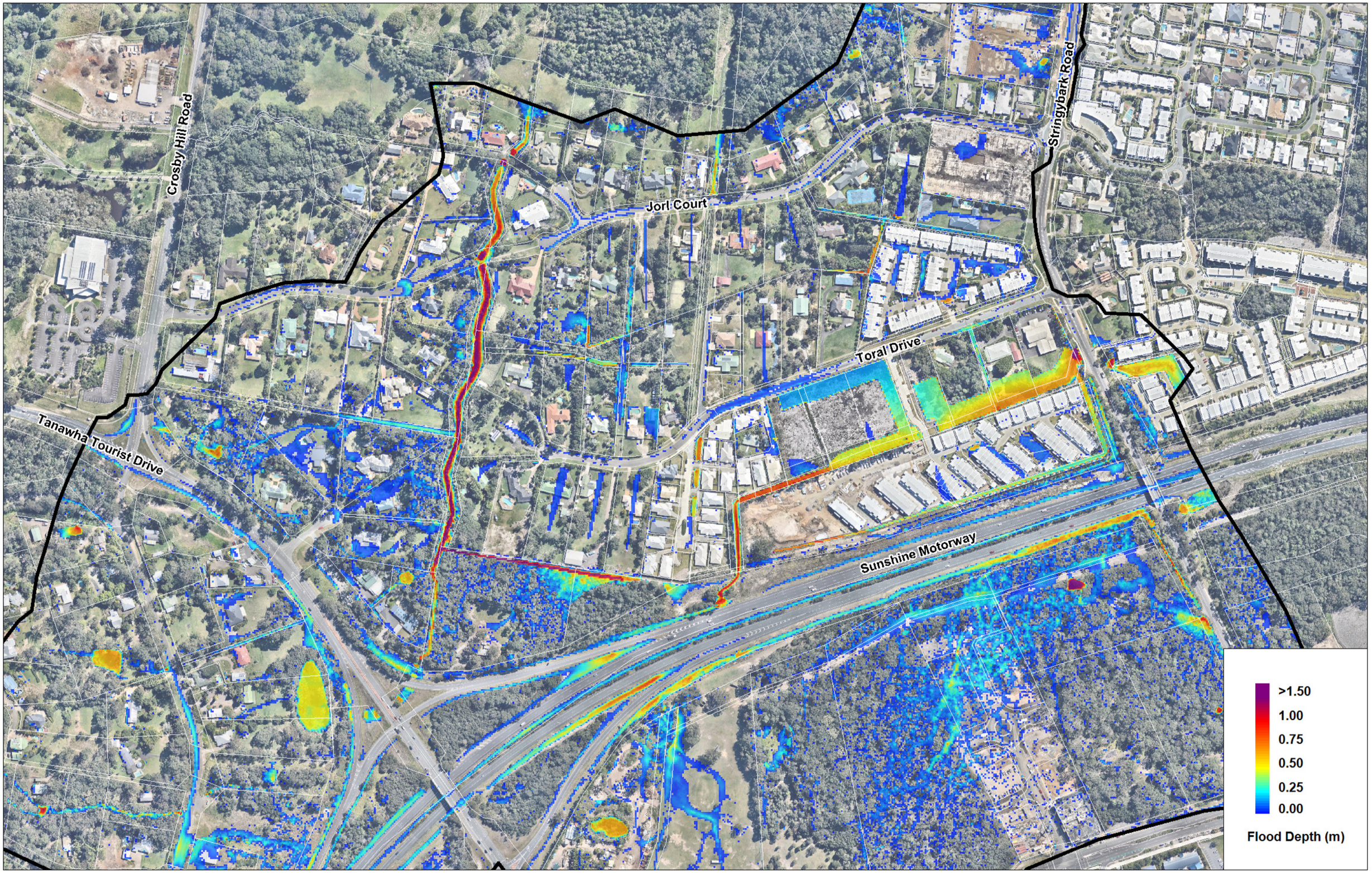
APPENDIX F PEAK FLOOD DEPTH MAPS - MITIGATED



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DRAWING NO. APPENDIX REVISION A STATUS DRAFT

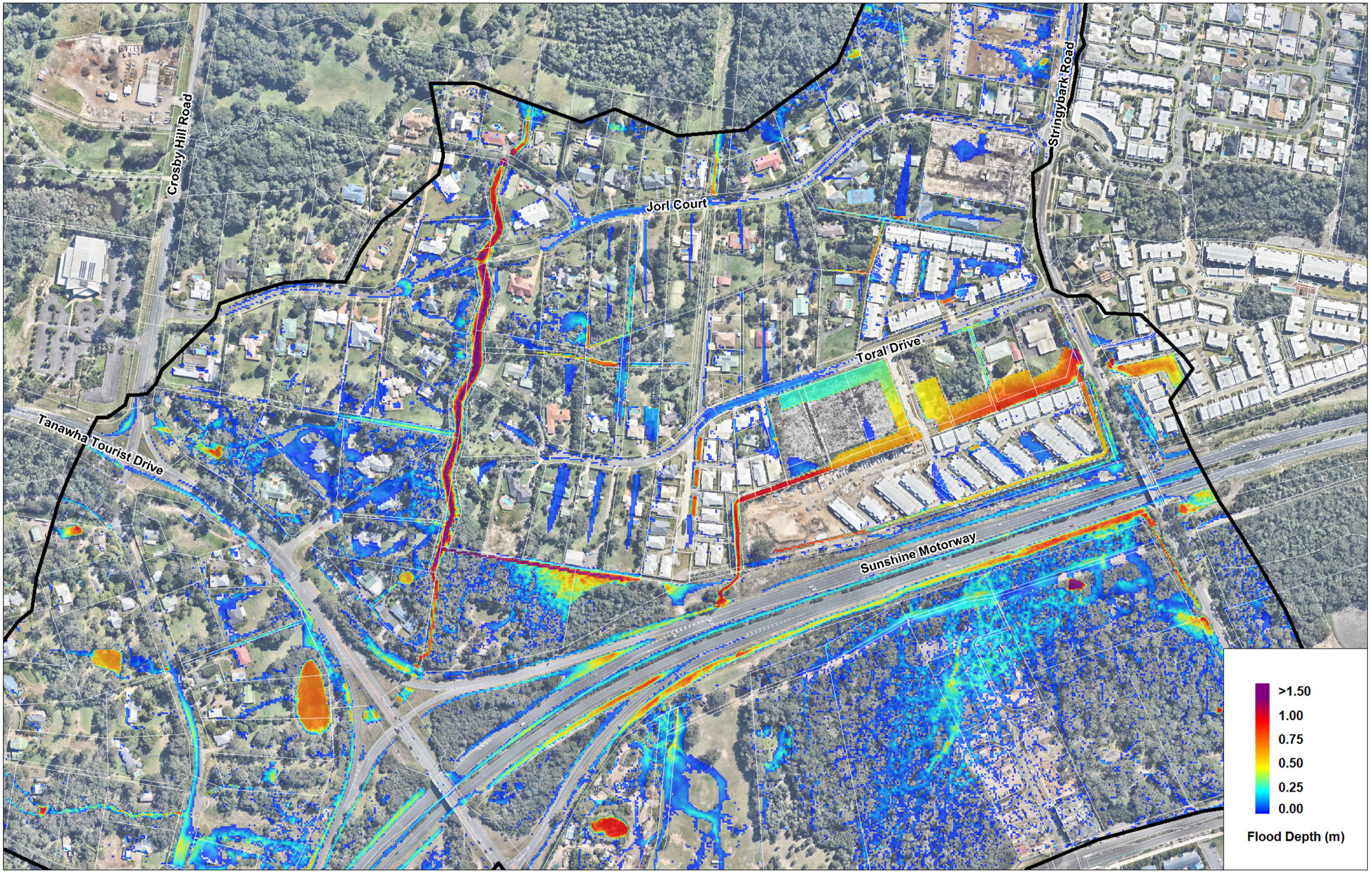
CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD DEPTH MAP - MITIGATED SCENARIO - 40% AEP**

CLIENT Sunshine Coast Council

CONSULTANT SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101



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NORTH

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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

DRAWING NO. APPENDIX REVISION A STATUS DRAFT

CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD DEPTH MAP - MITIGATED SCENARIO - 10% AEP**

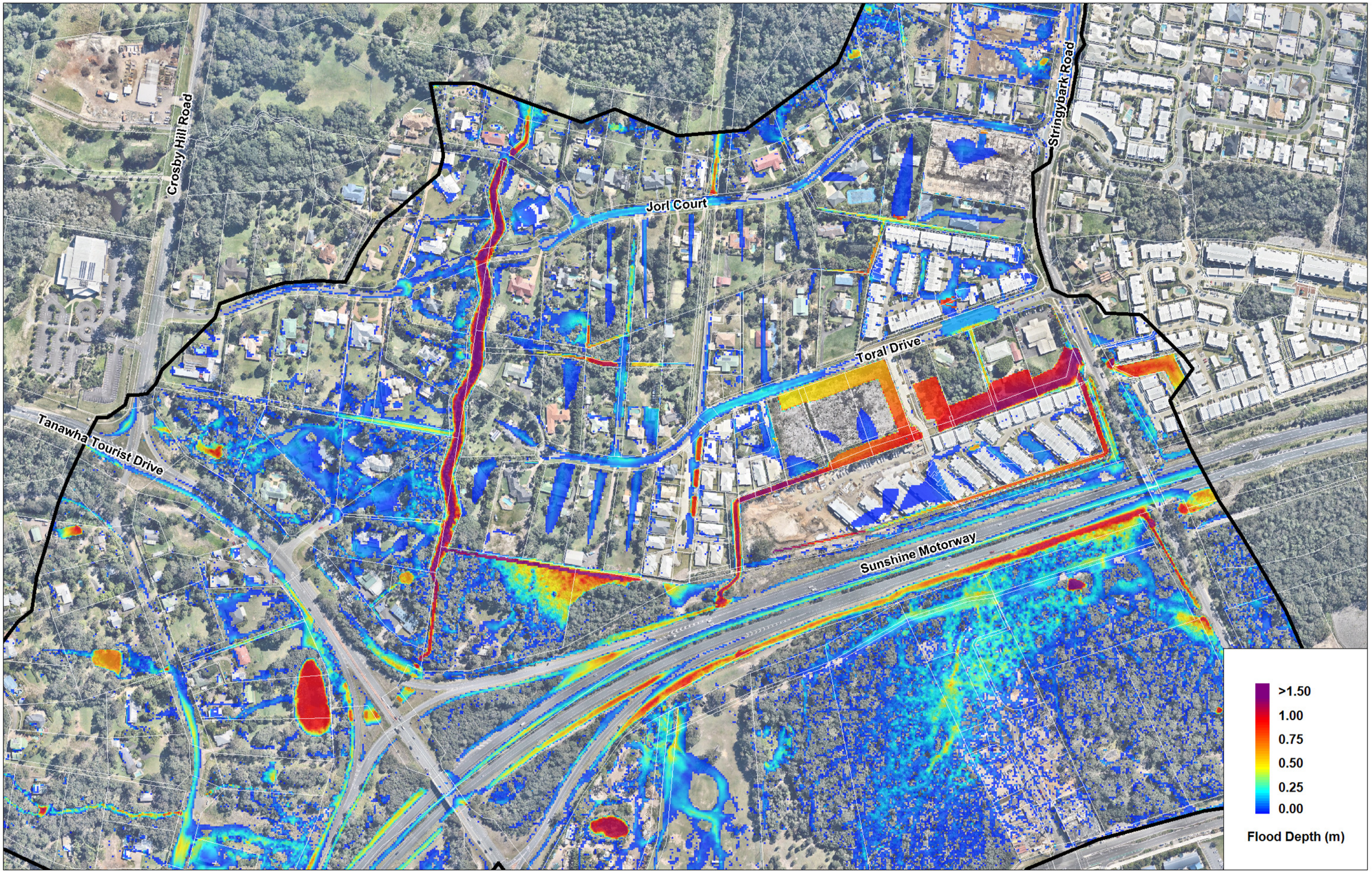
CLIENT

Sunshine Coast Council

CONSULTANT

SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101



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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

DRAWING NO. APPENDIX REVISION A STATUS DRAFT

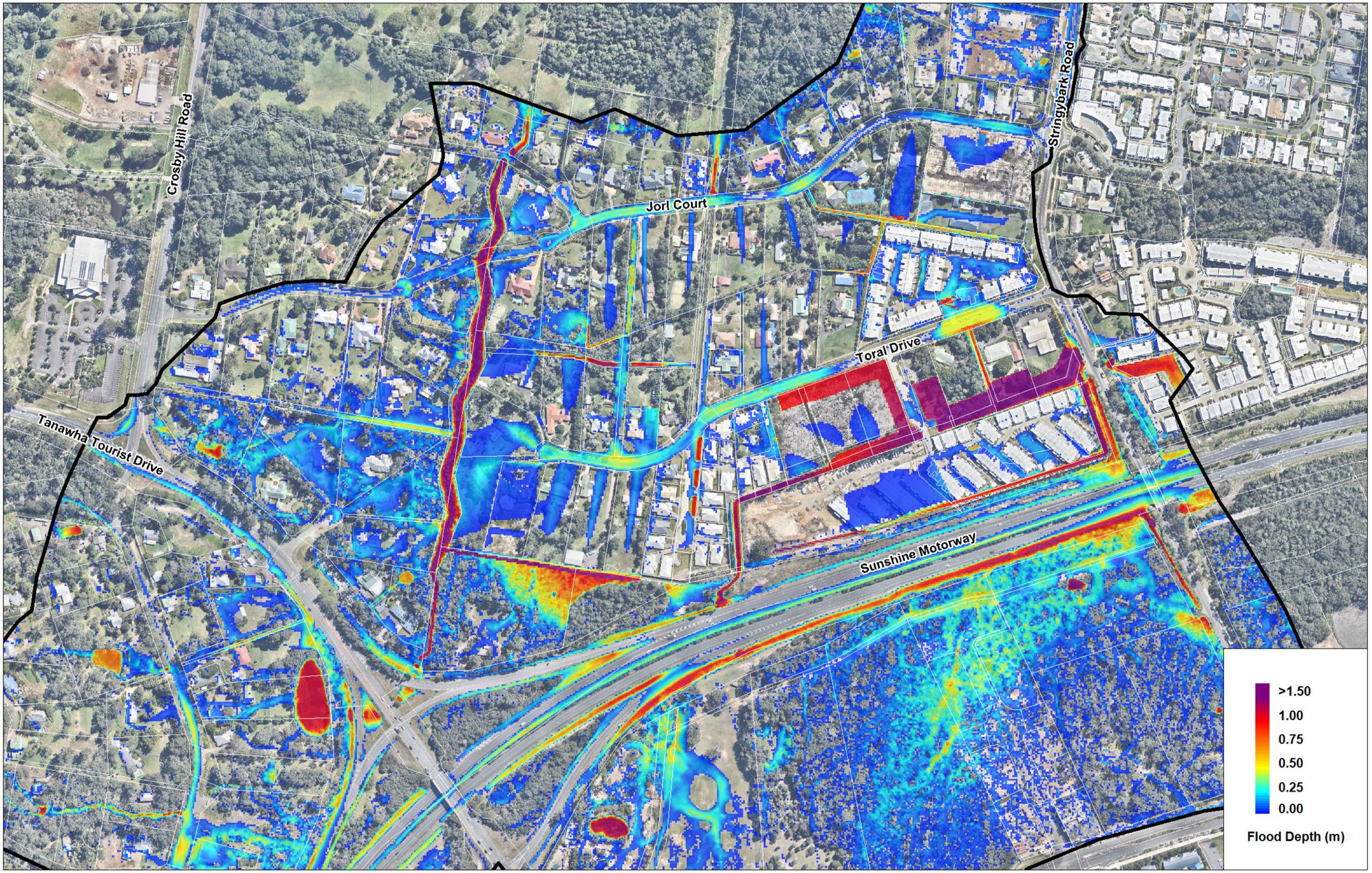
CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD DEPTH MAP - MITIGATED SCENARIO - 1% (2100) AEP**

CLIENT Sunshine Coast Council

CONSULTANT SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101



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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

DRAWING NO. APPENDIX REVISION A STATUS DRAFT

CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD DEPTH MAP - MITIGATED SCENARIO - 0.05% AEP**

CLIENT

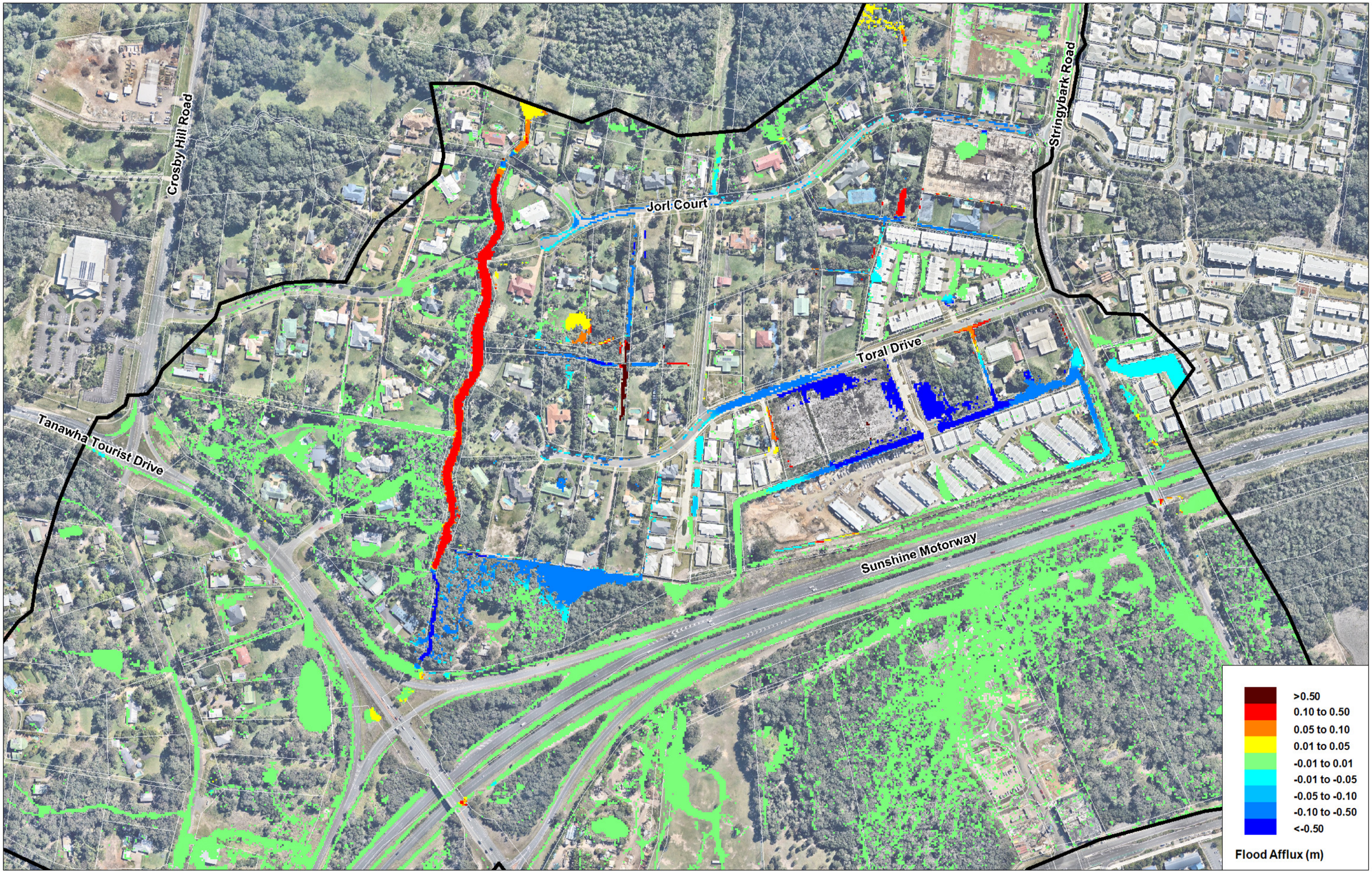
Sunshine Coast COUNCIL

CONSULTANT

SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101

APPENDIX G FLOOD AFFLUX MAPS



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DRAWING NO. APPENDIX REVISION A STATUS DRAFT

CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD AFFLUX MAP - 40% AEP**

CLIENT Sunshine Coast COUNCIL

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South Brisbane QLD 4101

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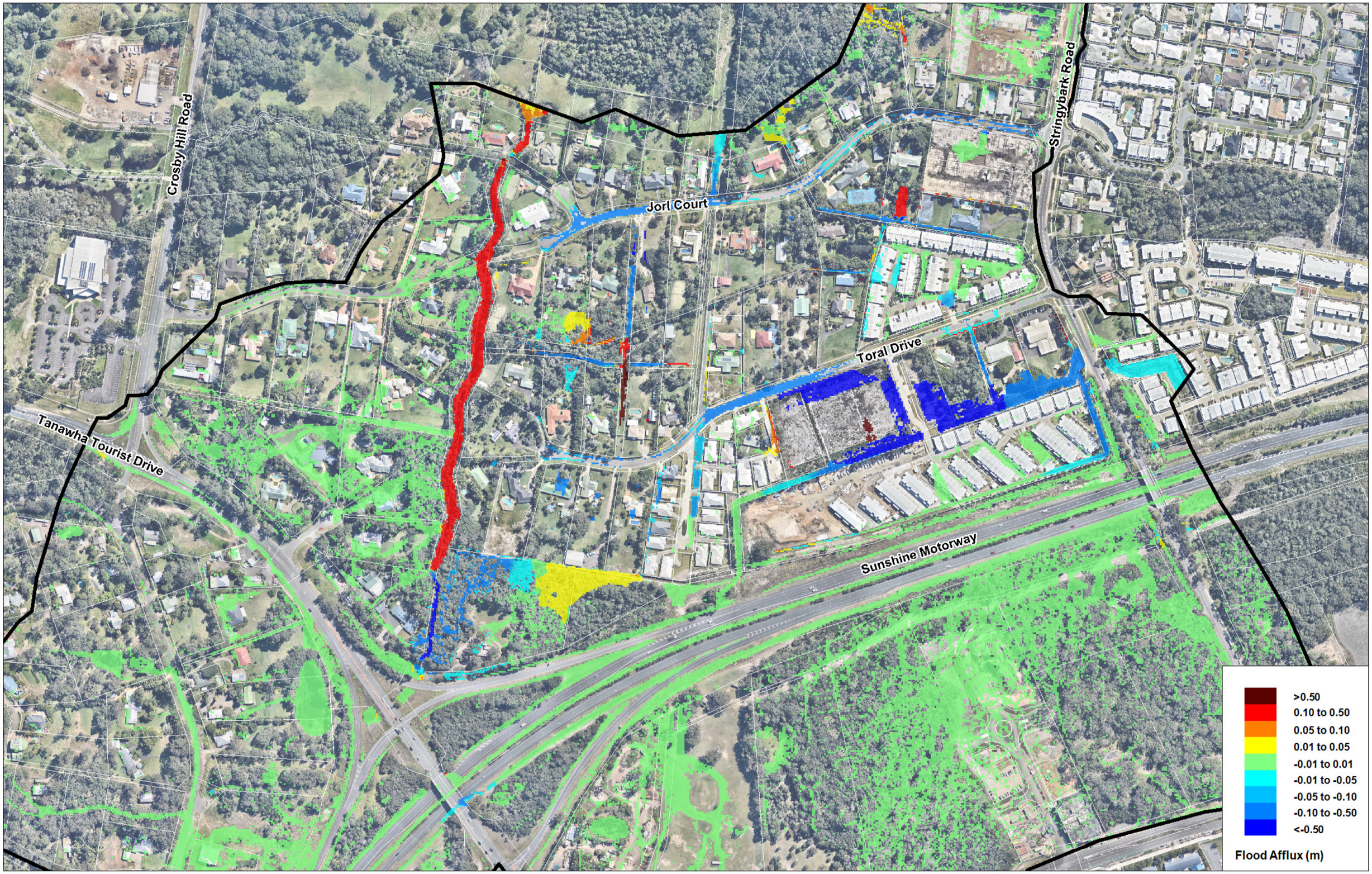

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PROJECT NO. 30031546 PROJECT TITLE BUDERIM MASTER DRAINAGE STUDY

DRAWING NO. APPENDIX REVISION A STATUS DRAFT

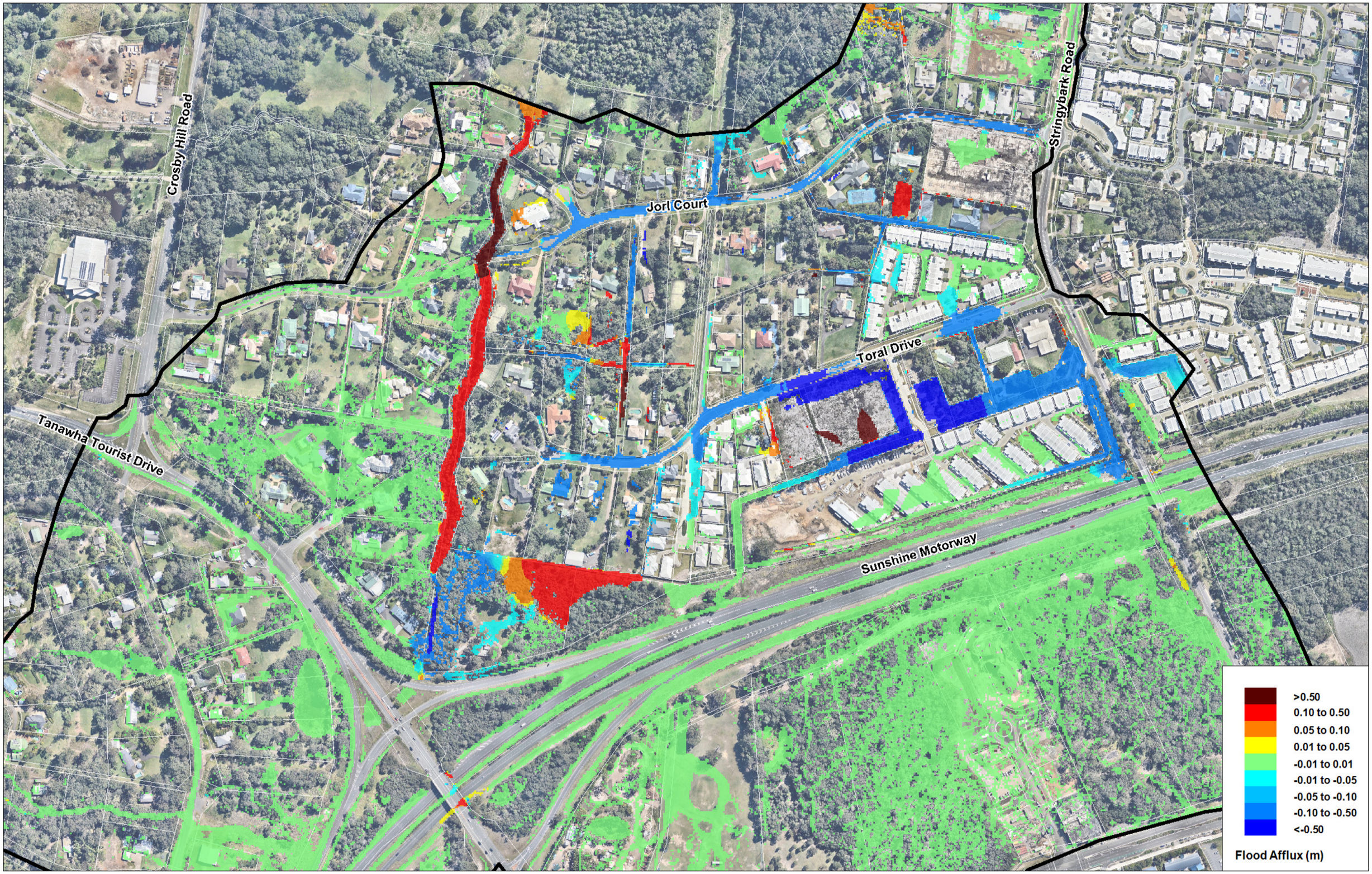
CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD AFFLUX MAP - 10% AEP**

CLIENT Sunshine Coast Council

CONSULTANT SMEC

SMEC Australia Ltd
Level 1, 154 Melbourne Street
South Brisbane QLD 4101



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DRAWING NO. APPENDIX REVISION A STATUS DRAFT

CREATED BY B BOLT DATE 08/12/2015 **NOT TO BE ISSUED**

TITLE **FLOOD AFFLUX MAP - 1% AEP (2100)**

CLIENT Sunshine Coast Council

CONSULTANT SMEC

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South Brisbane QLD 4101