FUTURE RESIDENTIAL LOT

FUTURE AGED CARE LOT

CONTROLLED ENTRY POINT
ENTRY SIGNAGE
FIRE TANK & PUMP
BOOSTER CABINET
BBQ / COMMUNITY LAWN
POOL
COMMUNITY & WEST APARTMENT WASTE COLLECTION POINT
PICKLEBALL COURT & BOCCE LAWN
SECURE PERIMETER FENCE
WASTE COLLECTION POINT
PARK

EXIT & RC/CARAVAN ACCESS ONLY
ERGON TRANSFORMER
SITE SWITCH BOARD
RESIDENT WORKSHOP & SITE MAINTENANCE
CARAVAN / BOAT WASH
CARAVAN / BOAT PARKING

FOOT PATH
COMMUNITY
1 STOREY
APARTMENT
3 STOREYS
APARTMENT
3 STOREYS
PARK / BBQ
OUTDOOR BBQ SPACE
FOOTPATH CONNECTION - LOCATION TO BE CONFIRMED
BIKE PATH

ASSISTED LIVING / INDEPENDENT VILLAS
FOOT PATH

DOG GROOMING PARKING
DOG WALK / OFF LEASH AREA

ACOUSTIC FENCE & SECURE PERIMETER
COMMUNITY GARDEN
CHOOK PEN
BIOBASIN
WETLAND FLOOD MITIGATION

BRUCE HWY
STUART DRIVE

1 - MASTERPLAN - RETIREMENT LIVING VILLAGE
SCALE 1:750 @ A1
SCALE 1:1500 @ A3

0 15 30 45 60 75

SCALE 1: 750 @ A1
SCALE 1: 1500 @ A3

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PARKSIDE GROUP

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ISSUE	PURPOSE	DATE	D	C	A
03	Draft DA Set	29/11/2024	VT/DL	GP	BD
02	For Coordination	22/11/2024	VT/DL	GP	BD
01	For Review	18/10/2024	VT	BD	SB

SCHEMATIC DESIGN

Parkside Annandale Masterplan

33 UNIVERSITY ROAD, ANNANDALE
CLIENT - PARKSIDE DEVELOPMENTS PTY LTD

DRAWING TITLE
MASTERPLAN - RETIREMENT VILLAGE

JOB No	DRAWING No	ISSUE
7309	SDA-1005	03

APPENDIX iii

NCE Flood Impact Assessment

NORTHERN CONSULTING engineers

CIVIL & STRUCTURAL ENGINEERS

FLOOD IMPACT ASSESSMENT

ANNANDALE RETIREMENT VILLAGE AND
RESIDENTIAL AGED CARE FACILITY

FOR
PARKSIDE DEVELOPMENT PTY LTD

JOB No: **PARK0014**

Report Ref: **PARK0014-FIA**

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DOCUMENT CONTROL

Rev	Author	Approved		Date	Issued To:	Purpose
A	Andrew Wallace	Andrew Wallace (RPEQ 6743)		6/12/2024	Client	Draft for Review - Support for development applications
B	Andrew Wallace	Andrew Wallace (RPEQ 6743)		13/12/2024	Cottee Parker	Support for development applications

EXECUTIVE SUMMARY

Parkside Development Pty Ltd is proposing a retirement village and residential aged care facility located at the corner of Stuart Drive and University Drive in Annandale. The site is proposed to be developed as depicted on the Cottee Parker layout plans and involves material change of use and a reconfiguration of a lot applications.

The purpose of this Flood Impact Assessment is to confirm the proposal can be carried out without causing impacts off site in respect of the existing flooding characteristics in accordance with the Performance Outcomes (PO) of the Flood hazard overlay code, in particular PO6 and PO7.

A review of the TCC Flood Hazard Overlay shows the site is within the low, medium and high hazard areas. The site is located in the TCC Ross River flood study area (2021) and is impacted by the 1% Annual Exceedance Probability (AEP) flood event.

This flood impact assessment report is prepared in support of the proposed development and outlines the proposal including the flood mitigation arrangements and demonstrates the site is suitable for the proposed uses.

An extensive flood impact assessment has been carried out using a fine scale mini TUFLOW model based on inputs and boundary conditions derived from Townsville City Council's new Ross River Flood Study 2021. A preliminary FIA had been carried out based on the former TCC flood model boundary conditions which was later updated based on the new TCC Ross River 2021 flood model inputs. The outcome of the assessment involved significant overbank widening / detention storage in the south-east, overbank widening upstream of the culvert crossing and use of the culverts to restrict and moderate the flows downstream. The outcome of the FIA included reducing the development extent (in conjunction with the above mitigation measures) in comparison to the original flood assessment prior to updating with the new TCC Ross River 2021 flood study inputs.

The mini model incorporates the Stuart Drive upgrade that was under construction at the time the report was finalised.

The assessment included consideration of a future residential subdivision on the western side of the drainage feature.

As the development is for a retirement village, the dwelling and building finished floor levels within the development are to be based on the 0.5% AEP flood level in accordance with the flood hazard overlay code.

This flood impact assessment demonstrates that the development proposal can proceed without any actionable impacts to the surrounding properties or the adjacent state controlled road. The assessment demonstrates the development can comply with the Flood Hazard Overlay Code and Planning Scheme Policy.

The details of this assessment are outlined herein.

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NCE Drawings

[Appendix I is omitted for clarity]

APPENDIX J

Preliminary Architectural Plans

1.0 INTRODUCTION

1.1 Overview

Parkside Development Pty Ltd are proposing to develop a retirement village and whilst not part of the immediate application, this engineering report also includes the future residential aged care facility. The site is located at 33 University Road, at the corner of Stuart Dr and University Drive in Annandale, formally described as Lot 1 on SP343205. The site location is shown in **Figure 1-1**.

NCE have conducted a flood impact assessment which is based on inputs from the Townsville City Council (TCC) Ross River Flood Study (2021), TUFLOW baseline model in order to assess the proposed development.

NCE have developed a fine scale TUFLOW model that incorporates the Australian Rainfall & Run-off 2019 (ARR2019) hydrology to ensure the assessment accurately depicts the flood conditions provided in the new TCC Ross River model.

1.2 Study Area

The site is located in the suburb of Annandale and bounded by Stuart Drive to the north-east, Racecourse Road (Bruce Highway) to the south, Shannahan Drive to the west and Gartrell Drive to the north. The model study area is bounded by a tributary of Ross River in the north, Fairfield lakes in the east, Wulguru and Lavarack Barracks to the south and Annandale residential estate at the west. The site is represented in its entirety within the TCC Ross River (2021) TUFLOW baseline model and is dominated by the following drainage features.

- A natural drainage corridor that traverses the site from the south to the north-east.
- A constructed drainage channel north-west of the site adjacent to Gartrell Dr and at the north at Stuart Drive.
- A major flow corridor from the south-east that conveys flood water to the north.
- All the above features convey stormwater to the table drain on Stuart Drive or directly to the Stuart Drive culverts.

The proposed retirement village and RACF is located in the eastern portion of the site. Access to the site is via the Shannahan Dr roundabout.

The site is currently vacant, however baseline flood mapping shows significant inundation across the site.

1.3 Scope of Works and Purpose of the Report

The purpose of this report is to assess if the proposed development layout is able to be filled and developed to achieve an appropriate level of flood immunity without generating actionable impacts to the surrounding flood characteristics. To achieve this, the scope of works incorporates:

- Develop a fine-scale 2D TUFLOW flood mini-model based on the provided TCC Ross River (2021) flood model;
- Adopt the hydrology and critical duration as provided in the Ross River Flood Report mapping and modelling;

- Model the 1% Annual Exceedance Probability (AEP) critical duration design event to compare the mini-model baseline to the Ross River (2021) model;
- Model the 0.5%, 1% and 50% AEP critical duration design events to determine the extent and magnitude of impacts to the existing flood characteristics;
- Identify mitigation measures necessary to reduce impacts to acceptable levels whilst maintaining as much of the proposed development, or reducing the development extent as required;
- Delivery of report and associated flood mapping.

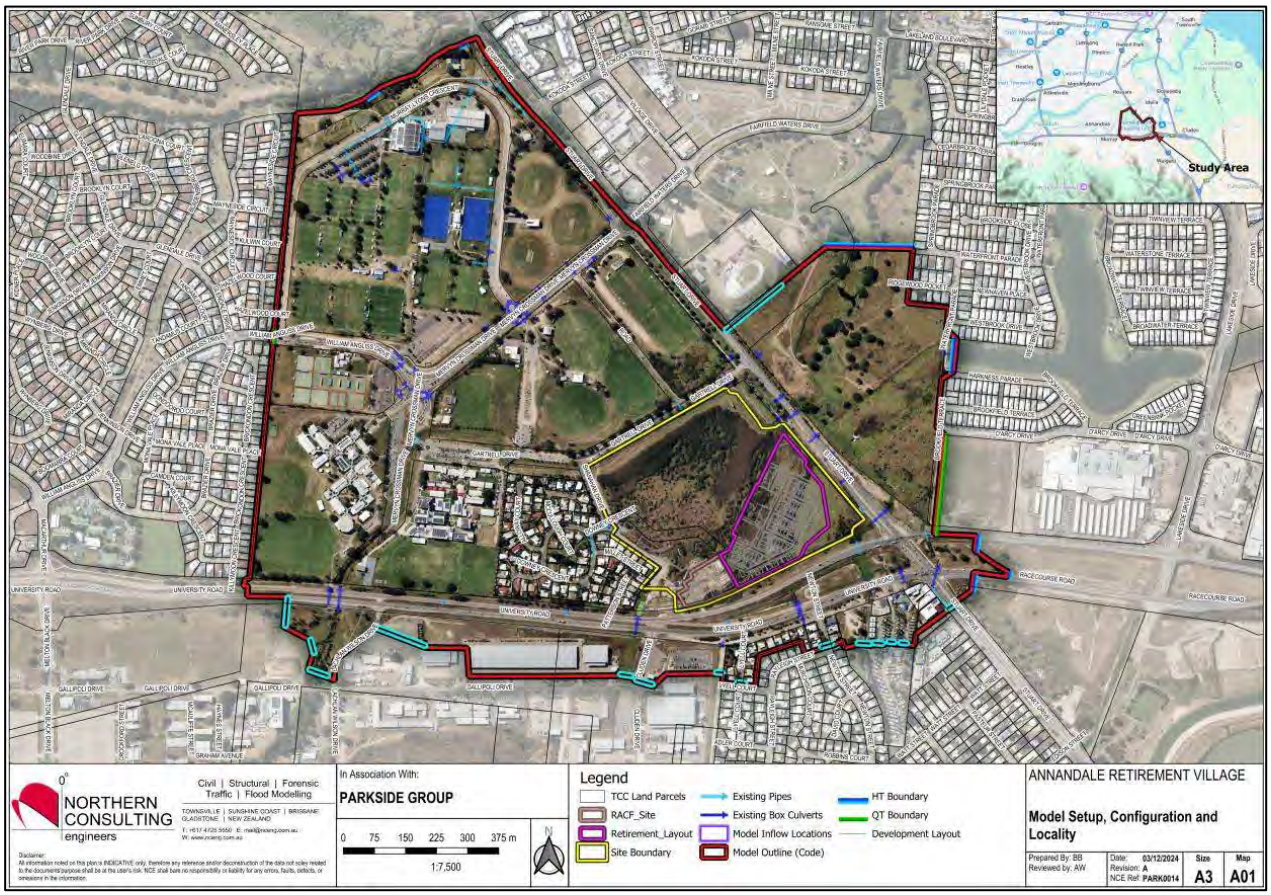

Figure 1-1 Study area locality

1.4 Limitations

In order to assess the implications of the proposed development extent, NCE has acquired TCC's Ross River (2021) TUFLOW model under a Confidentiality Deed. Details regarding the development of this model are provided in the 2021 Ross River Flood Study report, which was provided in conjunction with the model. A detailed audit of this model has not been undertaken, however, as the model has been calibrated, approved for use by TCC and promoted for use to inform planning and development decisions, it is reasonable to expect that industry standard modelling practices have been incorporated in both the hydrological and hydrodynamic components and is therefore suitable for this type of assessment.

Development or modification of the models necessary to undertake this assessment have been conducted in accordance with good engineering practices however, is bound by the practical limitations of the accuracy of information and data used for the modelling, and the software. The information produced in this report is accurate at the time of issue and is based on the information available at the time of the analysis. The report

has been prepared by NCE for the client and may only be used and relied on by the client for the specific purpose agreed between NCE and the client as set out in Section 1.3 of this report. All information contained herein is considered to align with the content and intent of the Confidentiality Deed. However, this report is issued for the express purposes and for the recipients noted. Any distribution or use other than that nominated, is considered to fall outside the bounds of the report intent and NCE take no responsibility for its use.

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The services undertaken by NCE in connection with preparing this report were limited to those specifically detailed in the scope and limitations of the report.

The opinions, conclusions and any recommendations in this report are based on assumptions made by NCE described in this report. NCE disclaims liability arising from any of the assumptions being incorrect.

NCE has prepared this assessment on the basis of information provided by 3rd parties, which NCE has not independently verified or checked beyond the agreed scope of work. NCE does not accept liability in connection with such unverified information, including errors and omissions in the supplied information.

1.5 Proposed Development

In accordance with the scope of works, the proposed development is associated with the proposed retirement village and RACF. The preliminary layout is depicted in **Figure 1-2** below with the relevant architectural plans provided in **Appendix J**. The current development application is based on the retirement village in the south-east of the site.

However, for the purposes of this FIA, the residential aged care facility (RACF) which was identified in the earlier iterations of the architectural layout is also assumed to be included in the development. This FIA caters for the option for the RACF to be developed to the extent and intensity assumed herein.

Figure 1-2 Proposed development – preliminary architectural layout plan

2.0 AVAILABLE DATA

This report and the associated hydrologic and hydraulic models have been largely prepared based directly or indirectly on the information contained in reports from previous studies, including but not limited to the 2021 Ross River Flood Study.

2.1 Topographic Information

For the TUFLOW model, the digital elevation model (DEM) is based on LiDAR survey data over the entire hydraulic model extent that was captured as part of the Townsville City Council 2016 LiDAR project and sourced from the Open Data portal. NCE note that the 2016 LiDAR was utilised in place of the 2019 LiDAR as this was adopted by the 2021 Ross River flood model. **Figure 2-1** depicts the model DEM in the vicinity of the site.

Where the model was shown to be inaccurate or not representative of the terrain on site, NCE incorporated areas where better definition terrain was available. The 2019 LiDAR and some available survey was incorporated to ensure better definition of key features.

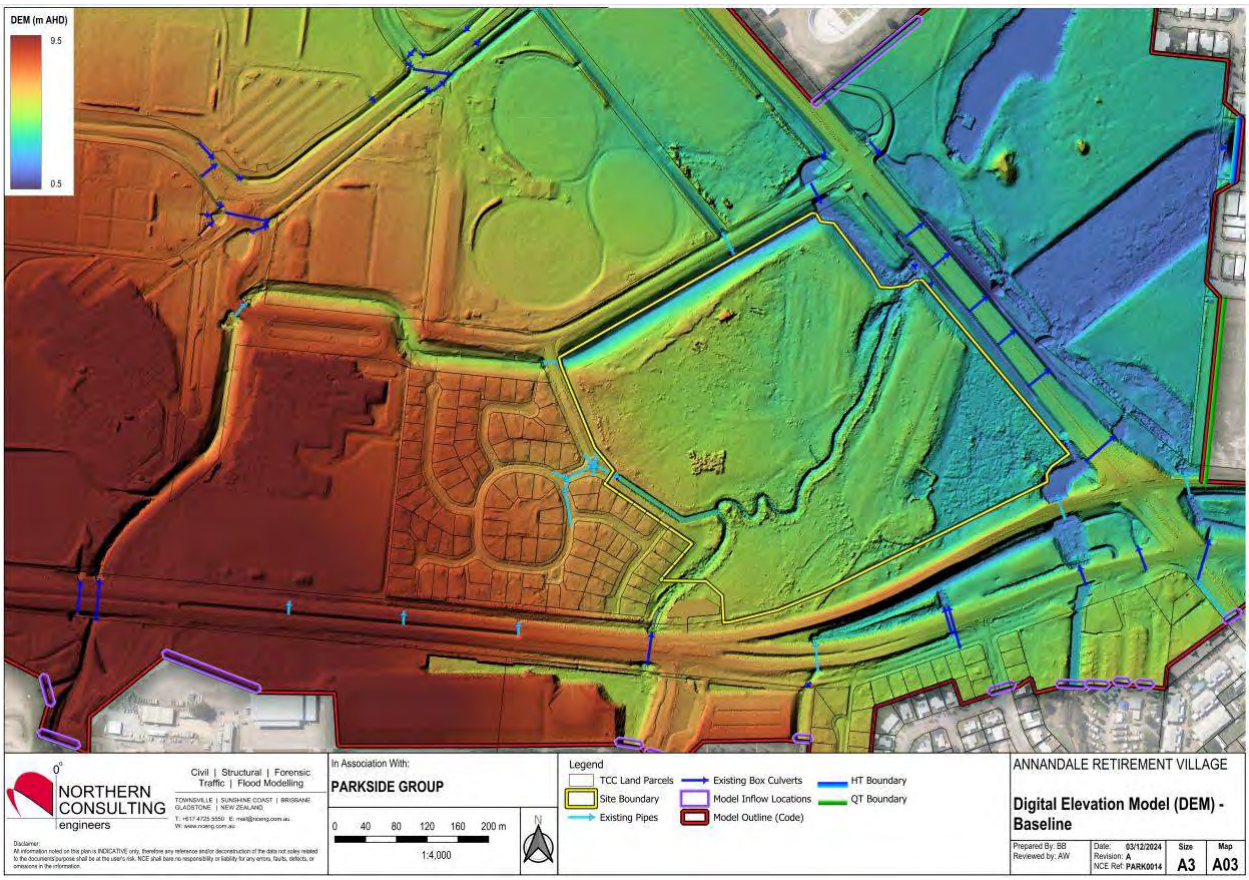


Figure 2-1 Baseline Model DEM based on 2016 LiDAR

2.2 Spatial Data

The following data was acquired to undertake this assessment:

- Cadastral data and other various data sources (i.e. watercourses, broad catchments, etc) of the site and surrounding area, sourced from the Queensland Government's QSpatial catalogue and TCC.

2.3 Aerial Imagery

Aerial imagery has been sourced from Google satellite sources and TCC's 2019 aerial photogrammetry, sourced from the TCC Open Data portal. This imagery has been utilised for roughness / land use mapping and flood results mapping.

2.4 Previous Reports

2.4.1 2021 Ross River Flood Study – Baseline Flooding Assessment

The report details the technical setup and calibration of the TUFLOW model which includes:

- a DEM resolved to a 5 m grid, utilising sub-grid sampling (SGS);
- underground drainage network including everything captured in the TCC Open Data Portal and additional surveyed network items;
- bridges applied as layered flow constrictions within the model;
- application of direct rainfall on the grid model (rain-on-grid (ROG));
- additional inflows derived from XP-RAFTS hydrologic models for the:

- Ross Creek catchment,
- Lower Ross River catchment, and
- Mundy Creek catchment;

- Storm tide inundation applied at the downstream end of the model.

The calibrated and verified model was used to assess design storm flood events with the results used to:

- quantify the floodplain hydraulic response;
- evaluate potential impacts on properties;
- identify flood hazard zones;
- inform planning and development works within the catchment;
- identify emergency management considerations.

The results of this model were used to validate / compare the results from the new fine scale TUFLOW model as outlined below. Map A05 shows the afflux maps which depicts the difference between the Mini model and the Ross River water surface levels.

3.0 MODELLING METHODOLOGY

To undertake this study, a new fine scale 2D TUFLOW model has been developed to assess the potential impact associated with the proposed development. As this site is located within a broader catchment, external flows and downstream tailwater levels were adopted from the TCC flood models.

This model had been developed based on inputs from the former TCC flood model. However, as the updated 2021 TCC Ross River Flood Study model became available, the model was revised with flows as well as downstream levels extracted and incorporated into the fine scale model.

It was observed that the new critical duration resulted in flood levels that were higher than the former modelling and TCC mapping.

Further detail on the critical duration is provided in Section 3.1.4 below

NCE also carried out an assessment of the master planned development to ensure that the future residential subdivision was not compromised. The flood levels shown on Drawing PARK0014/A02 in Appendix H are based on the ultimate master planned site development flood levels which are the highest levels that apply to the site. There are some areas where the interim flood levels following the development of the retirement village and RACF only are lower than these listed levels. However, the master planned flood levels are provided to ensure that the interim development is located at the appropriate ultimate finished levels.

Any future flood studies relating to the residential subdivision should be considered with respect to the holistic development and this FIA.

Given the nature of the assessment, the modelling to identify the required mitigation measures was an iterative process, where one set of results was used to inform or refine the subsequent simulation. With this in mind, the following approach was taken.

TUFLOW

For this assessment, as discussed herein a site specific 1D / 2D TUFLOW model has been developed which has adopted the HPC solver, sub-grid sampling (SGS) and the following methodology:

- Development of a fine scale model, adopting similar or updated parameters as the calibrated Ross River (2021) TUFLOW model.
- Introduce flood reporting locations at the relevant inflow and downstream boundary locations and run the 2021 Ross River model to obtain the results required for the model inputs in the mini model.
- Simulate the 0.5%, 1% and 50% AEP event for the critical duration events outlined in the Ross River flood results to verify / compare the model results.
- Update hydrology and other model parameters where appropriate to better correlate with the provided Ross River (2021) flood results.
- Confirm the critical duration against the provided flood model results for the Ross River (2021) model and modify the adopted parameters if necessary.
- Incorporate the proposed development to determine any impacts off site.
- Introduce mitigation measures and where required, reduce the development extent. Iterate until an acceptable outcome is identified.

In accordance with TCC Planning Scheme flood hazard overlay code, the defined flood event (DFE) is the 1% AEP, being the event which the development is to be assessed against. The fill extent and assessment to demonstrate non worsening is assessed based on the DFE critical duration(s).

The 50% AEP event was the adopted minor event as determined from the development manual planning scheme policy - Stormwater quantity. The actual event listed in the development manual was the 2 year ARI, however based on the new flood model and ARR 2019, the 50% AEP is considered appropriate and is considered to generally align with the intent of the policy. The new TCC flood study does not include the 2 year ARI event.

In addition, as the development is for a retirement village, the dwelling and building finished floor levels within the development are to be based on the 0.5% AEP flood level in accordance with the flood hazard overlay code.

All modelling was based on the Mean High Water Springs (MHWS) boundary condition within the Ross River flood study, i.e. initial water level of 1.31 m AHD, stage-discharge or stage-time curves, except for the climate change assessment.

3.1 Hydrologic Modelling

The Ross River (2021) Flood model was obtained from Townsville City Council (TCC) under the Purpose and Confidentiality Deed dated and used for this assessment. Technical details of the model set-ups are described in the Ross River (2021) Flood Study report and therefore only a summary of the technical details is provided in the following sections. An audit of the hydrological models has not been undertaken as it's our opinion that models are fit for purpose as they have been approved and endorsed by TCC.

Generally speaking, apart from the aspects discussed herein, there were no other changes applied to original hydrological models as the mini model generally showed good correlation to the Ross River (2021) model,

(except where modifications were carried out as described herein). Furthermore, the rainfall applied to the Ross River (2021) model has been calibrated to multiple past events.

The hydrological response of the local catchment has been derived using source area inflows and a rain-on-grid approach. Technical details of the model set-ups are described in the Ross River (2021) Flood Study report with changes discussed herein.

3.1.1 Rain on Grid

Rain-on-grid (ROG) is a method of hydrologic determination that applies rainfall directly to the surface of a 2D hydraulic model, rather than routing rainfall through a separate hydrologic model. This method is particularly advantageous in the fact that local catchment boundaries do not need to be defined, providing the 2D hydraulic model adequately represents that natural terrain.

In the TUFLOW model, the total rainfall depth is applied directly to the 2D grid with losses removed via soil infiltration, subject to the fraction impervious defined in the materials / land use mapping.

3.1.2 ROG Modifications

Once the extent of fill had been defined, the area was modified to reflect the impervious land use, representing a 'design' discharge from the future potential development. NCE have updated the Manning's 'n' value utilised by the TUFLOW model to better represent the materials across the mini-model in the fine-scale. This is also includes updating the percent impervious of the land uses.

Updating the rain-on-grid hydrology in this manner maintains alignment with the current approved calibrated model adopted by TCC.

3.1.3 Losses

The losses in the mini-model rain on grid have been applied using a soils file with the initial loss varying based on the storm event and duration in accordance with ARR 2016. The percent impervious is applied to the model using the materials file. This method varies from the overall Ross River (2021) model which nominates the losses directly on a per soil type basis. However, NCE have utilised the same loss values for the impervious areas from the Ross River model. The adopted losses area as follows:

The losses applied in accordance with ARR 2019 are:

- IL - Varies in accordance with ARR 2019
- CL - 4.0 mm/hr CL

3.1.4 Critical Duration Assessment

It was observed that the new critical duration resulted in flood levels that were higher than the former model that was set up based on the former TCC model and mapping.

As part of the original model development and preliminary flood impact assessment carried out in 2023, a median temporal pattern and critical duration assessment was carried out using the former TCC flood study RAFTS hydrologic model, but updated with the latest ARR2019 hydrology.

The ARR2019 approach as adopted by the flood study is to simulate the rainfall depth for a given duration under the ensemble of ten (10) temporal patterns to determine the median flood characteristics for the site. This means that for every flood event of a given durations, there are ten (10) design storms that require

assessment in order to identify the median temporal pattern. The critical duration for the 1% AEP event as per the provided mapping is the 1.5-hour and 18 hour storms. These were assessed as part of the preliminary assessment.

However, as the original preliminary mini model was developed in 2023, this was subsequently abandoned once the new model became available.

Given the Ross River (2021) flood model has been previously calibrated to past events, the mapping provided within the Ross River (2021) flood study report has been assumed to accurately depict the critical duration over the development site. The mapping provided in the flood study report indicates the critical durations for each flood frequency from 50% AEP to 0.1% AEP.

The ARR2019 approach as adopted by the flood study is to simulate the rainfall depth for a given duration under the ensemble of ten (10) temporal patterns to determine the median flood characteristics for the site. This means that for every flood event of a given durations, there are ten (10) design storms that require assessment in order to identify the median temporal pattern. The critical duration for the 1% AEP event as per the provided mapping is the 1.5-hour storm.

3.2 Hydraulic Modelling

For this assessment, a site specific 1D / 2D TUFLOW model has been developed which has adopted the HPC SGS solver on a 2m grid with an SGS sampling frequency of 11.

2016 LiDAR data was used for the DEM which was transposed onto a 2 m grid that covers an area of ~186 hectares. The extent of the model setup is shown in **Appendix A**.

3.2.1 TUFLOW

The TUFLOW (Two-dimensional Unsteady FLOW) modelling software was utilised to undertake the hydraulic modelling required for this flood level assessment. TUFLOW is a powerful computational engine that allows the ROG method to be applied directly to the 2D hydraulic model which provides 1D and 2D solutions of the free-surface flow equations to simulate flood and tidal wave propagation. TUFLOW is specifically oriented towards establishing flow and inundation patterns in floodplains, coastal waters, estuaries, rivers and urban areas where the flow behaviour is essentially 2D in nature and cannot or would be onerous to represent using a 1D model. Subsequently, TUFLOW is ideally suited for this assessment.

TUFLOW currently incorporates two (2) grid-based solvers:

- TUFLOW Classic: A second order semi-implicit solution available for computations using CPU hardware on a single core; and
- TUFLOW HPC (Heavily Parallelised Compute): A second order explicit solver. TUFLOW HPC can run a simulation using multiple CPU cores, or alternately GPU hardware for high-speed execution without sacrificing model accuracy.

Outputs from TUFLOW include GIS maps of flood depths, water surface levels (WSL), velocities, hazard and inundation extents.

TUFLOW also offers the use of sub-grid sampling (SGS). This method allows high resolution results and finer scale modelling while keeping run times low. This method calculates cell volume via a cell elevation-volume curve and cell face on cell width-elevation curve. SGS samples a specified number of points across the cell (eg. sampling frequency of 11 generating a 10x10 grid – 1/10th cell size) to create the elevation-

volume curve and width-elevation curves for each cell. This allows more accurate calculation of storage transfer between cells, however the shallow water equations are only calculated on a cell-by-cell basis.

The Ross River (2021) flood model utilises a 5m grid with a default SGS sampling distance of 1m equating to a sampling frequency of 6.

3.2.2 Hydraulic Roughness

The hydraulic roughness is defined by the Manning's 'n' values applied to the materials defined within the TUFLOW model. These roughness values and areas have been defined via aerial imagery and by reference to various guidelines such as ARR2019 and QUDM in conjunction with site visits and photographs. The below **Table 3-1** indicates the Manning's 'n' values applied to each land use as depicted in the materials mapping in **Appendix A**. A roughness sensitivity assessment was carried out as discussed in Section 4.2.2.

Table 3-1 Land use / materials inputs

Material ID	Material Description	Manning's 'n'	Percent Impervious
1	Roads	0.025	50
2	Impervious	0.018	100
3	Verges	0.035	40
4	Urban	0.08	65
5	Commercial / Industrial	0.04	90
6	Vegetated Channels (Maintained)	0.06	0
7	Open Space	0.07	0
8	Playing fields / Facilities	0.04	5
9	Medium Density Residential / Commercial Facilities	0.06	70
10	Existing Site (not zoned)	0.08	0
12	Unmaintained Vegetated Channels	0.08	0
13	Heavily Vegetated	0.1	0

The basis for the updated hydraulic modelling has been undertaken using the Ross River (2021) TUFLOW model, which is a dynamically linked hydrodynamic model that couples 1D structure (culverts, bridges, etc) hydraulics and 1D subsurface drainage networks with a 2D terrain model. Technical details of the model set-up are described in the Ross River (2021) Flood Study report with technical changes to the model discussed below.

The TUFLOW mini-model was used to determine flood levels for the events and durations listed in **Table 3-2**. These results were then post-processed to create flood extents, water surface levels (WSL), depth, velocity and afflux plots. The 1% and 50% AEP events which had the multiple critical durations were combined in the results and displayed as the maximum of the events.

Table 3-2 Flood events assessed

Flood event	0.5% AEP	1% AEP		50% AEP	
Duration (hour)	2	2	9	3	6
Baseline	✓	✓	✓	✓	✓
Developed	✓	✓	✓	✓	✓

4.0 FINDINGS, RESULTS AND DISCUSSION

Observations during the assessment indicated that the proposed development resulted in afflux off site and required a combination of mitigation measures to address to ensure non-worsening. The culvert crossing of the drainage feature incorporates a 2 tiered culvert system which balances the flows downstream and ensures the afflux upstream is kept within the site boundaries. The culverts consist of a bank of low level major culverts at the stream bed level as well as a high level overbank culverts 750mm above the bed.

Due to the nature of rain-on-grid, fine scale model results and to provide some clarity, the final maps have been filtered such that areas predicted to experience water depths less than 0.05 m and water velocities less than 0.5 m/s are shown free from flooding.

Table 4-1 lists the results that have been mapped and presented in the following appendices:

- Appendix B – Afflux plots
- Appendix C – WSL plots
- Appendix D – Depth plots
- Appendix E – Velocity plots
- Appendix F – Flood Hazard plots

Table 4-1 Result map plots

Scenario	Event (AEP)	Flood Characteristic and Event Duration			
		WSL	Depth	Velocity	Hazard
Baseline	50%	✓	✓	✓	✓
	1%	✓	✓	✓	✓
	0.5%	x	x	x	x
Developed	50%	✓	✓	✓	✓
	1%	✓	✓	✓	✓
	0.5%	✓	x	x	x
Masterplanned Site Fully Developed	50%	x	x	x	x
	1%	✓	x	x	x
	0.5%	✓	x	x	x
Afflux	50%	✓	x	✓	x
	1%	✓	x	✓	x
	0.5%	✓	x	x	x
Masterplanned Site Afflux	50%	✓	x	x	x
	1%	✓	x	✓	x
	0.5%	✓	x	x	x
	1% Climate Change	✓	x	x	x

The following sections discuss specific model modifications, in addition to those outlined in **Sections 4.3.2**, and results of the assessment.

4.1 Baseline Scenario

4.1.1 Digital Elevation Model (DEM) Modifications – TUFLOW

As discussed above, at the time of preparing the TUFLOW model, 2019 LiDAR data was available, however, given the Ross River (2021) considered the 2016 LiDAR data more appropriate, NCE have also adopted this. The 2016 LiDAR was transposed onto a 2 m grid to define the baseline topography of the hydraulic model. The primary update that been carried out is the upgrade to Stuart Drive. It is noted that a number of locations were also altered slightly to better match the existing levels / conditions. These minor DEM alterations are outlined below:

- Stuart Drive DTMR upgrade. This involves raising of the road and introduction of a number of additional major culverts.
  NCE were provided with a pdf copy of the Stuart Dr upgrade drawings and developed a terrain model in the extent of the works according to the drawings. Whilst an inefficient method of building a terrain, DTMR would not supply the digital terrain data due to confidentiality issues.

- Introducing the new pump station PS SC7 site.

- Minor reprofiling of the upstream portion of the channel adjacent to the new pump station which was improved as part of the pump station construction. The 2016 LiDAR showed the upstream portion of the channel as partially blocked and the 2019 LiDAR didn't indicate the correct profile.

NCE note that some DEM modifications utilised in the Ross River (2021) flood model have not been adopted for the mini-model if they have not been considered critical to the development site.

A comparison of the water surface level results showed close alignment between the Ross River (2021) model and the developed fine-scale mini-model. The comparison of the flood depths which generally show good correlation in magnitude and extent as shown in Map A05 in **Appendix A**. However, NCE note the primary areas where more significant differences are observed as follows:

- On the site, upstream of Stuart Drive, the levels are reduced which is considered to be due to the significant increase in the number and sizes of the culverts crossing Stuart Dr.

- Downstream of Stuart Dr, there is an increase in flood levels. This is also due to the increased culverts across Stuart Dr. This increase is limited to less than around 20mm except for a highly localised location.

- Increased flood levels north of Gartrell Dr due to the upgraded intersection with Stuart Dr.

- Increased flood levels in drainage channels. This is observed to be due to NCE introducing 20% blockage throughout for all existing structures (reduced to 10% for some). In addition, the areas where the channel definition was updated with more accurate terrain has resulted in differences.

- Increased flood levels upstream of University Dr. – This is observed to be due to the blockage introduced by NCE.

4.1.2 Baseline Critical Duration – TUFLOW

As NCE were supplied the flood results as part of the flood model agreement with TCC, a critical duration raster was also supplied for the 1% AEP event. The provided raster is generated by compiling all the flood model results and comparing the peak water surface levels (WSLs). The resultant raster indicates that the majority of the development site has a peak water surface level dominated by the 2-hour storm, with the

downstream portion of the site and downstream of Stuart Drive governed by the 9-hour event. The 3 hour (TP 8797) was also found to be critical in a small portion of the site but was found to only marginally higher than the 2 hour and 9 hour events and as it was limited to such a small region, was not included in this assessment.

The comparison of the flood report mapping and the raster mapping is provided in map A08 in **Appendix A**. NCE have utilised the provided results and confirmed that the critical duration raster is accurate and the 2-hour and 9-hour peak WSLs were significantly higher than for the 1.5-hour duration. Therefore, NCE have adopted the 2-hour and 9-hour critical durations for the 1% AEP event modelling and updated the development assessment accordingly.

NCE have not been provided a critical duration raster for the other event flood frequencies and thus have carried out a manual assessment of the 50% and 0.5% AEP durations and have adopted the dominant critical durations. The provided mapping shows the 3-hour and 6-hour storm durations as critical over the development site for the 50% AEP which has been adopted in the assessment. The 0.5% AEP event is dominated across the site by the 2 hour event only. Whilst the longer duration events were only applicable to the far downstream and areas downstream off-site, these events were also included to ensure that the worst case scenario was identified particularly for the sensitive receptors being the state controlled road and the downstream properties.

NCE have not conducted any further assessment on the median temporal patterns and have instead adopted the patterns presented in Appendix D of the Ross River (2021) flood study report. The adopted critical duration events are indicated in **Table 3-2**.

It is noted that the 9-hour peak WSLs are controlled by tailwater levels from the downstream lakes area and thus the flood characteristics are significantly different from the shorter duration event.

In progressing the development assessment, the initial results provided suitable results without significant impacts off site. However, through a series of further and final verifications and comparison with the report maps, it was found that there were anomalies with the results.

The updated model initially showed new impacts off site which had previously been addressed in the preliminary modelling based on the former TCC model. This required updated mitigation to address the additional afflux in accordance with the TCC flood hazard overlay code. This is discussed herein.

As discussed above the critical duration noted in the report maps differed from the raw model source files. An assessment of the flood levels within and in the vicinity of the site was carried out showing the critical durations that dominated the site are listed as follows:

- Defined flood event (DFE), 1% AEP short duration (2hr) – Typically dominant across the majority of the site.
- Defined flood event (DFE), 1% AEP long duration (9hr) – Typically dominant in the far downstream portion of the site and downstream from the site opposite Stuart Dr.
- Minor event 50% AEP short duration (3hr) – Typically dominant on the majority of the site.
- Minor event 50% AEP long duration (6hr) – Typically dominant in the downstream portion of the site and downstream from the site.
- 0.5% AEP (2hr) – Dominant across the entire of the site.

- Results are based on the maximum of the highest flood levels for each of the above events with multiple critical durations.

4.1.3 Existing Culverts

There were a number of culverts within the site that weren't included in the TCC Ross River (2021) model. DTMR provided pdf copies of the design drawings which were used to updated the relevant sections. **Table 4-2** lists the primary culverts added to the TUFLOW model which were deemed to influence the flooding in the vicinity of the site. The below table is not an exhaustive list of all modifications carried out but includes all major and relevant culverts.

Table 4-2 Culverts added to the baseline model

ID	US IL (m AHD)	DS IL (m AHD)	Length (m)	Configuration	Manning's n value	Location
TMR02A	2.15	2.00	32.39	12/1500x1200 RCBC	0.013	Stuart Dr (S) ~Ch 4360
TMR02B	2.15	2.00	28.79	12/1500x1200 RCBC	0.013	Stuart Dr (S) ~Ch 4425
TMR02C	2.15	2.00	27.60	12/1500x1200 RCBC	0.013	Stuart Dr (S) ~Ch 4485
TMR02F	1.63	1.54	28.8	22/2400x1800 RCBC	0.013	Stuart Dr (S) ~Ch 4560
TMR02G	1.83	1.68	30.0	1/2100x1500 RCBC	0.013	Stuart Dr (S) ~Ch 4610
TMR02H	1.83	1.68	30.0	4/1200x600 RCBC	0.013	Stuart Dr Table Drain
TMR03B	2.29	2.19	19.2	1/1200x900RCBC	0.013	Gartrell Dr near Intersection
TMR03D	2.55	2.50	9.23	3/1200x600 RCBC	0.013	Stuart Dr / GartrellDr Intersection Table Drain
TMR03E	2.54	2.42	25.2	3/1200x450 RCBC	0.013	Cycle track access Rd
TMR05G	3.79	3.6	37.2	16/1200x600 RCBC	0.013	Mervyn Crossman Dr

4.2 Sensitivity Assessments

The general purpose of the assessment is to identify the sensitivity of the model to the following variables:

- Culvert blockage
  - Increase blockage from design amounts to 50% across the entire model to assess the changes.

- Mannings roughness
  - Decrease and increase the Mannings roughness values across the entire model by 20%.

4.2.1 Culvert Blockage

An additional assessment was carried out to review the impact to the model area due to 50% culvert blockage. Consideration for the blockage potential was carried out where the majority of the site was considered to have low potential for debris mobilisation and blocking due to the urban built form and stormwater treatment devices upstream of the major proposed development culverts. The design blockage for the existing culverts has been nominated taken as 20% with the sensitivity run being blocked to 50%. **Map G02** shows the impacts due to the blockage in all culverts in the baseline scenario relative to the baseline case with the design blockage only.

The outcomes of this assessment logically show water levels upstream of the culverts increased and through the developed areas where inlet pits and pipe networks are 50% blocked. Additionally, downstream of the culverts are shown to have reduced flood levels.

Map G03 shows the impacts of the developed case with 50% blockage scenario compared to the baseline 50% blockage scenario. This shows relatively minor changes in the vicinity of the site and insignificant afflux offsite.

An assessment was carried out to review the impact to the development site due to total culvert blockage. Consideration for the blockage potential was carried out where the majority of the site was considered to have low potential for debris mobilisation and blocking due to the urban built form and stormwater treatment devices upstream of the major proposed development culverts. The design blockage for the existing culverts has been taken as 20% with the sensitivity run being completely blocked as per QUDM section 10.4.10. **Map G04** shows the impacts due to the blockage in all culverts relative to the developed case with design blockage values.

The outcomes of this assessment logically show water levels upstream of the culverts increased and through the developed areas where inlet pits and pipe networks are fully blocked. However, levels downstream of the Beck Drive culverts have also been increased. This is due to the fact that in the 100-year ARI event the Bohle River overflows and backflows over Beck Drive, however, with the culverts fully blocked the downstream levels are increased. Additional overtopping of Bluewattle Boulevard at both the Beck Drive and Saltbush Boulevard intersections occurs.

4.2.2 Mannings Roughness Sensitivity

Map G04 and **Map G05** show the impacts due to the increase and decreased Mannings respectively relative to the developed case.

It is evident from **Map G04** that the increase in Mannings n generally increases the WSL except upstream of University Dr. The increases varies across the model area but is generally considered to be minor overall. Within the bulk of the development site, the increases are minor and limited to be less than 20mm.

Map G05 shows that the reduced Mannings n values consistently result in reduced flood levels across the site noting that the differences are a little more pronounced on the site, with levels up to 140mm lower upstream of the culverts and 100mm difference downstream of the culverts.

Overall, the study area is considered to have low to moderate sensitivity, but given that the levels in the vicinity of the site do not vary significantly, the adopted Mannings values are considered suitable.

4.3 Developed Scenario

4.3.1 Digital Elevation Model (DEM) Modifications – TUFLOW

In the TUFLOW model, the fill pads representing the retirement village in the east and the RACF in the south / south-west have been added. Also as discussed herein, the future Lot 4, potential allied health has also been filled (and demonstrated to have negligible impact on the outcomes). The fill pads have been developed as preliminary bulk earthworks surfaces introduced over the baseline model.

The retirement village site is proposed to grade from the west / north west towards the south-east into the drainage corridor at the east. The RACF site is designed to grade from the southern boundary towards the north into the internal drainage corridor. The opposing grades above generally replicates the existing flow regime across the site and with the development filled in a manner that reduces the volume of fill and aligns with the design layout.

The concept arrangement is depicted in **Figure 4-1** as well in the NCE drawings in Appendix H.

Appendix A contain maps of the 2D terrain adopted for each scenario.

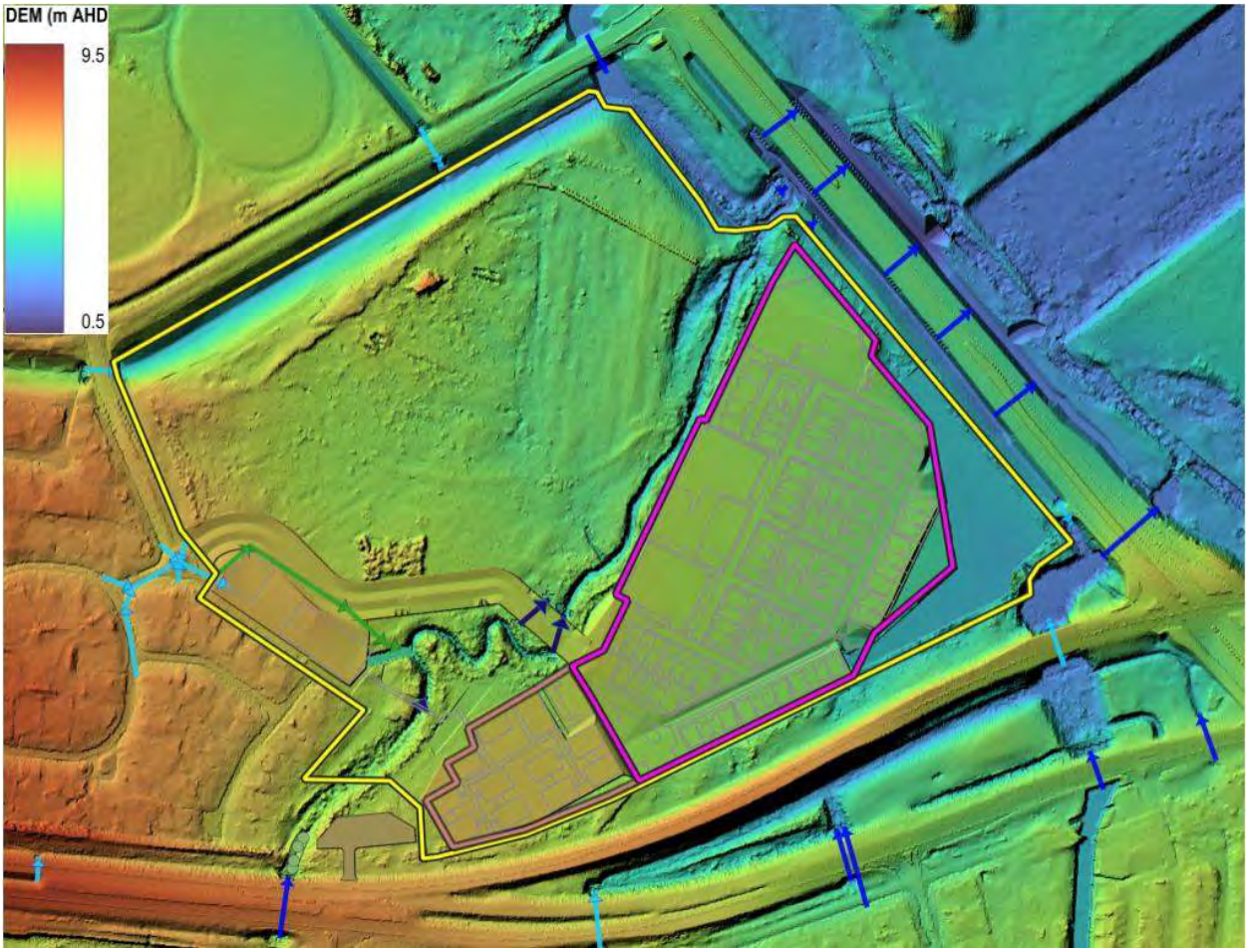


Figure 4-1 Developed Model DEM

4.3.2 Rain-on-grid Design Discharge

A technical summary of the rain-on-grid (ROG) setup, Ross River (2021) flood report references, are provided in Section 3.1.1.

In the TUFLOW model, the developed scenarios were updated to reflect the changed fraction impervious defined in the materials / land use mapping.

In order to account for changes in impervious areas for the proposed development, the land use for entire extent of each fill pad was modified to reflect a 70% imperviousness for the development and 50% for the roads, representing a 'design' discharge.

4.3.3 Initial Water Levels

Initial water levels have been adopted directly from the TCC Ross River (2021) flood model which are generally based on the Mean High Water Springs (MHWS) level of 1.31m, except for the climate change scenario which was based on HAT being 2.36m AHD.

4.3.4 Fill Extents

The development layout outlines the extent of fill expected as depicted in **Figure 4-2**. The extent of earthworks involved with the development of the site is generally depicted in the maps provided in **Appendix A**.

4.3.5 Mitigation Measures

Mitigation measures and/or alterations to the preliminary earthworks surface have been incorporated into the model using z-shapes and level points.

Following an extensive series of model iterations as discussed herein, mitigation measures adopted, in conjunction with reduced fill extents resulted in non-worsening off-site. The mitigation measures adopted include the following:

Table 4-3 Mitigation Measures

#	Location	Details	Purpose / Background
1	Existing floodplain region at the East / South-east corner of site	Overbank widening / Detention storage in the South-east corner. Involves varied cut levels that ensure positive drainage to all areas (except where nominated for stormwater quality devices).	Offsets floodplain encroachment and flow restriction by improving mid to high level overbank flow conveyance from the south-east towards the north-east. Reinstitutes the pre-developed flood regime and floodplain storage.
2	Upstream of the culvert crossing either side of the drainage feature	Shallow overbank widening either side of the drainage feature upstream of the culvert crossing.	Provides improved major flow conveyance and offset floodplain encroachment and flow constriction.
3	Road crossing of drainage feature	2 banks of culverts 4 x 1.5 x 1.5m RCBC withing creek invert & 6 x 1.2 x 0.9m RCBC elevated 750mm above on high bank	Sized to moderate and optimize flows as well as control upstream afflux in various events
4	Northern section of the site balance area	Levee with narrow free flowing outlet. Levee top level 4.8m AHD. Channel opening in levee located in natural low point with 2m wide base and 1:5 batters.	Detains the overbank flood plain flows which are conveyed northwards across the balance area to provide a non-actionable outcome off site.

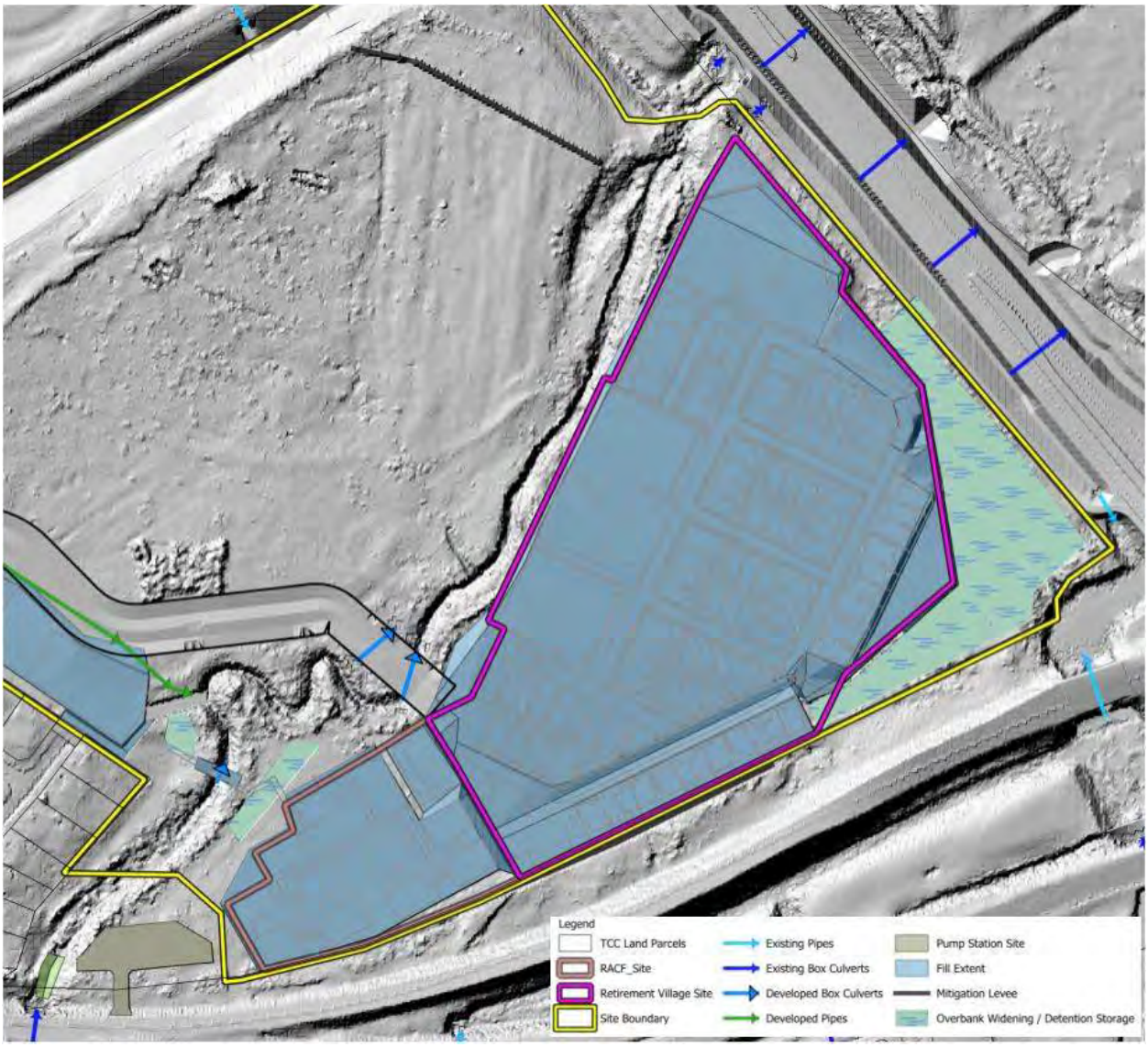


Figure 4-2 Development Layout and Mitigation Measures

4.3.5.1 Culverts

As listed in Item 3 of **Table 4-3**, the culvert crossing of the drainage feature incorporates a 2 tiered culvert system which balances the flows downstream and ensures the afflux upstream is kept within the site boundaries. The culverts consist of a bank of low level major culverts at the stream bed level as well as a high level overbank culverts 750mm above the bed.

The road way crossing is demonstrated to be trafficable in a 0.5% AEP event.

A minor low level culvert is also included upstream which aligns with the proposed pedestrian path that crosses the drainage feature.

A new pipe is connected to the existing pipe network on Shannahan Dr and is located in the road extension outlets to the south-east within the drainage feature.

The development culverts along with their use and parameters are outlined in **Table 4-4**. The 1d network and drainage layout is depicted in Map A06 and drawing PARK0014/A06 in **Appendix H**.

Table 4-4 Development culverts

ID	Type	US IL (m AHD)	DS IL (m AHD)	Configuration	Manning's n value	Description
Shann_ Culv	RCBC	3.65	3.45	4/1500x1500	0.015	Major culverts at stream bed level
Shann_ Culv2	RCBC	4.35	4.25	6/1200x900	0.015	Mid-level overbank culverts
Low_ Ped	RCBC	2.369	2.351	1/1200x900	0.015	Minor pedestrian culvert crossing
Shann 01	RCP (Mult)	4.23	3.84	1/1050	0.014	Pipe connected to existing RCP in Shannahan Dr located in road extension and outleting in drainage feature towards south-east

The combination of all the above mitigation and flow control devices are required in order to achieve no actionable impacts off site in both the major and minor events.

4.4 Results

Results associated with the maps provided in **Appendix B** to **Appendix G** are discussed in detail in the following sections.

As discussed in the preceding sections, the 1% AEP and 50% AEP events were found to be dominated by 2 separate critical durations. Therefore, the following results were mapped based on the maximums for each event.

NCE also carried out an assessment of the master planned development to ensure that the future residential subdivision was not compromised. This additional assessment demonstrated that the future subdivision can also be carried out without causing actionable nuisance off site. The flood levels shown on Drawing PARK0014/A02 in Appendix H are based on the ultimate master planned site development flood levels which are the highest levels that apply to the site. There are some areas where the interim flood levels following the development of the retirement village and RACF only are lower than these listed levels. However, the master planned flood levels are provided to ensure that the interim development is located at the appropriate ultimate finished levels. Further discussion is provided below.

With the incorporation of the future residential development, an additional overbank widening is incorporated in the vicinity of the subdivision near the middle of the site as well as a detention storage at the north which is located in conjunction with a future stormwater treatment area.

4.4.1 Afflux

The scope of works required the assessment of the proposed development layout which is undertaken by assessing the potential changes and impacts on the flood characteristics, and best analysed by assessing the afflux. Afflux is defined as the relative change in a flooding characteristic, namely WSL or velocity, between the baseline and developed situation. This is determined by subtracting the baseline peak results from the developed peak results, where a positive value represents an increase in the flood characteristic and a negative value is a decrease.

Afflux has been determined for two (2) flooding characteristics, WSL and velocity, which as discussed in detail in the following section.

4.4.1.1 WSL Afflux

WSL afflux has been assessed for both the 1% and 50% AEP events for both the proposed development as well as the full masterplanned development. In reference to the afflux maps in **Appendix B** the TCC parameters for acceptable development is +/- 10 mm change in WSL (shown in white). Depending on the circumstances, in areas that are not sensitive to flooding and do not impact the function of infrastructure or properties, NCE are of the opinion that increases in excess of this (light green/aqua) may also be acceptable in some instances being non-actionable. With this in mind, the following commentary is provided.

- 1% AEP
    - Adjacent to Stuart Dr, north of the development shows a highly isolated section of afflux. However directly adjacent to the carriageway has no actionable impacts nor is the carriageway function affected. Additionally, refer to the time of submergence assessment carried out in Section 4.4.5.
    - No other areas show afflux for the 1% AEP event.
    - For the masterplanned fully developed site, similar to the above results, north of the development shows a highly isolated section of increased afflux. Again, this has no actionable impacts nor is the carriageway function affected.
- 50% AEP
    - There is no afflux off site during the 50% AEP whatsoever.

Overall, any impact associated with this development is contained within the development site, other than those areas noted above. It is our opinion that the increase observed in the road corridors are non-worsening as there is no fundamental impact on the carriageway, i.e. the flood levels are below the carriageway or maintain the same functionality as previously observed.

4.4.1.2 Velocity Afflux

Any changes in flow velocities should be shown to have minimal impact on erosion potential which leads to an in-depth assessment of various characteristics. Some of these characteristics include the soil type, vegetation, energy dissipation measures and pre and post velocities.

When undertaking this assessment many of these characteristics were unknown which has led to a broader assessment of the potential impacts associated with a change in velocity. Subsequently the criteria adopted for changes beyond the extents of the proposed development for this assessment is as follows:

- Any change below 0.1 m/s has no cause for concern and is an acceptable outcome;
- 0.1 m/s to 0.3 m/s is of minor concern which may be considered acceptable following a review of the pre and post velocities;
- 0.3 m/s and above requires further investigation to determine if additional local erosion mitigation measures are required;

In reference to the maps provided in **Appendix B**, it is evident that changes in velocity that raises concern are generally contained within the extents of the development and isolated to new diversion channels and weirs. Consequently, appropriate detail design of these channels will be required to ensure potential scouring is minimised.

- 1% AEP
    - It is noted that there are 2 locations where there are highly localised increases in velocity due to the changes to the flow at those points. These locations are directly adjacent to the property boundary and well clear of the carriageway ~11m clear.
    - There is a very minor increase at the location of the existing table drain invert. However this is shown to be limited to the middle of the existing table drain and only just exceeding 0.1m/s increase (0.14m/s) and isolated in extent.
    - Additionally, refer to the time of submergence assessment carried out in Section 4.4.5.
    - No other areas on or off the site show concerning afflux for the 1% AEP event.
    - Similar to the 1% AEP results, north of the development shows a highly isolated section of increased afflux. Again, this has no actionable impacts nor is the carriageway function affected.
- 50% AEP
    - Similar to the above, there is a location where there are highly localised increase in velocity due to the changes to the flow at that point. These locations are directly adjacent to the property boundary and well clear of the carriageway ~12m clear.
    - No other areas on or off the site show concerning afflux for the 50% AEP event.

As part of the detailed design, an assessment will carried out to determine if local erosion protection is required adjacent to the site. Any possible erosion protection measures will be limited to the extent required to mitigate the erosion which and will remain out of the clear road side recovery area (clear zone).

4.4.2 Peak Flood Levels and Depths

Peak WSL and depths are shown in **Appendix C** and **Appendix D** respectively. On the WSL plots, 0.1m contours have been provided to help determine the minimum height of fill in order to achieve flood immunity. In addition to the information shown on the maps, the flood extents are contained within drainage corridors and existing flooding extents. The overall development is proposed to be carried out based on the following:

- All finished floor levels (FFL) of habitable areas associated with the retirement village and RACF are to be at or above the 0.5% AEP flood level, as defined by the flood hazard overlay code at the time that the report was drafted.
- All finished pad levels in the vicinity of the building areas are to be at or above the 1% AEP DFE as defined by the flood hazard planning scheme policy at the time that the report was drafted.
- Minor stormwater system designed to the 50% AEP as per TCC planning scheme requirements for residential areas.
- Council proposed roads are designed in accordance with current design standards including 50% AEP storm event for the underground stormwater system with balance flows conveyed overland within the roadway. Additionally, new road extensions are to be designed to remain trafficable during the DFE.

- Hazards in areas of inundation to be maintained within acceptable limits. Hazards are assessed against the flood hazard classification from the Australian Disaster Resilience Handbook (and ARR Book 6 Figure 6.7.9), which shows that classifications H1 and H2 are safe for the elderly.

- The detailed design of the final uses is anticipated to include a combination of underground and overland stormwater network.

- Whilst the bulk of the proposed development is above the 0.5% AEP / 1% AEP events as described above, shallow flooding may be experienced across the development site such as in roads, carparks and pedestrian access areas and account for suitable safe hazard limits in accordance with the ARR / TCC guidelines.

- Any critical infrastructure and hazardous storages areas can be located at suitable freeboard above a nominated rare event in accordance with SC6.7 flood hazard planning scheme policy. Details of this will be confirmed at the detailed design stage.

4.4.3 Peak Velocity

Appendix E contains the peak velocity maps. It is evident that the velocity is generally <0.5 m/s across the site and surrounding areas in both the 1% and 50% AEP events with the exception of channels. The typical peak velocity in the natural drainage corridors is ~1 m/s which is largely unchanged from the existing scenario. Where excavation is carried out, the typical minimum requirement will be ensure 70% vegetation coverage, to minimise the risk of scour and erosion. Portions of the channels particularly around culvert outlets and weirs are in excess of 1.2m/s and may require rock cover or other forms of scour treatment.

4.4.4 Flood Hazard

Hazards are assessed against the flood hazard classification from the Australian Disaster Resilience Handbook (and ARR Book 6 Figure 6.7.9) Refer to **Appendix F**.

Hazards in areas of inundation are maintained within acceptable limits, which shows that classifications H1 and H2 are safe for the elderly.

In areas adjacent to natural and constructed flow corridors where hazards exceed H2 are to be design with suitable protection measures such as buffers to paths or barriers.

4.4.5 Time of Submergence

The runoff over time has been captured by the TUFLOW modelling in the Stuart Drive table drain downstream of the development as well as downstream of Stuart Dr for a comparison of pre- vs post-development scenarios.

The recording locations for the results in the 1% AEP is shown in **Figure 4-3** below. The hydrographs at these locations are shown in **Figure 4-4** to **Figure 4-6**.

These recording locations have been used to consider the time of submergence at Stuart Drive. These hydrographs demonstrate that there is no distinguishable difference between the pre- and post-development scenarios and the carriageways are not impacted during the major event.

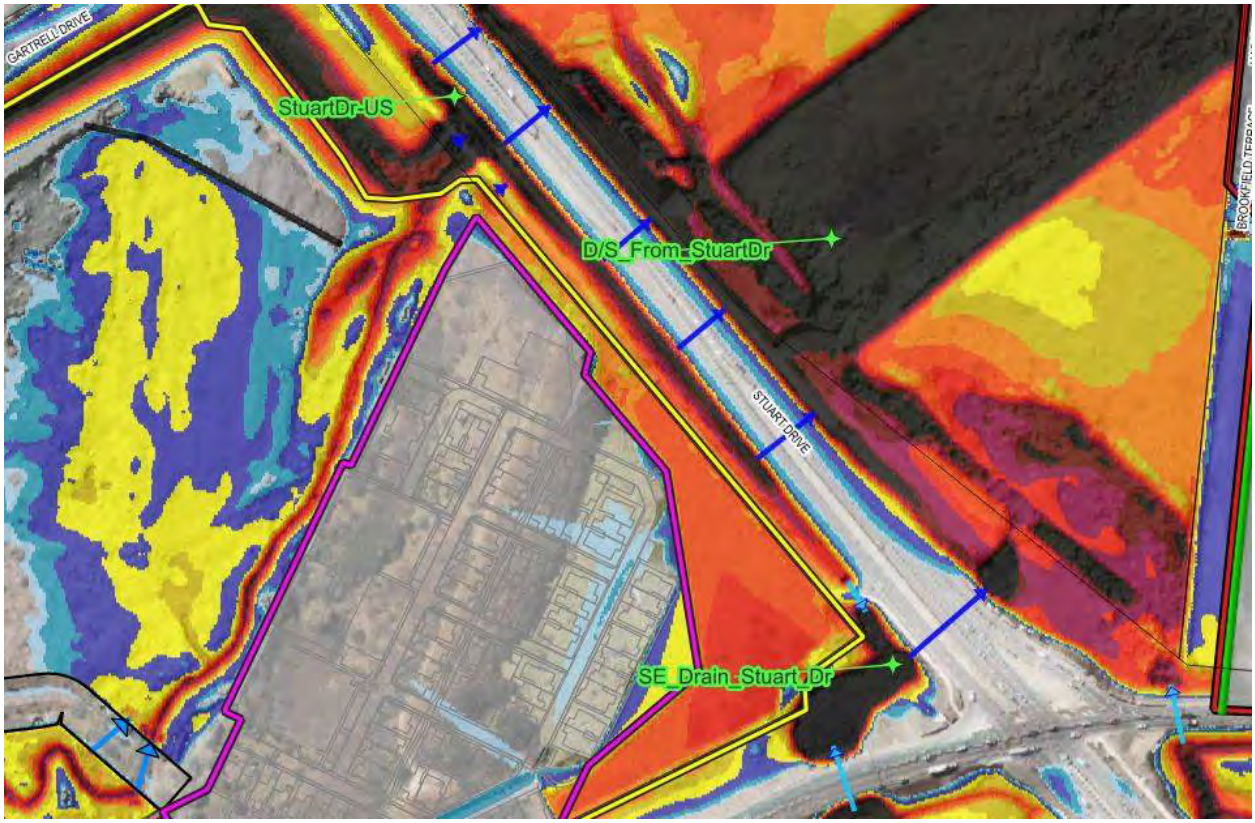


Figure 4-3 TUFLOW time-series reporting location

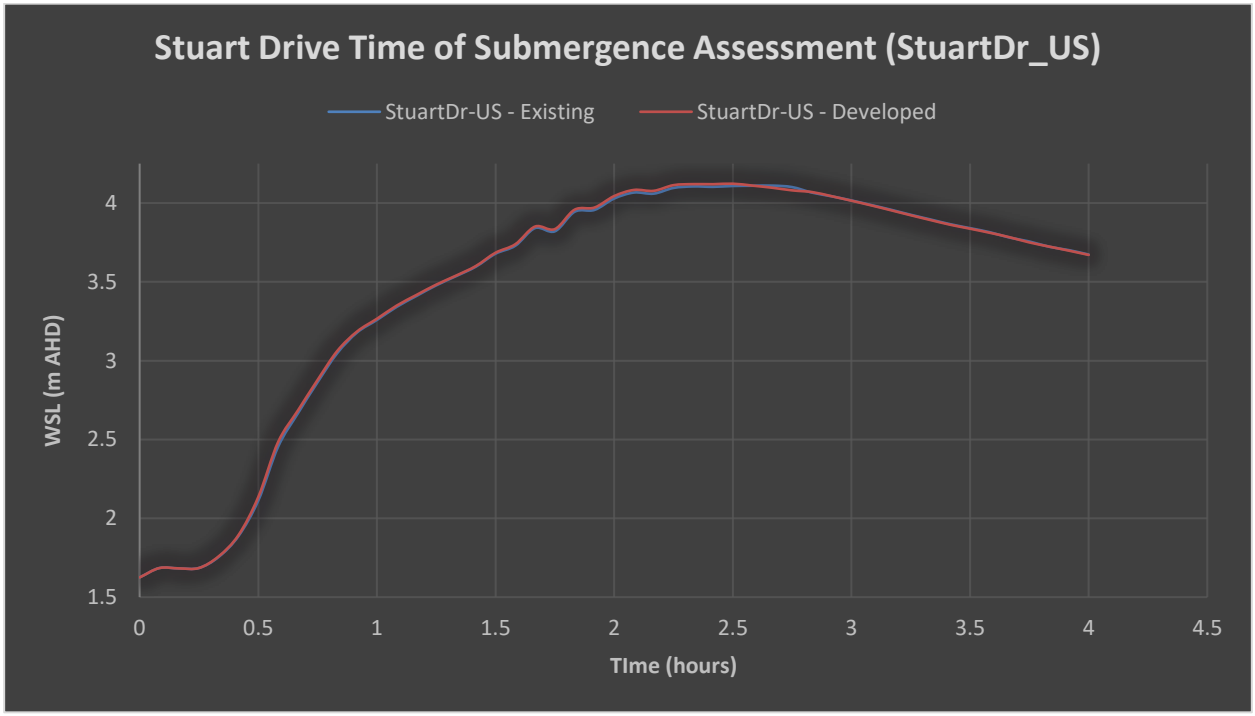


Figure 4-4 1% AEP WSL Hydrograph – Stuart Dr North-East

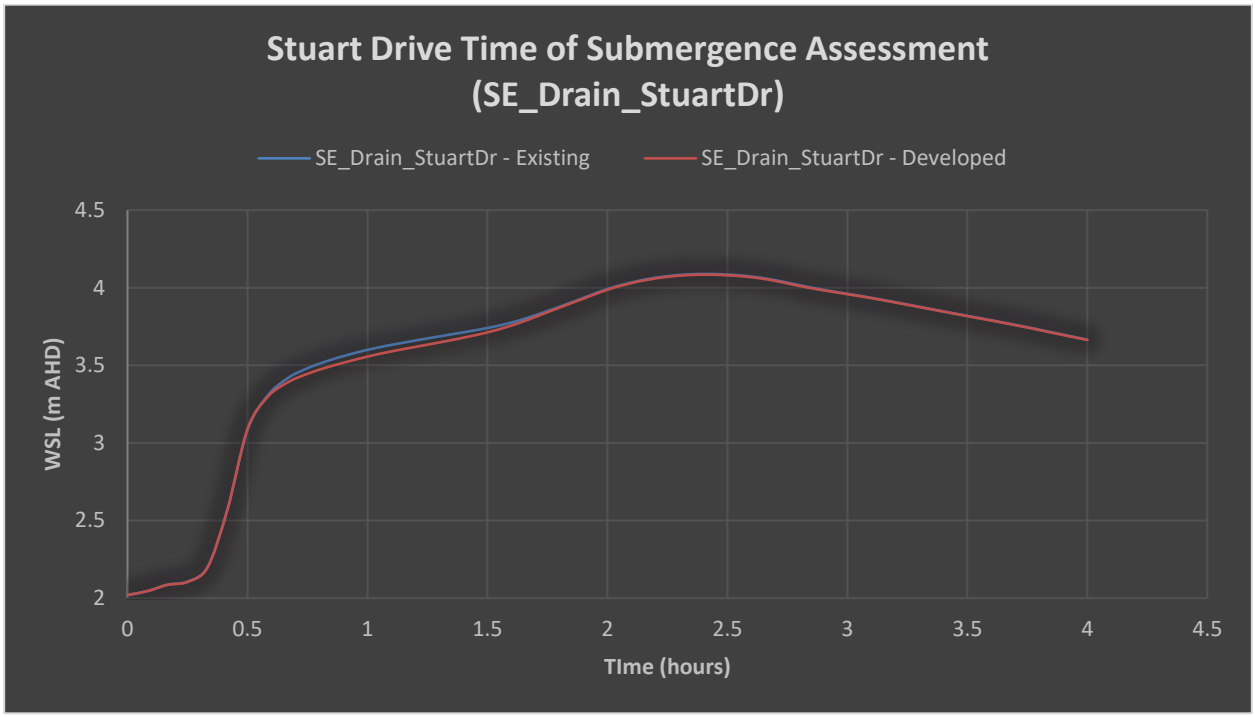


Figure 4-5 1% AEP WSL Hydrograph – Stuart Dr South-East

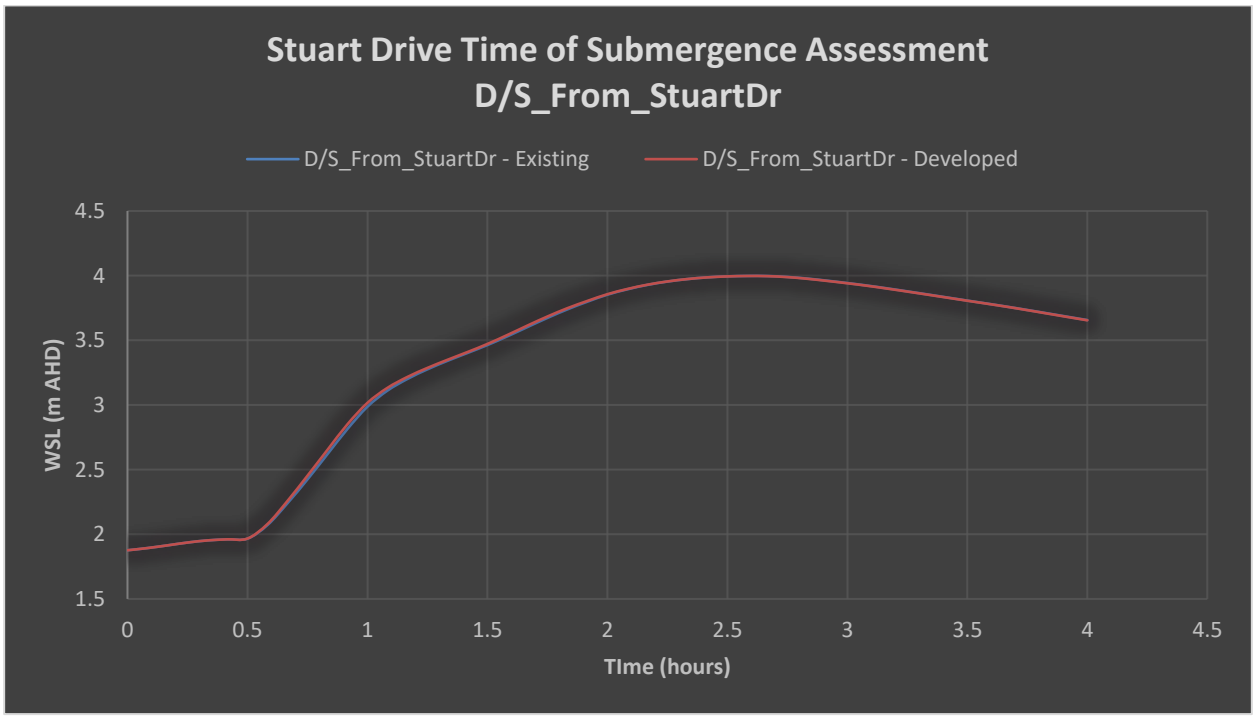


Figure 4-6 1% AEP WSL Hydrograph – Downstream from Stuart Dr

4.5 Climate Change and 0.5% AEP Assessments

In addition to the above results discussion NCE also carried out a sensitivity assessment of the climate change as well as the 0.5% AEP events for the fully developed masterplanned site.

These 2 events demonstrate very similar afflux outcomes, noting they have flood characteristics that are closely aligned.

Minor afflux is observed off site downstream, however this is noted to generally very minor (<20mm) or highly localised and offset from any public infrastructure.

There is also minor afflux in the upstream adjacent to the existing pump station but limited to the far eastern portion of the pump station access.

Given that this sensitivity assessment demonstrates very minor impacts for the 2100 climate change scenario as well as the 0.5% AEP event, NCE consider the proposal is suitable as proposed.

5.0 SUMMARY AND CONCLUSION

Parkside Development Pty Ltd is proposing the Annandale retirement village development at the corner of Stuart Drive and University Drive. The application involves a retirement village but this FIA includes the proposed residential aged care facility. In addition, the allied health precinct and a residential subdivision associated future overall master planned development has been assessed to ensure the masterplanned development is non-worsening.

NCE have conduct an assessment which is based on inputs from the new Townsville City Council (TCC) Ross River (2021) TUFLOW baseline model.

NCE have developed a fine-scale TUFLOW mini-model in order to assess the proposed development. The fine-scale mini-model has been developed using the Australian Rainfall & Run-off 2019 (ARR2019) hydrology.

As a result of the extensive investigation undertaken during the assessment, a suitable solution has been identified. This involves a series of mitigation measures for the proposed development as depicted in **Appendix A and H** consisting of a combination of overbank widening, flow controlling culverts and a levee to detain flows.

The investigation included an impact assessment which demonstrated that the proposed retirement village can be carried out without causing impacts off site in respect to the existing flooding characteristics in accordance with the Performance Outcomes (PO) of the Flood hazard overlay code, in particular PO6 and PO7. **Table 5-1** provides a summary of the FIA flood mapping.

Based on this flood impact assessment, the site is considered suitable for the proposed development.

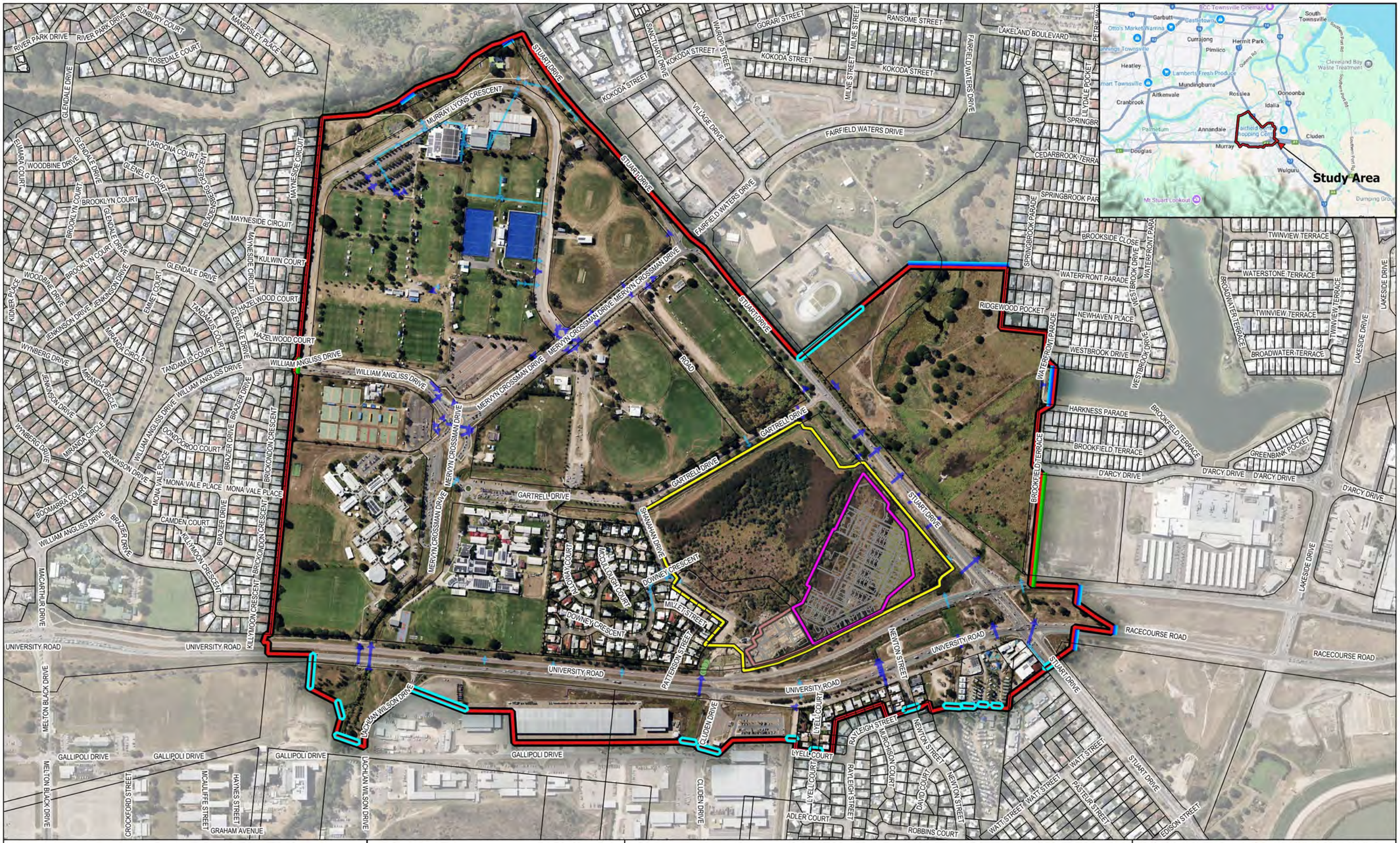
Table 5-1 Summary of the FIA mapping

Map Number	Description
Appendix A	
Map A01	Model Setup, Configuration and Locality
Map A02	Land Use and Roughness
Map A03	Digital Elevation Model (DEM) - Baseline
Map A04	Digital Elevation Model (DEM) - Developed
Map A05	Baseline Model Verification (Parkside Mini Model Minus Ross River Model WSL)
Map A06	Development Layout
Map A07	Masterplanned Development Layout – Fully Developed
Map A08	Critical Duration Mapping Comparison
Appendix B	
Map B01	1% AEP Maximum WSL Afflux
Map B02	50% AEP Maximum WSL Afflux
Map B03	1% AEP Maximum Velocity Afflux
Map B04	50% AEP Maximum Velocity Afflux

Map Number	Description
Map B05	Masterplanned Site 1% AEP Maximum WSL Afflux
Map B06	Masterplanned Site 50% AEP Maximum WSL Afflux
Map B07	Masterplanned Site 1% AEP Maximum Velocity Afflux
Map B08	0.5% AEP 120m WSL Afflux
Map B09	Masterplanned Site 0.5% AEP 120m WSL Afflux
Appendix C	
Map C01	1% AEP Maximum Baseline Water Surface Levels
Map C02	1% AEP Maximum Developed Water Surface Levels
Map C03	50% AEP Maximum Baseline Water Surface Levels
Map C04	50% AEP Maximum Developed Water Surface Levels
Map C05	Masterplanned Fully Developed 1% AEP Maximum Water Surface Levels
Map C06	Masterplanned Fully Developed 0.5% AEP Maximum Water Surface Levels
Appendix D	
Map D01	1% AEP Maximum Baseline Flood Depths
Map D02	1% AEP Maximum Developed Flood Depths
Map D03	50% AEP Maximum Baseline Flood Depths
Map D04	50% AEP Maximum Developed Flood Depths
Appendix E	
Map E01	1% AEP Maximum Baseline Flow Velocity
Map E02	1% AEP Maximum Developed Flow Velocity
Map E03	50% AEP Maximum Baseline Flow Velocity
Map E04	50% AEP Maximum Developed Flow Velocity
Appendix F	
Map F01	1% AEP Maximum Baseline Flood Hazard
Map F02	1% AEP Maximum Developed Flood Hazard
Map F03	50% AEP Maximum Baseline Flood Hazard
Map F04	50% AEP Maximum Developed Flood Hazard
Appendix G	
Map G01	1% AEP 120m WSL Afflux – Climate Change Sensitivity
Map G02	1% AEP 120m WSL Afflux Baseline 50% Pipe Blockage Minus Baseline Sensitivity
Map G03	1% AEP 120m WSL Afflux Dev 50% Pipe Blockage Minus Baseline 50% Blockage
Map G04	1% AEP 120m WSL Afflux – Mannings n +20% Sensitivity
Map G05	1% AEP 120m WSL Afflux – Mannings n -20% Sensitivity

APPENDIX A

Model Setup Maps



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0 75 150 225 300 375 m

1:7,500

N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement_Layout
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Development Layout

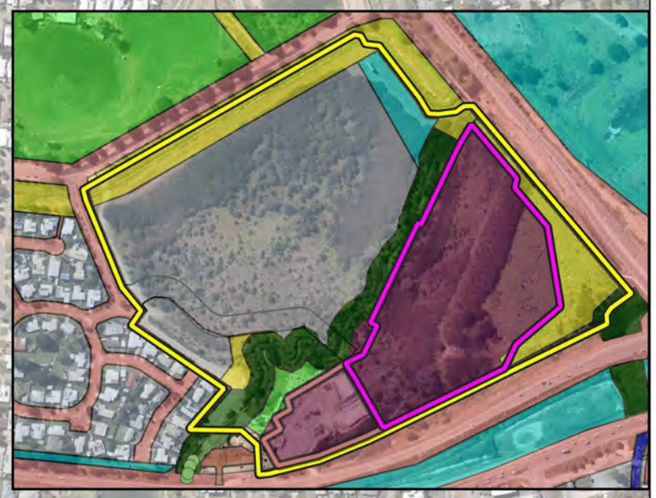
ANNANDALE RETIREMENT VILLAGE

Model Setup, Configuration and Locality

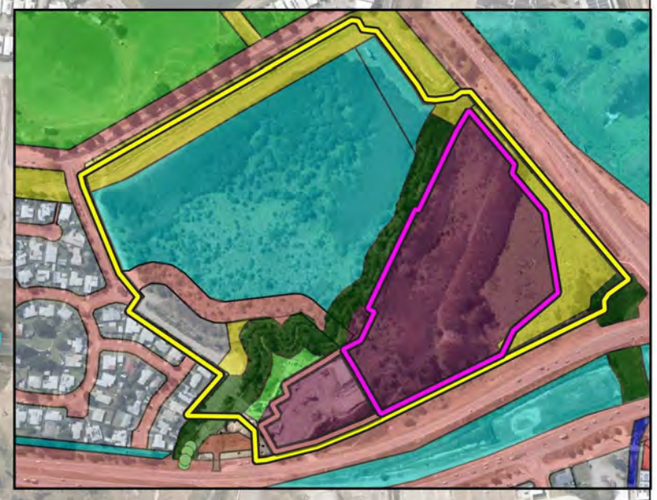
Prepared By: BB Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A01

Use / % Impervious / (Mannings n)

- Roads / 50% / (0.025)
- Impervious / 100% / (0.018)
- Urban Residential / 65% / (0.08)
- Commercial - Industrial / 90% / (0.04)
- Vegetated Channels (maintained) / 0% / (0.06)
- Open Space / 0% / (0.07)
- Playing Fields - Facilities / 5% / (0.04)
- Medium Density / Community Facilities 70% / (0.06)
- Unmaintained Vegetated Channels / 0% / (0.08)
- Heavily Vegetated / 0% / (0.1)



Full Master Planned Development



Retirement Village / RACF Development

Base Line

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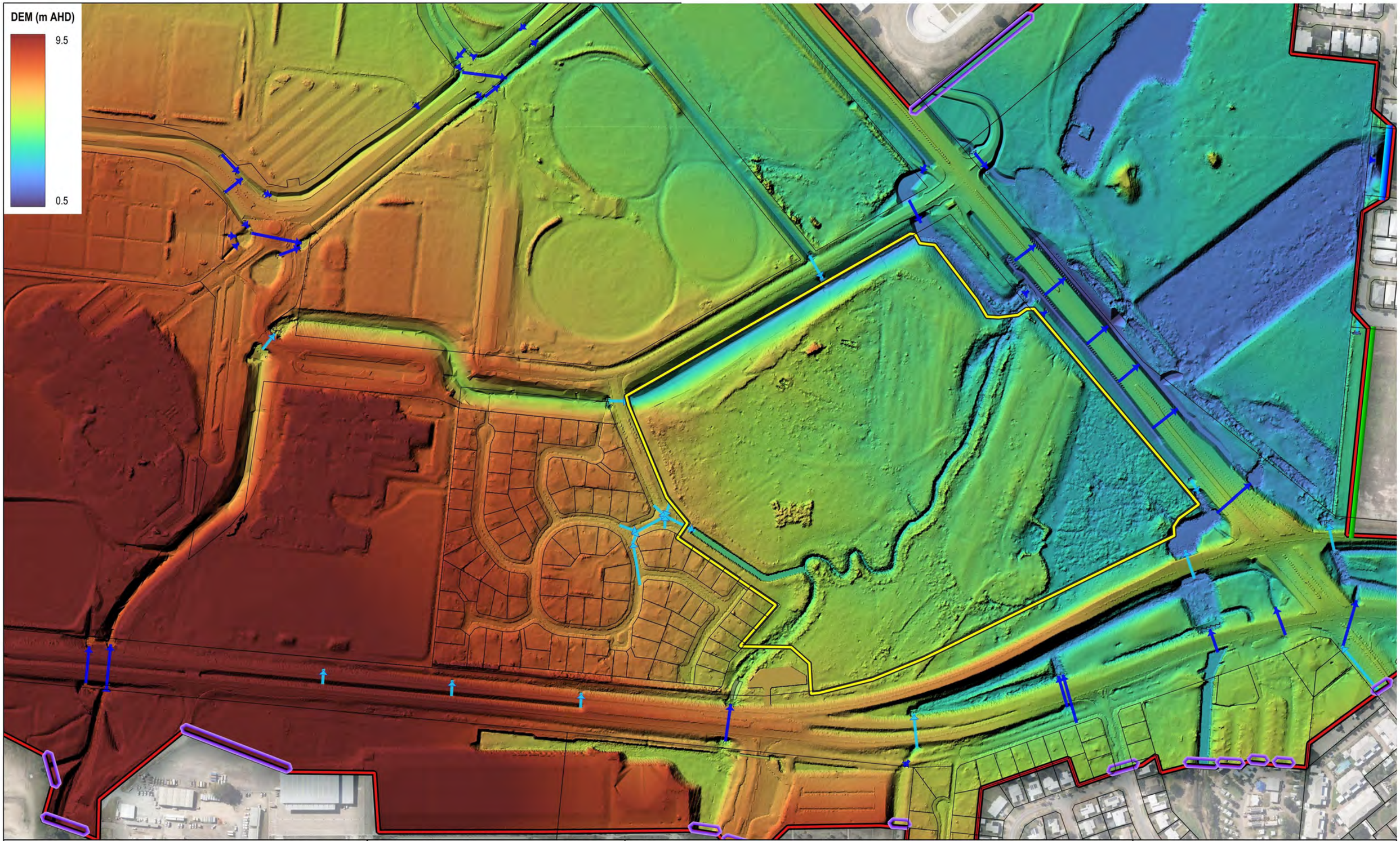
Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary

ANNANDALE RETIREMENT VILLAGE

Land Use and Roughness

Prepared By: BB Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A02



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0 40 80 120 160 200 m

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N

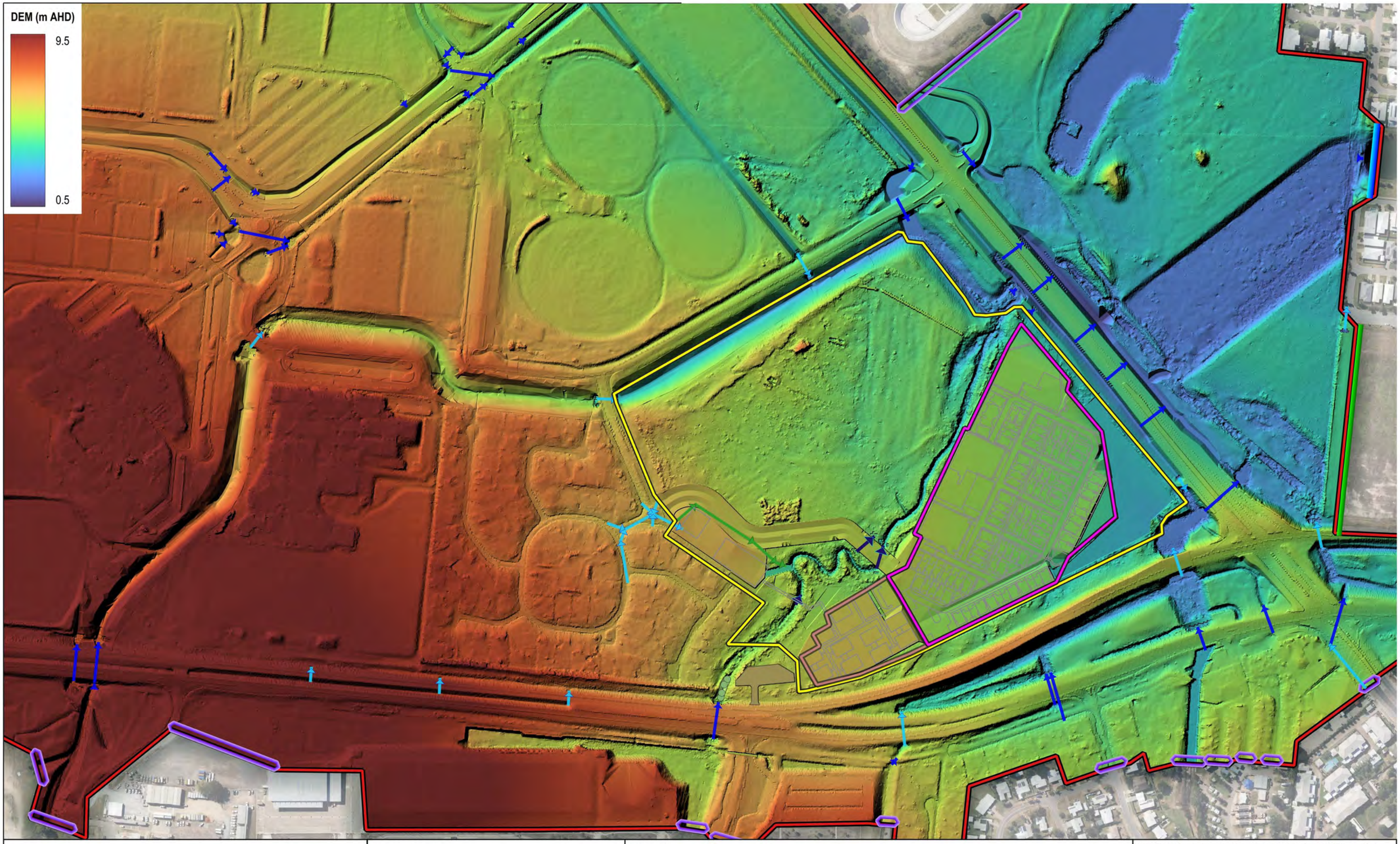
Legend

- TCC Land Parcels
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary

ANNANDALE RETIREMENT VILLAGE

Digital Elevation Model (DEM) - Baseline

Prepared By: BB Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A03



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N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Developed Box Culverts
- Developed Pipes

ANNANDALE RETIREMENT VILLAGE

Digital Elevation Model (DEM) - Developed

Prepared By: BB Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A04

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0 50 100 150 200 250 m

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N

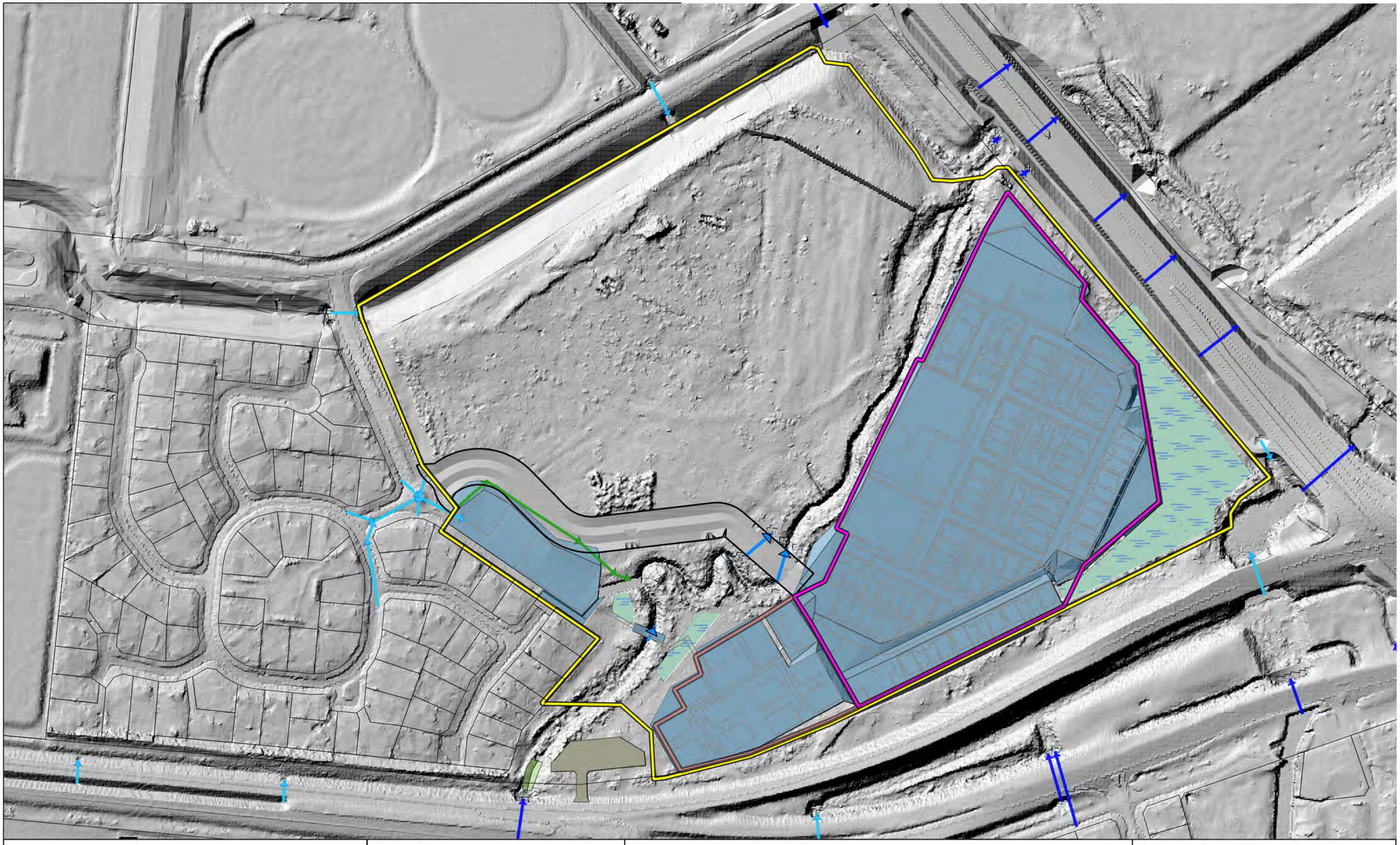
Legend

- TCC Land Parcels
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary

ANNANDALE RETIREMENT VILLAGE

Baseline Model Verification (Parkside Mini Model Minus Ross River Model WSL)

Prepared By: BB Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A05



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0 25 50 75 100 125 m

1:2,500

N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Pump Station Site
- Fill Extent
- Mitigation Levee
- Overbank Widening / Detention Storage

ANNANDALE RETIREMENT VILLAGE

Development Layout

Prepared By: BB Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A06

Indicates high level detention combined with stormwater treatment

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0 25 50 75 100 125 m

1:2,500

N

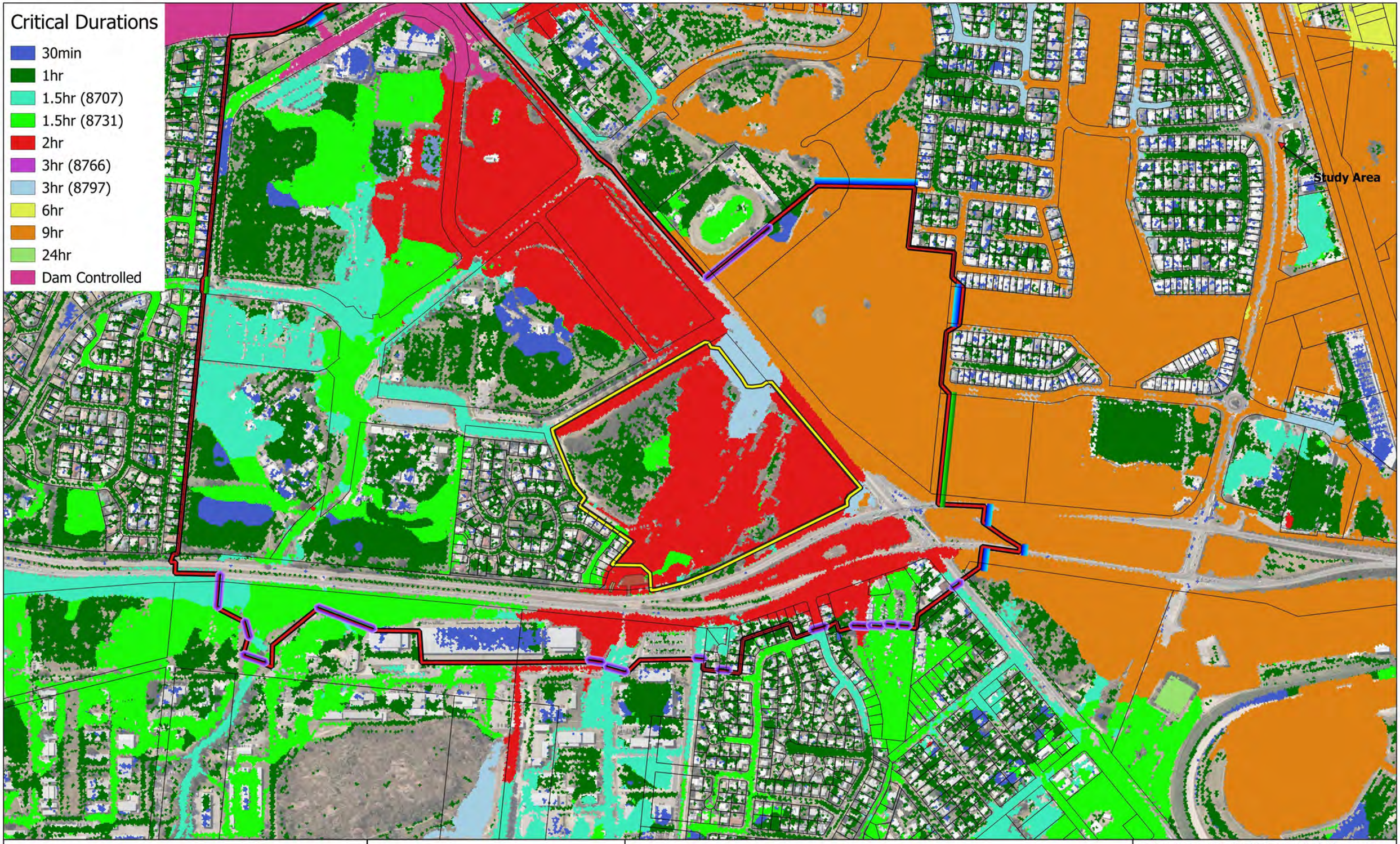
Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Pump Station Site
- Mitigation Levee
- Overbank Widening / Detention Storage
- Masterplanned Fill Extent

ANNANDALE RETIREMENT VILLAGE

Masterplanned Development Layout - Fully Developed

Prepared By: AW Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A07



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0 75 150 225 300 375 m

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N

Legend

- TCC Land Parcels
- Site Boundary
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary

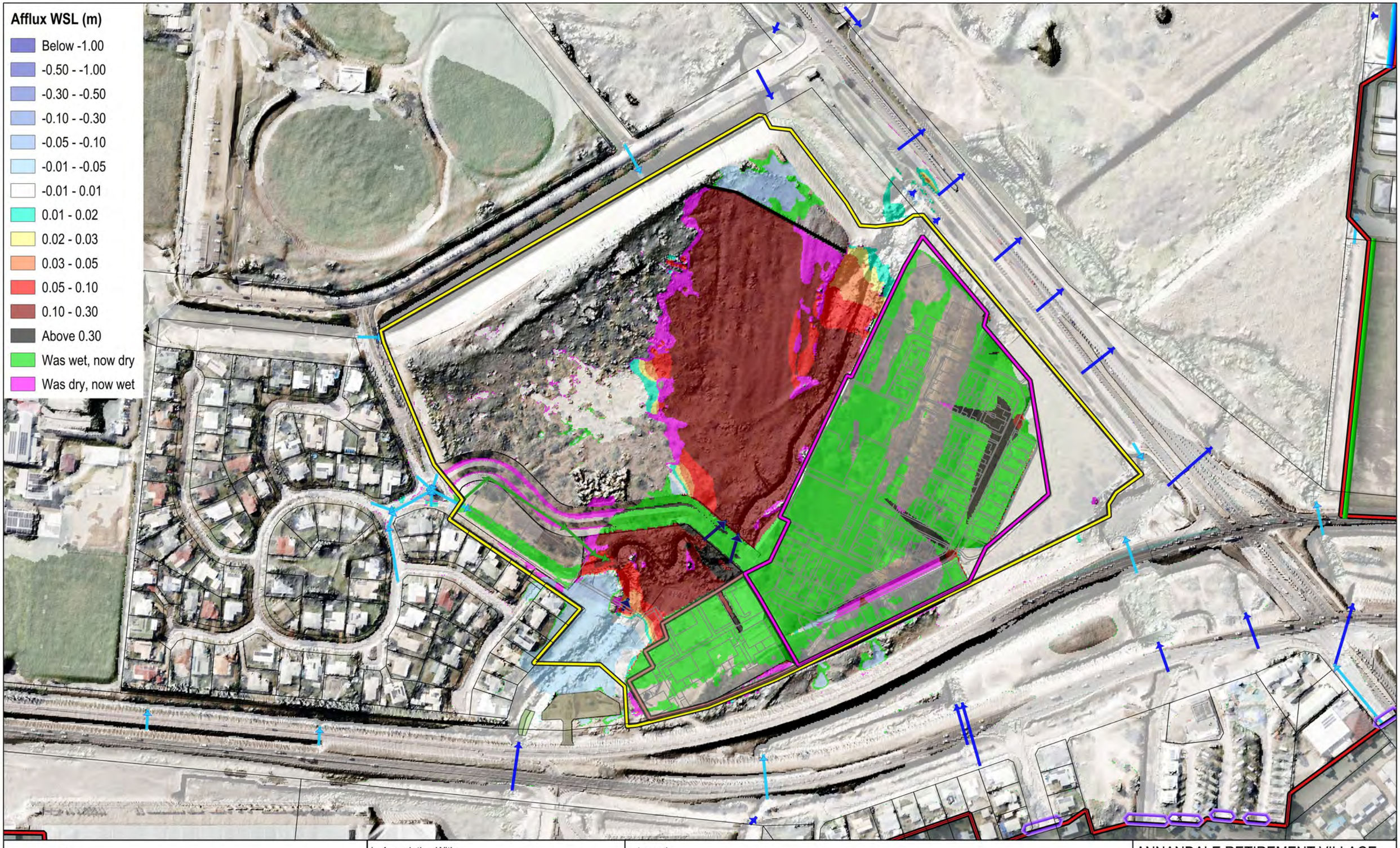
ANNANDALE RETIREMENT VILLAGE

Critical Duration Mapping Comparison

Prepared By: BB Reviewed by: AW	Date: 06/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map A08

APPENDIX B

Flood Afflux Results (WSL & Velocity Afflux)



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N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

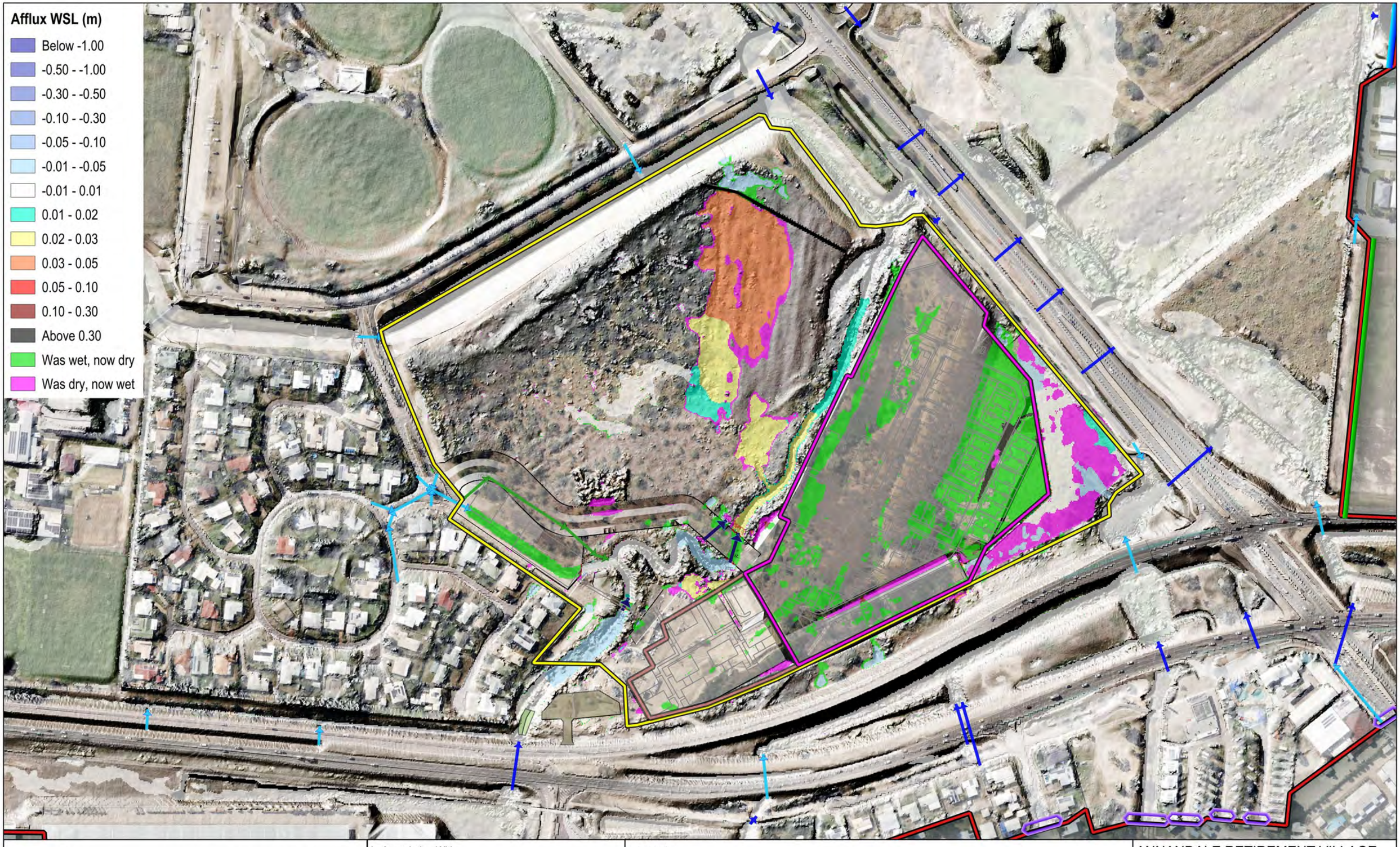
1% AEP Maximum WSL Afflux

Prepared By: AW
Reviewed by: AW

Date: 03/12/2024
Revision: A
NCE Ref: PARK0014

Size: A3

Map: B01



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0 25 50 75 100 125 m

1:3,000

N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

50% AEP Maximum WSL Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	B02

Afflux Velocity (m/s)

- Below -0.50
- -0.30 - -0.50
- -0.10 - -0.30
- -0.10 - 0.10
- 0.10 - 0.30
- 0.3 - 0.50
- 0.50 - 0.75
- Above 0.75
- Was wet, now dry
- Was dry, now wet

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0 25 50 75 100 125 m

1:3,000

N

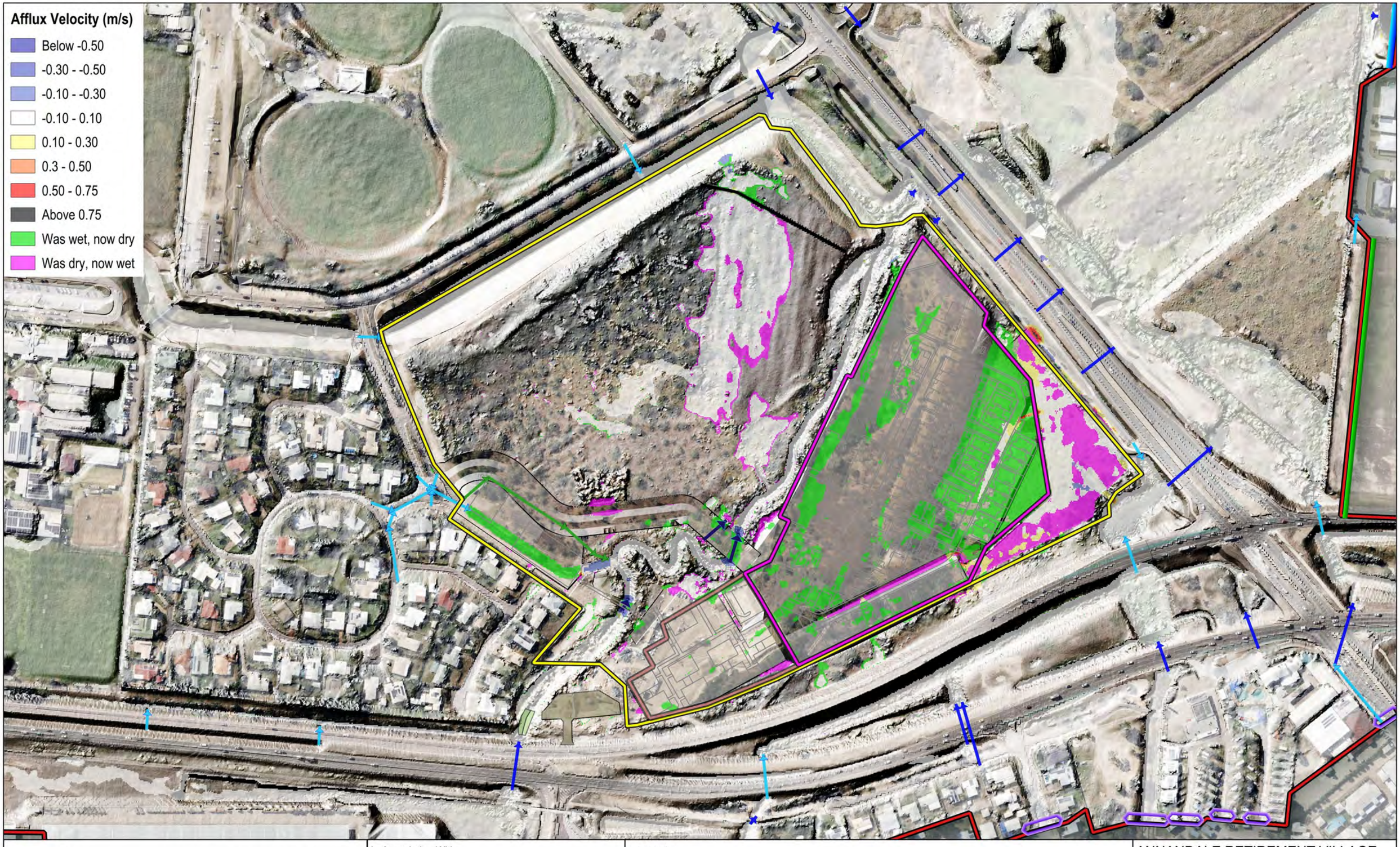
Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

1% AEP Maximum Velocity Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	B03



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N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

50% AEP Maximum Velocity Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	B04

Afflux WSL (m)

- Below -1.00
- -0.50 - -1.00
- -0.30 - -0.50
- -0.10 - -0.30
- -0.05 - -0.10
- -0.01 - -0.05
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- Above 0.30
- Was wet, now dry
- Was dry, now wet

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0 25 50 75 100 125 m

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N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

Masterplanned Site
1% AEP Maximum WSL Afflux

Prepared By: AW Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map B05

Afflux WSL (m)

- Below -1.00
- -0.50 - -1.00
- -0.30 - -0.50
- -0.10 - -0.30
- -0.05 - -0.10
- -0.01 - -0.05
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- Above 0.30
- Was wet, now dry
- Was dry, now wet

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0 25 50 75 100 125 m

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N

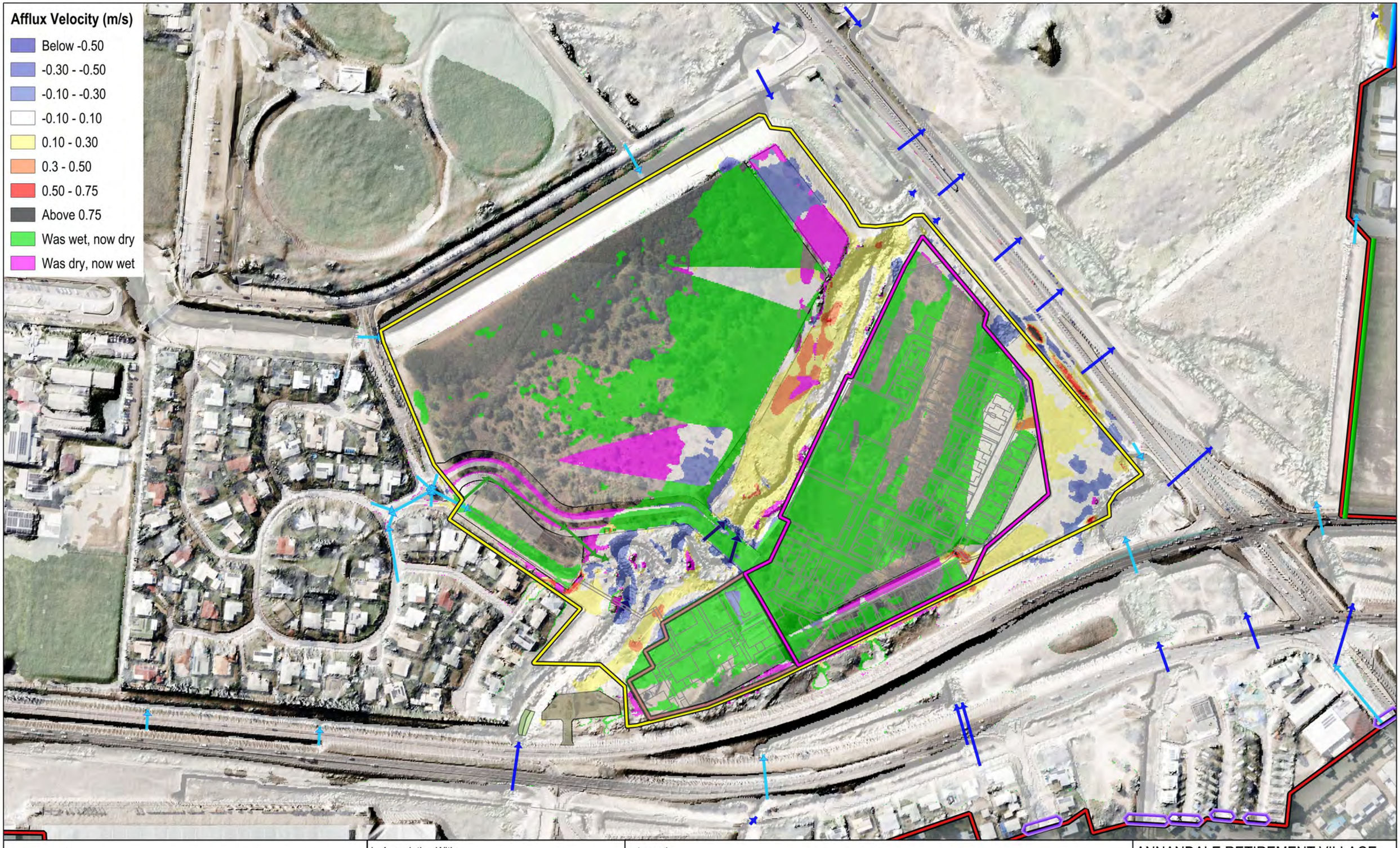
Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

Masterplanned Site
50% AEP Maximum WSL Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	B06



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N

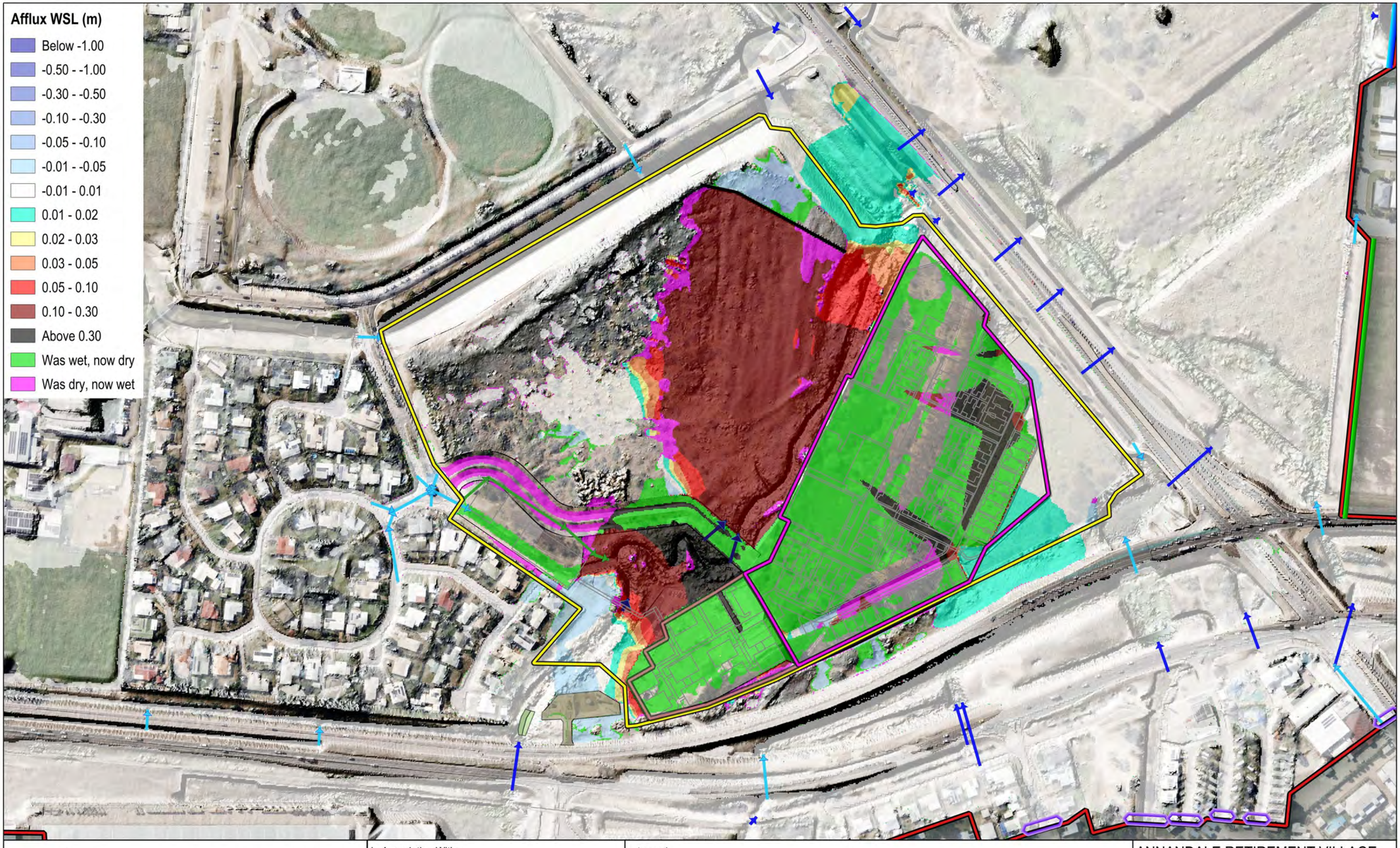
Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

Masterplanned Site
1% AEP Maximum Velocity Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	B07



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0 25 50 75 100 125 m

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N

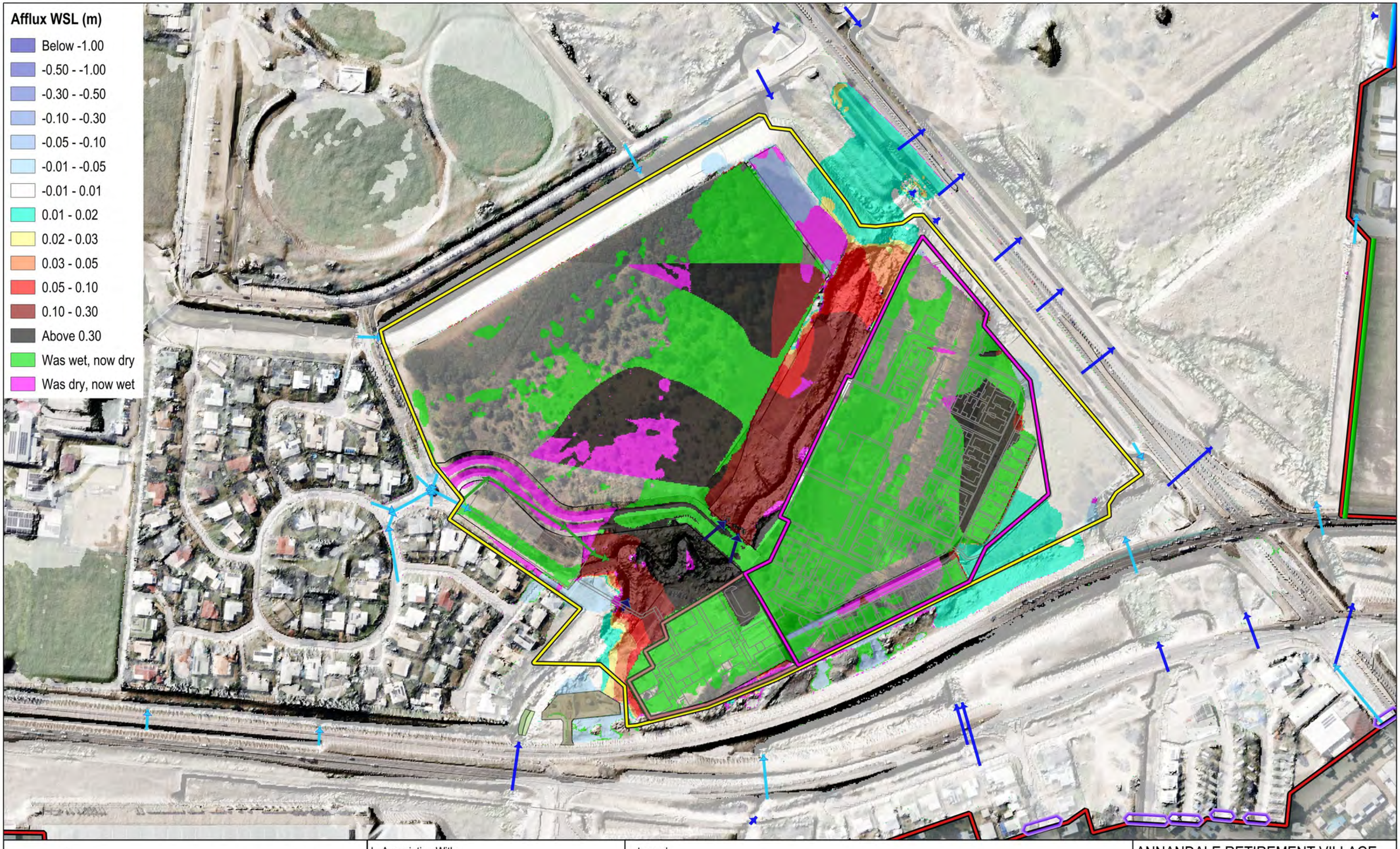
Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

0.5% AEP 120m WSL Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A	A3	B08
	NCE Ref: PARK0014		



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N

Legend

- TCC Land Parcels
- RACF_Site
- Retirement Village Site
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Developed Box Culverts
- Developed Pipes
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Mitigation - Levee
- Pump Station Site

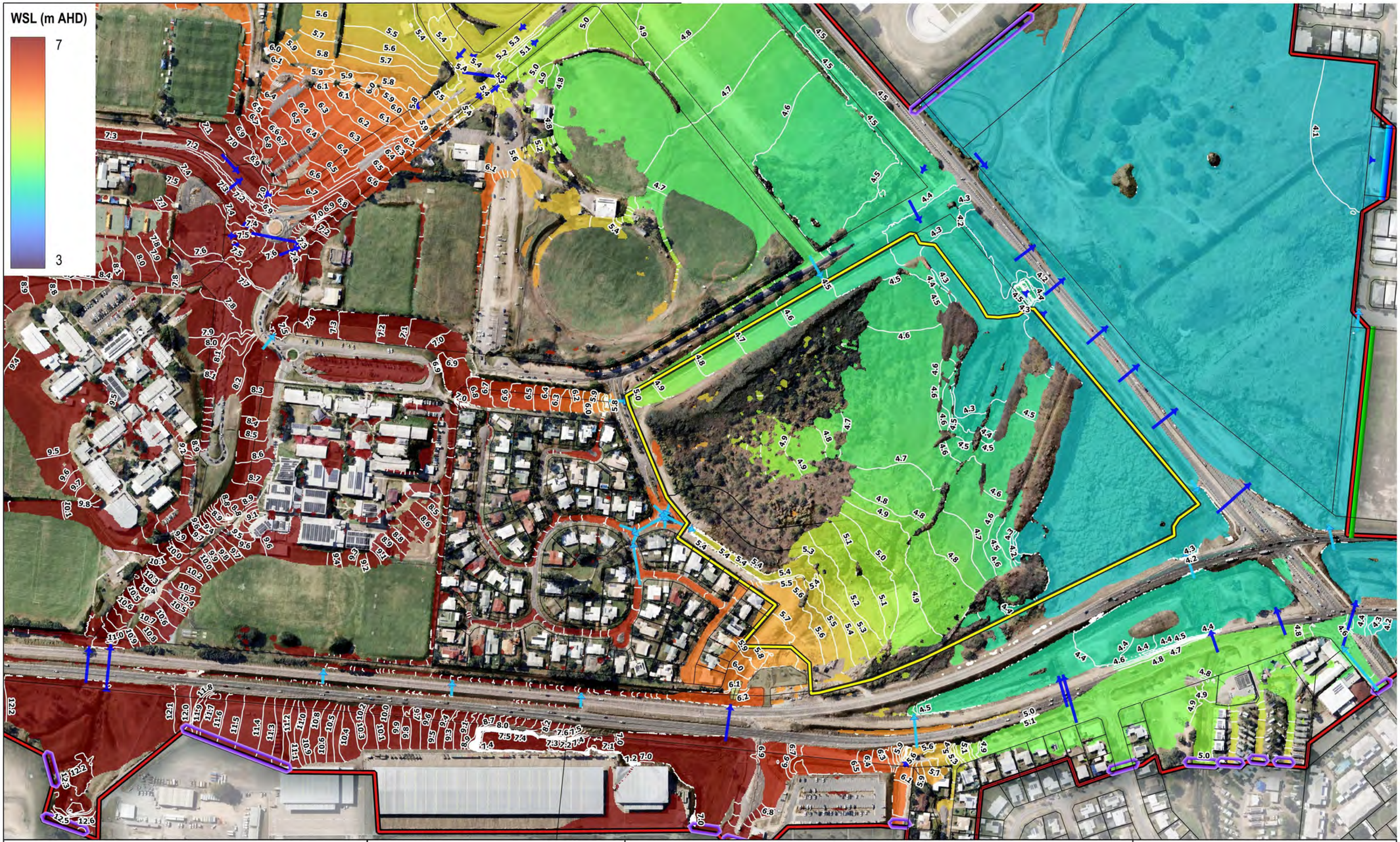
ANNANDALE RETIREMENT VILLAGE

Masterplanned Site
0.5% AEP 120m WSL Afflux

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	B09

APPENDIX C

Water Surface Level Results



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0 40 80 120 160 200 m

1:4,000

N

Legend

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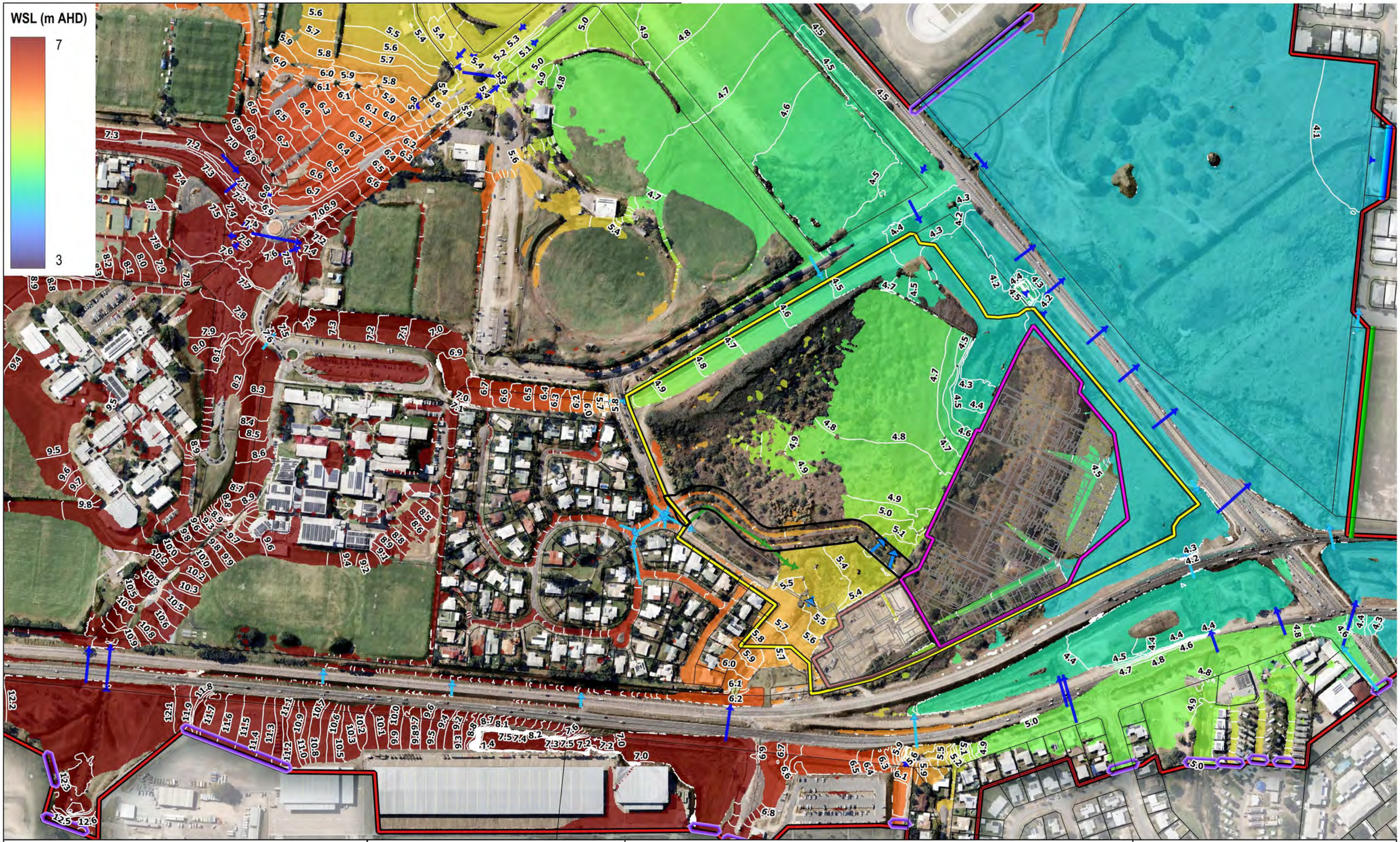
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary

ANNANDALE RETIREMENT VILLAGE

1% AEP Maximum Baseline Water Surface Levels

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A	A3	C01
	NCE Ref: PARK0014		



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0 40 80 120 160 200 m

1:4,000

N

Legend

- TCC Land Parcels
- Site Boundary
- Retirement_Layout
- RACF_Site
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Developed Box Culverts
- Developed Pipes

ANNANDALE RETIREMENT VILLAGE

1% AEP Maximum Developed Water Surface Levels

Prepared By: AW Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map C02

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0 40 80 120 160 200 m

1:4,000

N

Legend

- TCC Land Parcels
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary

ANNANDALE RETIREMENT VILLAGE

50% AEP Maximum Baseline Water Surface Levels

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A	A3	C03
	NCE Ref: PARK0014		

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Disclaimer:
All information noted on this plan is INDICATIVE only, therefore any reference and/or deconstruction of the data not soley related to the documents'purpose shall be at the user's risk. NCE shall bare no responsibility or liability for any errors, faults, defects, or omissions in the information.

In Association With:

PARKSIDE GROUP

0 40 80 120 160 200 m

1:4,000

N

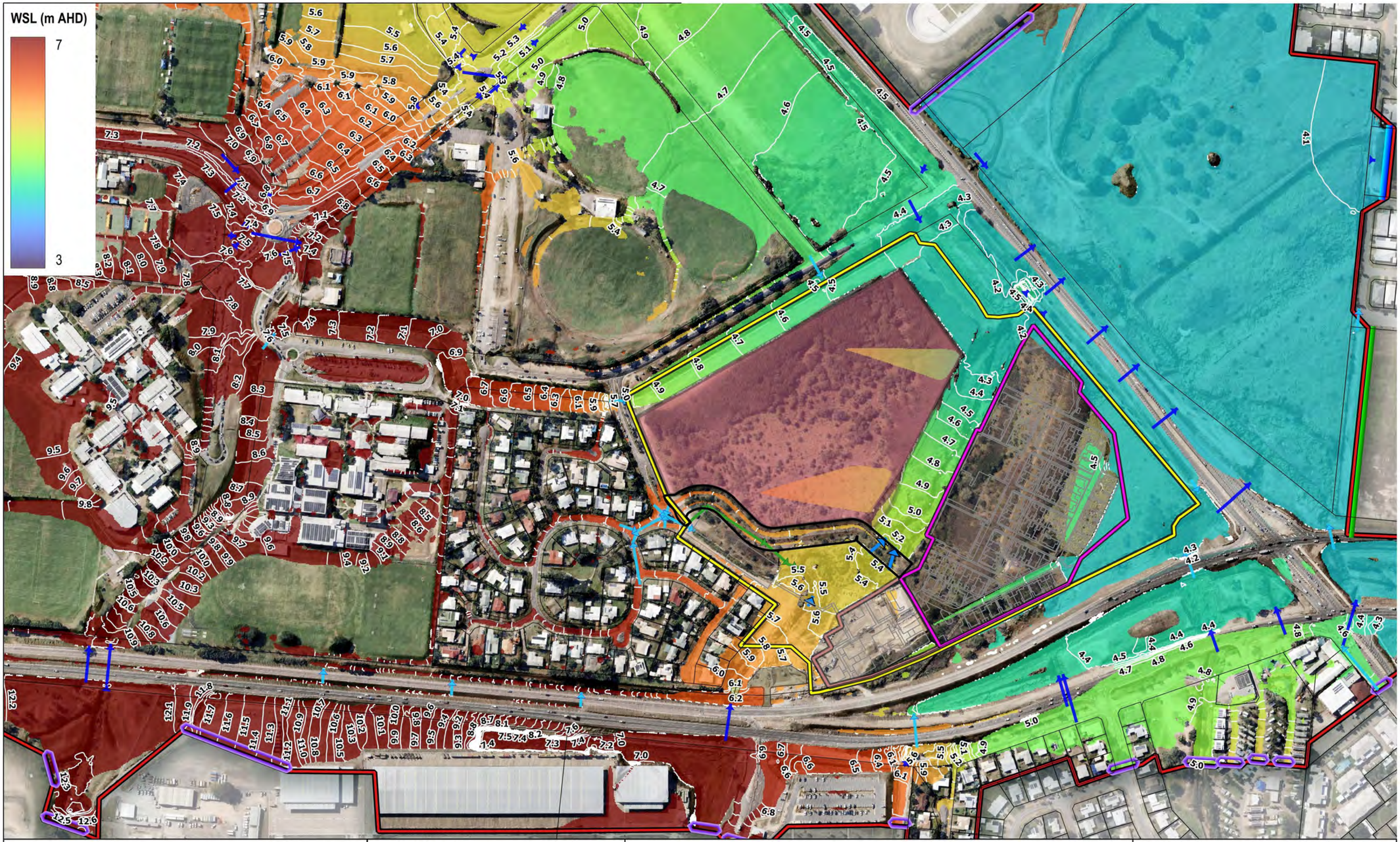
Legend

- TCC Land Parcels
- Site Boundary
- Retirement_Layout
- RACF_Site
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Developed Box Culverts
- Developed Pipes

ANNANDALE RETIREMENT VILLAGE

50% AEP Maximum Developed Water Surface Levels

Prepared By: AW Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map C04



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In Association With:

PARKSIDE GROUP

0 40 80 120 160 200 m

1:4,000

N

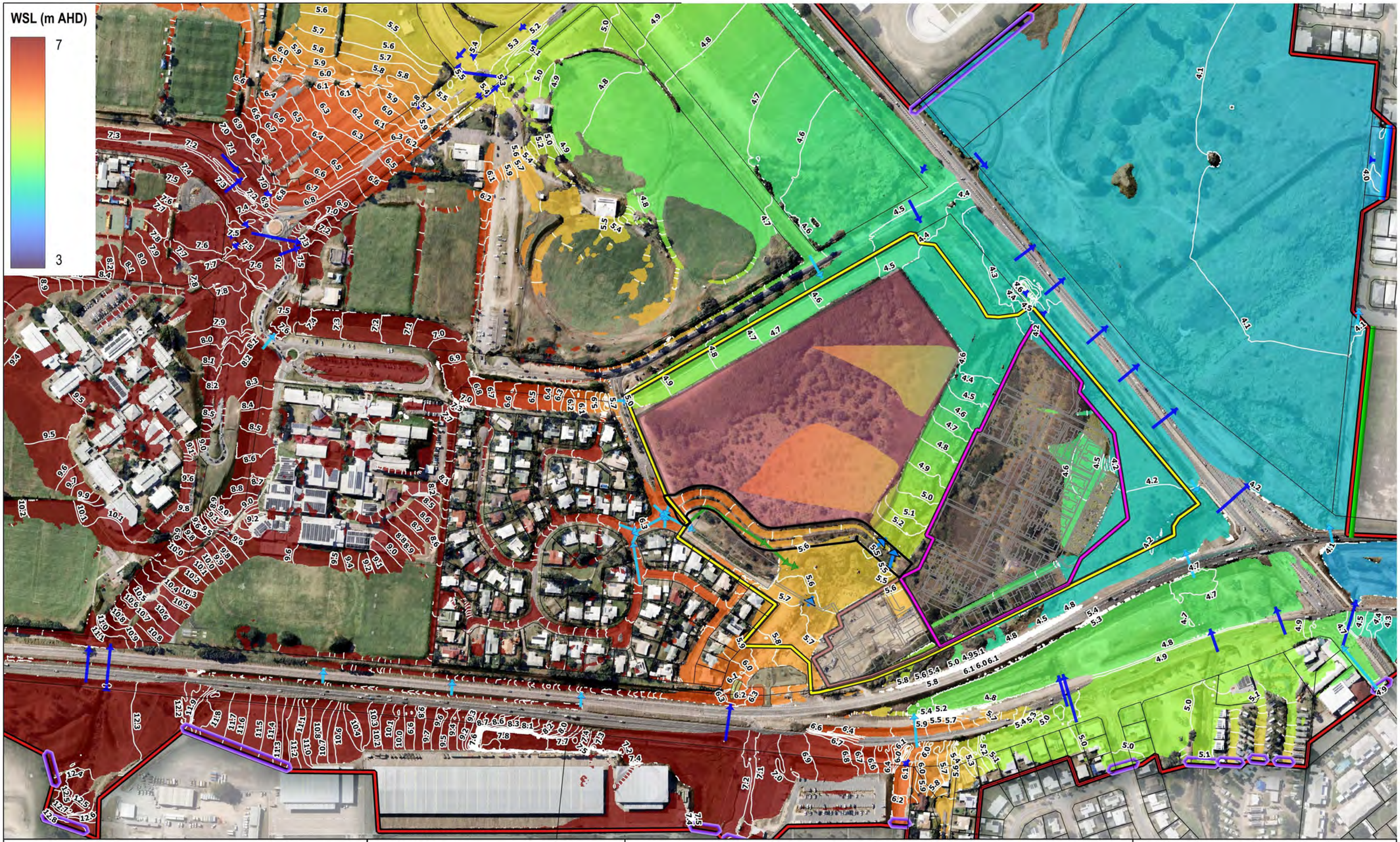
Legend

- TCC Land Parcels
- Site Boundary
- Retirement_Layout
- RACF_Site
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Developed Box Culverts
- Developed Pipes
- Future Subdivision

ANNANDALE RETIREMENT VILLAGE

Masterplanned Fully Developed 1% AEP Maximum Water Surface Levels

Prepared By: AW Reviewed by: AW	Date: 03/12/2024 Revision: A NCE Ref: PARK0014	Size A3	Map C05



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In Association With:

PARKSIDE GROUP

0 40 80 120 160 200 m

1:4,000

N

Legend

- TCC Land Parcels
- Site Boundary
- Retirement_Layout
- RACF_Site
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Developed Box Culverts
- Developed Pipes
- Future Subdivision

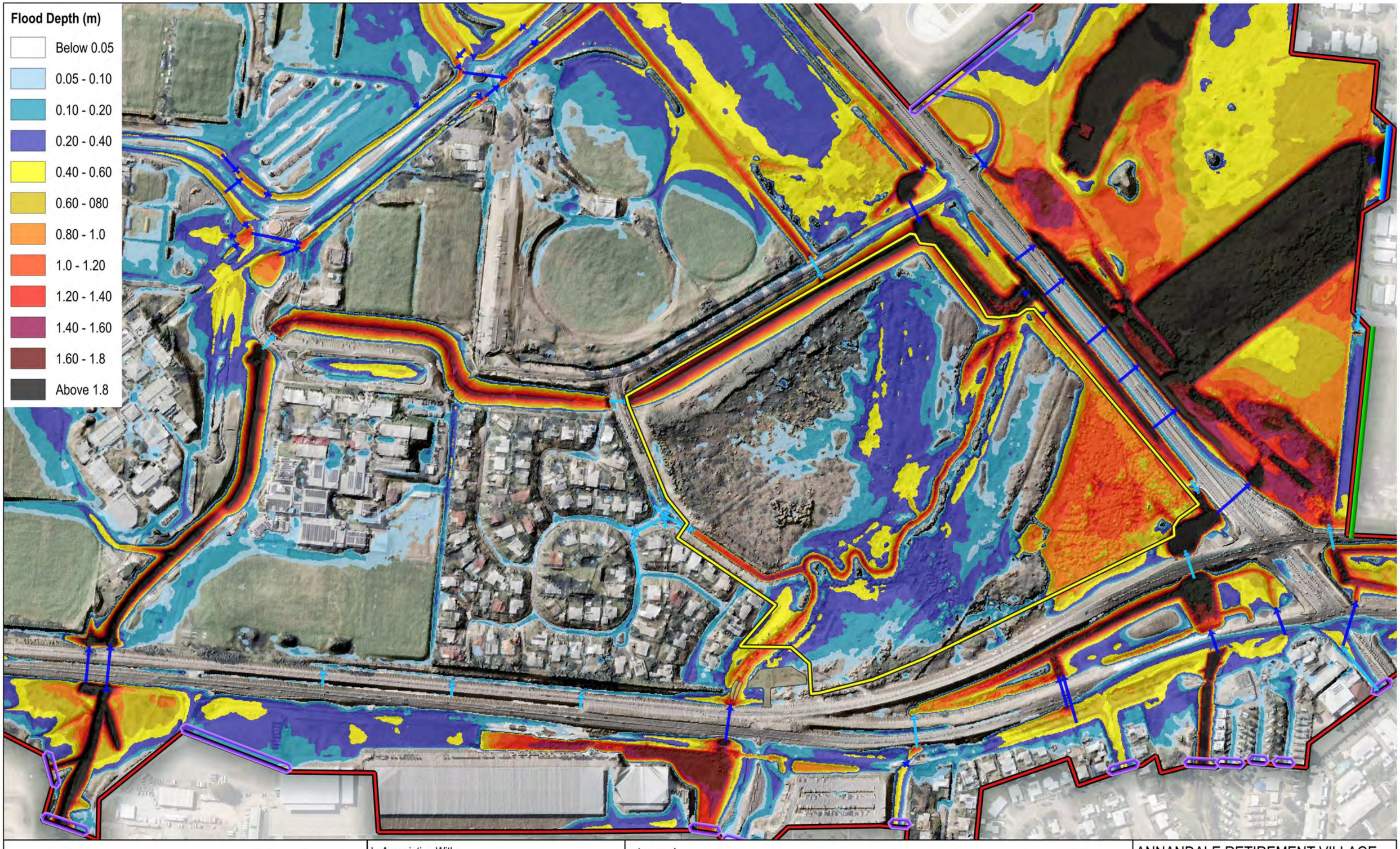
ANNANDALE RETIREMENT VILLAGE

Masterplanned Fully Developed 0.5% AEP 120min Water Surface Levels

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A	A3	C06
	NCE Ref: PARK0014		

APPENDIX D

Flood Depth Maps



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In Association With:

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0 40 80 120 160 200 m

1:4,000

N

Legend

- TCC Land Parcels
- Site Boundary
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Pump Station Site

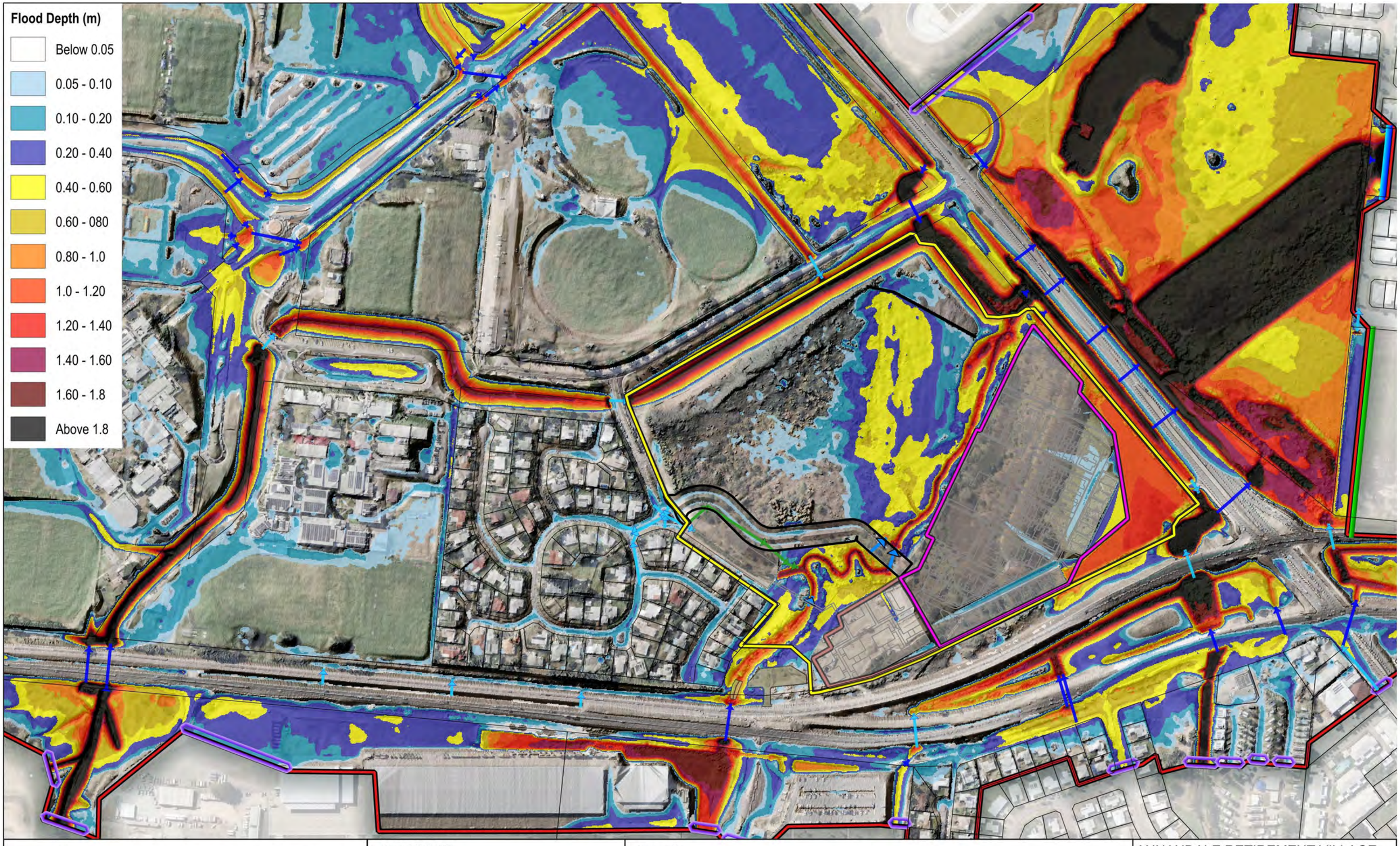
ANNANDALE RETIREMENT VILLAGE

1% AEP Maximum Baseline Flood Depths

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	D01

Flood Depth (m)

- Below 0.05
- 0.05 - 0.10
- 0.10 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 080
- 0.80 - 1.0
- 1.0 - 1.20
- 1.20 - 1.40
- 1.40 - 1.60
- 1.60 - 1.8
- Above 1.8



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0 40 80 120 160 200 m

1:4,000

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Legend

- TCC Land Parcels
- Site Boundary
- Retirement_Layout
- RACF_Site
- Existing Pipes
- Existing Box Culverts
- Model Inflow Locations
- Model Outline (Code)
- HT Boundary
- QT Boundary
- Developed Box Culverts
- Developed Pipes
- Mitigation Levee
- Pump Station Site

ANNANDALE RETIREMENT VILLAGE

1% AEP Maximum Developed Flood Depths

Prepared By: AW	Date: 03/12/2024	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: PARK0014	A3	D02