GLENORCHY CITY COUNCIL
ATTACHMENTS
MONDAY, 29 APRIL 2024

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COMMUNITY

ENVIRONMENT

GOVERNANCE

Safer Communities

Terms of Reference (TOR): Internal Working Group

Name of Internal Working Group	Safer Communities
Briefly state the Working Group's Specific Purpose	• Providing advice to Council regarding public safety, including youth and other crime; • Promoting safety within the Glenorchy community; • Providing advice to Council regarding graffiti and vandalism issues within Glenorchy; and • Providing advice to Council regarding public events within the municipality.
Date of Formation	
Resolution Details	e.g. Council Meeting on 24 October 2016, Item 15
Strategic Reference	Include Strategic Plan and Annual Plan related items and any relevant strategies / frameworks
Elected Members: **Chair; and** **Co-Chair**	
Invited Subject Matter Experts	**TBA**
Responsible Officer(s)	**Emilio Reale**
Working Group Review Date (if prior to next LG election)	(Insert date) **NOTE: All working groups will be subject to:** **1. A maximum term of 4 years; or** **2. Cessation upon notification of the start of the Election Caretaker Period.** **All working groups are subject to Council review and possible amendment or cessation after the Local Government elections and Council mandated review of its strategic plans (*s. 70E Local Government Act 1993*).**

• Principles

Working groups are committed to the following principles:

Community: Encouraging the development of a strong and inclusive community that advances access, equity, connections and participation in decision-making and shapes a better community for everyone.

Creativity: Encouraging diversity and creative expression in the community, nurturing innovation and always seeking opportunities for continuous improvement.

Sustainability: Ensuring that all decisions and future planning considers a balance of economic, environmental, cultural and social factors to enhance the quality of life in our local community.

Community engagement: Promoting ideas for actions, initiatives, events and programs that are authentic and fit the future vision and needs of our local Community.

• Purpose

Purpose of working group and area of focus

The Safer Communities Working Group will engage with the community and subject matter experts to inform itself and Council on the current issues relating to crime, youth justice, vandalism and graffiti.

Additionally, the working group will also provide advice to Council regarding Council events.

The working group's purpose aligns to the following Council strategies:

Making Lives Better

Objective	We deliver services to meet our community's needs
Strategy	Deliver services to our community at defined levels.
Objective	We champion greater opportunities for our community.
Strategy	In partnership with others, facilitate and advocate for a welcoming, inclusive, healthy and learning community.

Leading our Community

Objective	We are a leader and partner that acts with integrity and upholds our community's best interests.
Strategy	Listen to our community to understand their needs and priorities.
Strategy	Champion and work together to address our community's needs and priorities.
Strategy	Communicate effectively with our community and stakeholders about what Council is doing.
Strategy	Build and maintain proactive relationships with all levels of government, other councils and peak bodies to achieve outcomes for Glenorchy and Greater Hobart.

Detailed Terms of Reference (objectives)

INFORMING:

To deliver the above areas of focus the working group will liaise with Tasmania Police, local charities, community support agencies (including Youth Justice) and community representatives.

IMPACTS:

The working group may also seek information from community members and businesses regarding the impacts of anti-social behaviour on the various segments of the Glenorchy community.

PLANNING:

The above material will be reported to Council to assist it in planning for the future delivery of its services.

Extent of Authority

- The working group does not have the authority to instruct or bind the Council (including Council officers with the relevant delegated duties) in its decision making or activities; and
- The working group must adhere to the Media and Communications and Social Media Policies in its external communications.

• Membership

Composition

Elected Members are elected to working groups in accordance with the adopted Committee Nominations and Appointments Policy. Council Officers are selected by ELT and with the General Manager approval. Council Officers will present to the working group on an ad hoc basis.

Other membership is by invitation of Glenorchy City Council and expressions of interest are advertised via social media channels and on the Council's website. This is also detailed in the Committees Nominations and Appointments Policy.

If external persons are needed to be members of the working group then a selection criteria is to be developed to define the conditions used to determine a successful applicant. This could include specialist subject matter, lived experience, residential address (i.e. within subject geographical area if relevant), etc.

The working group will then advertise an "Expressions of Interest" (EOI) process and also invite applications from relevant subject matter experts (eg. Tas Police & Metro Tas.). The EOI will detail the selection criteria. The selection criteria will be used to assess applications received under the EOI process. The selection will be subject to General Manager oversight, delegated to the relevant Director. The General Manager will formally invite approved applicants to join the working group via a letter of offer.

• Meetings

Frequency

Meetings are held quarterly at Council Chambers, or at an alternative venue as approved by a majority of the working group.

Quorum

A simple majority of members present, one of whom must be the Chair or Co-Chair.

Meeting Procedures

- Meetings are to be conducted formally.
- Meetings agendas and minutes must include apologies, confirm minutes of previous meeting, deal with each item of business separately, and take formal votes about any resolution.
- Agendas for the meetings are to be circulated to members at least 4 working days in advance of the meeting.
- Items not on the agenda may be considered with the consent of the Chair.

Conflict Resolution

- The working group is not a decision making group, however if a vote is required to seek the opinion of the group on a particular issue, then the majority vote will be taken as the group's position. This may be done informally (show of hands) or formally (ballot box voting) depending upon the issue.
- While a collaborative approach to resolving issues and identifying opportunities of interest will always be preferred, overall responsibility for all decisions for Glenorchy City Council's adopted strategy and action plans strategy remains with the Council.
- It is acknowledged that parties will at times differ in their views and may agree to disagree. While every attempt will be made to reach common ground, this may not always be possible. In such cases, individual member views will be documented in the meeting notes subject to the approval of the relevant member(s).

Minutes

- Minutes are to be recorded using the template attached to this TOR.
- Draft minutes are to be circulated to members within 4 working days of a meeting.

• Reporting Requirements

Frequency of Reports

Quarterly reports are to be provided to the ELT for comment and then go to a Council meeting for noting.

The report is to be drafted by the Secretariate of the working group and approved by the Chair of the working group prior to submission.

A report is also to be presented to Council at the conclusion of the working group.

Content of Reports

The report is to provide:

- A concise report from the Chair of the working group summarising:
  - attendance;
  - an update on the key outcomes and achievements of the working group matched to the objectives contained in the terms of reference;
  - an outline of how the outcomes have been communicated to internal stakeholders in the formulation of related strategies, frameworks and plans; and
  - any recommendations for future consideration.

Version History

Version	Date	Adoption	Amendments Made
1.0			Council approval of working group and TOR

TEMPLATE: Internal Working Group Minutes

(Name of Working Group) MINUTES OF MEETING (DD Month YYYY)	GLENORCHY CITY COUNCIL
Venue:	**Time:**

In attendance:		**Present**	**Apology**	**Absent**
Chairperson		✓		
Members				
Staff				

Item		**Action**
1	**Acknowledgement of Country**	-
2	**Minutes** (approve / changes) **and actions from previous meeting:**	
3	**Correspondence:** 3.1 3.2 etc	
4	**Business arising:**	
5	**Update on projects:**	
6	**Other Business:**	
7	**Agenda items for next meeting:**	
Next Meeting:		

Economic Development

Terms of Reference (TOR): Internal Committee

Name of Internal Committee	Economic Development
Briefly state the Committee's Specific Purpose	i. Increase local employment for Glenorchy Municipality residents ii. Increase workforce participation of Glenorchy residents iii. Increase engagement by Glenorchy residents in formal education and training. iv. Meet local workforce / skills needs.
Date of Formation	
Resolution Details	
Elected Members Chair and Co-Chair	
Invited Subject Matter Experts	**TBA**
Responsible Officer(s)	**Tracey Ehrlich**
Committee Review Date (if prior to next LG election)	This Committee is subject to: 1. A maximum term of 4 years; or 2. Cessation upon notification of the start of the Election Caretaker Period. All Committees are subject to Council review and possible amendment or cessation after the Local Government elections and Council mandated review of its strategic plans (*s. 70E Local Government Act 1993*).

Principles

All committees are committed to the following principles:

Community: Encouraging the development of a strong and inclusive community that advances access, equity, connections and participation in decision-making and shapes a better community for everyone.

Creativity: Encouraging diversity and creative expression in the community, nurturing innovation and always seeking opportunities for continuous improvement.

Sustainability: Ensuring that all decisions and future planning considers a balance of economic, environmental, cultural and social factors to enhance the quality of life in our local community.

Community engagement: Promoting ideas for actions, initiatives, events and programs that are authentic and fit the future vision and needs of our local Community.

Purpose

1 Purpose of Committee and Areas of Focus

The Economic Development Committee will engage with the community, business and industry and subject matter experts to inform itself and Council on the current issues relating to employment, business and industry and youth employment within the Glenorchy municipal area.

The committee will specifically target the following issues:

i. Local employment for Glenorchy municipality residents;
ii. Increasing workforce participation of Glenorchy residents;
iii. Increasing engagement by Glenorchy residents in formal education and training;
iv. Identifying key employee skills need required by local business and industry to assist with business sustainability in the municipality; and
v. Establishment of a forum to enable effective consultation with Glenorchy's business and industry.

The Committee's purpose aligns to the following Council strategies:

Making Lives Better

Objective	We deliver services to meet our community's needs
Strategy	Deliver services to our community at defined levels.
Objective	We champion greater opportunities for our community.
Strategy	In partnership with others, facilitate and advocate for a welcoming, inclusive, healthy and learning community.

Leading our Community

Objective	We are a leader and partner that acts with integrity and upholds our community's best interests.
Strategy	Listen to our community to understand their needs and priorities.
Strategy	Champion and work together to address our community's needs and priorities.
Strategy	Communicate effectively with our community and stakeholders about what Council is doing.
Strategy	Build and maintain proactive relationships with all levels of government, other councils and peak bodies to achieve outcomes for Glenorchy and Greater Hobart.

Open for Business

Objective: We encourage responsible growth for our City.

Strategy: Maintain a progressive approach that encourages investment and jobs.

2 Detailed Terms of Reference (objectives)

The terms of reference includes the following:

- Provide informed strategic advice and expert recommendations to Glenorchy City Council (GCC) and the Jobs Hub contracted service provider relating to local employment, workforce participation and education and training. This includes, but is not limited to, job seeker needs and employer needs/skills deficits;
- Oversee performance of the Jobs Hub in collaboration with GCC officers to ensure it meets its contracted responsibilities in accordance with the Grant Deed;
- Harness the capacity of the Jobs Hub Reference Group and together, actively promote the work of the Jobs Hub across the Glenorchy employment, jobs, and training ecosystem;
- Consider the information gathered at Jobs Tasmania Regional Jobs Hub Community of Policy and Practice in the development and implementation of Jobs Hub programs and services;
- Develop and oversee implementation of agreed three-year Strategic and one-year Implementation Plans with the support of GCC officers;
- Advocate to State and Federal Governments for increased program support and funding that increases capacity to meet program objectives; and
- Strategically understand, and influence, the employment, jobs, and training ecosystem in Glenorchy to increase local employment and deliver benefits to local employers.

3 Extent of Authority

The committee does not have the authority to instruct or bind Council (including Council officers with the relevant delegated duties) in its decision making and/or activities.

The committee must adhere to the Media and Communications and Social Media Policies in its external communications.

Membership

1 Composition

Elected Members are elected to Committees in accordance with the adopted Committee Nominations and Appointments Policy. Council Officers are selected by ELT and with the General Manager approval. Council Officers will present to the Committee on an ad hoc basis.

Other membership is by invitation of Glenorchy City Council and expressions of interest are advertised via social media channels and on the Council's website. This is also detailed in the Committees Nominations and Appointments Policy.

If external persons are needed to be members of the Committee then a selection criteria is to be developed to define the conditions used to determine a successful applicant. This could include specialist subject matter, lived experience, residential address (i.e. within subject geographical area if relevant), etc.

The Committee will then advertise an "Expressions of Interest" (EOI) process and also invite applications from relevant subject matter experts (eg. Tasmanian Chamber of Commerce and Industry). The EOI will detail the selection criteria. The selection criteria will be used to assess applications received under the EOI process. The selection will be subject to General Manager oversight, delegated to the relevant Director. The General Manager will formally invite approved applicants to join the Committee via a letter of offer.

Meetings

1 Frequency

Meetings are held quarterly at Council Chambers, or at an alternative venue approved by a majority of the committee.

2 Quorum

A simple majority of members, one of whom must be the Chair or Co-Chair.

3 Meeting Procedures

- Meetings are to be conducted formally.
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4 Conflict Resolution

- The Committee is not a decision making group. However, if a vote is required to seek the opinion of the group on a particular issue, then the majority vote will be taken as the group's position. This may be done informally (show of hands) or formally (ballot box voting) depending upon the issue.
- While a collaborative approach to resolving issues and identifying opportunities of interest will always be preferred, overall responsibility for all decisions for Glenorchy City Council's adopted strategy and action plans strategy remains with the Council.
- It is acknowledged that parties will at times differ in their views and may agree to disagree. While every attempt will be made to reach common ground, this may not always be possible. In such cases, individual member views will be documented in the meeting notes subject to the approval of the relevant member(s).

5 Minutes

Minutes are to be recorded using the template attached to this TOR.

Draft Minutes are to be circulated to members within 4 working days of a meeting.

Reporting Requirements

1. Frequency of Reports

Quarterly reports are to be provided to the ELT and Council, drafted by the Secretariate of the Committee and approved by the Chair of the Committee prior to submission.

2. Content of Reports

The report is to provide:

- A report from the Chair of the Committee summarising:
  - attendance;
  - an update on the key outcomes and achievements of the Committee matched to the objectives contained in the terms of reference;
  - an outline of how the outcomes have been communicated to internal stakeholders in the formulation of related strategies, frameworks and plans; and
  - any recommendations for future consideration.

Version History

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1.0			Council approval of Committee and TOR

TEMPLATE: Internal Committee Minutes

(Name of Committee) MINUTES OF MEETING (DD Month YYYY)	GLENORCHY CITY COUNCIL
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In attendance:		**Present**	**Apology**	**Absent**
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Members				
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6	**Other Business:**	
7	**Agenda items for next meeting:**	
Next Meeting:		

GLENORCHY CITY COUNCIL

STORMWATER SYSTEM MANAGEMENT PLAN

Glenorchy City Council

Enhancing Flood Resilience: Key Recommendations for Stormwater Management

Document Control

Rev	Date	Revision Details	Author	Reviewer	Approver
0	17 Jan 2024	Submitted to Council for adoption	Balaji Sivakumar, Flussig Engineers	Patrick Marshall	Emilio Reale

Contents

Figures

Tables

Abbreviations

AEP – Annual Exceedance Probability

AHD – Australian Height Datum

ARI – Average Recurrence Interval

ARR – Australian Rainfall and Runoff

BOM – The Australian Bureau of Meteorology

CL – Continuing Loss (mm/hr)

DEM – Digital Elevation Model

DTM – Digital Terrain Model

GIPS – Glenorchy Interim Planning Scheme

GCC – Glenorchy City Council

HGL – Hydraulic Grade Line

IL – Initial Loss (mm)

IWL – Initial Water Level describing the first water level during a stormwater model simulation

PMP – Probable Maximum Perception

PMF – Probable maximum Flood

IFD – Intensity-Frequency-Duration

SSMP – Stormwater System Management Plans

SLR – Sea Level Rise (m)

Glossary

Annual Exceedance Probability	The probability of exceedance of a given discharge within a period of one year.
Average Recurrence Interval	The average or expected value of period between the exceedance of a given discharge.
Australian Height Datum	A common national plane of level corresponding approximately to mean sea level.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Development	The erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow which is a measure of how fast the water is moving rather than how much is moving.
Flood	Relatively high streamflow which overtops the natural or artificial banks in any part of a stream river or surcharged from underground reticulation system due to its deficiency.
Flood hazard	Potential for damage to property or persons due to flooding.
Floodplain	The area subject to flooding during and after rainfall events.
Hydraulics	The study of water flow, in particular the valuation of flow parameters such as stage and velocity in a river or a stream.
Hydrology	The study of rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Overland Flow path	A natural or man-made path to allow surface flow passing through.
Peak Discharge	The maximum discharge occurring during a flood event.

Probable Maximum Perception	The term to define the maximum rainfall intensity that could conceivably occur at a particular location and is used to estimate the Probable Maximum Flood.
Probable Maximum Flood	The maximum flood will ever occur within the catchment area.
Probability	A statistical measure of the expected frequency or occurrence of flooding.
Runoff	The portion of rainfall which ends up as streamflow, also known as rainfall excess.
TUFLOW	TUFLOW is a suite of advanced 1D/2D/3D computer simulation software for flooding, urban drainage, coastal hydraulics, sediment transport, particle tracking and water quality.

Executive Summary

The Stormwater System Management Plan prepared by the Council's Assets, Engineering, and Design Department, aims to comprehensively address flood behaviours within the Glenorchy Municipality Area. This plan is designed to foster a deep understanding of the impact of floods in both present and future scenarios, aligning with the regulatory requisites laid out in the Urban Drainage Act of 2013.

A rainfall-runoff model has been established to provide a precise depiction of the study area. This model has been leveraged to assess inundation extents for a spectrum of design flood events, including the 1% Annual Exceedance Probability (AEP), while accounting for the influence of climate change and sea level rise. The study delivers critical information regarding flood flows, velocities, levels, and extents for the 1% AEP, thereby empowering the formulation of effective planning controls, the establishment of minimum floor levels, and the identification of flood mitigation options.

This report encapsulates a summary of the findings stemming from the analysis of fourteen catchments under the jurisdiction of the Glenorchy City Council, excluding the Humphreys Rivulet, Barossa Creek and Little John Creek catchments, which were completed separately by SMEC Holdings as part of the Glenorchy CBD Stormwater System Management Plan 2018 and attached to this report. It outlines a pragmatic and cost-effective strategy for mitigating flood-related risks to both buildings and road infrastructure. In addition to assessing structural damage to both residential and non-residential buildings, the study addresses a wide array of losses, encompassing inventory loss, loss of rental income, loss of business income, and the associated costs of fatalities.

The majority of the analysed flood mitigation options have demonstrated benefit-to-cost ratios exceeding 1.0, signifying sound investment decisions. While some exceptions exist, such as cases of dry and wet floodproofing, the utilisation of temporary barriers in high hazard zones has emerged as the most cost-effective measure.

Furthermore, the mitigation options encompass general stormwater maintenance in catchments where flood mitigation would only be feasible through land acquisition. This has been deemed unrealistic and unfeasible at this stage, warranting further investigations and internal discussions among high-level decision-makers at the Glenorchy City Council.

In this report, all urban catchments within the Glenorchy municipality were comprehensively modelled using TUFLOW to map flood extents and assess flood risks during 1% AEP rainfall events. The study has identified the critical rainfall duration for these catchments and highlighted deficiencies in the existing reticulation system, particularly during major rainfall events with a 1% AEP. To address these issues, 1D networks for pipes greater than 300mm in diameter were included in the model to enhance the accuracy of floodplain mapping. It's important to note that the Council's responsibility for providing capacity in the stormwater pipe networks only extends to minor rainfall events up to 5% AEP, and therefore, the capacity of the stormwater pipe networks for 1% AEP events were not assessed as part of this flood study, but were included to improve the flood plain model.

The floodplain maps generated in this study underscore the significant flooding risk faced by several properties during major rainfall events with a 1% AEP. Notable areas affected include Hestercombe Reserve and Playground, Gould's Lagoon, Brooker Highway, Hilton Road, Main Road, Merley Road, Weston Park, Beedhams Reserve, Claremont Oval, Newtown Rugby Park, Southern Waste Solutions, and Montrose Bay High School Playground.

While model calibration was not performed due to a lack of historic flood level data, the study underwent a rigorous validation process, which included comparing flood extents with previous models and addressing residents' complaints. Consulting engineers, Entura, conducted a peer review of the model, and model parameters were selected from the previous Glenorchy CBD Stormwater System Management Plan in 2018, prepared by SMEC Australia. Sensitivity analysis was performed in previous models by varying different parameters and scenarios.

The study also incorporates climate change scenarios, including Sea Level Rise and Storm Surge projections for the 2100s. These projections are based on assumptions of a 16% increase in rainfall and a sea level rise of 1.62 metres, as stipulated in previous flood studies and the Glenorchy Interim Planning Scheme.

To maximise the benefits derived from this study, we recommend future efforts that include integrating identified overland flow paths and flood hazard areas into the Planning Control process, exploring upgrade and flood mitigation measures, determining catchment-wide infrastructure upgrade requirements, and prioritising these upgrades. Such initiatives will aid in the achievement of a systematic, strategic, and sustainable approach to stormwater infrastructure management that aligns with the Council's commitment to safeguarding its residents from major flood risks, meeting the Level of Service promised.

1 Stormwater System Management Plan

1.1 Overview of Plan Content

This document outlines the methodology employed in crafting the Stormwater System Management Plans, adhering to the guiding principles delineated in "Stormwater System Management Planning – A Guide for Local Government in Tasmania" (LGAT, 2016).

A comprehensive Stormwater System Management Plan is expected to encompass:

- An identification of objectives and outcomes for management of stormwater in the designated urban areas
- A description of the catchment to which the plan applies, including a definition of the urban area
- A description of the existing public stormwater system, including identification of current condition and ownership of assets where known
- An identification of stormwater management problems and opportunities for achieving outcomes for public and environmental benefit in the urban areas
- An identification of strategies to meet specified management objectives for the urban areas
- Determination of capital and maintenance (including recurring) costs associated with identified management strategies
- An assessment of the benefits to be derived by implementation of proposed management strategies
- Prioritisation of the strategies and a timeframe for implementation
- Assignment of responsibilities for implementing the strategies and meeting any costs;
- A communication / consultation strategy for the Plan;

1.2 Stormwater System Management Plan Objectives

When determining the objectives of a Stormwater System Management Plan, the broader objectives of the Urban Drainage Act 2013 should be taken into account:

- to protect people and property by ensuring that stormwater services, infrastructure and planning are provided so as to minimise the risk of urban flooding due to stormwater flows; and
- to provide for the safe, environmentally responsible, efficient and sustainable provision of stormwater services in accordance with the objectives of the Resource Management and Planning System of Tasmania, as set out in Schedule 1 of the Act.

The SSMP crafted by GCC is designed to comprehensively tackle the following key aspects:

- Develop flood inundation maps for the 1% Annual Exceedance Probability (AEP) design event, illustrating flood extents, depth, flood hazard, and maximum velocities.
- Provide recommendations for modifications to the State Planning Provisions of the Tasmanian Planning Scheme, along with assessing the extent of existing planning overlays within the study area.
- Propose and prioritise mitigation solutions for recognised flood risk areas, contingent upon resource availability.

- Foster resilience and incorporate considerations for climate change impacts to proactively address future demands on the urban stormwater system.
- Cultivate community awareness and engagement, promoting effective participation in the appropriate management of stormwater.

1.3 Description of Study Catchment

20 of the 21 catchments within the Glenorchy municipality have considerable urban area, and SSMPs are required under the Urban Drainage Act 2013. All these catchments with urban areas have been modelled and analysed to identify floodplain during major events (1% AEP) and associated flood risks.

Humphreys Rivulet, Barossa Creek, Little John Creek were completed separately by SMEC Australia as part of the Glenorchy CBD Stormwater System Management Plan 2018 and are included as an attachment to this report.

Figure 1 Stormwater Catchments with Watercourse Layers

The catchments are presented in Table 1.

Table 1 List of Catchments

Order	Catchment Initial	Catchment Name	SSMP Required (Y/N)
1	BC	Barossa Creek Catchment	Not included in this SSMP
2	BB	Beedhams Bay Catchment	Y
3	BS	Black Snake Rivulet Catchment	Y
4	CB	Connewarre Bay Catchment	Y
5	DC	Dooleys Creek Catchment	Y
6	DP	Dowsing Point Catchment	Y
7	FR	Faulkners Rivulet Catchment	Y
8	GW	Goodwood Catchment	Y
9	GN	Granton Catchment - 1	Y
10	GN	Granton Catchment - 2	Y
11	GN	Granton Catchment - 3	Y
12	HR	Humphreys Rivulet Catchment	Not included in this SSMP
13	IR	Islet Rivulet Catchment	Y
14	JR	Jacques Rivulet Catchment	Y
15	LJ	Little John Creek Catchment	Not included in this SSMP
16	LB	Lowestoft Bay Catchment	Y
17	NR	New Town Catchment	Not included in this SSMP
18	RR	Roseneath Rivulet Catchment	Y
19	SC	Sorell Creek Collinsvale Catchment	N
20	SF	Springfield Catchment	Y
21	EZ	Zinc Works Catchment	Y

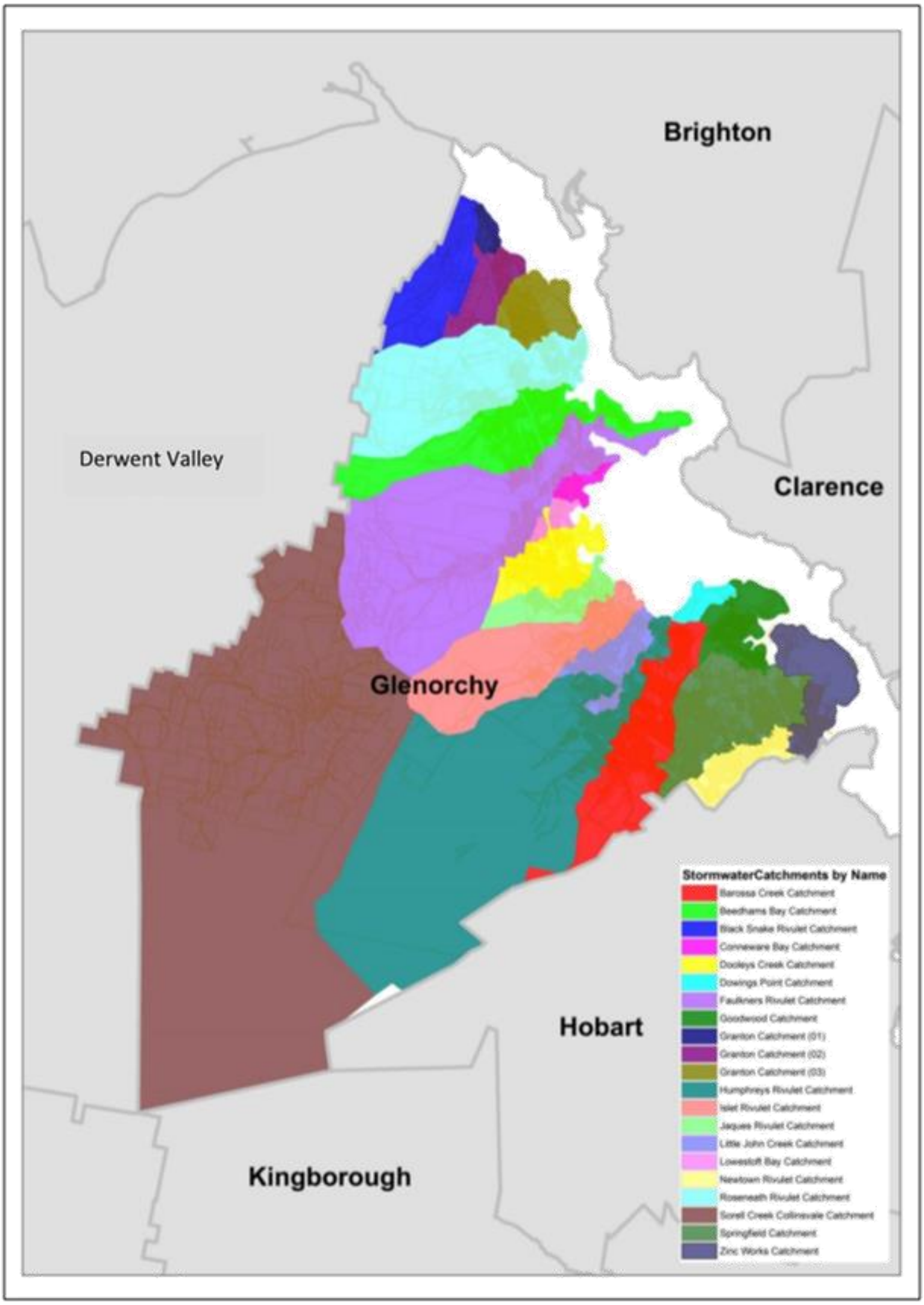


Figure 2 Stormwater Catchments by Name

Table 2 Flood Studies Catchment Size

Catchment Name	Catchment Size (ha)
Beedhams Bay Catchment	505
Black Snake Rivulet Catchment	545
Connewarre Bay Catchment	44
Dooleys Creek Catchment	210
Dowsing Point Catchment	52
Faulkners Rivulet Catchment	1280
Goodwood Catchment	184
Granton Catchment - 1	36
Granton Catchment - 2	144
Granton Catchment - 3	177
Islet Rivulet Catchment	568
Jacques Rivulet Catchment	151
Lowestoft Bay Catchment	41
Roseneath Rivulet Catchment	858
Springfield Catchment	448
Zinc Works Catchment	250
Not Included in this SSMP	
Barossa Creek Catchment	500
Humphreys Rivulet Catchment	1390
Little John Creek Catchment	270
New Town Catchment	176
Sorell Creek Collinsvale Catchment	4452

1.3.1 Beedhams Bay

Beedhams Bay Catchment is approximately 505 Ha, located in the Claremont area where most of the catchment is a natural forest positioned on a step hill. It also has a residential area situated at the lower, flatter area, adjacent to the Brooker Highway and Derwent River.

The catchment has two watercourses, namely Abbotsfield Rivulet and Hilton Creek, flowing from west to east and entering Beedhams Bay on the Derwent River.

Abbotsfield Rivulet flows from the southeast side of Mt Faulkner, through Claremont into the Bay, approximately 5 km in total length. The majority of the Abbotsfield Rivulet remains open channels expect a short section was piped in 1966.

Hilton Creek flows in parallel to Abbotsfield Rivulet at the north before joining Abbotsfield Rivulet at Main Rd. Several sections of Hilton Creek have been piped to suit the urban development needs.

The elevation changes rapidly between the upper and middle part of the catchment, dropping from 900 m (AHD) to 120 m (AHD) within only 7km horizontal distance on an average slope of 11%.

Given the close locations of these two watercourses and the potential interactions between them during large rainfall events, the two watercourses and other nearby piped stormwater drainage systems were modelled together in this Beedhams Bay Catchment Flood Study.

1.3.2 Black Snake Rivulet

Black Snake Rivulet is in the Granton area, where a large portion of the catchment remains undisturbed and undeveloped. The undisturbed and undeveloped area is mainly occupied by natural forest, positioned on steep slopes of Blacksnake.

At the lower side of the catchment in Granton, residential developments have occurred in the past few decades which only covers 15% of the total area. The remaining 85% of the catchment is a natural forest positioned on a step hill.

This catchment is approximately 545 Ha, and has a rivulet, named Blacksnake Rivulet, flowing from west to east and entering the Derwent Rive.

The rivulet channel is open, and the riparian zone remains vegetated. Along the channel, there are several culverts and bridge structures constructed over the channel to provide road and traffic crossings at multiple locations, including one major culvert underneath the Brooker Highway at Granton.

1.3.3 Dooleys Creek

Dooleys Creek Catchment is in the Chigwell and Berridale area, where approximately 30% of the catchment being a natural forest positioned on a step hill, with the balance being a residential area situated on lower, flatter land, adjacent to the Brooker Highway and Derwent River.

Dooleys Creek was flowing from west to east and entering the Derwent River before it was piped. Most of the rivulet channel within the urbanised area was piped during urban development.

The upstream piped section starts from Kilander Crescent, following Berriedale Road and ends at Main Road. Like other urban catchments in Glenorchy, the elevation changes rapidly between the upper and middle part of the catchment, dropping from 380 m (AHD) at the top of the catchment to 50 m (AHD) at the intersection of Marys Hope Road and Radcliff Crescent, on an average slope of 20%.

The lower and middle parts of the catchment are mainly occupied by residential dwellings and recreational uses.

1.3.4 Faulkners Rivulet

Faulkners Rivulet is a stream located nearby to Chigwell and Berriedale Reserve, flowing down from the Mount Faulkner Conservation area discharging into Windermere Bay.

A large portion of the Faulkners Rivulet catchment area remains undisturbed and undeveloped. The undisturbed and undeveloped area is mainly occupied by natural forest, positioned on steep slopes of Mount Faulkner.

At the lower side of the catchment in Chigwell and Berriedale, residential developments have happened over the past few decades. During the same period (1960s onwards), residential development along the southern side of the catchment also started to occur.

This catchment is approximately 1,280 Ha. The main stream, named Faulkners Rivulet, has various tributaries jointing at the upper level of the catchment. The Rivulet itself flows from west to east and enters the Derwent River at Windermere Bay.

The Rivulet channel is open, and the riparian zone remains vegetated. Along the channel, there are several culverts and bridge structures constructed over the channel to provide road and traffic crossings at multiple locations, including a major twin box culvert underneath the Brooker Highway and a bridge, made of sandstone abutment and concrete deck, at Cadbury Road, Claremont.

Elevations in the upper and middle parts of the catchment change rapidly, dropping from 600 m AHD at the top of the catchment to 100 m AHD at the Richards Road Bridge, within 3kms longitudinal distance. This change is equivalent to an average slope of 16.7%, which is moderately steep and has considerable impact on the catchment hydrology.

The middle catchment area situated at the southern side of the rivulet mainstream has been developed in the past for residential purposes, with significant growth and development potential along the northern side of the rivulet main stream.

The lower part of the catchment, between the Brooker Highway and the foreshore area, has already been developed for residential dwellings and recreational/community uses due to its relatively flat grade extending to the waterfront.

1.3.5 Goodwood and Zinc Works

Goodwood Catchment is approximately 184 Ha and Zinc Works Catchment is approximately 250 Ha, located in the Goodwood and Lutana area. Both the catchments were flowing from west to east and entering the Derwent River.

Most of the Goodwood Catchment is developed with General residential buildings where partially developed with Industrial business. Majority of the Zinc Works Catchment is developed with Industrial business and given the catchment is close proximity to the Derwent River, no pipe networks were provided. Only a small portion of the catchment at the southern side is developed with residential buildings and where stormwater network services were provided.

1.3.6 Granton

Granton Catchment is approximately 357 Ha, located in the Granton area where 50% of the catchment is general residential area and the remaining half of the catchment is a natural forest positioned on a step hill. It also has a residential area situated at the lower, flatter area, adjacent to the Brooker Highway and Derwent River.

Granton Catchment was flowing from west to east and entering the Derwent River before it was piped. Most of the rivulet channel within the urbanised area was piped during urban development.

The lower part of the catchment, after the Brooker Highway, has already been developed for residential dwellings and recreational uses due to its relatively flat grade extending to the waterfront.

1.3.7 Jacques Rivulet

Jacques Rivulet Catchment is in the Montrose area, where approximately half of the catchment being a natural forest positioned on a step hill, with the balance being a residential area situated on lower, flatter land, adjacent to the Brooker Highway and Derwent River.

Jacques Rivulet was flowing from west to east and entering the Derwent River before it was piped. Most of the rivulet channel within the urbanised area was piped during urban development.

The upstream piped section starts from Redlands Drive, following Marys Hope Road and ends at Radcliff Crescent. The open section of the rivulet flows adjacent to the rear boundary of residential properties between No. 2 and No. 22 Glenmore Street and re-enters the underground reticulation system after passing the railway embankment, close to the outlet of the Derwent River.

Like other urban catchments in Glenorchy, the elevation changes rapidly between the upper and middle part of the catchment, dropping from 410 m (AHD) at the top of the catchment to 50 m (AHD) at the intersection of Marys Hope Road and Radcliff Crescent, on an average slope of 20%.

The lower and middle parts of the catchment are mainly occupied by residential dwellings and recreational uses. The lower part, starting from the Rosetta Primary School, has a relatively flat grade extending to the river.

1.3.8 Lowestoft Bay and Connewarre Bay

Lowestoft Catchment is approximately 41 Ha and Connewarre Bay Catchment is approximately 44 Ha, located in the Berriedale and Claremont area where most of the catchment is urbanised area with residential buildings. Almost 95% of the catchment is developed with residential buildings.

Apart from the small section of rivulet channel, most of the rivulet channel within the urbanised area was piped during urban development.

1.3.9 Roseneath Rivulet

Roseneath Rivulet is in the Claremont and Austins Ferry area, where a large portion of the catchment remains undisturbed and undeveloped. The undisturbed and undeveloped area is mainly occupied by natural forest, positioned on steep slopes of Mount Faulkner.

At the lower side of the catchment in Austins Ferry, residential developments have occurred in the past few decades. During the same period (1970s onwards), residential developments along the southern side of the catchment also started to occur.

This catchment is approximately 850 Ha, and has a rivulet, named Roseneath Rivulet, flowing from west to east and entering the Derwent River at Rusts Bay.

The rivulet channel is open, and the riparian zone remains vegetated. Along the channel, there are several culverts and bridge structures constructed over the channel to provide road and traffic crossings at multiple locations, including two major culverts underneath the Brooker Highway and a sandstone bridge at Main Road, Claremont.

Elevations in the upper and middle parts of the catchment change rapidly, dropping from 900 m AHD at the top of the catchment to 130 m AHD before Toffolis Road, within 2.86kms longitudinal distance. This change is equivalent to an average slope of 26.9%, which is relatively steep and has considerable impact on the catchment hydrology.

The middle part of the catchment has a small portion of urban residential land use, with significant growth and development potential along the western side of the Brooker Highway.

The lower part of the catchment, between the Brooker Highway and the foreshore area, has already been developed for residential dwellings and recreational uses due to its relatively flat grade extending to the waterfront.

1.3.10 Springfield

Springfield Catchment is approximately 448 Ha, located in the Moonah area where 50% of the catchment is general and inner residential area and the remaining half of the catchment is a local business area. It also has a residential area situated at the lower & upper flatter area, adjacent to the Brooker Highway and Derwent River.

Springfield Catchment was flowing from west to east and entering the Derwent River. Overall, 98% of the catchment is developed and most of the rivulet channel within the catchment area was piped during the development.

1.4 Description of Existing Stormwater System

The plan delineates the infrastructure assets, as outlined in Table 3, which serve as essential components in delivering effective stormwater drainage infrastructure services to the community.

Table 3 Assets covered by this Plan

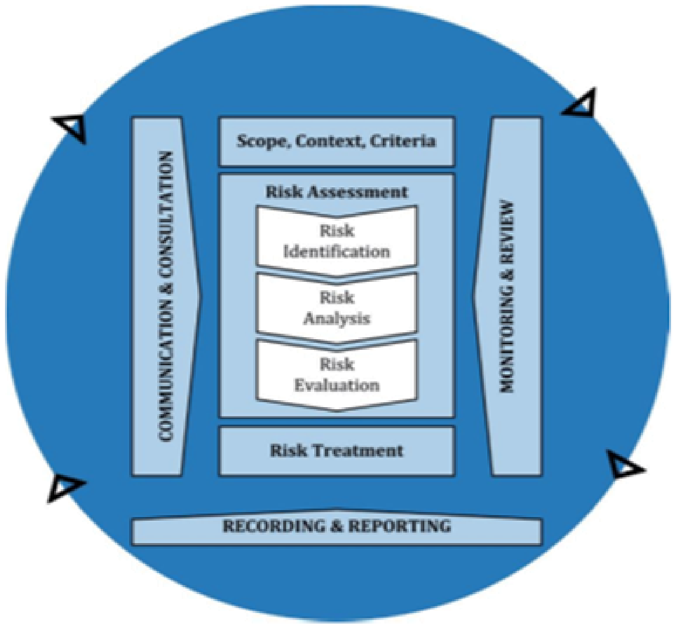
Asset Class	Asset Category	Asset Type	Dimension
Drainage	Bores & Wells	Pump Well	3 (No.)
	Irrigation	Irrigation	27 (No.)
	Lagoon	STSB (Stormwater Storage Basin)	13 (No.)
	Stormwater Drains	Box Culvert	54 (1.73 Km)
		Creek	94 (27.6 Km)
		Gravity Main	16043 (402.8 Km)
		Open Drain	442 (25.5 Km)
		Property Connection	20060 (No.)
		Sub Soil Drain	445 (26.7 Km)
	Stormwater Pits	Inlet Pit	6520 (No.)
		Maintenance Hole	7331 (No.)
		Miscellaneous	1074 (No.)
		Node Point	3903 (No.)
	Stormwater Pump	Pump	3 (No.)
	Water Nodes	Miscellaneous	3 (No.)
	Water Pumps	Water Pump	1 (No.)
	Water Plant and Equipment	Steel Plate	4 (No.)

Additional information about the Council's drainage assets is available in both the Drainage Asset Management Plan and Council's Strategic Asset Management Plan. For spatial data pertaining to the Council's current stormwater system, please refer to the online resources at:

https://maps.gcc.tas.gov.au/

1.5 Identification of Risks, Issues and Opportunities

Illustrated in Figure 3 below is the risk management process employed, serving as an analytical and problem-solving technique. Designed to offer a systematic approach, this process aids in the discernment of treatment plans and management actions, safeguarding the community against unacceptable risks. It aligns with the principles outlined in the International Standard ISO 31000:2018.



Source: ISO 31000:2018, Figure 1, p9

Figure 3 Risk Management Process – Abridged

The risk assessment process systematically identifies credible risks by assessing the likelihood and consequences of potential events. This involves the development of a risk rating, evaluation of risks, and the formulation of a treatment plan for non-acceptable risks.

In the context of service delivery, the risk assessment focuses on potential threats leading to a loss or reduction in service, personal injury, environmental impacts, financial shocks, reputational damage, or other significant consequences.

Critical risks, categorised as those with 'Very High' (requiring immediate corrective action) and 'High' (requiring corrective action) risk ratings, are pinpointed in the Infrastructure Risk Management Plan. The residual risk and associated treatment costs for the chosen treatment plan are detailed in Table 4. It is imperative to report these critical risks and costs to both management and the Council

Table 4 Risks and Treatment Plans

What can Happen	Risk Rating (VH, H)	Risk Treatment Plan	Residual Risk *
Inadequate Community Involvement - The community lacks awareness regarding the distinction between network blockages and the network's designed capacity.	M	Enhance knowledge on flood risk through additional education initiatives.	L
Insufficient Funding for Lifecycle Expenses - Falling short of meeting 100% renewal requirements.	M	Align the Long-Term Financial Management Plan (LTFMP) with the funding outlined in the Asset Management Plan (AMP) and develop a drainage predictor model.	L
Deficient Asset Data and Systems - The extensive drainage network size and the costs associated with CCTV assessments make it challenging to comprehensively assess the network's condition.	M	Employ the drainage predictor model to strategically prioritise Closed-Circuit Television (CCTV) assessments.	L
Legacy Subpar Assets - Uncertain asset quality inherited from subdivisions and ambiguous penetrations from service providers.	M	Collaborate with the planning department to guarantee thorough compliance inspections. Explore the possibility of augmenting compliance resources if needed.	L
Absence of Planning Controls - Development permitted within overland flow paths results in property flooding.	M	Foster communication between Development Engineers and civil engineers.	M
Network Capacity Issues - Inadequate stormwater network capacity to handle frequent rainfall events, leading to asset, environmental, and property damage.	M	Give precedence to network upgrades within the capital works program.	L
Impact of Climate Change - Increasingly frequent extreme weather events contributing to heightened and more regular instances of flooding.	M	Emphasise the importance of prioritising network upgrades within the capital works program.	L

1.6 Identification of Strategies and Outcomes

Section 7 documents the identification of flood risk mitigation options specific to each catchment. Within the Council, a mature understanding of stormwater asset management, design, construction, and operational management exists, supported by adequate operational resources and funding. Recent Council efforts have concentrated on comprehending the origins of various flood incidents, leading to the identification and implementation of flood mitigation works, as evidenced in this document.

However, as outlined in previous sections, additional work is needed in this domain. The discussion and risk assessments in Section 7 prompted the identification of specific actions related to works implementation, flood studies, and more strategically oriented initiatives. Matters pertaining to internal process improvements, information capture, and communication were also acknowledged, with existing administrative arrangements poised to address these gradually, as detailed in Council's Drainage Asset Management Plan.

An Action Plan has been developed to address specific tasks that require focused attention and resources. The proposed overall priorities for managing urban stormwater systems, in order of importance, are as follows:

- Develop flood inundation maps for the 1% Annual Exceedance Probability (AEP) design event, illustrating flood extents, depth, flood hazard, maximum velocities and flood heights.
- Recommend changes to provisions within the State Planning Provisions of the Tasmanian Planning Scheme and assess current planning overlays within the study area.
- Propose and prioritise mitigation solutions for identified flood risk areas as resources become available.
- Strengthen resilience and consider climate change impacts to meet future demands on the urban stormwater system.
- Enhance community awareness of and participation in the appropriate management of stormwater.

While recognising the importance of waterway environment and water quality, the Council, from a broad community perspective, prioritises the protection of people and property from flood risk. Future iterations of the Stormwater System Management Plans (SSMP) will progressively focus on waterway environment and water quality improvements.

Table 5 Action Plan

Action	Catchment	Strategy	Capital Cost	Operational Cost	Responsibility	Timeline
1	Beedhams Bay	Abbotsfield Park DN600 Replacement	$310,000	$7,750	AED	3 years
2	Humphreys Rivulet	Humphreys Rivulet Retaining Wall - Murrayfield Court	$213,000	$5,325	AED	3 years
3	Jacques Rivulet	Redlands Drive Flood Remediation Works	$540,000	$13,500	AED	3 years
4	Dooleys Creek	Chandos Drive Stormwater Diversion	$170,000	$4,250	AED	3 years
5	Zinc Works	New Town Rivulet Outlet Remediation	$415,000	$10,375	AED	3 years
6	Little John Creek	Little John Creek Flood Mitigation	$100,000	$2,500	AED	3 years
7	Springfield	Prince of Wales Bay GPT (CDS Unit) Rectification	$400,000	$1,000	AED	3 years
8	Dooleys Creek	Kilander Crescent Earth Bund – Levee Flood Detention	$120,000	$3,000	AED	5 years
9	Beedhams Bay	Dewar Place Earth Bund - Levee Flood Detention	$280,000	$7,000	AED	5 years
10	Islet Rivulet	Flood wall and culvert extension at reserve	$220,000	$5,500	AED	5 years
11	Jacques Rivulet	Vegetation – Open Drain Maintenance		$100,000	O&M	7 years
12	Faulkners Rivulet	Earth Bund - Levee Flood Detention	$200,000	$5,000	AED	7 years
13	Springfield	Flood Wall – Flow Diversion	$120,000	$3,000	AED	7 years
14	Granton	Earth Bund - Levee Flood Deviation Wall	$596,371	$14,909	AED	7 years
15	Lowestoft Bay	Earth Bund - Levee Flood Deviation Wall	$110,000	$2,750	AED	10 years
16	Black Snake Rivulet	Vegetation Management	$125,000	$3,125	AED	10 years
17	Roseneath Rivulet	Vegetation – Rivulet Maintenance		$180,000	O&M	Ongoing
18	Connewarre Bay	Underground Detention and Double Side Entry Pit	$60,000	$1,500	AED	N/A

19	Dowsing Point	Vegetation – Open Drain Maintenance		$20,000	O&M	Ongoing
20	Goodwood	General stormwater maintenance		$80,000	O&M	Ongoing
21	Zinc Works	General Stormwater Maintenance		$20,000	O&M	Ongoing

1.7 Costs, Benefits and Funding Arrangements

The cost, benefit and funding arrangement for specific flood risk mitigation options are included in Section 7.

The Action Plan has comprehensively outlined cost, benefit, and funding opportunities to tackle identified projects and strategies. This approach aids in broadly identifying priorities.

For most projects and strategies, securing funding is essential, whether through the Council's capital works program or external sources such as grants or other agencies. When pursuing such funding, a more in-depth assessment of "Cost and Benefit" is typically required to substantiate the project's viability.

This detailed assessment may encompass:

- Preliminary design and project costing.
- Cost-benefit analysis.
- Risk assessment.

This multifaceted evaluation ensures a thorough understanding of the project's financial implications, benefits, and potential risks, facilitating informed decision-making during the funding acquisition process.

1.8 Priorities and Timeframes

The action plan delineates project priorities, primarily assigned based on an assessment of risk exposure, either to the Council or more directly to the community at various levels. The prioritisation process takes into account the potential impact on both local and broader community interests. Adjustments to timeframes will be made dynamically, influenced by budget allocations, periodic reviews of project priorities, and responses to unforeseen circumstances.

1.9 Responsibilities

The Council bears the primary responsibility for urban stormwater management, while the State Government oversees the management of river environments and coastal beach strips. Any works in these areas concerning stormwater assets necessitate approval from the relevant Government Agencies. The shared responsibility for comprehending the impacts of riverine flooding involves both the State Government and the Council. However, the Council's specific role lies in understanding the extent of the risk and collaborating with stakeholders to either mitigate the risk or ensure that individuals at risk are aware of the potential for inundation.

1.10 Communication and Consultation

The purpose of this plan is to foster a comprehensive understanding of the urban stormwater system among the community and Council staff. It aims to clarify how the system is managed, highlight existing issues and potential risks, and present a prioritised plan of action for addressing them. This plan serves as a valuable tool, guiding resource allocation decisions within the Council and supporting applications for external funding to tackle identified challenges.

In addition to facilitating internal decision-making, the plan emphasises effective communication and engagement with the community. This involves:

- Providing relevant information on flood impacts, advice for flood preparedness, and outlining mitigation actions where applicable.
- Creating a dedicated page on the Council's website to disseminate information on stormwater, stormwater management, flooding, flood preparedness, and water quality issues. This page will also include a link to the State Planning Scheme hazard and flood mapping.
- Publishing the Stormwater System Management Plan on the Council's website for transparency and accessibility.
- Providing a medium to receive feedback on proposed flood mitigation strategies.

This approach ensures that the community is well-informed, engaged, and actively participating in stormwater management efforts.

2 Historical Flood Events

2.1 2005 & 2007 Flood Events

Council has recorded and mapped complaints received from residents arising from flooding on 25th October 2005 and 21st January 2007. It was noticed that during these two-events flooding occurred at various locations, due to excessive surface runoff.

Those properties affected by flooding in 2005 and 2007 are highlighted in the following map (Figure 4, Figure 5 & Figure 6. Unfortunately, due to lack of data, rainfall analysis cannot be performed for the 2005 event, but it is believed that the severity of the 2005 events was less than the 2007 event.

Rainfall data for the 2007 event was collected from three BOM owned gauges, and the analysis conducted indicates that the storm occurring on 21st January 2007 between 13:30 and 19:30 was a 6-hour storm event between 5% AEP and 1% AEP.

2.2 2018 Flood Events

Based on the complaints received from the residents, Council has recorded and mapped all the damages occurred for public infrastructure and private properties from flooding on 11th May 2018. Flooding and infrastructure damage occurred at various locations due to insufficient capacity of the stormwater infrastructure. Those properties affected by flooding in 2018 are highlighted in the following maps.

Hobart and the nearby Wellington Range, where almost all recording sites reported their highest May daily rainfall on record in the 24 hours to 9.00am on 11 May. The daily totals of 236.2 millimetres at kunanyi/Mount Wellington and 226.4 millimetres at Leslie Vale were second and third highest on the list of the top three highest May daily rainfalls ever recorded in Tasmania (behind 258 millimetres at Gray on 18 May 1986).

Much of the rain fell in about six hours on the Thursday evening, leading to flash flooding in many streams in southeast Tasmania. Hobart recorded 128 millimetres, with a third of that falling in one hour between 10.00pm and 11.00pm on the Thursday evening.

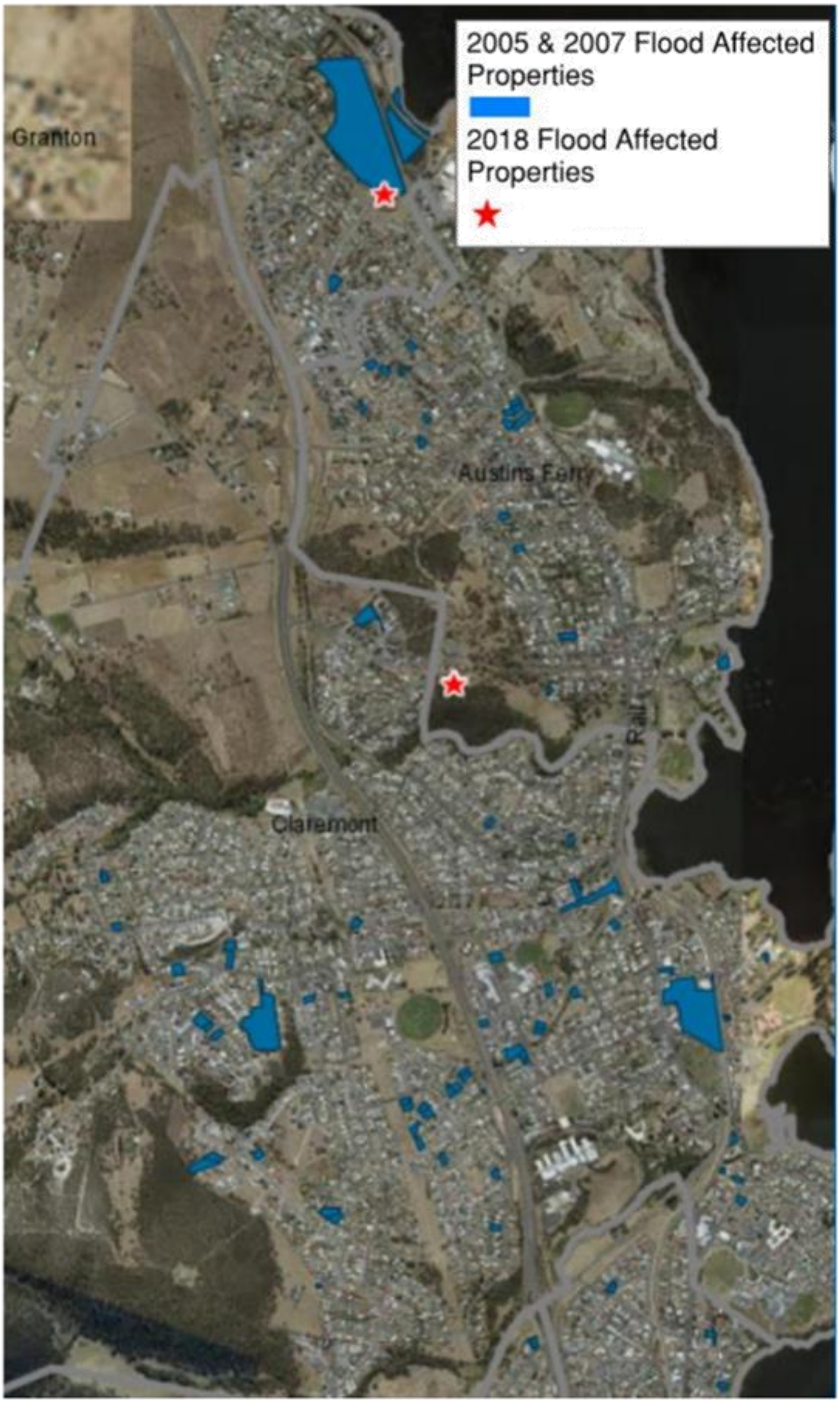


Figure 4 Properties Affected by Flood in 2005, 2007 & 2018.

Figure 5 Properties Affected by Flood in 2005, 2007 & 2018.

Figure 6 Properties Affected by Flood in 2005, 2007 & 2018.

3 Land Use Categories

As defined in the Glenorchy Interim Planning Scheme, the land use categories within the Glenorchy Municipality area include, Environmental Management, Environmental Living, Utilities, General Residential, Community Purpose, Inner Residential, Light Industrial, Local Business, Low Density Residential, Recreation and Open Space.

It was found that the Glenorchy Interim Planning Scheme has zoned over 70% to 75% of the Glenorchy Municipality area, mainly at the upper and middle elevation of the catchment, as 'Environmental Management'.

At lower elevations of the catchment where the existing urban area is, most of the land is zoned 'General Residential' with a small portion of the area is zoned 'Inner Residential'. The proportional make up of zones and zone locations are presented in Figures 6.

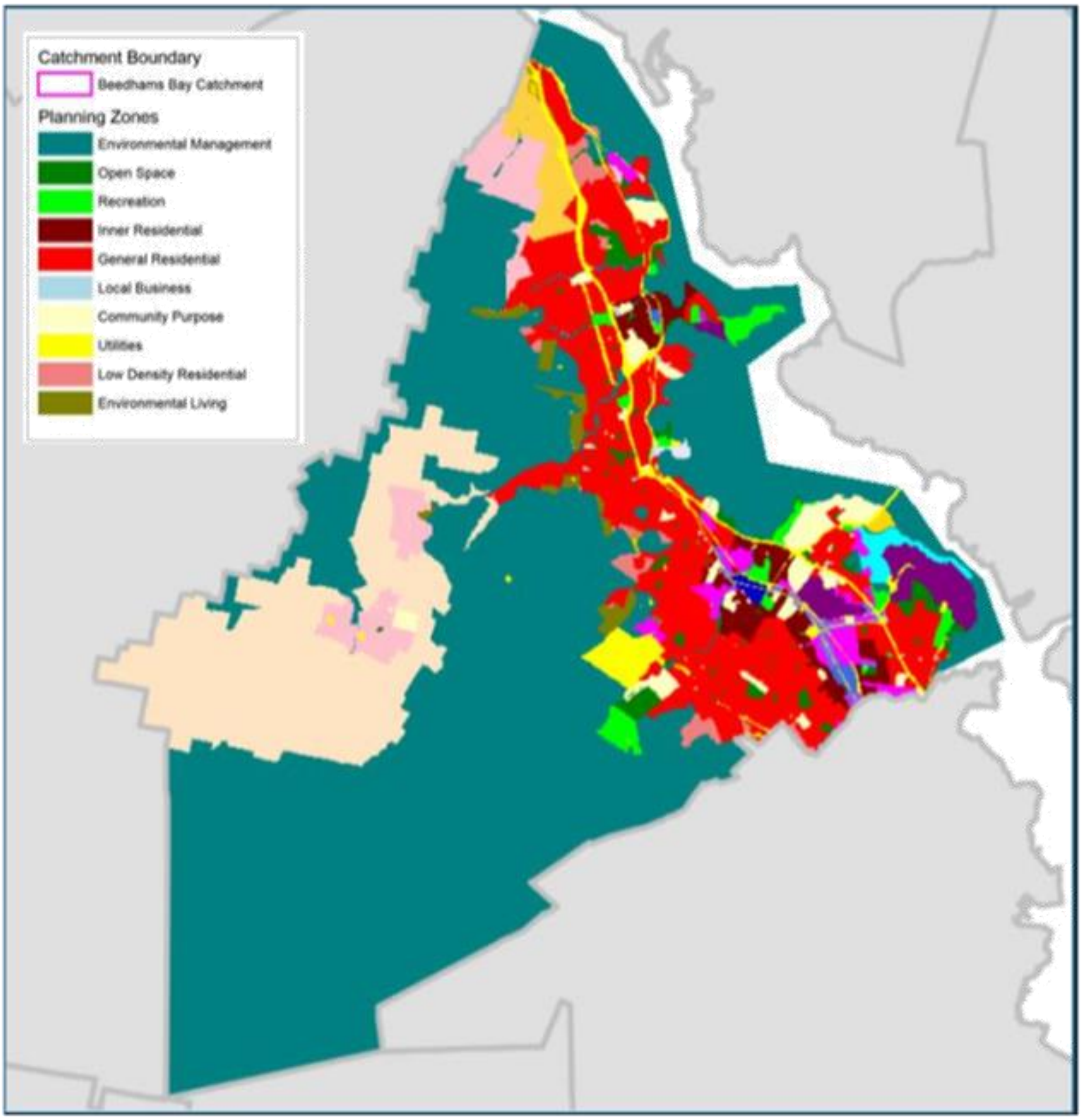


Figure 7 Glenorchy Municipality Catchment Land Use Map

4 Flood Model Development and Results

4.1 Model Setup

A rainfall-runoff model has been set up to describe the Study Area, and the layout diagram is shown as Figure 7.

The Study Area has been divided into two types, namely 'rural' and 'urban'. Both urban and rural catchment was modelled using rainfall-on-grid with Tuflow HPC (Heavily Parallelised Compute), a dynamic hydraulic model which combines 1D calculation for pit and pipe flow with 2D overland flow calculations.

The Tuflow model represents both the urban and rural catchment using 2D surface terrain, surface roughness, and a 1D pit and pipe network (no less than 300mm diameter or equivalent). Tuflow version 2020-10-AA single precision has been used with HPC GPU settings. A grid size of 2x2 were used in the model to obtain more accurate results.

To balance runtime and model definition a grid size of 2x2 m was used, specifically to enhance the detail of some narrow rivulet channels modelled using the 2D grid surface. A grid size this fine for an area this large has recently become possible through the HPC version of the model.

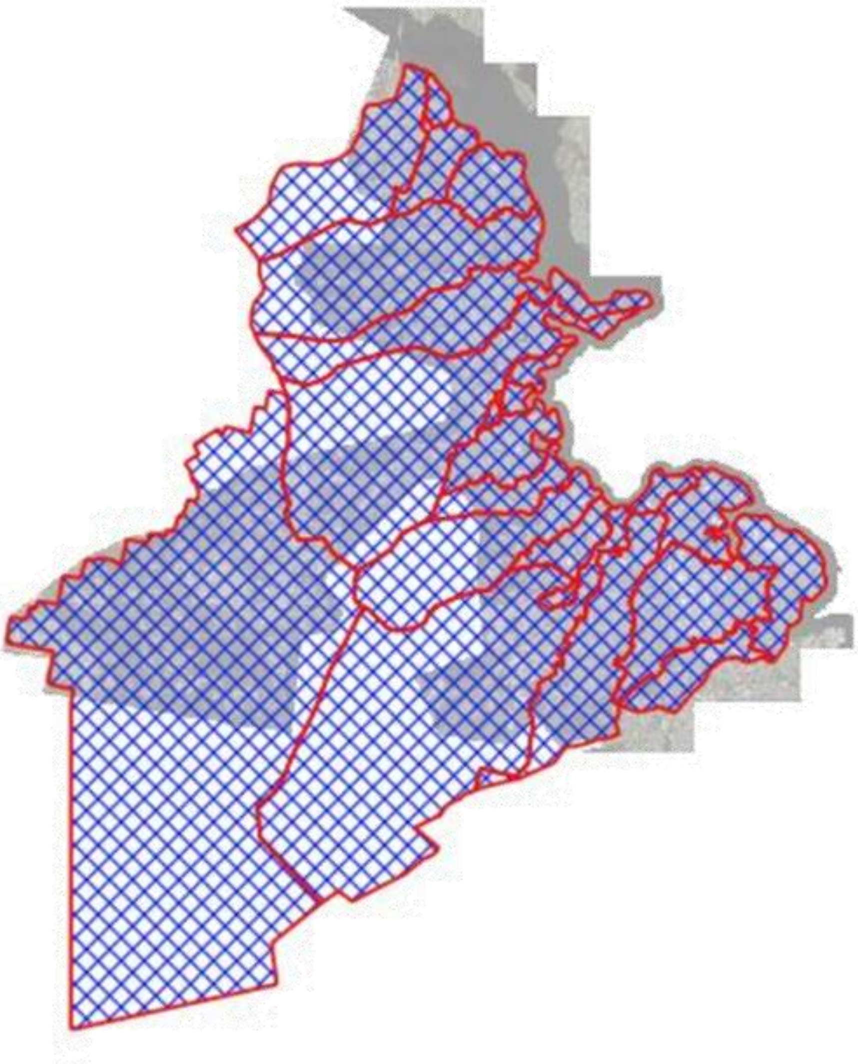


Figure 8 Hybrid Model Layout – TUFLOW Domain

(Square hatching is cosmetic only and does not represent 2D grid size or orientation)

4.2 Input Data

4.2.1 Topographic Data

In the urban catchment area, the topographic data was interpolated from the Glenorchy 0.25m contour layer derived from Mt Wellington LiDAR from 2011 and Greater Hobart LiDAR from 2013. Where the 0.25m Contour data is not available, particularly in the upper area of Mt Wellington a combination of 2m, 5m and 10m contours were used, depending on the most accurate and available contour, to determine the sub catchment, sub catchment slope and 2D terrain model used in the modelling.

The aerial image used in the model was taken in 2013 by Fugro Imagery at 0.1 m resolution (equivalent to 0.1 m per pixel). A quality assessment process of the aerial image accuracy found that it has a mean error of 0.1 m (horizontal error) with standard deviation of 0.09.

4.2.2 Rainfall Data

1% AEP design rainfalls were estimated using the online Bureau of Meteorology

(BoM) website tool located at http://www.bom.gov.au/water/designRainfalls/ifd/index.shtml. It may be noted that currently there are two IFD relationships available on this website, being 1987 and 2016 data sets. The 2016 IFD data set has been applied in this analysis.

4.2.3 Modelling Pipes and Pits

The drainage network built in the model was based on the data captured in Council's digital stormwater maps. These maps are required to be kept by Council under Section 12 of the Urban Drainage Act 2013.

This entire drainage network is formed by four types of assets, including box culverts, natural/lined creeks, gravity mains and open drains.

During the model development process, minor drainage components such as boundary boxes and pipes less than 150 mm diameter, were excluded from the model to simplify the process. It is envisaged that excluding these minor components has minimal impacts on the model integrity and modelling results.

All the 1D network (Pipes & Pits) for all the catchments were exported from XPSWMM model which was then modified to suit TUFLOW. However, for the XPSWMM models where the confidence levels for the calculated inverts were not high, site surveys were conducted by Council's Asset Survey Officer using RTK GPS handset to capture more accurate invert levels.

All the pipes and pits created in the model were represented using 1D links and nodes associating with length, inverts, surface levels, slopes and roughness assigned to individual elements. All pits were modelled as rectangular opening 'R' type as 1.5 m wide by 0.2 m opening height. All headwalls were modelled as 'Node' type.

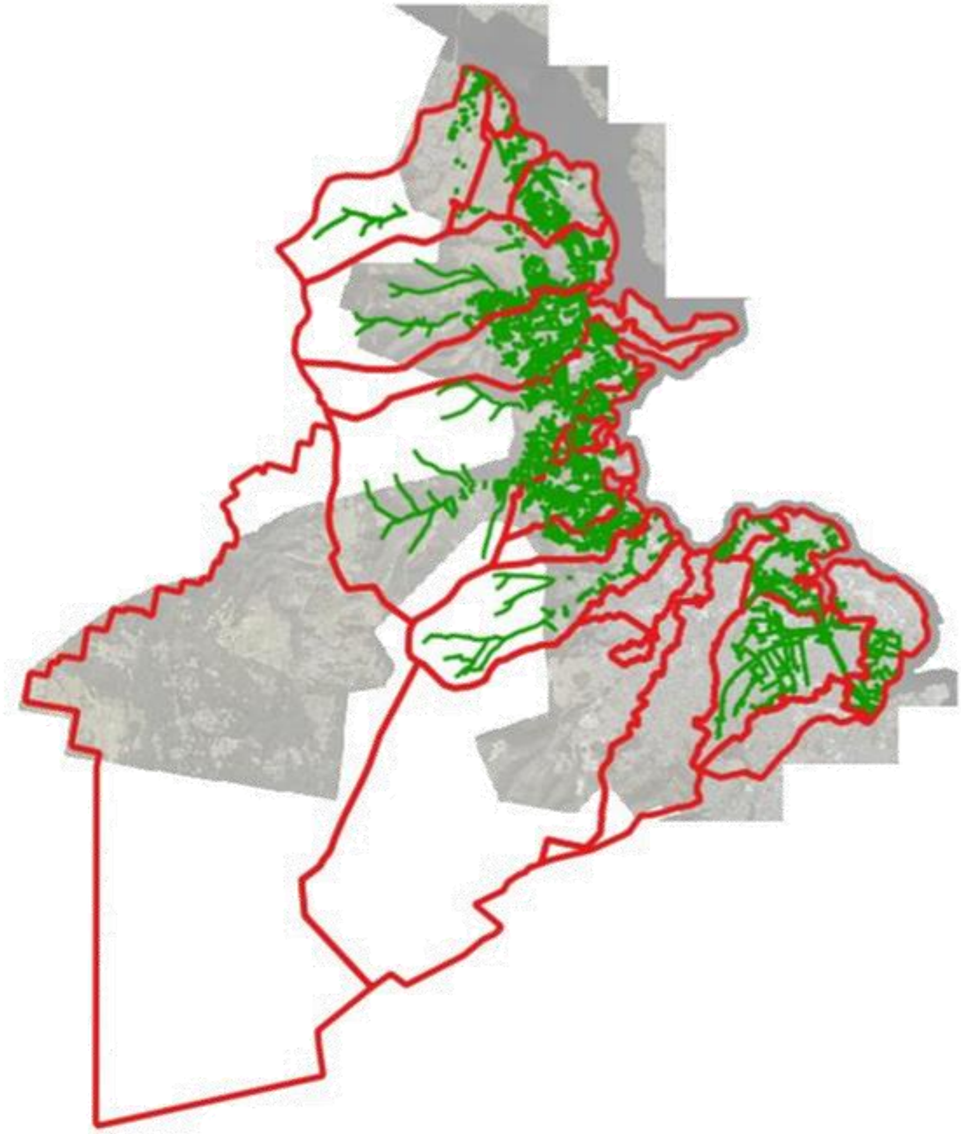


Figure 9 Glenorchy Municipality Catchment Stormwater Drainage Layout

4.2.4 Terrain Modelling

2D terrain was used to model channel flows and surface flow, and to estimate flood extents inclusive of water overflowing/ surcharging from 1D Nodes and Links.

In this study, the Digital Terrain Model is used for both rural and urban areas, was created using the topographical data mentioned in Section 3.2.1.

To achieve a balance between the level of detail and model efficiency, a 2m x 2m grid with 0.2 s timestep was selected and set in the model to calculate the extent of overland flow and its flow direction, depth, velocity, and volume.

As suggested in the *Representation of Buildings in 2D Numerical Flood Model* (Smith and Wasko, 2012) all the building footprints were given an increased elevation (e.g., 999 m AHD) and set to be above the maximum expected flood height, instead of applying a high Manning's Roughness. By elevating the level of building polygons in the 2D terrain model, this simulates the impact of the building, acting as physical obstructions, and impacting on flood direction, depth, and velocity during various flood events.

4.2.5 Fraction Impervious for Different Land Uses

As mentioned in Section 2.3, the land uses within the catchment include Environmental Management, Environmental Living, Utilities, General Residential, Community Purpose, Inner Residential, Light Industrial, Local Business, Low Density Residential, Recreation and Open space.

These land uses were applied to the estimation of the maximum impervious area percentages of individual sub catchments, and then imported into the model to calculate runoff.

Table 4.5.1 of the Queensland Urban Drainage Manual provides an estimated fraction impervious for different land uses, and was adopted for this study (Table 6).

Table 6 Estimated Fraction Impervious for Different Land Uses

Land Uses	% Of Impervious
Community Purpose	80%
Environmental Living	5%
Environmental Management	0%
General Business	90%
General Industrial	95%
General Residential	65%
Inner Residential	80%
Light Industrial	90%
Local Business	90%
Low Density Residential	40%
Open Space	0%
Recreation	0%
Utilities (TasNetworks Easement)	0%
Roads	90%

The study is aware of that, in some areas which are zoned General Residential but allowed for extensive unit developments, the impervious may exceed 65%. However, it is also expected that not all the area will reach its maximum impervious ultimately. Therefore, any underestimate of the fraction impervious rate would be offset by areas of the same catchment being assigned same impervious rate (65%) which may never to reach their maximum development potential.

It is suggested that, for future 'street-scale' flood studies and infrastructure design, a more detailed approach, including site-specific fraction impervious analysis, should be applied.

4.2.6 Rainfall Loss Parameters

The storm initial loss has been applied to Tuflow through the materials files. For impervious surfaces, the initial loss was zero. For pervious surfaces, 28 mm initial loss was applied. For each land use, a fraction impervious was selected, and the initial loss was calculated as the proportion of the two values (i.e., 0 and 28 mm).

Table 7 Losses by Land Use

Land Type/Planning Zone	Tuflow Material ID	Manning's n	Initial Loss (mm)	Continuous Loss (mm/hr)
General Business	14	0.02	1	0
Roads	11	0.02	5.6	0.3
Community Purpose	5	0.03	25.2	1.35
Recreation	7	0.045	25.2	1.35
Open Space	6	0.035	25.2	1.35
Local Business	8	0.045	2.8	0.15
Utilities	9	0.045	25.2	1.35
Inner Residential	3	0.08	11.2	0.3
General Residential	2	0.08	11.2	0.6
Waterbodies/Rivulets	12	0.04	0	0
Environmental Management	10	0.15	26.6	1.425
Environmental Living	4	0.15	22.4	1.2

The initial loss and continuing loss values used in the model are presented in Table 8 below.

Table 8 Rainfall Loss Parameters

Storm AEP	Initial Loss (mm)	Continuous Loss (mm/hr)
100	28.0	1.5

4.2.7 Roughness Coefficients

Roughness coefficient is a value to present the roughness characteristics of closed conduits or natural overflow paths. It is a critical parameter in the Manning's Equation in terms of calculating the flow velocity and depth.

For closed conduits, the roughness values adopted in the model for different conduit materials are presented in Table 9 (Chow, 1959).

Table 9 Manning's roughness for closed conduits

Material	Abbreviation	Manning's Roughness Value
Polyvinyl chloride	PVC	0.011
Steel, Cast Iron/ Ductile Iron	Steel/CI/DICL	0.012
Concrete/Reinforced Concrete	CO/RCP	0.013
Earthenware	EW	0.014

For the flood plain, the roughness for different surface conditions (Table 10) was adopted as described in the Queensland Urban Drainage Manual (QUDM, 2013).

Table 10 Manning's Roughness for Different Surface Conditions

Surface Conditions	Manning's Roughness Value
Roads	0.015
Residential Yard	0.065
Forest	0.15
Grassed Area	0.03

4.2.8 Climate Change Scenarios

The climate change scenario for this study was based on:

- Southern Slopes Tasmania Natural Resource Management Cluster
- Interest in 1% AEP places planning horizon out to the year 2090; and
- Practitioner assumption: high emissions (RCP8.5) scenario (IPCC 2013).

(Ball J, 2019) provides guidance for climate change impact on rainfall intensities at a regional level (allocating Tasmania to a region with Southern Victoria and NSW).

It is worth noting that the flood mitigation infrastructure resulting from this study will have design lives out to 100 years, and therefore adequate justification for the long-term planning horizon needs to be considered and adopted.

(T.A. Remenyi, 2020) study used a downscaling approach to create climate projections from the IPCC Special Report on Emissions Scenarios (Nebojsˇa Nakic´enovic´, 2000) at a finer grid scale over Tasmania (Antarctic Climate & Ecosystems CRC, 2010). (Antarctic Climate & Ecosystems CRC, 2010) reports the temperatures slightly lower than the (Ball J, 2019) values. (Antarctic Climate & Ecosystems CRC, 2010) reports that in the high emissions scenario the 2090 temperature rise for Tasmania is 2.6 to 3.3 degrees Celsius and rainfall depth increases 12-30% seasonally and 24% average increase annually.

(Ball J, 2019) uses the more recent (IPCC, 2013) Representative Concentration Pathways (RCPs) compared to (Antarctic Climate & Ecosystems CRC, 2010). Use of SRES, and its climate change chapter is based on coarser scale regional climate modelling by (CSIRO ansd Bureau of Meteorology, 2015).

(Ball J, 2019) allows practitioner judgement of choice between Representative Concentration Pathways (RCPs) (IPCC, 2013) of RCP4.5 and RCP8.5. RCP8.5 has been selected based on the most current CO2 trajectories, and USA withdrawal from (UNFCCC, 2015).

Following the (Ball J, 2019) procedure based on these inputs, the (CSIRO ansd Bureau of Meteorology, 2015) estimates that on average the Tasmanian region will be more than 3 degrees Celsius hotter and a median temperature of 3.6 degrees Celsius hotter in 2090. From this temperature, the Intensity factor (FCC) calculation gives a multiplicative factor of 1.19, or a 19.2% increase in rainfall intensity (Ball J, 2019).

The results (and emissions pathways selected) between the two studies are reasonably comparable.

Table 11 below summarises the climate change parameters adopted for this study.

Table 11 Climate Change Scenarios

AEP	Rainfall Intensity (mm/hr)	Sea Level (mAHD)	Storm Surge (m)	Water level Adopted (mAHD)
1%	1% Intensity × F_{cc}^{*}	2010 HAT + SLR = 1.62	0.0	1.62

A 16% increase in rainfall depths in the year 2090 has been adopted for a climate change scenario in accordance with the ARR Data Hub.

Both Climate Change Factor and Tidal boundary level has been applied in conjunction with the SMEC Glenorchy CBD System Management Plan.

4.2.9 Tidal Boundary

A tidal boundary condition (elevation versus time) has been applied where the rivulets discharge to Elwick Bay. A historical relation has been used for the calibration model, whilst a fixed water level is applied to design model runs and varied for each scenario.

It is considered that selecting the average conditions for the Elwick Bay water level is more appropriate than the worst case. Any given design storm event has an independent probability to the tide level in Elwick Bay at the moment of maximum flow. Without conducting a joint probability assessment, the average conditions are most likely during a storm event.

Tidal gauges around Tasmania were assessed to augment understanding of tidal conditions in the Derwent River. A comparison of Hobart tidal data with Spring Bay over the same time series suggested that they share the same amplitude but differ slightly in mean (Spring Bay is higher by 0.2 m). Both gauges are somewhat sheltered from the open ocean with minimum water levels around 0.0 mAHD compared with, for example, the Burnie tidal gauge with typical -1.0 mAHD minimum tide levels.

The selected tidal boundary level of 0.16 mAHD is based on the average level of ~30 years of continuous recordings at Spring Bay of 0.36mAHD (mean and median are the same for the 2 gauges; adjusted down by 0.2m to 0.16m AHD for Hobart).

4.2.10 Peer Review

To further increase in confidence in the flood models and their results, a peer review process was undertaken by Entura. Experienced flood engineers from Entura were engaged to review the model and to provide recommendations on the following aspects, including:

- General review of model setup;

- Review of model parameters including design rainfalls, loss rates, and tailwater conditions, etc;
- Review of model validation process;
- Review of design event model results, including general assessment of model results, selected critical storm duration, and model mass balance and instabilities;
- Review of assumptions and method used to assess the impacts of Climate Change;

The review prepared by Entura stated that most model parameters were selected within reasonable ranges, and the 2D terrain and its surface roughness were correctly represented in the model, both spatially and geometrically.

5 Model Results

5.1 Critical Storm Duration

To identify the critical storm duration for the catchment area, eleven storm durations from 10 mins up to 540 mins (9 hours) were simulated in the model using the design temporal patterns.

The design rainfall patterns for 1% AEP critical storms are presented in Appendix 1 and then all the eleven storm events were modelled to determining the capacity of the reticulation system, mapping flood extents and analysing flood risks.

Refer to Appendix 1 – Critical Event Maps.

5.2 Floodplain Mapping

The flood maps presented in this section were generated using the inundation depth results from the model, as described below.

5.2.1 Post Processing Model Results

To produce fit for purpose flood level, depth, velocity and hazard maps from the model results, post processing of model results is required.

The maximum rainfall depth and velocity may vary with different rainfall intensities despite the critical duration for the catchment being identified.

The grid files from a range of rainfall durations (up to 540 mins) as tested in the model, containing depth and velocity, were post-processed by using ASC to ASC utility to find the maximum depth, velocity, and Hazard.

5.2.2 Filtering of Results

The rainfall-on-grid rainfall-runoff process applies the rainfall in a distributed manner across the entire catchment and then leaves the routing to hydraulic processes across the grid surface. This can leave behind small clusters of flooding up to a dozen grid cells within localised depressions in the model grid that are not necessarily representative of the real topography. These small water clusters, or 'puddles', produce a speckled effect on the inundation maps that distract from the information being presented and so require removal.

(Melbourne Water Corporation, 2012) guidelines on minimum requirements for Flood Mapping Projects provide guidance on the inundation map filtering parameters expected for projects within their jurisdiction.

"The filtering parameters were that all points with a depth greater than or equal to 50mm AND a velocity times depth product greater than 0.008 would be used for the flood extent determination."

Similar filtering criteria were applied to this study. To account for Glenorchy's on average steeper topography, a depth criterion of 30mm was applied in addition to the product of depth and velocity (DV) of 0.008 m2/s.

The adopted filtering parameters are:

- Remove all inundated area with water depth less than 50mm and with DV (depth times velocity) less than 0.008 m2/s

- Remove all separate 'puddles' with an area of 15 grid cells (i.e., 30 m2) or smaller.

5.2.3 1% AEP Flood Extent

A flood map was produced for 1% AEP events from the combined maximum depth and velocity results, using the post-processing and filtering parameters mentioned above. Flood Depth Maps for all the catchments are presented in Appendix 2.

Refer to Appendix 2 – Inundation Depth Maps.

5.2.4 Floodplain Hazard Mapping

To understand the risks associating with flooding, a process of flood mapping and risk assessment is critical. High stream flow velocities excessive depth of water and inundation hazards need to be mapped and understood. Flood Hazard Maps for all the catchments are presented from Appendix 3.

Refer to Appendix 3 – Inundation Hazard Maps.

5.2.5 Methodology

The flood hazards for the flood models within Glenorchy Municipality area were identified by the model following the Australian Rainfall & Runoff.

Chapter 7. Safety Design Criteria indicates that when dealing with specific floodplain management or emergency management analysis there may be a clear need to use specific thresholds as described above. However, particularly in a preliminary assessment of risks or as part of a constraints analysis such as might be applied as part of a strategic floodplain management assessment, there is also an acknowledged need for a combined set of hazard vulnerability curves, which can be used as a general classification of flood hazard on a floodplain. A suggested set of curves based on the referenced thresholds presented above is provided in Figure 10.

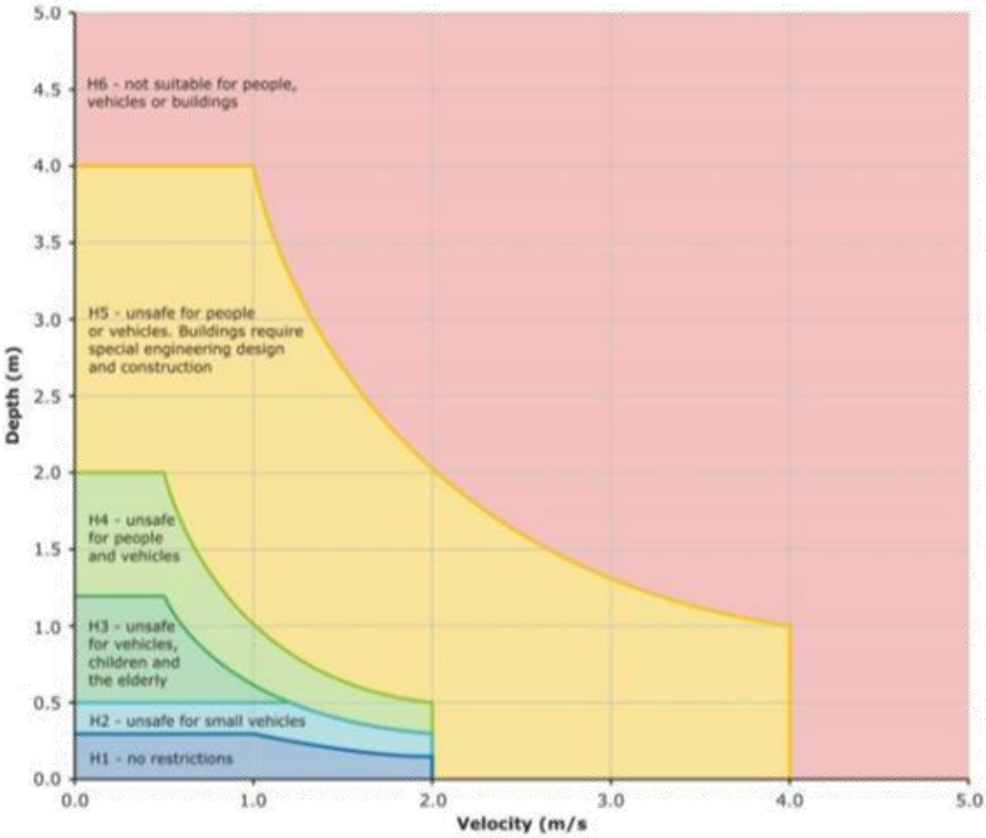


Figure 10 Depth and Velocity in term of Food Hazard (Australian Institute for Disaster Resilience , 2017)

It was defined that flood hazard rating was derived as the multiple of the water depth (m) and the flow velocity (m/s) with the hazard assessed, broadly consistent with the categories in the Australian Rainfall & Runoff. All the flood hazards can be divided into six categories based on their magnitudes (Depth x Velocity), namely Low, Moderate, Significant, High, and Extreme.

In this study flood hazards are defined as:

Table 12 Combined Hazard Curves – Vulnerability Thresholds

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 13 Combined Hazard Curves – Vulnerability Thresholds Classification Limits

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Note that the flood hazard ratings identified in this report and the hazard maps generated from these ratings are indicative and provisional. More detail study should be conducted to look further into the relationship between hazard categories and local features such as land use, demography, and other social, environmental, and economic patterns.

5.2.6 Flood Hazard Maps

Hazard mapping was undertaken for the 1% AEP including climate change scenario.

These maps have been incorporated into the Local Provisions Schedule of the Tasmanian Planning Scheme.

Code C12.0 Flood Prone Hazard Code defines Flood-Prone Hazard Area as land:

a) shown on an overlay map in the relevant Local Provisions Schedule, as within a flood-prone hazard area; or
b) identified in a report for the purposes of C12.2.3.

The maps generated in this section highlight the land and properties which are defined as a Flood-Prone Hazard Area. It is believed that by completing the hazard maps presented in this section, Council will understand the locations of all these hazard areas, their hazard categories, and use them to manage future developments.

6 Economic Impact of Flooding

6.1 Scope

Council engaged Flüssig Engineers to conduct catchment research into possible flood mitigation measures for the 14 identified catchments in the municipal area. The goal of this inquiry is to examine the hydraulic model to better understand how the watershed and its infrastructure will behave during floods caused by storm events with 5% and 1% AEP, as well as to estimate the potential damage from such events.

The purpose of the investigation was to determine the flooding characteristics of the various catchments affecting the Glenorchy City Council to provide a dollar estimate of the likely damages to public and private property during a 1% AEP + CC storm event.

6.2 Introduction

This investigation consists of the review of the hydraulic model to better understand flood behaviour of the catchment and its infrastructure for 1% AEP storm event to determine an estimate of damages during a resultant storm.

Infoworks ICM (ICM) version 2023.1 was utilised to undertake the analysis of the supplied TUFLOW flood data model. ArcGIS was utilised for the data exploring and parameter manipulation of the results.

6.3 Assessment of Likely Damages

Damages were assessed at a high level using the ANUFLOOD criteria (NRE 2000) without onsite verification or surveys. This method determines direct damages using stage-damage curves for the level of flooding over floors for both commercial and residential premises. The residential and commercial damage curves came from a 2006 revision of Melbourne Water's NRE 2000 stage damage curves.

Indirect damages are damages that occur because of the flood occurring and are related more to temporal impacts, rather than direct contact with water, such as business disruptions, disruption to transport and costs associated with temporary housing of evacuees. These costs were estimated at 30% of direct damages to the property as per Rapid Appraisal Method (RAM), (NRE 2000) guidelines. Damage costs were indexed according to Reserve Bank of Australia inflation rise of 39% from 2006 to 2021, and all values shown in this report are shown as AUD 2021.

Residential curves as shown in Figure 11 provide total damages for structural and contents based of flooding over floor level. These were calculated for each property identified within the model as being flooded above 300 mm and summed into a total damages per event. (Due to the variability of what constitutes a 'shed,' these structures were not included in the damages assessment. Only residential housing and contents were estimated.)

Similarly, commercial damages Figure 12 combines structural and contents damages into a per m^2 quantity, so damages are assessed on the size of the commercial property.

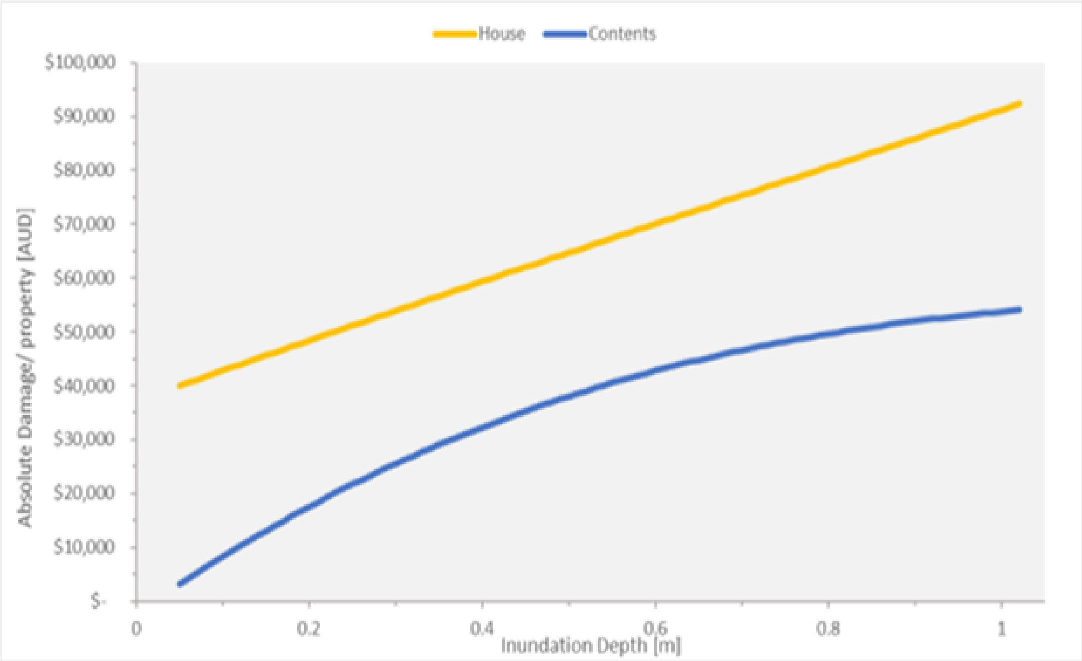


Figure 11 Residential Stage-Damage Curve (NRE, 2006)

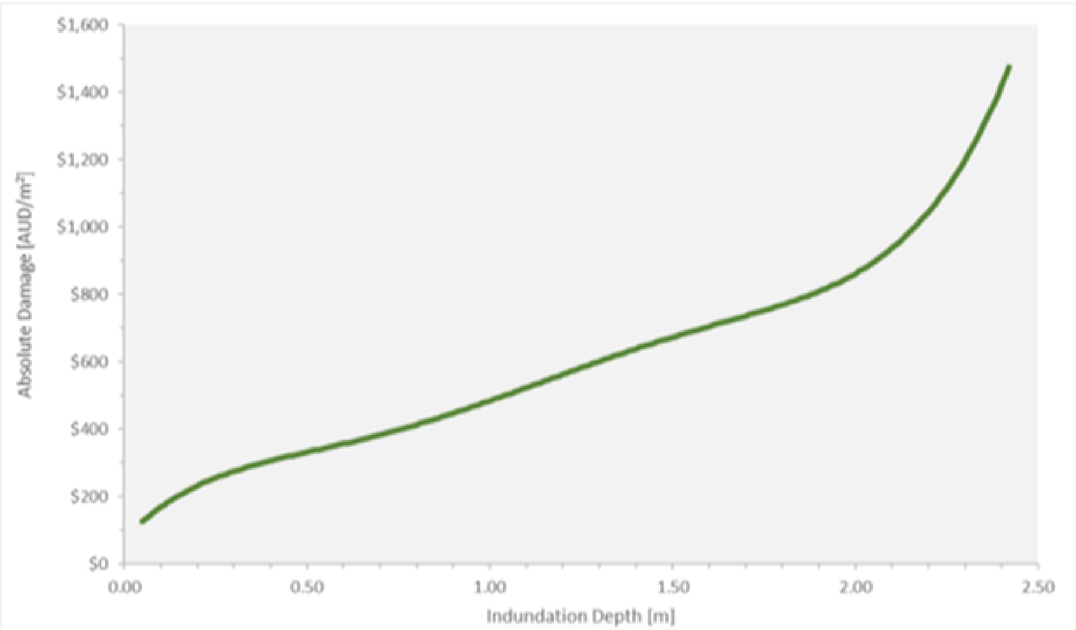


Figure 12 Commercial Stage-Damage Curve (NRE, 2006)

Additionally, the damage caused to roads assets were calculated using the RAM method where damage is assigned per km of road flooded to a depth greater than 300mm. Under the RAM method major, minor and gravel roads are assigned a value per km. Given that the lower reaches of Glenorchy City Council that are prone to flooding are mostly urban areas, gravel roads were not considered. Major roads are assigned a value of damages of $102,975 per km (2021 price) flooded, while minor roads are assigned a value of damages as $32,888 per km. As it is difficult to measure flooding linearly in GIS this figure was converted to a per m^2 value by using the average width of the road being approximately 16m. This gave a damages value of \$6.44 / m^2 and \$2.02 / m^2, respectively.

The Average Annual Damages (AAD) method, which RAM recommends, gives a cost per year by dividing the total damages per frequency against its likelihood and summing the total damages over a year. But to do this, a wide range of events — from frequent to rare — must be evaluated. Considering this limitation, the assessment was limited to the damages that could be linked to a 1% AEP +CC event.

The purpose of this assessment is to derive comparative figures based on probable costs of damages in a 1% AEP storm event. These figures are based of averages of past flooding and therefore cannot be used as an actual damage cost. To determine accurate damage costs, a survey of all premises to derive financial parameters would be required.

For the purposes of this study, the Granton catchments 1, 2 & 3 have been summarised into one catchment, and the Goodwood and Zinc Works catchments have been separated into individual catchments due to the specific nature of the Zinc Works catchment which required further in-depth analysis of the large commercial properties in this area.

6.4 Limitations

This study is limited to the availability and reliability of data, and including the following:

- The flood model is limited to a 1% AEP worst case temporal design storm.
- All parameters have been derived from best practice manuals and available relevant studies (if applicable) in the area.
- All provided data by the client or government bodies for the purpose of this study is deemed fit for purpose.
- Inflation costs are estimated to the end of the calendar year 2021. Consideration should be given to further inflation incurred after this time.
- This study is desktop only. No site visits were undertaken to determine current site conditions.

6.5 Results Summary

The image in Figure 13 shows the dollar amount in AUD (2021) of combined residential and commercial damage for properties inundated above 300 mm. There are two significant outliers in the Springfield and Zinc Works catchments. The Springfield catchment encompasses some areas in the Glenorchy City Council area just north of New Town Rivulet where 81 residential and 108 commercial properties were found to be affected by flood depths above 300mm.

The Zinc Works catchment includes the INCAT site and other industrial properties near the Prince of Wales Bay which results in a large square metre result of buildings affected which should be taken into consideration when viewing the data. The Zinc Works catchment resulted in two property ID's that were very large which, when applying the stage damage curves to such a large m^2 area of floor space, returned damage values that were probably unrealistic. These particular property IDs were separated into individual building IDs with flood damage > 300 mm being identified within the one property ID to ascertain a more realistic value of damages for these properties.

Other catchments returning significant damage values include Beedham's Bay which includes Cadbury's factory, Dooley's Creek which includes MONA museum, and Islet Rivulet that impacts 47 residential and 8 commercial properties.

Catchments that did not return any results of buildings impacted by > 300 mm flood depth include:

- New Town Catchment
- Humphreys Rivulet Catchment
- Little John Creek Catchment
- Barossa Creek Catchment
- Sorell Creek Collinsvale Catchment

The total economic damages for the Glenorchy City Council were estimated to be **$152,215,815.**

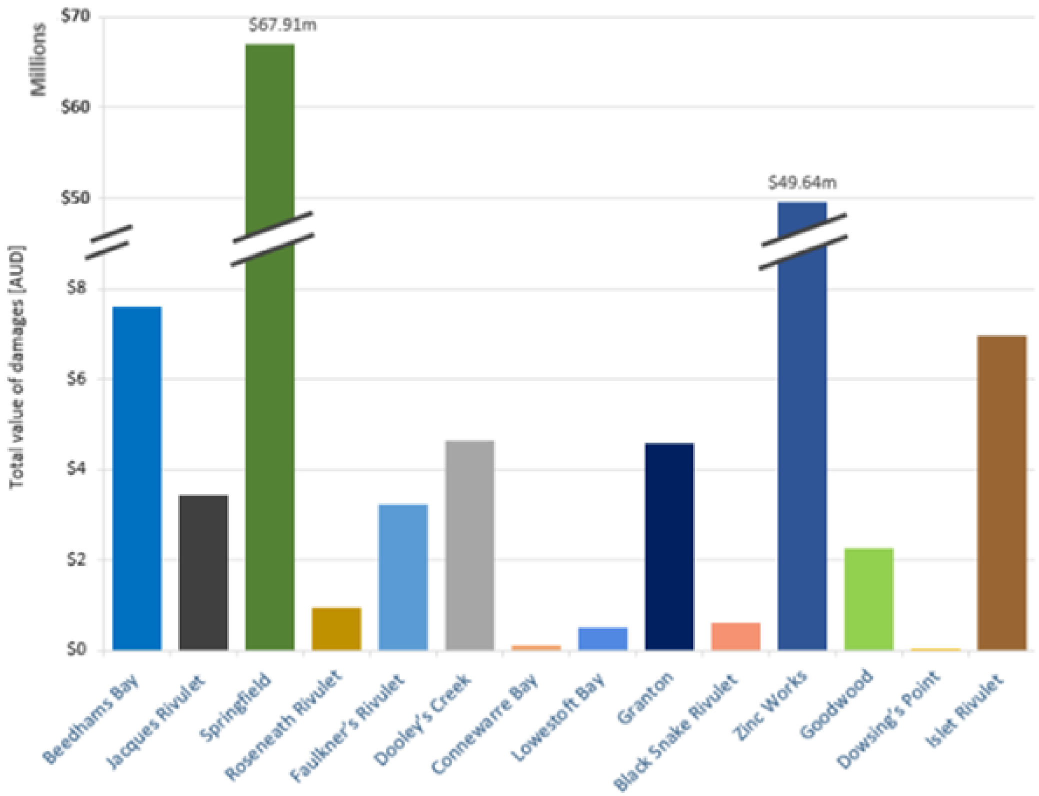


Figure 13 Total combined damages commercial and residential

6.6 Catchment Data

6.6.1 Beedhams Bay Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	28	$2,189,227
Commercial/industrial	5	$3,507,363
Roads	m²	
Public	13175	$27,378
Direct Damages		$5,723,968
Indirect Damages (30%)		$1,717,191
Total Damages		$7,441,159

6.6.2 Black Snake Rivulet Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	6	$436,063
Commercial/industrial	0	$0
Roads	m²	
Public	21873	$45,041
Direct Damages		$481,104
Indirect Damages (30%)		$144,331
Total Damages		$625,436

6.6.3 Connewarre Bay Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	1	$73,763
Commercial/industrial	0	$0
Roads	m²	
Public	629	$1,271
Direct Damages		$75,033

Indirect Damages (30%)	$22,510
Total Damages	$97,543

6.6.4 Dooleys Creek Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	18	$1,273,227
Commercial/industrial	3	$2,287,286
Roads	m²	
Public	1605	$3,490
Direct Damages		$3,564,003
Indirect Damages (30%)		$1,069,201
Total Damages		$4,633,204

6.6.5 Dowsing Point Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	0	$0
Commercial/industrial	1	$30,712
Roads	m²	
Public	1673	$3,379
Direct Damages		$34,091
Indirect Damages (30%)		$10,227
Total Damages		$44,318

6.6.6 Faulkners Rivulet Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	20	$1,656,744
Commercial/industrial	4	$751,628
Roads	m²	

Public	28272	$83,669
Direct Damages		$2,492,041
Indirect Damages (30%)		$747,612
Total Damages		$3,239,653

6.6.7 Goodwood Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	3	$208,977
Commercial/industrial	7	$1,506,674
Roads	m²	
Public	6879	$13,931
Direct Damages		$1,729,582
Indirect Damages (30%)		$518,875
Total Damages		$2,248,456

6.6.8 Granton Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	32	$2,393,729
Commercial/industrial	1	$1,130,748
Roads	m²	
Public	639	$1,291
Direct Damages		$3,525,768
Indirect Damages (30%)		$1,057,730
Total Damages		$4,583,498

6.6.9 Islet Rivulet Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		

Residential	47	$3,791,626
Commercial/industrial	8	$1,462,033
Roads	m²	
Public	7742	$18,835
Direct Damages		$5,272,494
Indirect Damages (30%)		$1,581,748
Total Damages		$6,854,242

6.6.10 Jacques Rivulet Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	35	$2,557,629
Commercial/industrial	0	$0
Roads	m²	
Public	4001	$75,383
Direct Damages		$2,633,012
Indirect Damages (30%)		$789,903
Total Damages		$3,422,915

6.6.11 Lowestoft Bay Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	6	$389,457
Commercial/industrial	0	$0
Roads	m²	
Public	125	$253
Direct Damages		$389,709
Indirect Damages (30%)		$116,913
Total Damages		$506,622

6.6.12 Roseneath Rivulet Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	9	$670,966
Commercial/industrial	0	$0
Roads	m²	
Public	24654	$71,110
Direct Damages		$742,076
Indirect Damages (30%)		$222,623
Total Damages		$964,699

6.6.13 Springfield Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	81	$6,175,105
Commercial/industrial	108	$45,807,486
Roads	m²	
Public	98653	$257,110
Direct Damages		$52,239,702
Indirect Damages (30%)		$15,671,911
Total Damages		$67,911,612

6.6.14 Zinc Works Catchment

Scenarios	1% Base	
	Quantity	Damages
Buildings		
Residential	5	$383,806
Commercial/industrial	21	$37,790,789
Roads	m²	
Public	5896	$11,910
Direct Damages		$38,186,505
Indirect Damages (30%)		$11,455,952

Total Damages	$49,642,457

6.7 Conclusion

Hydrologic and hydraulic modelling of the entire Glenorchy City Council catchments was evaluated to provide an estimate of economic impacts of a 1% AEP storm event using the Rapid Appraisal Method based on ANUFLOOD guidelines (NRE 2000).

Most catchments had an estimated total damage value of less than $8m, except for the Springfield catchment and Zinc Works catchment which were $68m and $50m, respectively. However, as this study was a desktop analysis, no onsite verification was undertaken, and site-specific conditions may provide a more accurate estimate of damages.

Damage estimates were based on applying stage damage curves from a 2006 revision by Melbourne Water of the NRE 2000 guidelines and applying the consumer price of inflation from 2006 – 2021. Consideration should be given to ongoing market conditions for inflation to specific flood remediation costs such as building materials.

The accessible data base, the used modelling approach, and the type of flooding must all be taken into consideration when determining the level of detail to be applied in estimating vulnerability to flood damage. In this study, where pluvial flooding was predominant, unit cost methodologies were shown to produce acceptable findings, such methods should only be used in conjunction with sophisticated modelling techniques, such as high resolution 1D-2D hydraulic modelling.

A summary of the total estimated damages for the Glenorchy City Council area is shown in the table below.

Table 14 Summary of the Total Estimated Damages

Compiled Catchment Data	Quantity	Damages
Buildings		
Residential	291	$22,200,319
Commercial/industrial	158	$94,274,720
Roads	m²	
Public	215,816	$614,050
Direct Damages		$117,089,089
Indirect Damages (30%)		$35,126,727
Total Damages		$152,215,815

6.8 Recommendations

The RAM method of estimating damages by using a m² approach may differ significantly for buildings such as MONA art gallery compared to a storage facility for bricks and paving. As this study was conducted as a desktop analysis without onsite verification, it is recommended that areas recording flood damage for large commercial sites, undertake an on-site assessment as to the specific use of the site, considering the nature of the assets within the building and any local on-site conditions that may affect localised flood flow through the property.

Commercial properties that are returning high estimates for losses based on the building size and a flood depth impacting on some parts of that building are listed in the table below. It is recommended that further site-specific investigation be undertaken to gauge a more accurate estimate of damages.

The Zinc Works site is of particular concern in estimating damages based on a desktop analysis as the site is very large with unknown operations occurring in some of the buildings that are returning high estimated damages with one building alone (building ID 55323) recording almost $10m of damages.

Similarly, the Springfield catchment, which includes areas near the New Town Rivulet, has many properties with high damage estimates which may benefit from a more detailed economic damages assessment.

A summary of specific properties with high value of estimated damages that could benefit from more detailed investigation are shown in the table below.

Table 15 Summary of Specific Properties with High Value of Estimated Damages

Catchment	Property ID	Address	Facility	m^2	Est. losses
Springfield	7394129	10 Derwent Park Road, Derwent Park	Retail businesses	6282	$1,729,157
Springfield	7611509	20 Lampton Avenue, Derwent Park	Searoad freight company	6355	$1,867,309
Springfield	7611509	20a Lampton Avenue, Derwent Park	Disability support provider	4603	$2,003,213
Springfield	3357734 3357742	82-86 Gormanston Road & 34 Chesterman Street, Moonah	Auto Parts supplier and Tricab manufacturing	7162	$2,297,541
Springfield	5411386	5-7 Bowen Road, Moonah	Mercury Walch Printing	4968	$2,069,999
Springfield	5411394	1-3 Bowen Road, Moonah	Langford Support services	4852	$3,641,611
Springfield	5403124	95 Albert Road, Moonah	Stanley Centre (multiple tenancies)	6960	$2,890,762
Beedham's Bay	2245343	100 Cadbury Road, Claremont	Cadbury Factory	7962	$4,003,484
Dooley's Creek	2250425	651-655 Main Road, Berriedale	Moorilla Estate (MONA)	3562	$2,706,728
Zinc Works	5442043	401 Risdon Road, Lutana	Wharf, Industrial buildings Zinc Works	14837	$6,684,021
Zinc Works	7855159 (BLD_ID 55336)	300 Risdon Road, Lutana	Zinc Works	22945	$6,790,862
Zinc Works	7855159 (BLD_ID 55323)	300 Risdon Road, Lutana	Zinc Works	18867	$9,791,672
Zinc Works	3478683	18 Bender Drive, Derwent Park	INCAT	11155	$3,849,425

Zinc Works	3049264	4-8 Sunmont Street, Derwent Park	Hartz International	7042	$2,854,560

7 Flood Risk Management Options

7.1 Scope

The purpose of the investigation was to determine the flooding characteristics of the various catchments affecting the Glenorchy City Council to provide a proposed mitigation option at each catchment with an estimated value of the likely damages to public and private property during a 5% AEP and 1% AEP storm event.

7.2 Introduction

The Glenorchy City Council has undertaken catchment research into possible flood mitigation measures for the 14 identified catchments in the municipal area. The goal of this inquiry is to examine the hydraulic model in order to better understand how the watershed and its infrastructure will behave during floods caused by storm events with 5% and 1% AEP, as well as to estimate the potential damage from such events.

The fundamental cause of this level of damage and the key factor contributing to flood risk in general is the presence of vulnerable buildings constructed within floodplains due to ineffective land use inside the flood prone areas.

Retrospective analysis shows large benefits from disaster risk reduction (DRR) in the context of private and public assets. However, in spite of potentially high returns, there is limited research available on assessing the benefits of different mitigation strategies and the consequential reduction in investment made in loss reduction measures by individuals and local governments.

This report aims to identify economically optimal upgrading solutions so the finite resources available can be best used to minimise losses, decrease human suffering, improve safety, and ensure amenity for some areas of the Glenorchy City Council communities affected by flooding. This report describes the research methods, project activities, outcomes, and their potential for utilisation.

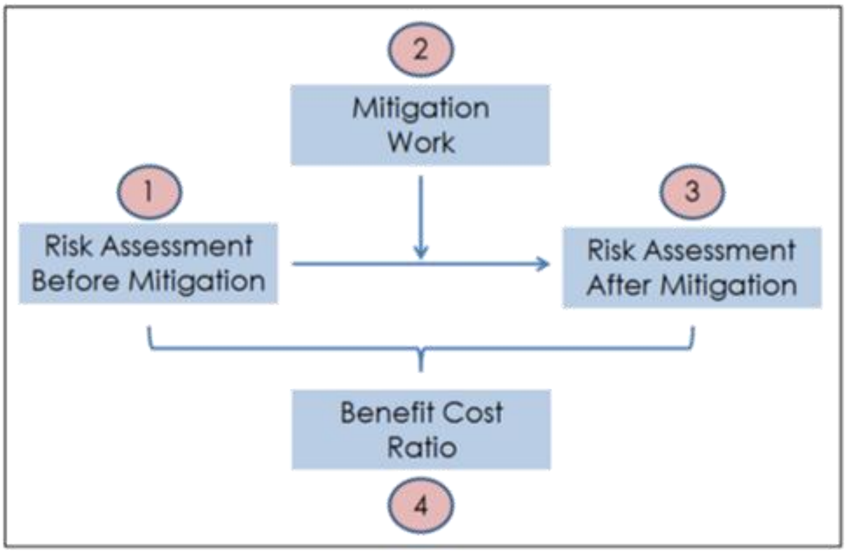


Figure 14 Cost Versus Benefit Analysis Framework (Adapted from Mechler, 2005)

The four phases that have been used in this report's methodology to determine whether each mitigation strategy is feasible and realistically implementable in the chosen catchment region are listed below.

- Risk Assessment before mitigation: at this step risk was calculated in terms of conditional loss ($) based on existing building stock (un-retrofitted).
- Mitigation work: this was the investment ($) to reduce potential impacts assessed in the first step. It was comprised of the costs of conducting the mitigation work on the relevant area.
- Risk Assessment after mitigation: at this step risk was again calculated incorporating the effects of the mitigation investment. There is typically a reduction of loss ($) compared to the pre-mitigation state. This reduction in loss ($) was considered to be the benefit arising from the investment.
- Benefit Cost Ratio: finally, economic effectiveness of the mitigation investment was evaluated by comparing benefits and costs. Costs and benefits accumulating over time needed to be discounted to make current and future effects comparable as any money spent or saved today has more value than that realised from expenditure and benefits in the future. This concept is termed Time Value of Money. Future values therefore need to be discounted by a discount rate representing the loss in value over time. A Benefit Cost Ratio of 1.0 or more suggests the mitigation investment was an economically viable decision.

The fourteen catchment mitigation options outlined in the report are below. The affected private and public assets are only included in the area of the proposed potential mitigation works and do not reflect a proposed solution for the entire Glenorchy City Council's full contributing catchment areas.

7.3 Flood Mitigation Options

7.3.1 Beedhams Bay

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Dewar Place Earth Bund - Levee Flood Detention

In order to mitigate the immediate flooding and lessen the severity of the risk and damages to some homes in the Beedhams Bay Catchment from Dewar Place to the Brooker Highway, the earth bund flood retention has been recommended. Section 1.3 has a description of the option.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in Section 1.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 16 compares the number of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels determines the actual damage cost.

Table 16 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	14	30
Commercial/industrial	0	0
Roads (m²)		
Minor	650	1270

Table 17 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 17 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$754,574	$1,617,802
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$4,225	$8,255
Damage Estimates		

Direct Damages	$758,799	$1,626,057
Indirect Damages	$227,760	$487,817
Total Damages	**$986,959**	**$2,113,874**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 18 below, shows net present value of damages determined in Table 17 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of >10 with the lowest value being the 5% AEP with a benefit-cost ratio of 4.4.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 18 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$986,959**	$280,000	$706,959	4.4	2
	1% AEP Base	**$2,113,874**	$280,000	$1,833,874	10.7	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 18 would be the 1% AEP having the highest benefit for the lowest cost. Figure 1.2 in Appendix 5 shows the relative location of the proposed earth bund flood wall described in the option.

Option 1 – Earth Bund Wall - Levee

Temporary detention with a proposed earth bund wall fitted with 5 x DN300 pipes to reduce the flood depth the existing flood impacted dwellings from >300mm to >150mm running along Dewar Place to the Brooker Highway This option provides a benefit of $1,833,874 in reduction of damages with a benefit-cost ratio (BCR) of 10.7 in the 1% AEP flood scenario, making this the most preferred option.

Further investigation of the constructability of the option shall be carried out by Council for the use of available space in the electrical corridor easement, which needs to be assessed against the TasNetwork's requirements prior to the addition of the mitigation option.

Other Mitigation Options and reason for not being Considered:

Detention pond adjacent to Abbotsfield Park – No significative benefit to the downstream catchment based in construction cost v/s reduction in damages.

Detention dam Abbotsfield Rivulet / Russell Rd – No significative benefit to the downstream catchment based in construction cost v/s reduction in damages.

7.3.2 Black Snake Rivulet

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Vegetation Management

The general Rivulet maintenance from has been recommended as it would provide a degree of relief to the immediate flooding either easing or reducing the severity of risk and damages to some of the Black Snake Rivulet Catchment properties from the Brooker Highway to the end of Black Snake Road. A description of the option can be found in section 2.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 2.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 19 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 19 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	0	3
Commercial/industrial	0	0
Roads (m²)		
Minor	300	3000

Table 20 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 20 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$0	$215,707
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$1,950	$19,500
Damage Estimates		

Direct Damages	$1,950	$235,207
Indirect Damages	$585	$70,000
Total Damages	**$2,535**	**$305,769**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 21 below, shows net present value of damages determined in Table 20 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide to be the most benefit to the overall mitigation option being the only option that results in a ratio of >1.4 with the lowest value being the 5% AEP with a benefit-cost ratio of -1.0.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 21 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$2,535**	$125,000	-$122,465	-1.0	0
	1% AEP Base	**$305,769**	$125,000	$180,769	1.4	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 21 would be the 1% AEP having the highest benefit for the lowest cost. Figure 2 in Appendix 5 shows the relative location of the proposed vegetation management described in the option.

Option 1 – Vegetation Management

The vegetation management option is to maintain adequate hydraulic conveyance capacity a natural or modified creek channel such as Black Snake Rivulet, avoiding experiencing a significant reduction in hydraulic capacity within 2% AEP to 1% AEP flood scenarios. This is because invasive species can completely block a channel in a relatively short period either directly or indirectly by creating blockages and snags. This option provides a benefit of $180,769 in reduction of damages with a benefit-cost ratio (BCR) of 1.4 in the 1% AEP flood scenario, making this the most preferred option.

Other Mitigation Options and reason for not being Considered:

Dam extension at 81 Black Snake Rd – No significative benefit to the downstream catchment based in land acquisition, construction cost v/s reduction in damages.

Detention dam at 239 Black Snake Rd boundary – Negative benefit to the downstream catchment based in land acquisition, construction cost v/s reduction in damages.

7.3.3 Connewarre Bay

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Underground Detention and Double Side Entry Pit

It has been suggested that the detention system and double-sided entrance pit be used since they would serve as a road dewatering system for flooding and shorten the amount of time that water would pool above ground along No. 1 to No. 11 Teering Road. Section 3.3 has a description of the option.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 3.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 22 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 22 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	0	1
Commercial/industrial	0	0
Roads (m^2)		
Minor	480	1500

Table 23 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 23 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$0	$53,927
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$3,120	$9,750
Damage Estimates		

Direct Damages	$3,120	$63,677
Indirect Damages	$936	$19,103
Total Damages	**$4,056**	**$82,780**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 24 below, shows net present value of damages determined in Table 23 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 0.4 with the lowest value being the 5% AEP with a benefit-cost ratio of -0.9.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 24 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$4,056**	$60,000	-$55,944	-0.9	2
	1% AEP Base	**$82,780**	$60,000	$22,780	0.4	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 24would be the 1% AEP having the highest benefit for the lowest cost. Figure 3.2 in Appendix 5 shows the relative location of the proposed detention system and double side entry pit described in the option.

Option 1 – Underground Detention and Double Side Entry Pit

Reduce the flood depth and pooling along Nos. 1 to 11 Teering Road to aid in the quickest road dewatering. An underground detention system with 4 x DN450 pipes, "CorruTank" or a similar, and the construction of 2 x double side entrance pits are proposed. In the 1% AEP flood scenario, this alternative reduces damages by $22,780 with a marginal benefit and a benefit-cost ratio (BCR) of only 0.4, making it a viable choice. In order to make the best use of the available road space and avoid using subsurface services that can be inconvenient, Council must conduct additional research on the option's constructability.

Other Mitigation Option and reason for not being Considered:

Pipe upsize at 31/29 Connewarre Cr– Not enough clearance between underground services for a bigger pipe to dewater the road, adverse constructability issues.

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7.3.4 Dooleys Creek

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Kilander Crescent Earth Bund – Levee Flood Detention

The earth bund flood detention has been recommended as it would provide a degree of relief to the immediate flooding either easing or reducing the severity of risk and damages to some of the Dooleys Creek Catchment properties from Chandos Drive to the Brooker Highway. A description of the option can be found in section 4.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 4.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 25 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 25 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	13	29
Commercial/industrial	0	0
Roads (m²)		
Minor	350	2000

Table 26 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 26 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$701,048	$1,563,875
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$2,275	$13,000
Damage Estimates		

Direct Damages	$703,323	$1,576,875
Indirect Damages	$210,997	$473,063
Total Damages	**$914,319**	**$2,049,938**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 27 below, shows net present value of damages determined in Table 26 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of >10 with the lowest value being the 5% AEP with a benefit-cost ratio of 4.4.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 27 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$914,319**	$120,000	$794,319	6.6	2
	1% AEP Base	**$2,049,938**	$120,000	$1,929,938	16.1	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 27 would be the 1% AEP having the highest benefit for the lowest cost. Figure 4.2 in Appendix 5 shows the relative location of the proposed earth bund flood wall described in the option.

Option 1 – Earth Bund – Levee Wall Detention

Temporary detention to minimise the flood depth along Chandos Drive to the Brooker Highway, with a proposed earth bund wall equipped with 3 x DN300 pipes. In the 1% AEP flood scenario, this alternative reduces damages by $1,929,938 and has a high benefit-cost ratio (BCR) of 16.1, making it the recommended choice. Prior to the inclusion of the mitigation option, Council shall conduct additional research into the option's constructability for the use of available space in the existing recreational green area.

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Other Mitigation Options and reason for not being Considered:

Detention pond at front of 193 Marys Hope Rd – Negative benefit to the upstream catchment based in land acquisition, construction cost v/s reduction in damages.

Detention dam at the back of 13 /14 Dooleys Av – Negative benefit to the downstream catchment based in land acquisition, constructability, construction cost v/s reduction in damages.

7.3.5 Dowsing Point

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Vegetation – Open Drain Maintenance

The management and maintenance of the existing open drain has been recommended as it would provide future resilience to erosion and flooding either easing or reducing the severity of risk and damages to the stormwater system. A description of the option can be found in section 5.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 5.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 28 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 28 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	0	0
Commercial/industrial	0	0
Roads (m²)		
Minor	0	0

Table 29 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 29 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$0	$0
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$0	$0
Damage Estimates		

Direct Damages	$0	$0
Indirect Damages	$0	$0
Total Damages	**$0**	**$0**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 30 below shows the net present value of damages determined in Table 29 against the net present capital cost of each option and the benefit by means of a reduction in damages. These costs run through the above equation and provide a ratio to compare each flood scenario option. As the mitigation option would be qualified as general maintenance for the 1% and 5% AEP flood scenarios, the table below would not provide a benefit value on this occasion.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 30 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$0**	$20,000	-$20,000	-1.0	0
	1% AEP Base	**$0**	$20,000	-$20,000	-1.0	0

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, as it would be a maintenance option only, there wouldn't be a preferred option as per Table 30. Figure 5 in Appendix 5 shows the relative location of the proposed maintenance works.

Option 1 – Vegetation – Open Drain Maintenance

Regular inspections should be undertaken to identify any erosion or sediment deposition. The inspection should identify the cause of the erosion and source of sediment and works should be undertaken to rectify the problem. Any areas where grass coverage has decreased should be revegetated. Once vegetation is established, there is no need for grading. This option provides a benefit of -$20,000 in reduction of damages with a benefit-cost ratio (BCR) of -1.0 in the 1% and 5% AEP flood scenarios, making this option an integral part of the Council's maintenance schedule.

Other Mitigation Options and reason for not being Considered:

No other option– No other mitigation options has been assessed as the few inundated areas are inside private or state government land.

7.3.6 Faulkners Rivulet

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Earth Bund - Levee Flood Detention

The earth bund flood detention has been recommended as it would provide a degree of relief to the immediate flooding either easing or reducing the severity of risk and damages to some of the Faulkners Rivulet Catchment properties from Boondar Street to Karambi Street. A description of the option can be found in section 6.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 6.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 31 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 31 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	16	27
Commercial/industrial	0	0
Roads (m²)		
Minor	570	5500

Table 32 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 32 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$862,828	$1,456,022
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$3,705	$35,750
Damage Estimates		

Direct Damages	$866,533	$1,491,772
Indirect Damages	$259,960	$447,532
Total Damages	**$1,1126,493**	**$1,939,303**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 33 below, shows net present value of damages determined in Table 32 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 8.7 with the lowest value being the 5% AEP with a benefit-cost ratio of 4.6.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 33 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$1,126,493**	$200,000	$926,493	4.6	2
	1% AEP Base	**$1,939,303**	$200,000	$1,739,303	8.7	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, as it would be a maintenance option only, there wouldn't be a preferred option as per Table 33. Figure 6.2 in Appendix 5 shows the relative location of the proposed earth bund wall.

Option 1 – Earth Bund Wall - Levee

The proposed earth bund wall for temporary detention to lower the flood depth along Faulkner's Rivulet from Boondar Street to Karambi Street In the 1% AEP flood scenario, this solution reduces damages by $1,739,303 and has a benefit-cost ratio (BCR) of 8.7, making it the best choice. Council must do additional research into the waterway protection area for constructability for the use of the available space, which must be compared to the requirements previous to the inclusion of the mitigation option.

Other Mitigation Options and reason for not being Considered:

Detention pond at 123 Berriedale Rd – Negative benefit to the downstream catchment based in land acquisition, construction cost v/s reduction in damages.

Detention dam at the back of 35 /37 Glenlusk Rd – Negative benefit to the downstream catchment based in land acquisition, constructability, construction cost v/s reduction in damages.

7.3.7 Goodwood

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

General stormwater maintenance

General stormwater system maintenance has been recommended as it would reduce the risk of flooding of public and private property to acceptable levels for some of the Goodwood Catchment properties. As the proposed mitigation option would be classified as a past of Council's maintenance schedule and budget, a description of the option can be found in Section 7.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 7.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 34 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 34 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	0	0
Commercial/industrial	0	0
Roads (m²)		
Minor	0	0

Table 35 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 35 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$0	$0
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$0	$0
Damage Estimates		

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Direct Damages	$0	$0
Indirect Damages	$0	$0
Total Damages	**$0**	**$0**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 36 below shows the net present value of damages determined in Table 35 against the net present capital cost of each option and the benefit by means of a reduction in damages. These costs run through the above equation and provide a ratio to compare each flood scenario option. As the mitigation option would be qualified as general maintenance for the 1% and 5% AEP flood scenarios, the table below would not provide a benefit value on this occasion.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 36 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$0**	$80,000	-$80,000	-1.0	0
	1% AEP Base	**$0**	$80,000	-$80,000	-1.0	0

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, as it would be a maintenance option only, there wouldn't be a preferred option as per Table 36. Figure 7 in Appendix 5 shows the relative location of the proposed maintenance works.

Option 1 – General Stormwater Maintenance

Regular system maintenance and storm drain cleaning, remove trash, sediment, and debris from storm drains, roadways and other watershed areas to help minimise erosion and related damage and prevent flooding.

This option provides a benefit of -$80,000 in reduction of damages with a benefit-cost ratio (BCR) of -1.0 in the 1% AEP flood scenario, making this option an integral part of the Council's maintenance schedule.

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Other Mitigation Options and reason for not being Considered:

No other option– No other mitigation options has been assessed as the few inundated areas are inside private or state government land.

7.3.8 Granton

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Earth Bund - Levee Flood Deviation Wall

The earth bund flood deviation wall has been recommended as it would provide a degree of relief to the immediate flooding either easing or reducing the severity of risk and damages to some of the Granton Catchment properties from the Brooker Highway to Hestercombe Road. A description of the option can be found in section 8.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 8.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 37 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 37 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	6	10
Commercial/industrial	0	0
Roads (m²)		
Minor	210	630

Table 38 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 38 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$323,560	$539,267
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$1,365	$4,095
Damage Estimates		

Direct Damages	$324,925	$543,362
Indirect Damages	$97,478	$163,009
Total Damages	**$422,403**	**$706,371**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 39 below, shows net present value of damages determined in Table 38 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 5.4 with the lowest value being the 5% AEP with a benefit-cost ratio of 2.8.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 39 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$422,403**	$110,000	$312,403	2.8	2
	1% AEP Base	**$706,371**	$110,000	$596,371	5.4	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 39 would be the 1% AEP having the highest benefit for the lowest cost. Figure 8.2 in Appendix 5 shows the relative location of the proposed earth bund flood wall described in the option.

Option 1 – Earth Bund - Levee Flood Deviation Wall

1.8m high deviation flood earth bund wall to reduce the flood depth running along the Brooker Highway to Hestercombe Road. This option provides a benefit of $596,371 in reduction of damages with a benefit-cost ratio (BCR) of 5.4 in the 1% AEP flood scenario, making this the most preferred option. Further investigation of the constructability of the option shall be carried out by Council for the use of available space in the existing open drain corridor easement, which needs to be assessed against The Department of State Growth requirements prior to the addition of the mitigation option.

Other Mitigation Options and reason for not being Considered:

Detention dam extension at the back of 8 Gillies Rd – Negative benefit to the downstream catchment based in land acquisition from the crown, constructability, construction cost v/s reduction in damages.

Detention dam extension at the back of 32 Gillies Rd – Negative benefit to the downstream catchment based in land acquisition from the crown, constructability, construction cost v/s reduction in damages.

7.3.9 Islet Rivulet

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Flood wall and culvert extension at reserve

The earth bund flood detention and extension of the exiting DN1800 culvert has been recommended as it would provide a degree of relief to the immediate flooding either easing or reducing the severity of risk and damages to some of the Islet Rivulet Catchment properties along the channel from Philip Avenue to the Main Road. A description of the option can be found in section 9.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 9.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 40 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 40 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	22	35
Commercial/industrial	0	0
Roads (m²)		
Minor	1200	2600

Table 41 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 41 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$1,186,388	$1,887,436
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$7,800	$16,250
Damage Estimates		

Direct Damages	$1,194,188	$1,903,686
Indirect Damages	$358,256	$571,106
Total Damages	**$1,552,445**	**$2,474,791**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 42 below, shows net present value of damages determined in Table 41 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 10.2 with the lowest value being the 5% AEP with a benefit-cost ratio of 6.1.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 42 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$1,552,445**	$220,000	$1,332,445	6.1	2
	1% AEP Base	**$2,474,791**	$220,000	$2,254,791	10.2	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 42 would be the 1% AEP having the highest benefit for the lowest cost. Figure 9.2 in Appendix 5 shows the relative location of the proposed earth bund flood wall and culvert extension described in the option.

Option 1 – Earth Bund Wall - Levee and DN1800 Culvert Extension

The proposed DN1800 culvert extension would be crossed by an earth bund wall for temporary detention in order to lessen the depth of flooding inundating some of the existing dwellings along the channel from Philip Avenue to Main Road. In the 1% AEP flood scenario, this alternative reduces damages by $2,254,791 and has a benefit-cost ratio (BCR) of 10.2, making it the recommended choice.

Prior to the inclusion of the mitigation option, Council shall conduct more research into the alternative's constructability for the use of available space on the recreational land.

Other Mitigation Options and reason for not being Considered:

Footpath and kerb rise from 96-124 Montrose Rd– Negative benefit to the affected dwelling based topographic constrains, construction cost v/s reduction in damages.

Detention pond at Montrose Rd/ Pitcairn St – Negative benefit to the downstream catchment based in constructability, construction cost v/s reduction in damages.

7.3.10 Jacques Rivulet

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Vegetation – Open Drain Maintenance

The management and maintenance of the existing open drain has been recommended as it would provide future resilience to erosion and flooding either easing or reducing the severity of risk and damages to the stormwater system. The proposed works extent from the back of the rear boundary of No12 Addison Street to the rear boundary at No54 Driscoll Street. A description of the option can be found in section 10.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 10.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 43 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 43 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	5	14
Commercial/industrial	0	0
Roads (m²)		
Minor	0	0

Table 44 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 44 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$269,634	$754,974
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$0	$0

Damage Estimates		
Direct Damages	$269,634	$754,974
Indirect Damages	$80,890	$226,492
Total Damages	**$350,524**	**$981,467**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 45 below, shows net present value of damages determined in Table 44 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of >10 with the lowest value being the 5% AEP with a benefit-cost ratio of 4.4.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 45 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$350,524**	$100,000	$250,524	2.5	2
	1% AEP Base	**$981,467**	$100,000	$881,467	8.8	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 45 would be the 1% AEP having the highest benefit for the lowest cost. Figure 10.2 in Appendix 5 shows the relative location of the proposed open drain maintenance wall described in the option.

Option 1 – Vegetation – Open Drain Maintenance

The goal of maintaining adequate hydraulic conveyance capacity in a natural or modified stream channel, like Jacques Rivulet improving the Manning's coefficient for roughness from 0.055 to 0.025 and maintaining open drains is to prevent experiencing a major drop in hydraulic capacity during 5%

AEP to 1% AEP flood scenarios. This is due to the fact that invasive species have the potential to fully obstruct a channel in a short amount of time by causing blockages and snags. In the 1% AEP flood scenario, this alternative reduces damages by $881,467 and has a benefit-cost ratio (BCR) of 8.8, making it the recommended option.

Other Mitigation Options and reason for not being Considered:

Detention dam at Redlands Dr – Negative benefit to the downstream catchment based in constructability, construction cost v/s reduction in damages.

Footpath, kerb rise and flood walls from 54-136 Marys hope Rd– Negative benefit to the affected dwelling based topographic constrains, construction cost v/s reduction in damages.

7.3.11 Lowestoft Bay

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Earth Bund - Levee Flood Deviation Wall

The earth bund flood deviation wall has been recommended as it would provide a degree of relief to the immediate flooding either easing or reducing the severity of risk and damages to some of the Lowestoft Bay Catchment properties from Woorin St to Main Road. A description of the option can be found in section 11.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 11.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 46 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 46 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	6	10
Commercial/industrial	0	0
Roads (m²)		
Minor	120	440

Table 47 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 47 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$323,560	$431,414
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$780	$2,860
Damage Estimates		

Direct Damages	$324,340	$434,274
Indirect Damages	$97,302	$130,282
Total Damages	**$421,643**	**$564,556**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 48 below, shows net present value of damages determined in Table 47 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 4.1 with the lowest value being the 5% AEP with a benefit-cost ratio of 2.8.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 48 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$421,643**	$110,000	$311,643	2.8	2
	1% AEP Base	**$564,556**	$110,000	$454,556	4.1	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 48 would be the 1% AEP having the highest benefit for the lowest cost. Figure 11.2 in Appendix 5 shows the relative location of the proposed earth bund flood wall described in the option.

Option 1 – Earth Bund - Levee Flood Deviation Wall

1.0m high deviation flood earth bund wall to reduce the flood depth running along the northern boundary of 680 Main Rd Berriedale to Main Road. This option provides a benefit of $454,556 in reduction of damages with a benefit-cost ratio (BCR) of 4.1 in the 1% AEP flood scenario, making this the most preferred option. Further investigation of the constructability of the option shall be carried out by Council in agreement with the property for the use of available space inside the lot boundary prior to the addition of the mitigation option.

Other Mitigation Options and reason for not being Considered:

Detention pond at the back of 9 Kanella Av – Negative benefit to the downstream catchment based in, constructability, construction cost v/s reduction in damages.

Detention pond between 41/45 Catherine St – Negative benefit to the downstream catchment based in constructability, construction cost v/s reduction in damages.

7.3.12 Roseneath Rivulet

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Vegetation – Rivulet Maintenance

The management and maintenance of the existing Roseneath Rivulet from Erskine Street to the Rusts Bay has been recommended as it would provide future resilience to erosion and flooding either easing or reducing the severity of risk and damages to the stormwater system. A description of the option can be found in section 12.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 12.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 49 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 49 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	1	5
Commercial/industrial	0	0
Roads (m²)		
Minor	250	1000

Table 50 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 50 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$53,927	$269,634
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$1,625	$6,500
Damage Estimates		

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Direct Damages	$55,552	$276,134
Indirect Damages	$16,666	$82,840
Total Damages	**$72,217**	**$358,974**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 51 below, shows net present value of damages determined in Table 50 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 1.0 with the lowest value being the 5% AEP with a benefit-cost ratio of -0.6.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 51 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$72,217**	$180,000	-$107,783	-0.6	2
	1% AEP Base	**$358,974**	$180,000	$178,974	1.0	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 51 would be the 1% AEP having the highest benefit for the lowest cost. Figure 12 in Appendix 5 shows the relative location of the proposed vegetation and rivulet maintenance described in the option.

Option 1 – Vegetation – Rivulet Maintenance

It is important to conduct routine inspections to spot any erosion or silt buildup. Following the inspection, action should be made to address the issue by determining the reason for the erosion and the source of the silt. It is advisable to revegetate any locations where grass coverage has decreased. Grading is not required once vegetation has established itself. This option is a crucial component of the Council's maintenance programme to lessen the damages brought on by the Rivulet overflowing

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since it offers a benefit of $178,974 in damages reduction with a benefit-cost ratio (BCR) of 1.0 in the 1% AEP flood scenario.

Other Mitigation Options and reason for not being Considered:

Detention dam at 40 Cammeray Rd – Negative benefit to the downstream catchment based in land acquisition, construction cost v/s reduction in damages.

Detention dam at 22 Russell Rd – Negative benefit to the downstream catchment based in land acquisition, construction cost v/s reduction in damages.

7.3.13 Springfield

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

Flood Wall – Flow Diversion

The flood wall will achieve a grade change along the flow inundation path has been recommended as it would potentially provide a degree of relief of the immediate flooding in the private properties reducing the severity of risk and damages to some of the Springfield Catchment properties from Homer Avenue to Coleman Street intersection. A description of the option can be found in section 13.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 13.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 52 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 52 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	8	11
Commercial/industrial	0	0
Roads (m²)		
Minor	2800	3200

Table 53 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 53 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$431,414	$593,194
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$20,800	$22,750

Damage Estimates		
Direct Damages	$452,214	$615,944
Indirect Damages	$135,664	$184,783
Total Damages	**$587,878**	**$800,727**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 54 below, shows net present value of damages determined in Table 53 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of 4.4 with the lowest value being the 5% AEP with a benefit-cost ratio of 2.8.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 54 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$587,878**	$120,000	$467,878	3.9	2
	1% AEP Base	**$800,727**	$120,000	$680,727	5.7	1

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, the preferred option as per Table 54 would be the 1% AEP having the highest benefit for the lowest cost. Figure 13.2 in Appendix 5 show the relative location of the proposed flood wall described in the option.

Option 1 – Impervious Flood Wall.

The Construction of a flood wall at the right of way of 28B Coleman St, would help to lessen the flow flood that is flooding the existing dwellings. In the 1% AEP flood scenario and would spread the overland flow path through less populated areas. this alternative reduces damages by $680,727 and has a benefit-cost ratio (BCR) of 5.7, making it the recommended choice. Prior to the inclusion of the mitigation option, Council shall conduct additional research into the constructability of the mitigation option at the existing lot boundary at 20B Coleman St for the proposed 1000mm x 500mm impervious flood wall.

Other Mitigation Options and reason for not being Considered:

Detention pond in Council's land at rear of 18 Coleman St – Negative benefit to the downstream catchment based in construction cost v/s reduction in damages.

Detention pond at 23 First Av – Negative benefit to the downstream catchment based in land acquisition, construction cost v/s reduction in damages.

7.3.14 Zinc Works

Outcomes from various flood scenarios have highlighted the following location for consideration of mitigation measure that include.

General Stormwater Maintenance

General stormwater system maintenance has been recommended as it would reduce the risk of flooding of public and private property to acceptable levels for some of the Goodwood Catchment properties. As the proposed mitigation option would be classified as a past of Council's maintenance schedule and budget, a description of the option can be found in Section 14.3.

Comparison of Damages for the upgrade scenario

Using the same appraisal method as outlined in section 14.2, damages for each upgrade scenario were calculated to view the overall effect of the upgrade.

Table 55 compares the quantity of buildings and roads affected by each option. However, as per the depth damage, the degree of flooding above floor levels provides the actual damage cost.

Table 55 Number of affected buildings and roads at pre mitigation options

Scenario	5% AEP Base	1% AEP Base
Buildings (number)		
Residential	0	0
Commercial/industrial	0	0
Roads (m^2)		
Minor	0	0

Table 56 below shows the comparison of damages of each flood scenario option, when singularly compared to a do-nothing scenario.

Table 56 Damages for each individual flood scenario at "do nothing" option

Scenario	5% AEP Base	1% AEP Base
Buildings (Damage)		
Residential	$0	$0
Commercial/ industrial	$0	$0
Roads (Damage)		
Sealed Road	$0	$0
Damage Estimates		

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Direct Damages	$0	$0
Indirect Damages	$0	$0
Total Damages	**$0**	**$0**

Cost Benefit Assessment

Cost benefit analysis provides a financial assessment of the capital cost of the project versus the benefits from the outcome of the project by dividing the benefit by the capital cost. The resultant ratio is than either >1 or <1, greater than one being the benefit outweighs the cost and vice versa.

$$Benefit - Cost\ Ratio = \frac{PV\ of\ Expected\ Benefits}{PV\ of\ Expected\ Costs}$$

Table 57 below, shows net present value of damages determined in Table 56 against the net present capital cost of each option and the benefit by means of reduction in damages. These costs run through the above equation provide a ratio to compare each flood scenario option. It can be seen from this table that the 1% AEP flood scenario would always provide by far the most benefit to the overall mitigation option being the only option that results in a ratio of >10 with the lowest value being the 5% AEP with a benefit-cost ratio of 4.4.

The flood mitigation option presents the most benefit for money. These ranking apply only to direct cost of an events of 5% AEP and 1% AEP magnitude occurring and do not consider the cost or benefits of social impacts on the community.

Table 57 Benefit cost table for Net Present Value (NPV) at each flood scenario mitigation option

Option	Description	NPV of Damages	NPV Cost of Option	Option Benefit Relative to Base Option	BCR	RANK
1	5% AEP Base	**$0**	$20,000	-$20,000	-1.0	0
	1% AEP Base	**$0**	$20,000	-$20,000	-1.0	0

Outcome of the option

Below is an outline of the proposed mitigation option and its benefits. If only one flood scenario was to be selected, as it would be a maintenance option only, there wouldn't be a preferred option as per Table 57. Figure 14.1 in Appendix 5 shows the relative location of the proposed maintenance works.

Option 1 – General Stormwater Maintenance

Regular system maintenance and storm drain cleaning, remove trash, sediment, and debris from storm drains, roadways and other watershed areas to help minimise erosion and related damage and prevent flooding.

This option provides a benefit of -$20,000 in reduction of damages with a benefit-cost ratio (BCR) of -1.0 in the 1% AEP flood scenario, making this option an integral part of the Council's maintenance schedule.

Other Mitigation Options and reason for not being Considered:

No other option– No other mitigation options has been assessed as the few inundated areas are inside private or state government land.

8 Recommendations

In light of the comprehensive assessment conducted in our Stormwater System Management Plan, this set of recommendations serves as a strategic roadmap to further enhance the resilience of the Glenorchy Municipality Area against potential flood events. Building upon the insights gained from the study, these recommendations are designed to refine and strengthen our approach to flood management, risk reduction, and infrastructure preparedness.

The objective of these recommendations is to fortify our stormwater system management strategies by implementing a series of targeted actions, each geared towards enhancing the accuracy of our flood models, validating our assumptions, and optimising our mitigation measures. By adopting these measures, we aim to ensure the utmost safety and well-being of our community members and the protection of their assets and infrastructure in the face of flood-related challenges.

These recommendations span various aspects of our approach, from hydraulic modelling refinements and sensitivity analyses to expanding our data sources and bolstering our understanding of flood scenarios. The ultimate goal is to foster a more resilient and adaptive stormwater management system that not only withstands the impacts of climate change but also maximises the benefits derived from our study.

By following these recommendations, we position ourselves to take a systematic and strategic approach to flood risk management while aligning with our commitment to uphold the Level of Service pledged to our residents. It is imperative that we take a forward-thinking stance in addressing these challenges, and these recommendations provide a well-defined pathway to achieving our objectives.

1. **Enhance Sensitivity Analysis for Manning's n Value:** Conduct a comprehensive sensitivity study on Manning's n value, incorporating depth-varying Manning's n coefficients. Utilise cross-validation techniques by integrating a rain-on-grid model for a catchment with well-established hydrological calibration, as demonstrated in the SMEC study of Glenorchy CBD. This will help fine-tune the accuracy of the model, improving its performance.

2. **Utilise More Historical Flood Impact Records:** Extend the scope of the study by incorporating additional historical flood impact records. Thoroughly model these events to provide more detailed data for validating the model. This will enhance the model's reliability and precision.

3. **Explore Tailwater Improvements:** Investigate potential tailwater improvements, varying the level along the River Derwent. Consider adopting a higher level than previously used, such as the 10% Annual Exceedance Probability (AEP) River Derwent flood levels for 1% AEP land-based flood scenarios. Additionally, assess a reverse case by analysing the impact of 10% AEP land-based flooding with 1% AEP River Derwent levels, incorporating wave runup considerations. This will help identify effective measures to manage river and land-based flooding.

4. **Model Additional AEP Scenarios:** Extend the range of scenarios considered by modelling different Annual Exceedance Probability (AEP) events, including 5% AEP (for pipe sizing considerations) and 2% AEP (for assessing building risks). This will provide a more comprehensive understanding of potential flood scenarios and their implications. 5% AEP flood mapping is mostly complete for all urban catchments at the time of this review.

5. **Perform Sensitivity Runs on Key Model Parameters:** Conduct sensitivity runs on the critical model parameters as described in the report. This will ensure that the model is robust and can adapt to different conditions and inputs.

6. **Verify TUFLOW Model Input Files:** Thoroughly validate the TUFLOW model input files to ensure accuracy and consistency. This step is essential for maintaining the integrity of the model.

7. **Interpret Results to Quantify and Prioritise Impacted Areas:** After modelling and analysis, interpret the results to quantify and rank the areas that are most significantly impacted by flood events. This prioritisation will aid in decision-making and resource allocation for mitigation efforts.

8. **Develop Conceptual Design and Cost Management Options:** Create conceptual designs for flood risk reduction measures and cost management options. These designs should align with the prioritised impacted areas and include cost estimates. This will provide a basis for informed decision-making and resource allocation.

9. **Enhance Stream Gauging Network:** Invest in improving the stream gauging network by expanding its coverage and capabilities. Capture more data related to flow, water level, and water quality. This enhanced network will provide valuable real-time data for monitoring and managing stormwater and flood events.

Implementing these recommendations will significantly strengthen the stormwater system management plan, ensuring its effectiveness in mitigating flood risks and safeguarding the Glenorchy Municipality Area against potential flood events.

9 References

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10 Appendix 1 – Critical Event Maps

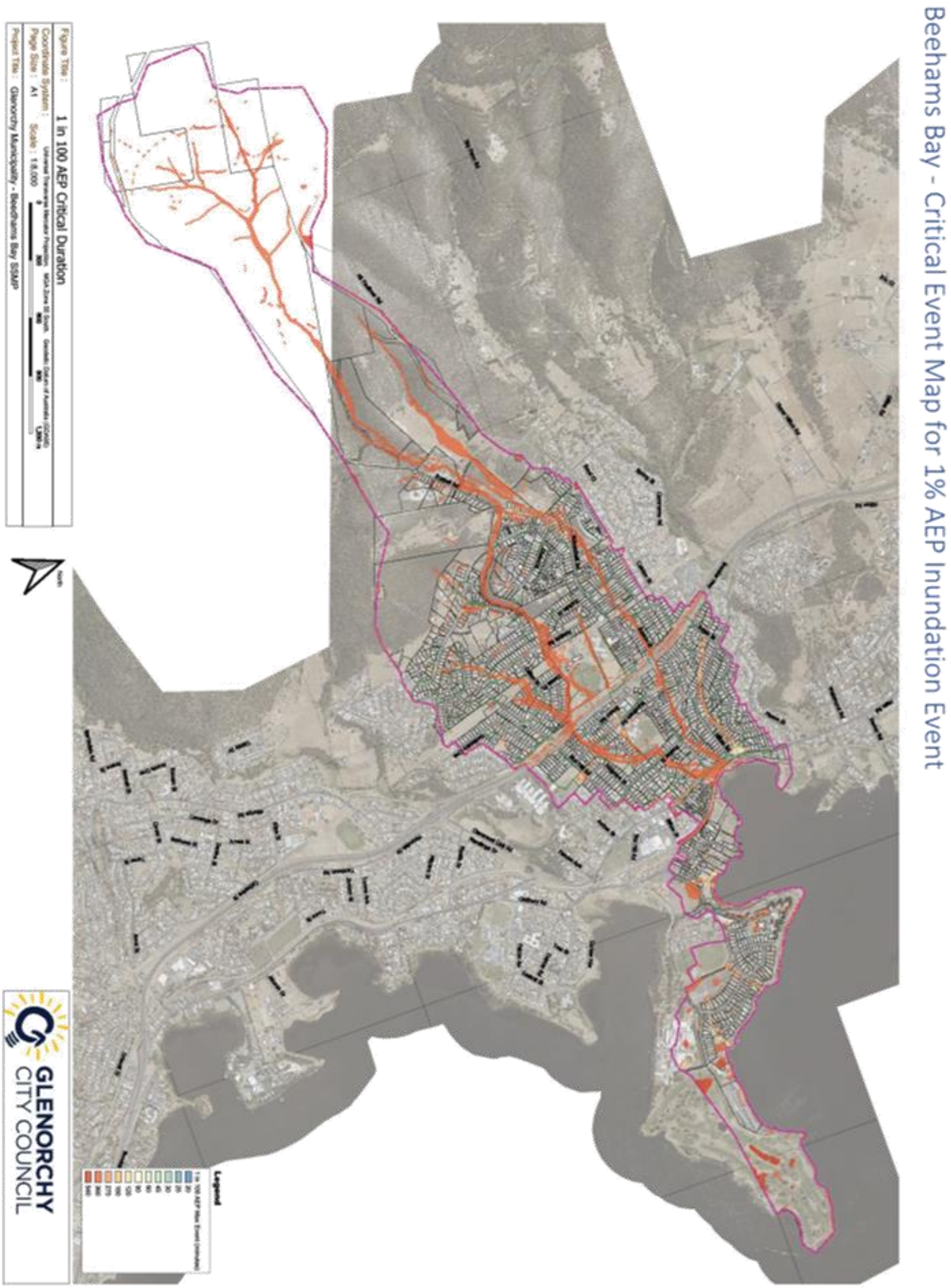
11 Appendix 2 – Inundation Depth Maps

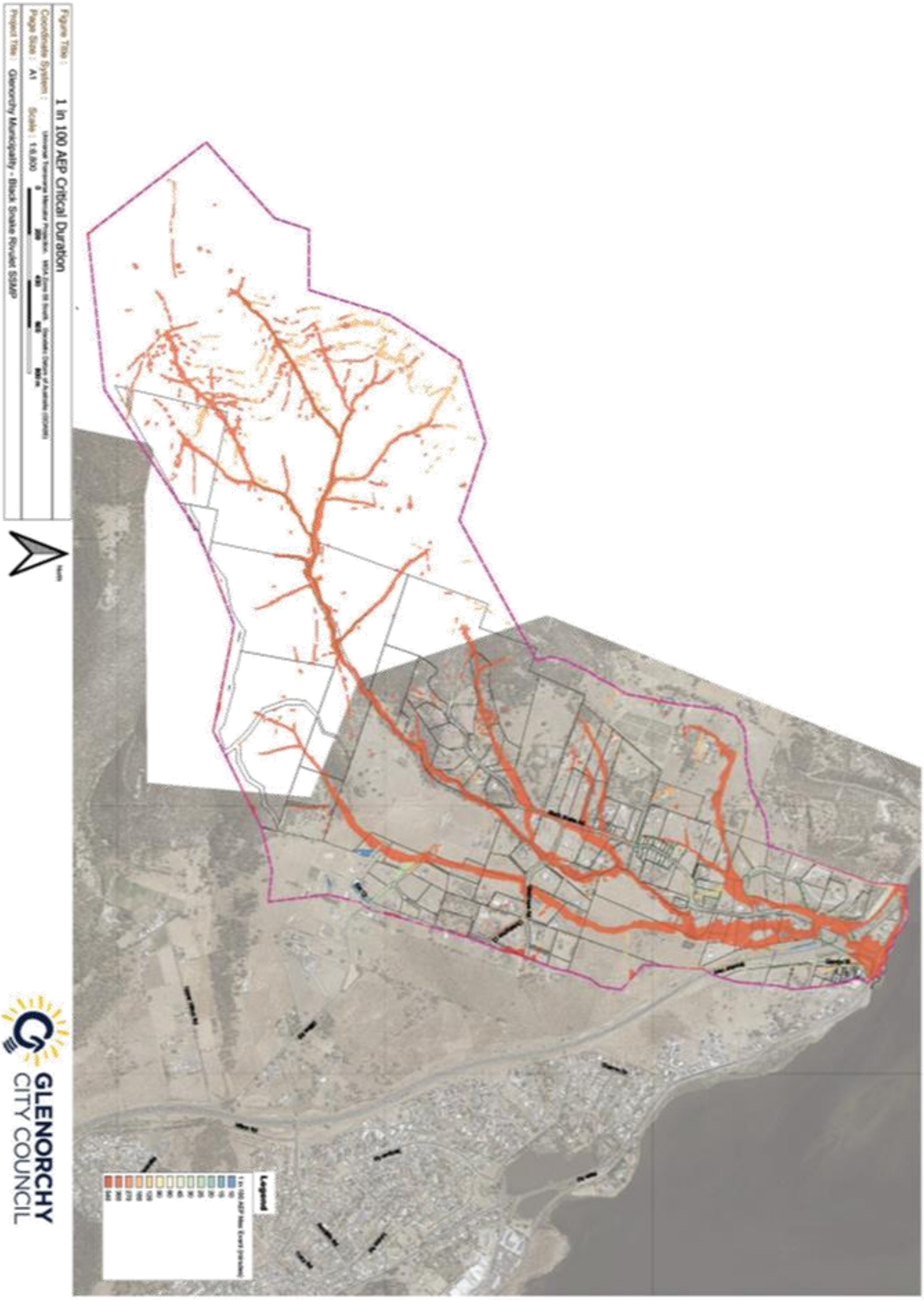
12 Appendix 3 – Inundation Hazard Maps

13 Appendix 4 – Economic Impacts of Flooding Maps

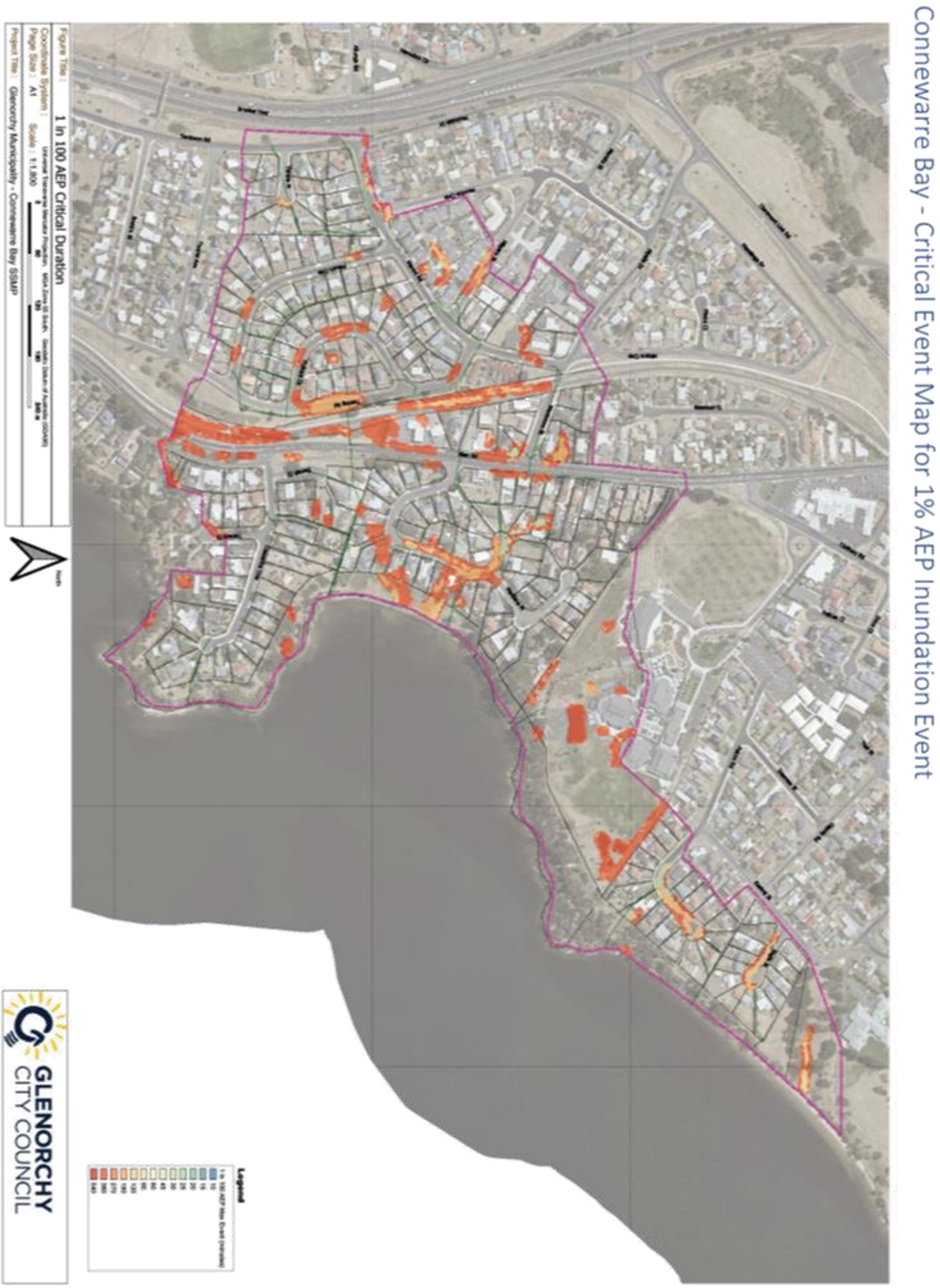
14 Appendix 5 - Flood Mitigation Option Maps

15 Appendix 6 – Glenorchy CBD Stormwater System Management Plan


Beehams Bay - Critical Event Map for 1% AEP Inundation Event
1 in 100 AEP Critical Duration
GLENORCHY
CITY COUNCIL
Legend



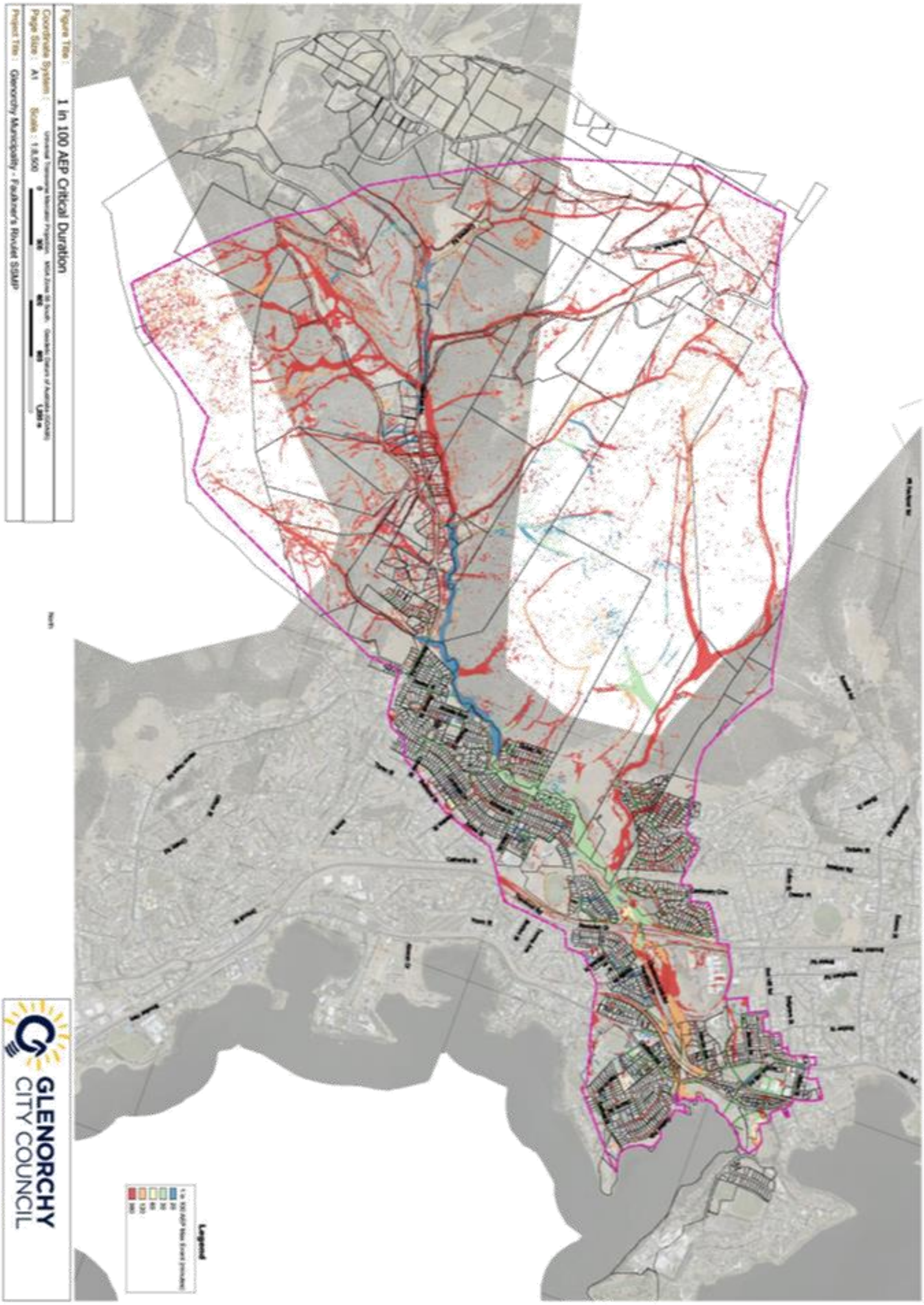
Black Snake Rivulet - Critical Event Map for 1% AEP Inundation Event

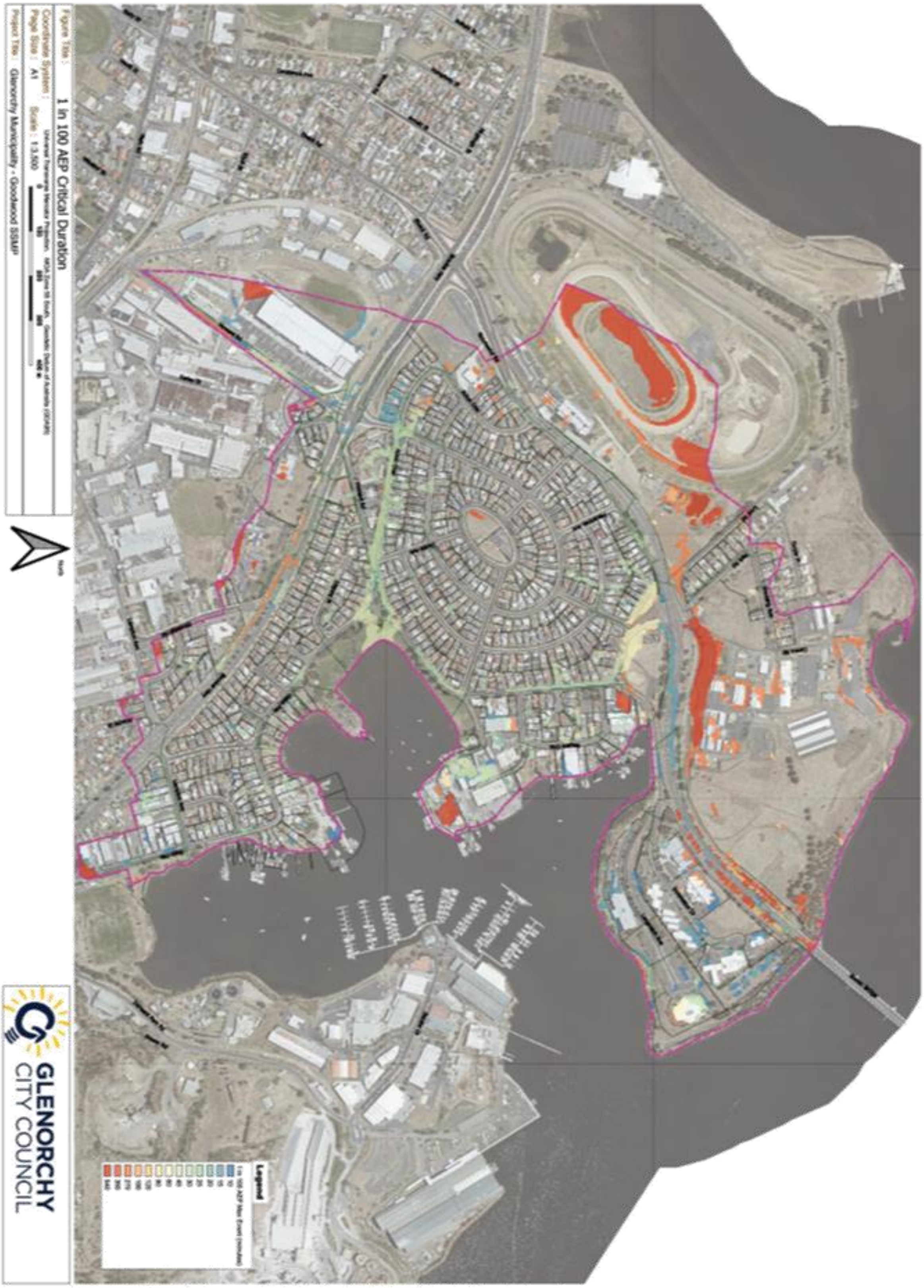

Connewarre Bay - Critical Event Map for 1% AEP Inundation Event
1 in 100 AEP Critical Duration
GLENORCHY CITY COUNCIL

Dooleys Creek - Critical Event Map for 1% AEP Inundation Event

Dowsing Point - Critical Event Map for 1% AEP Inundation Event

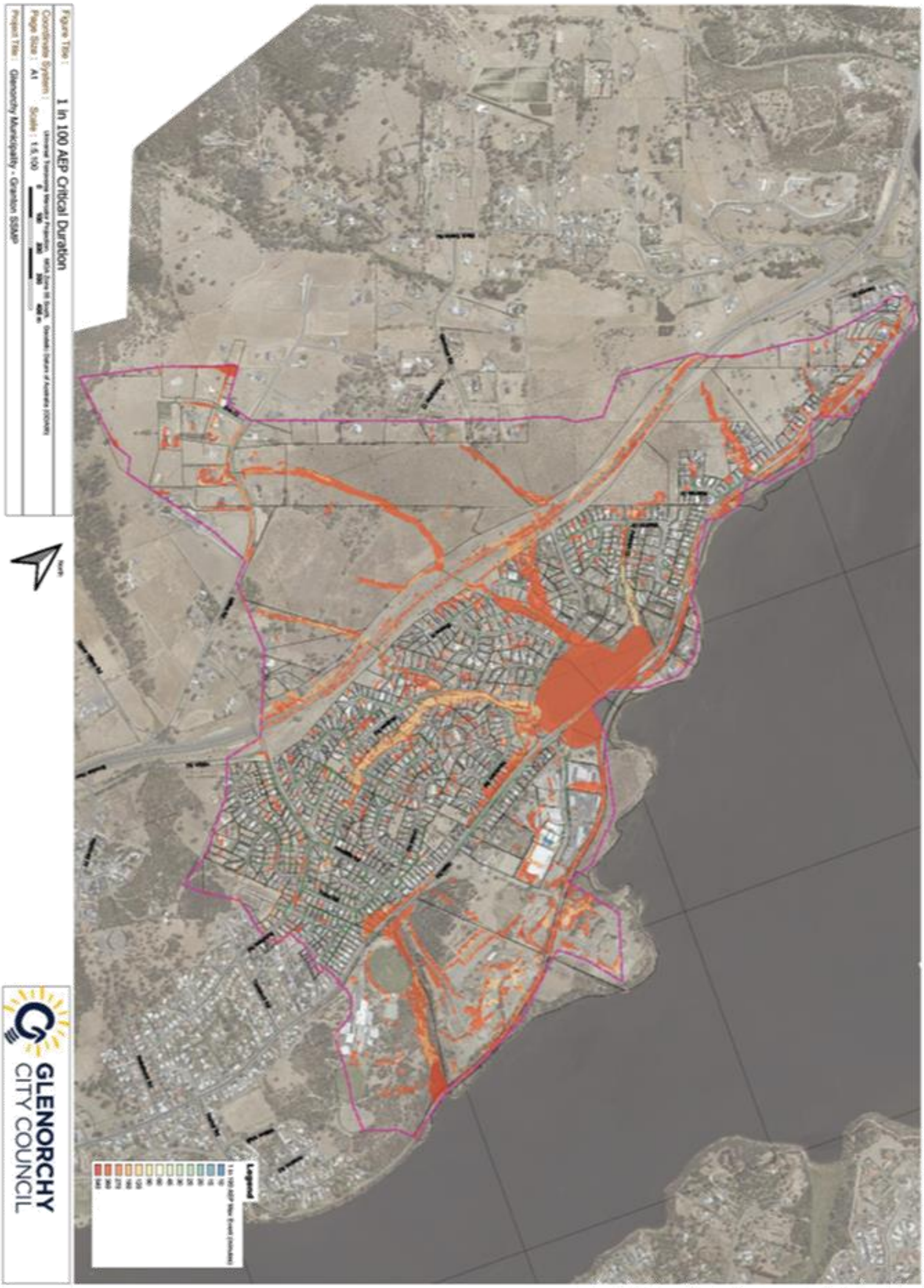
Faulkners Rivulet - Critical Event Map for 1% AEP Inundation Event

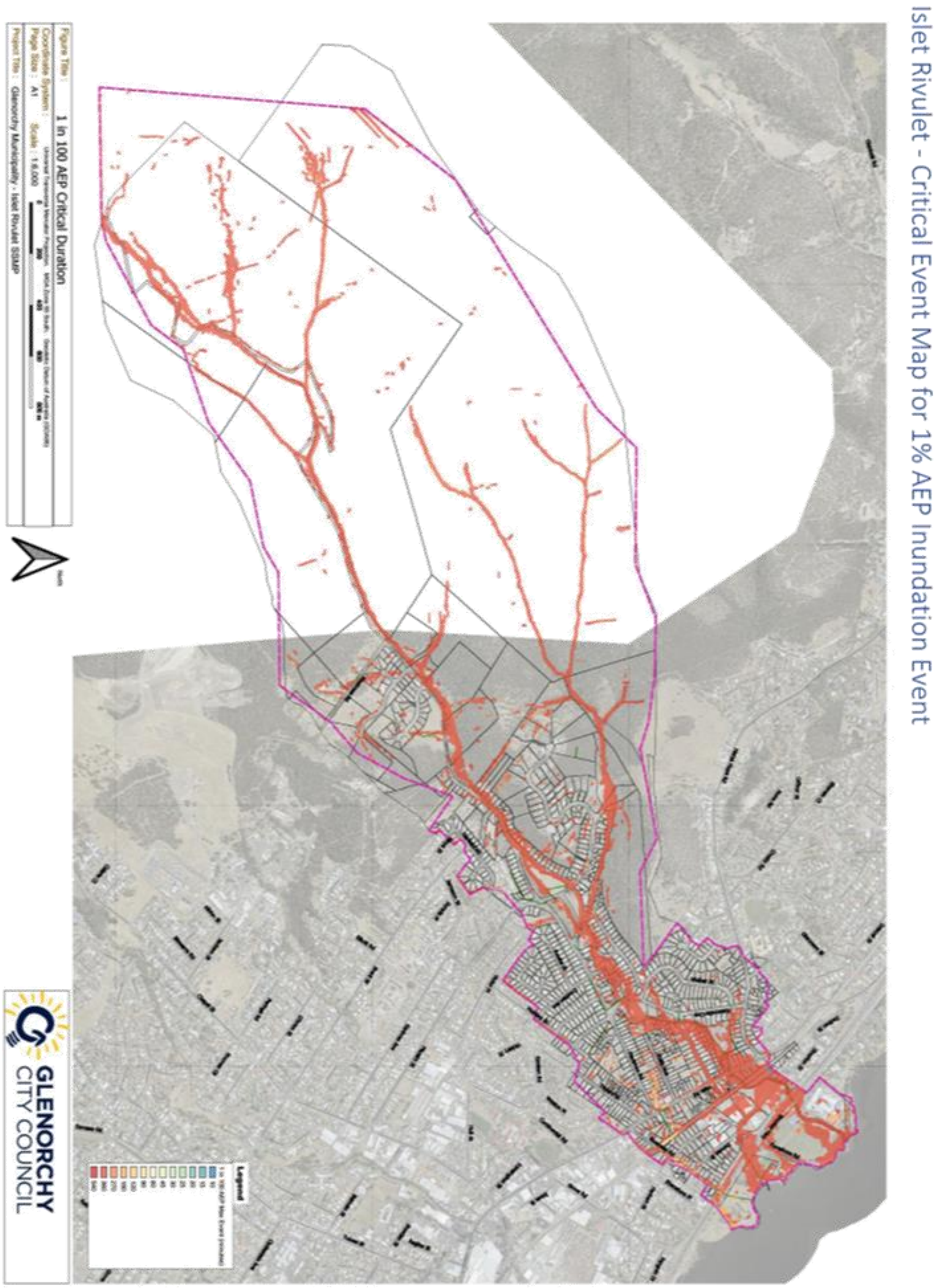




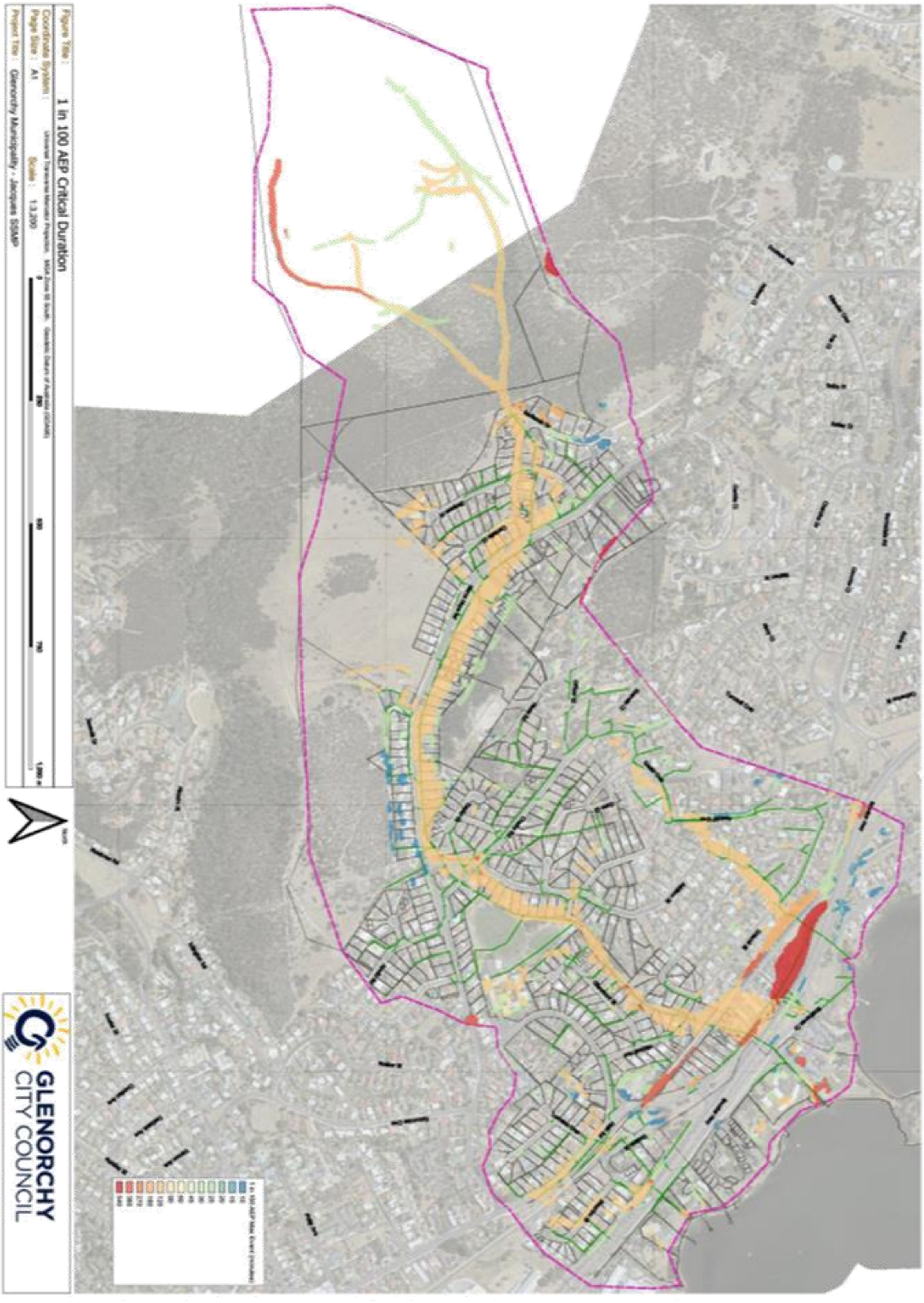
Goodwood - Critical Event Map for 1% AEP Inundation Event

Granton - Critical Event Map for 1% AEP Inundation Event

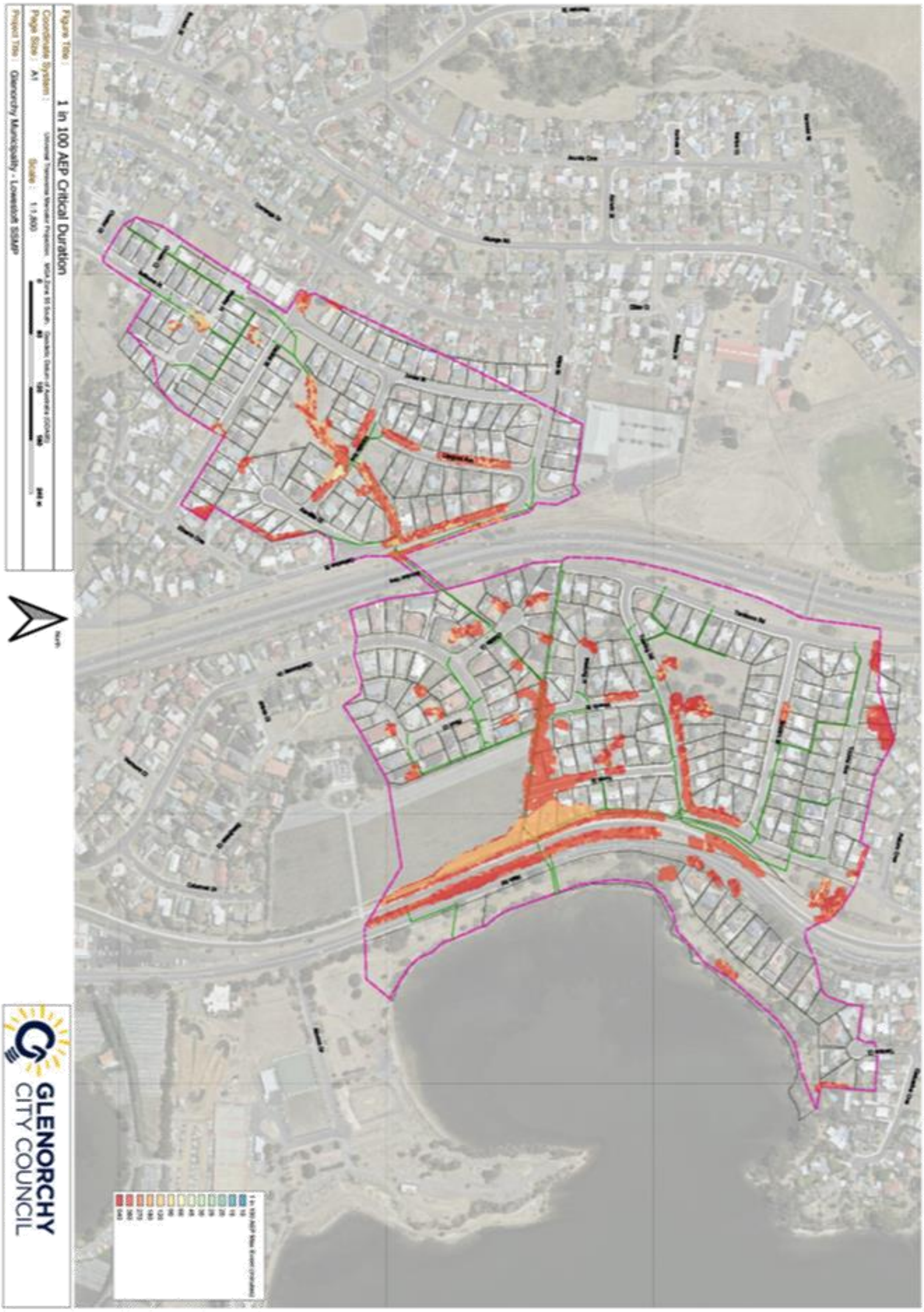



Islet Rivulet - Critical Event Map for 1% AEP Inundation Event
1 in 100 AEP Critical Duration
Project Title : Glenorchy Municipality - Islet Rivulet SSMP
GLENORCHY
CITY COUNCIL
Legend

Jacques Rivulet - Critical Event Map for 1% AEP Inundation Event



Lowestoft Bay - Critical Event Map for 1% AEP Inundation Event



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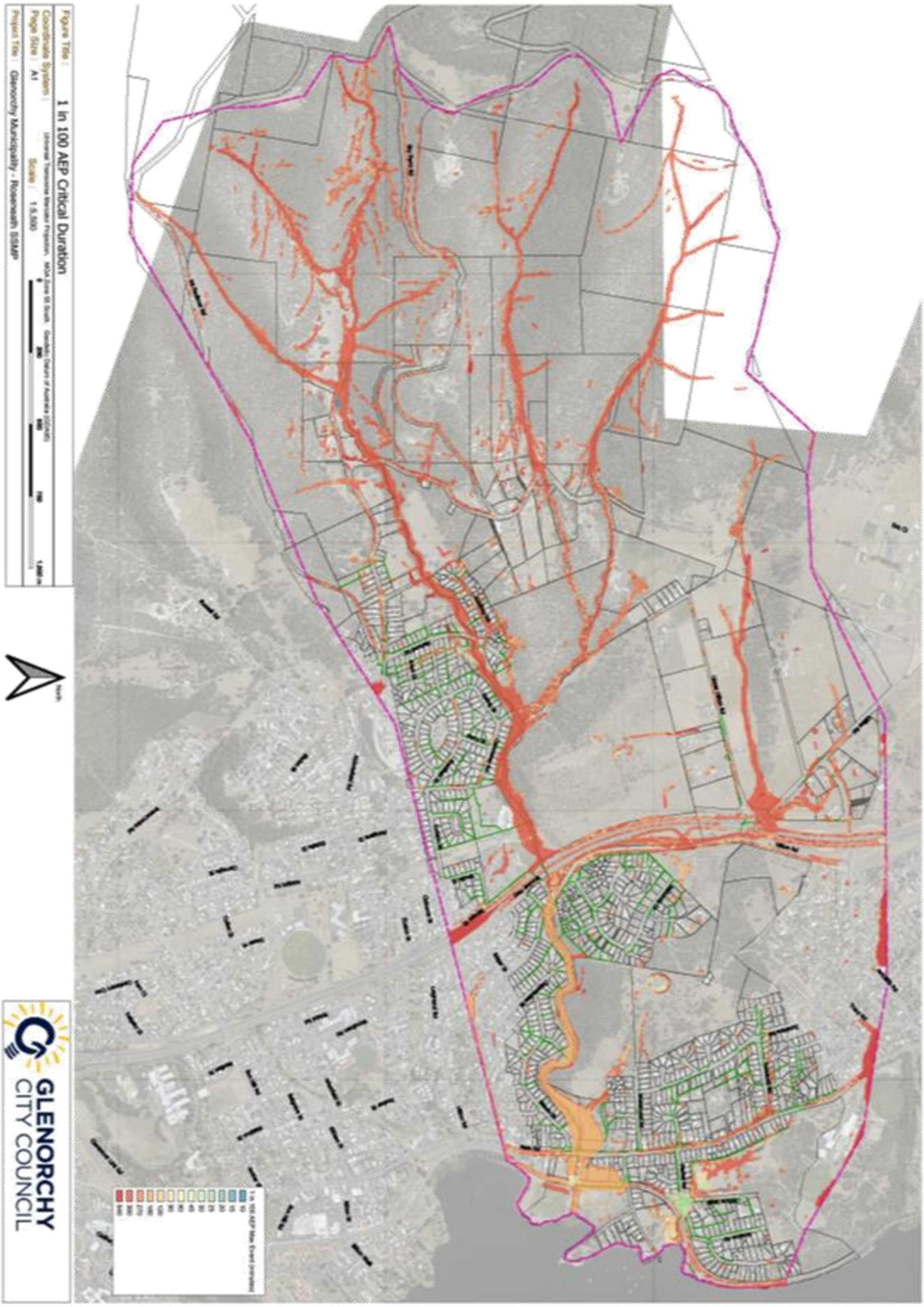

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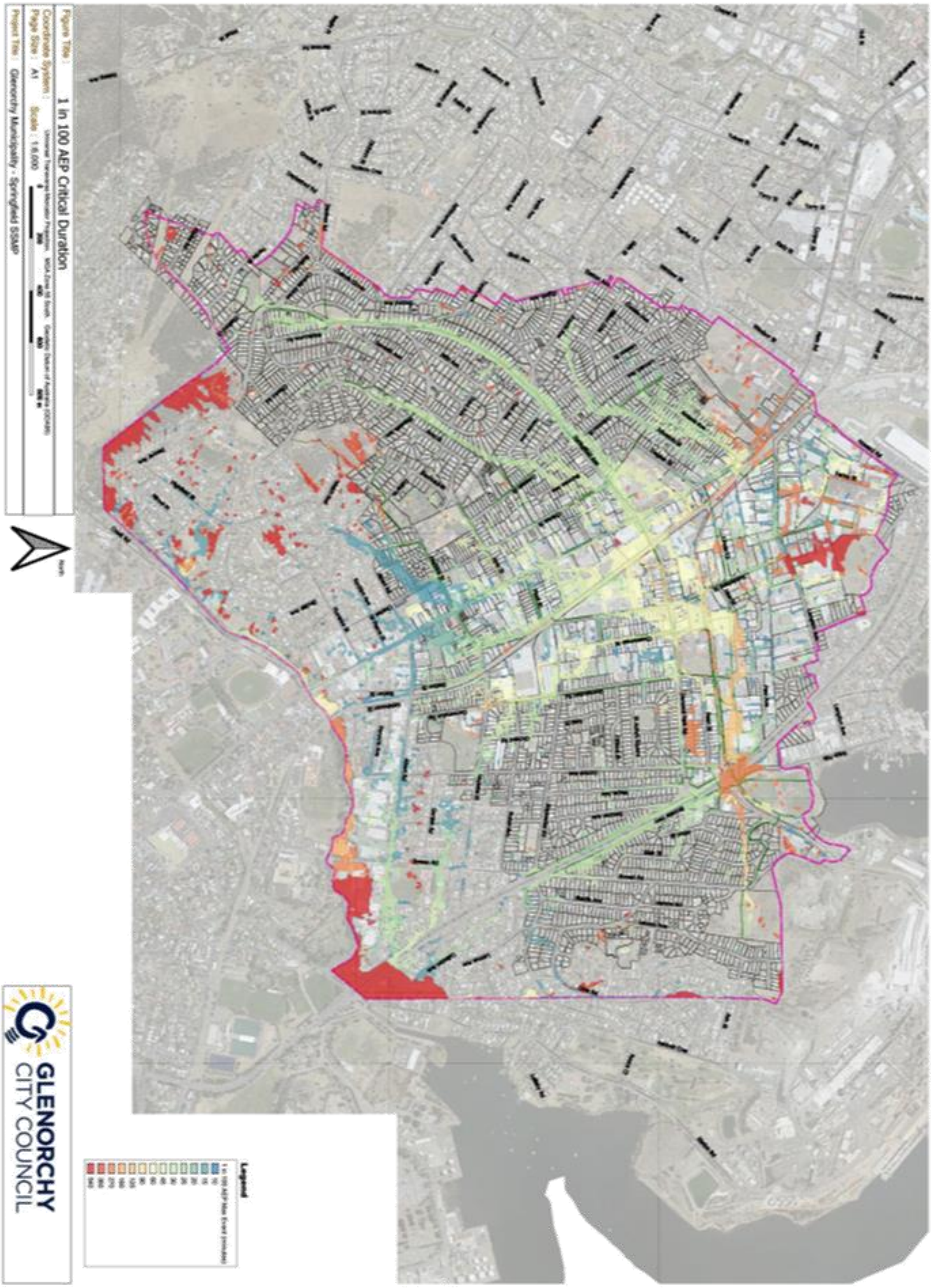

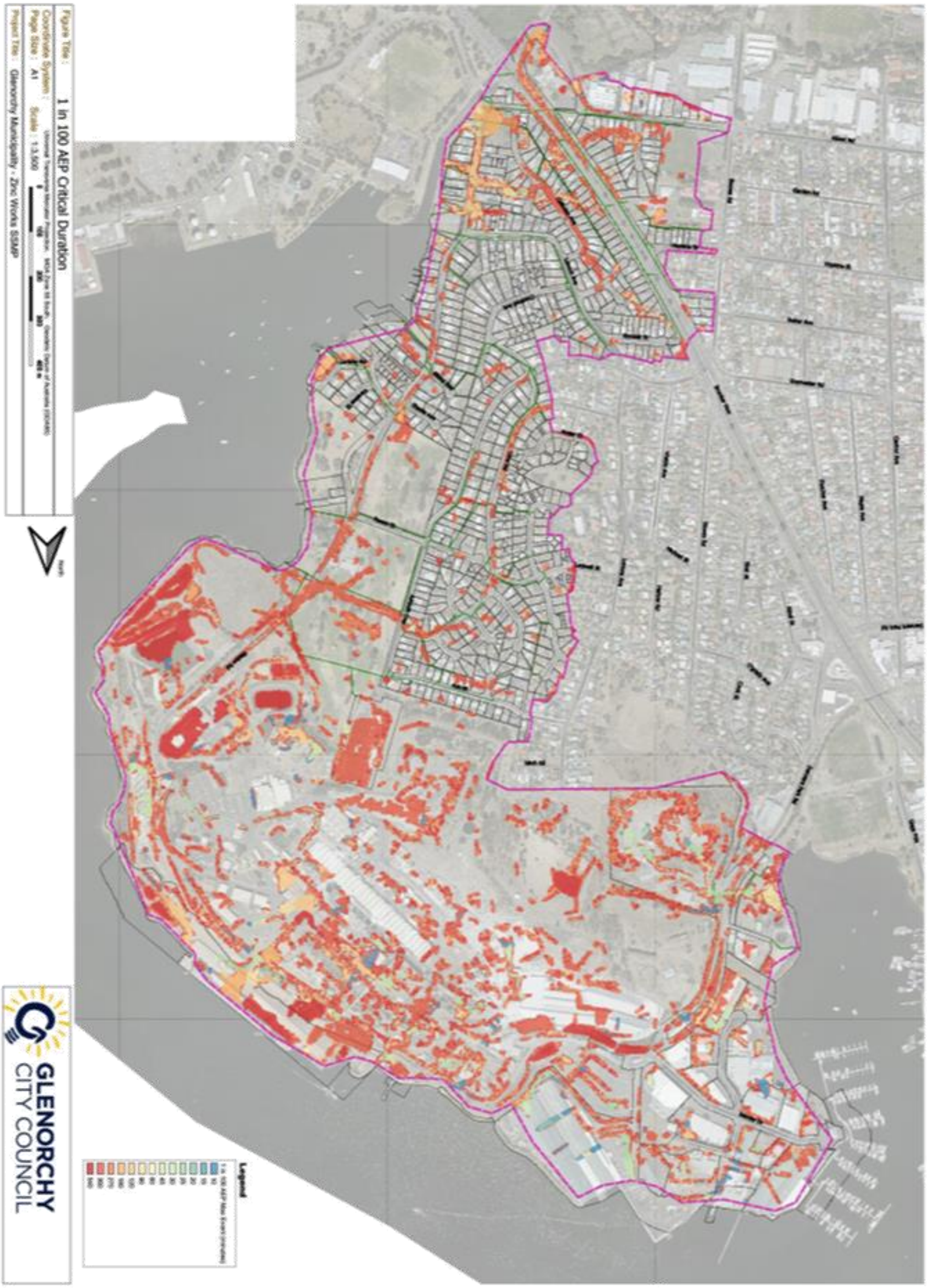

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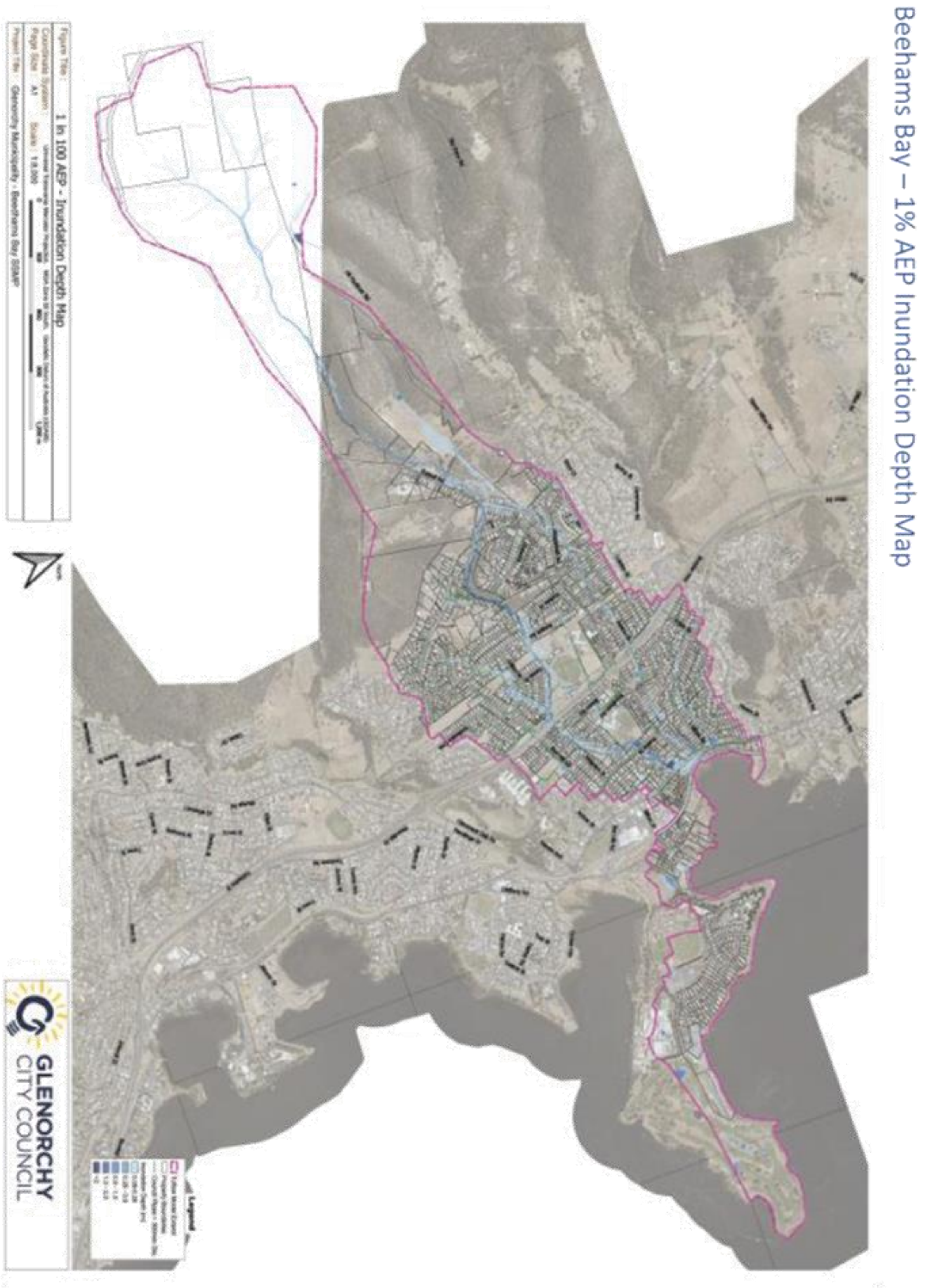
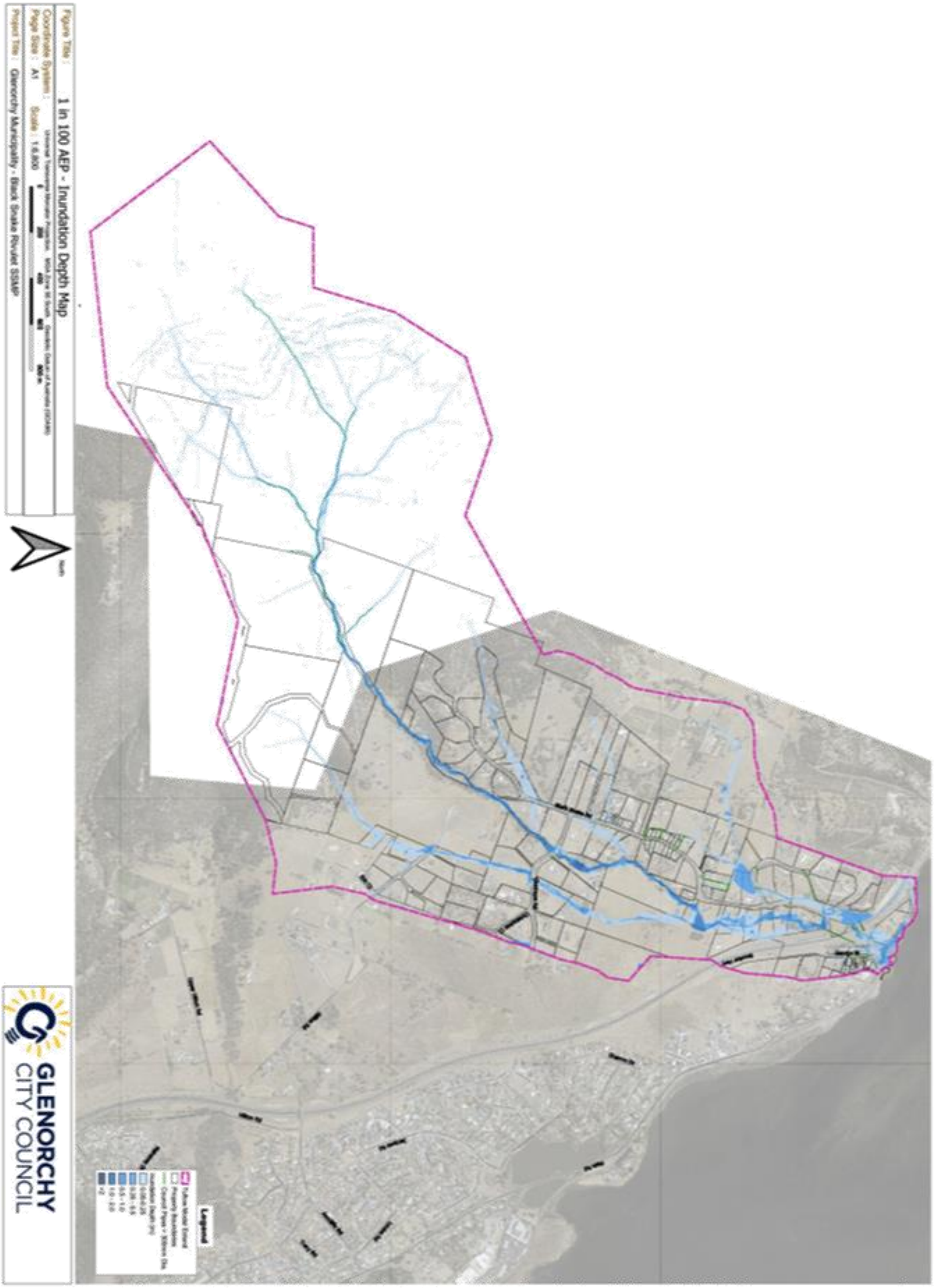
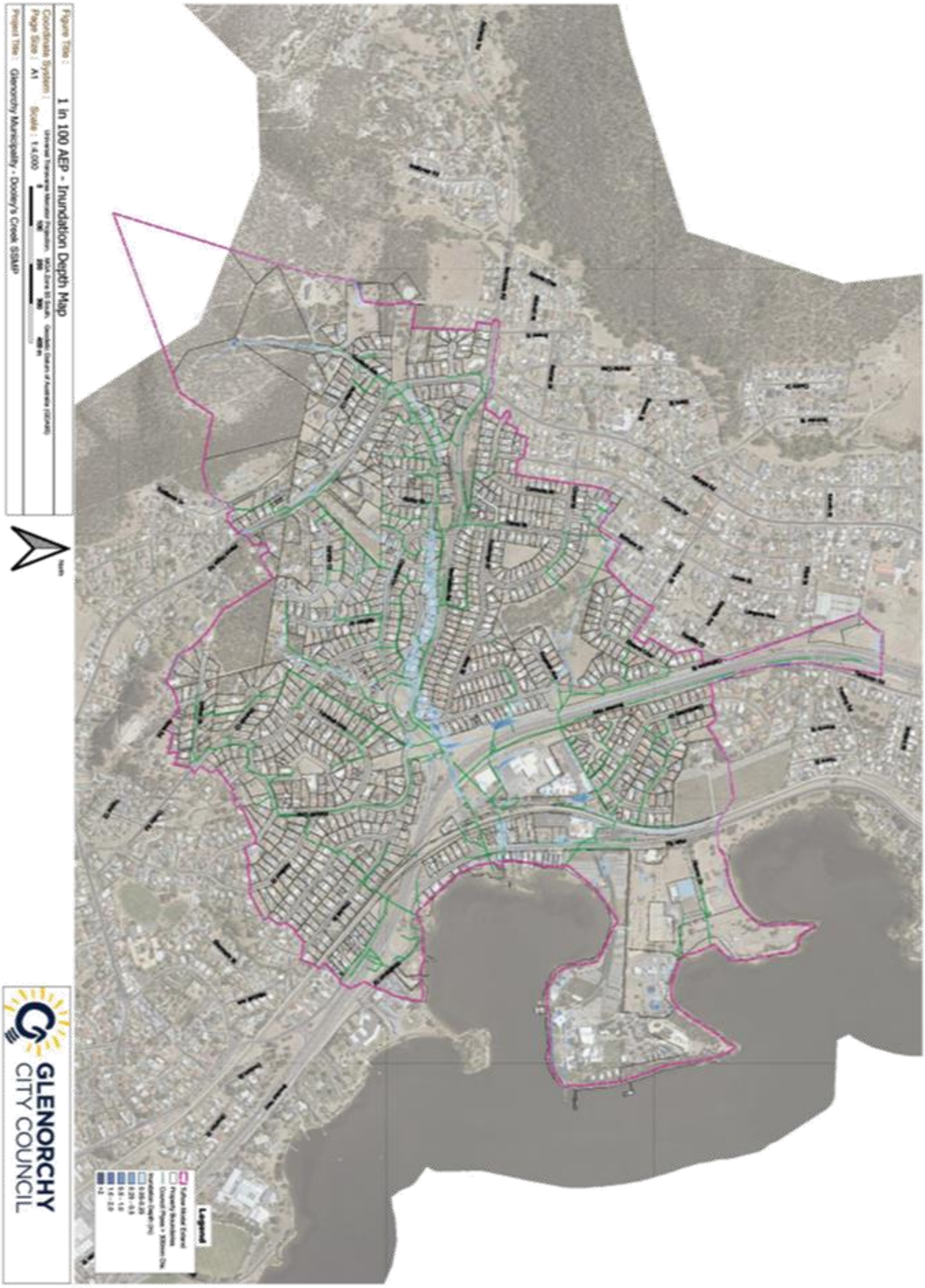

Beehams Bay – 1% AEP Inundation Depth Map
1 in 100 AEP - Inundation Depth Map
GLENORCHY
CITY COUNCIL
Legend

Black Snake Rivulet – 1% AEP Inundation Depth Map



Connewarre Bay – 1% AEP Inundation Depth Map

Dooleys Creek – 1% AEP Inundation Depth Map



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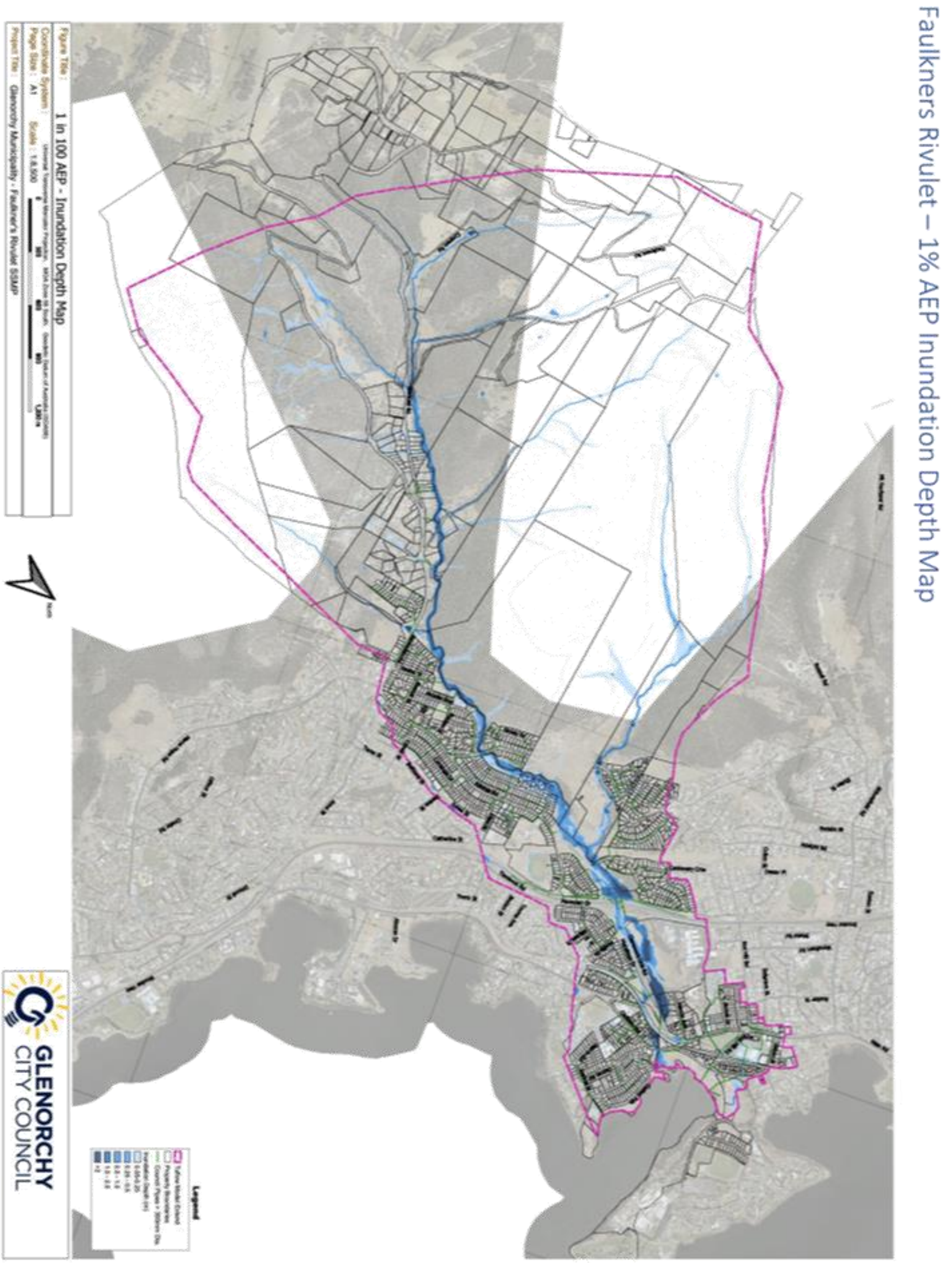
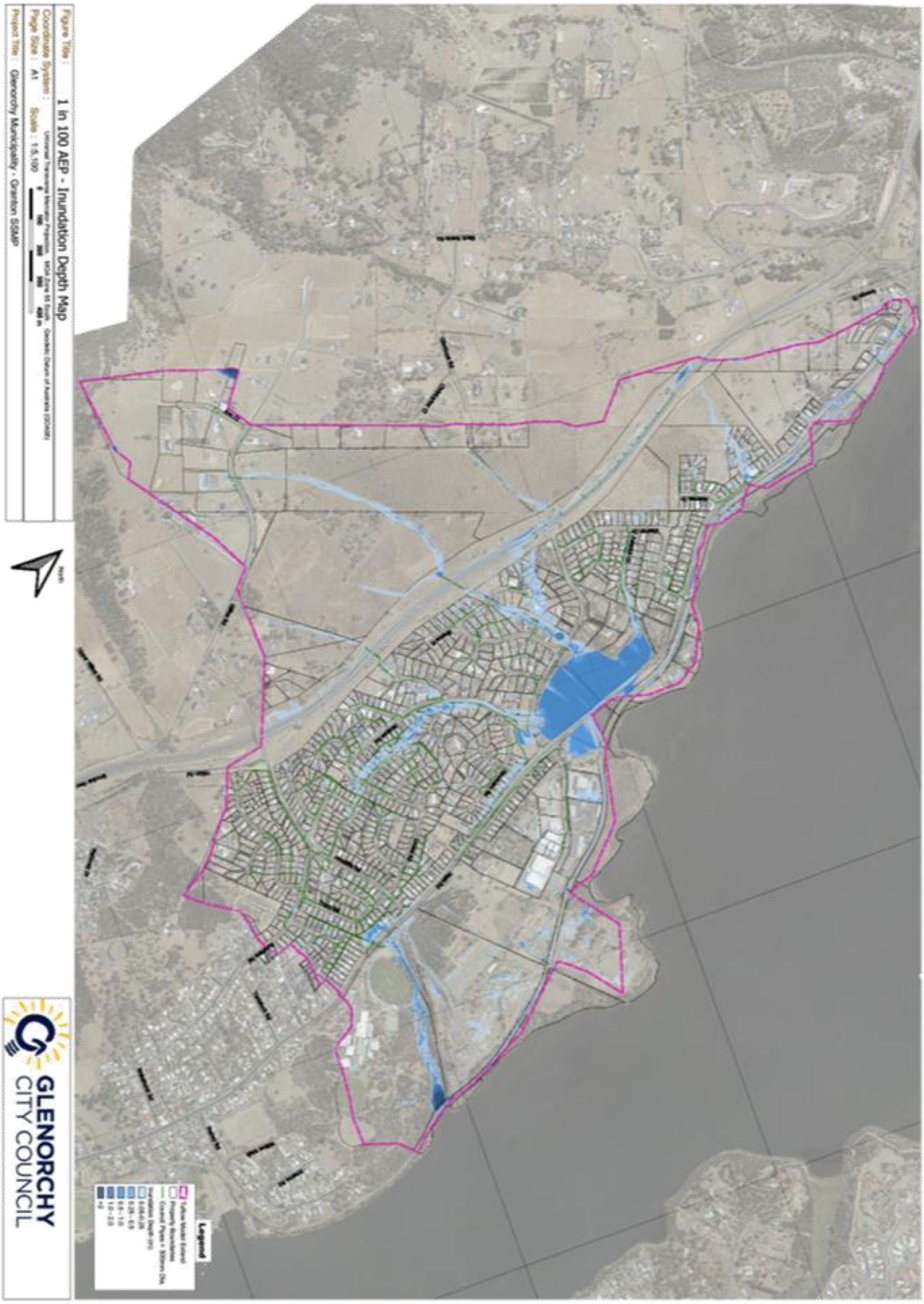
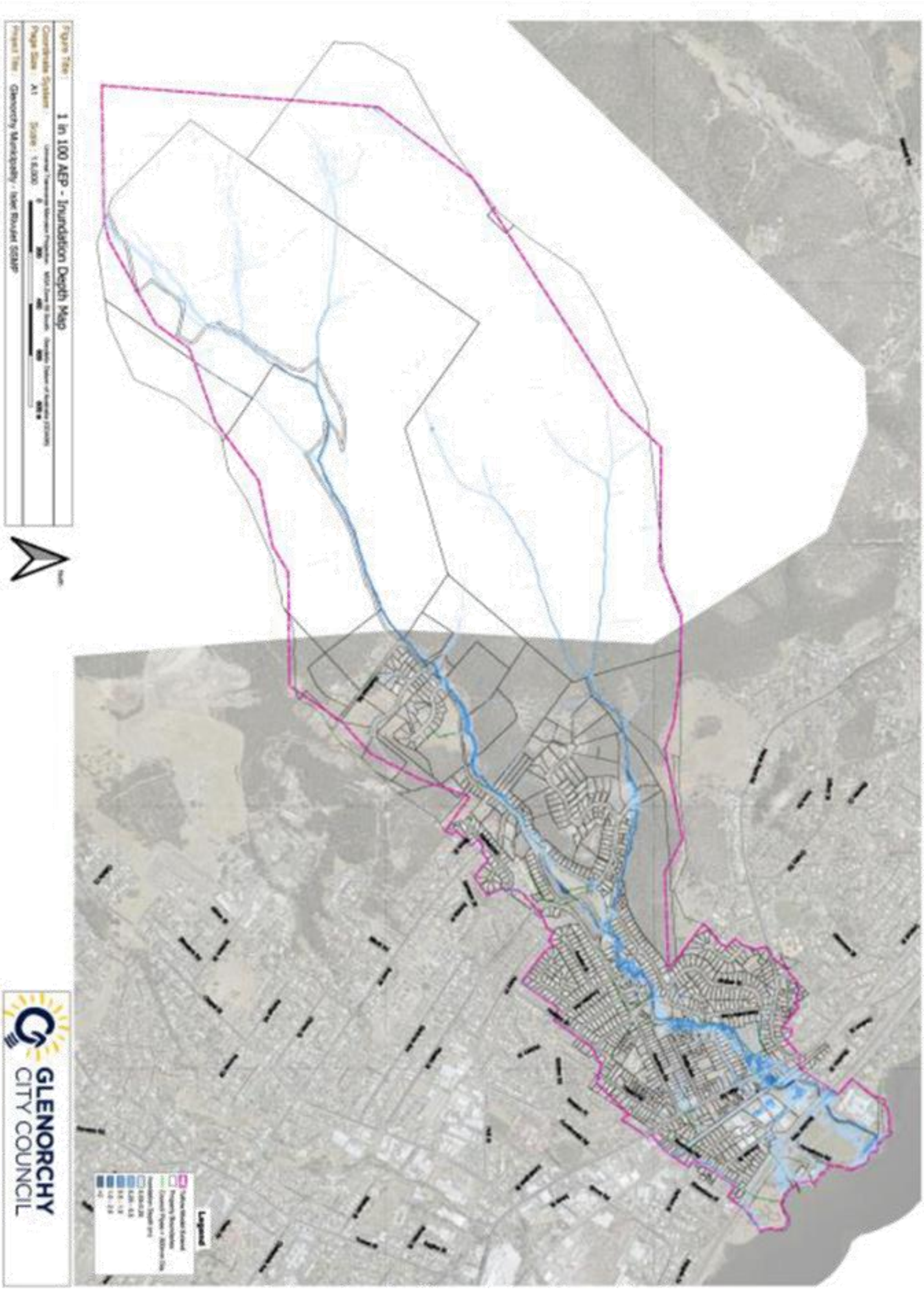

Faulkners Rivulet – 1% AEP Inundation Depth Map
1 in 100 AEP - Inundation Depth Map
Glenorchy Municipality - Faulkner's Rivulet SSMP
GLENORCHY
CITY COUNCIL
Legend

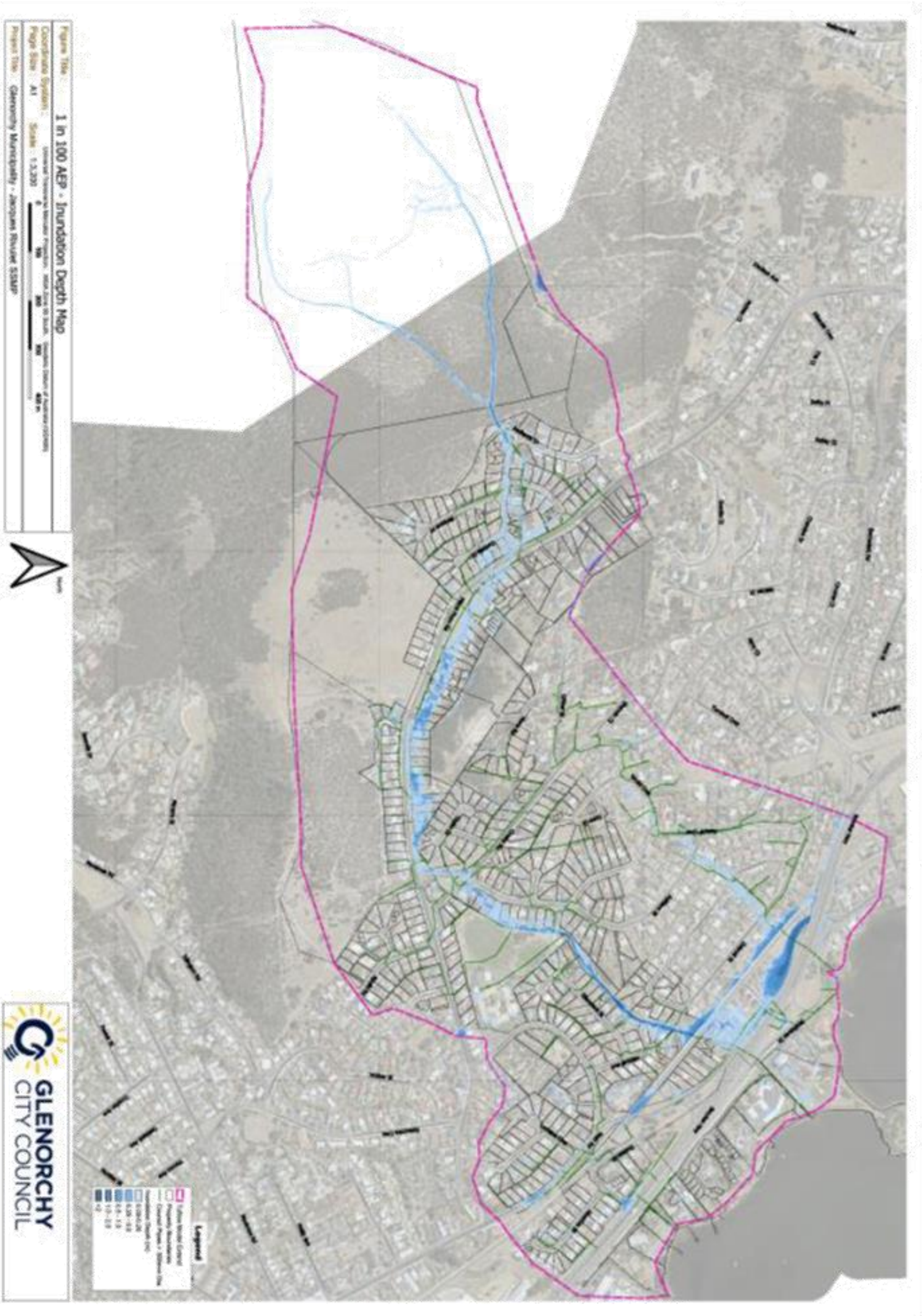
Goodwood – 1% AEP Inundation Depth Map

Granton – 1% AEP Inundation Depth Map



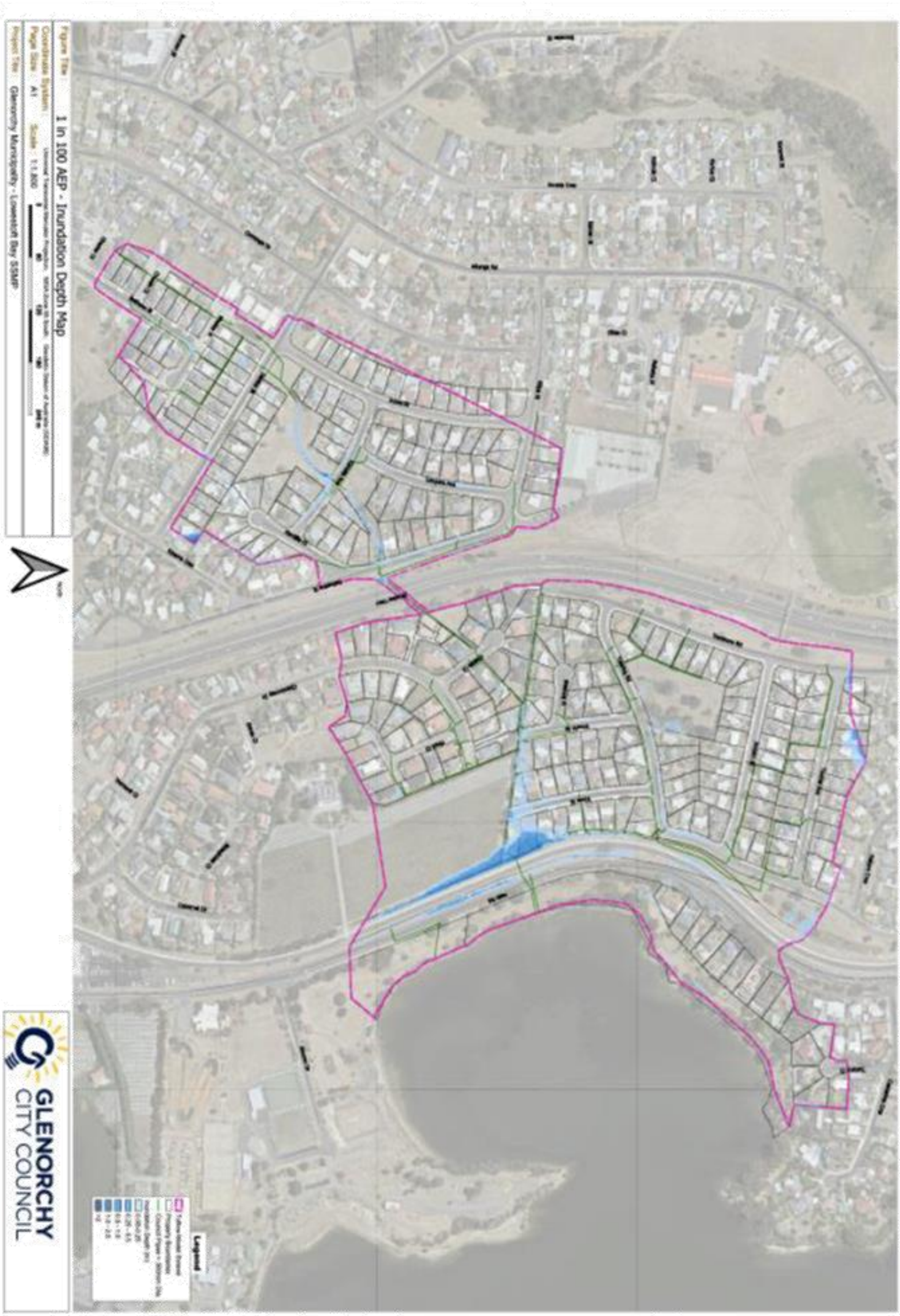


Islet Rivulet – 1% AEP Inundation Depth Map

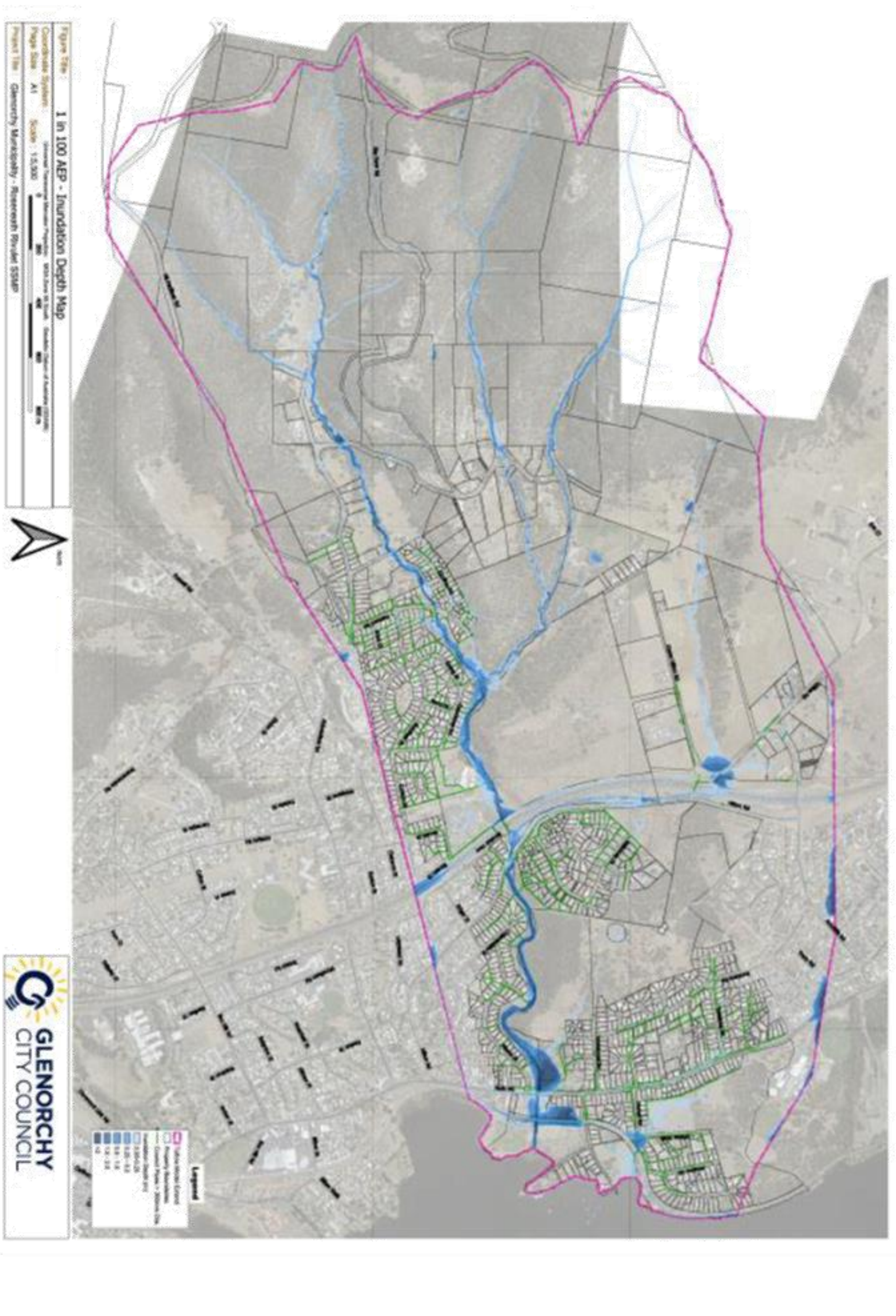


Jacques Rivulet – 1% AEP Inundation Depth Map

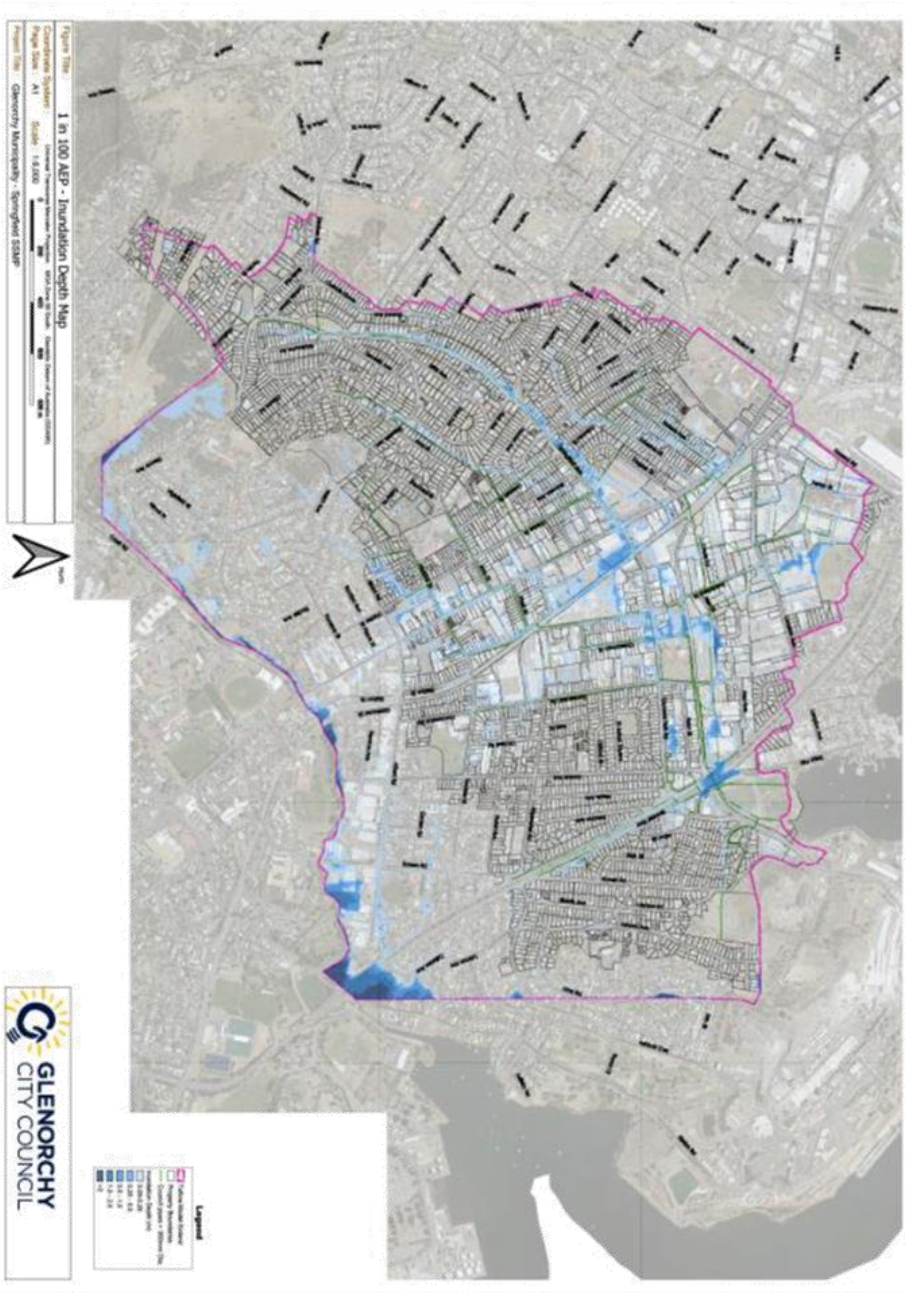
Lowestoft Bay – 1% AEP Inundation Depth Map



Roseneath Rivulet – 1% AEP Inundation Depth Map



Springfield – 1% AEP Inundation Depth Map



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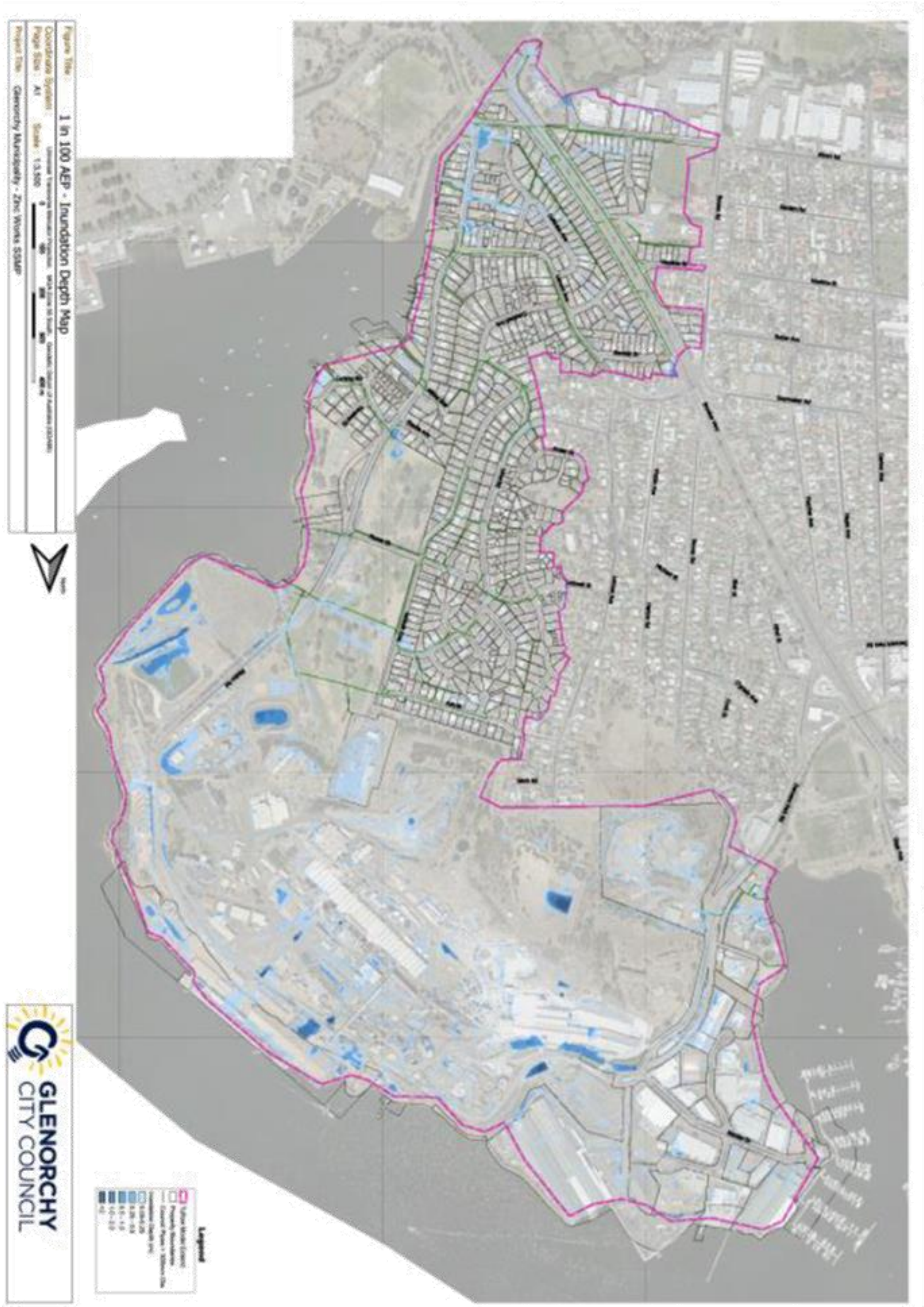
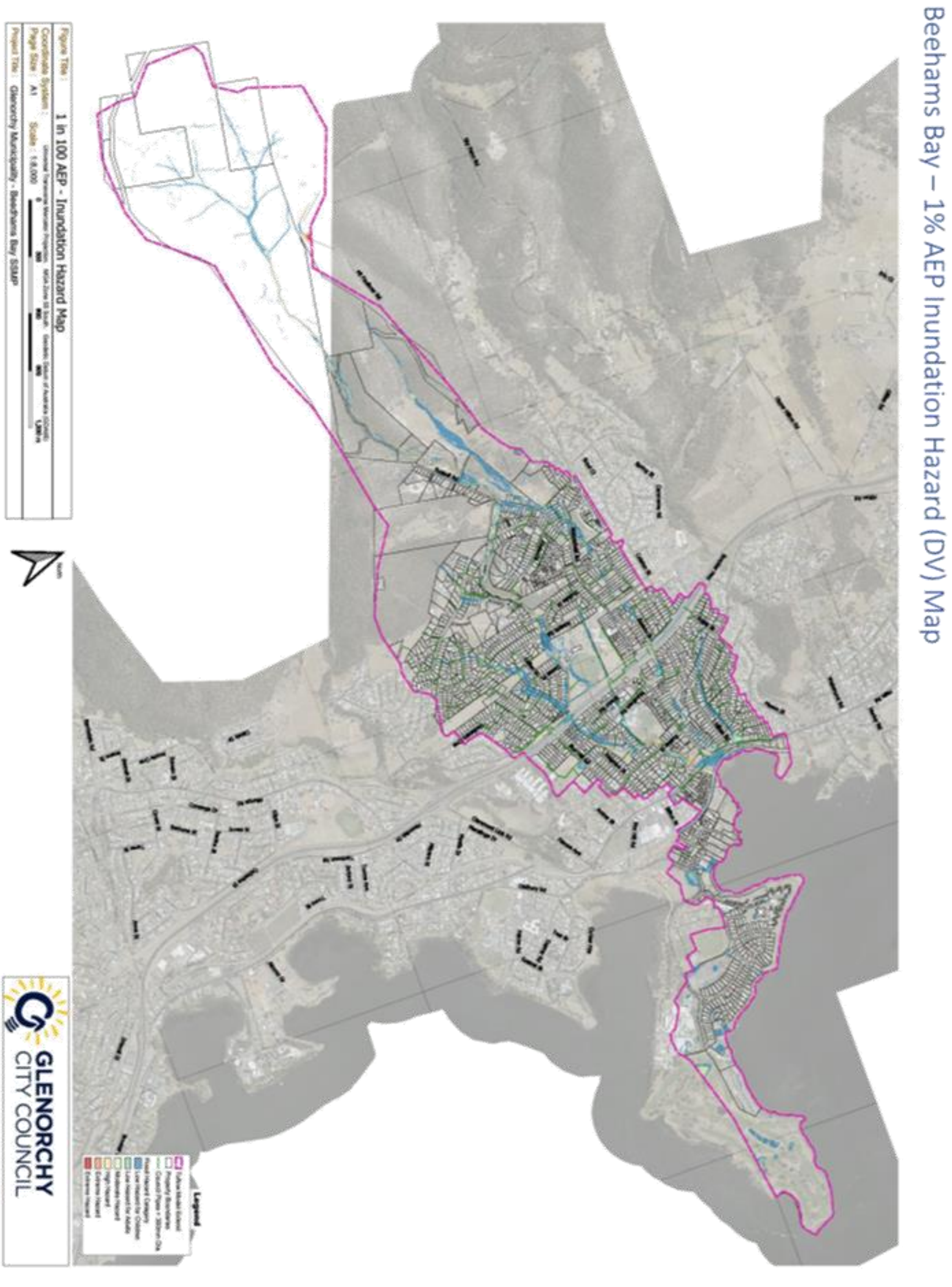
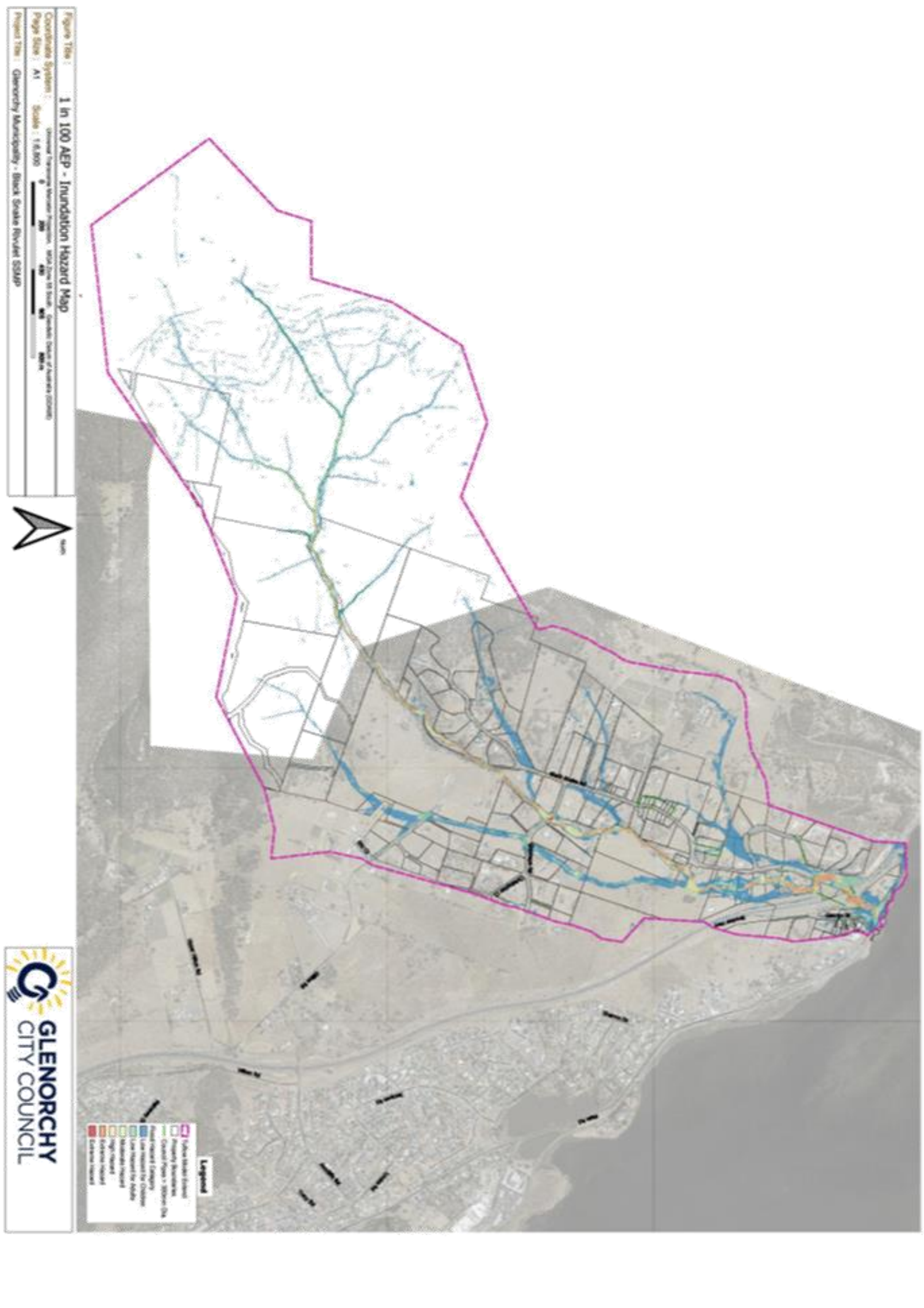


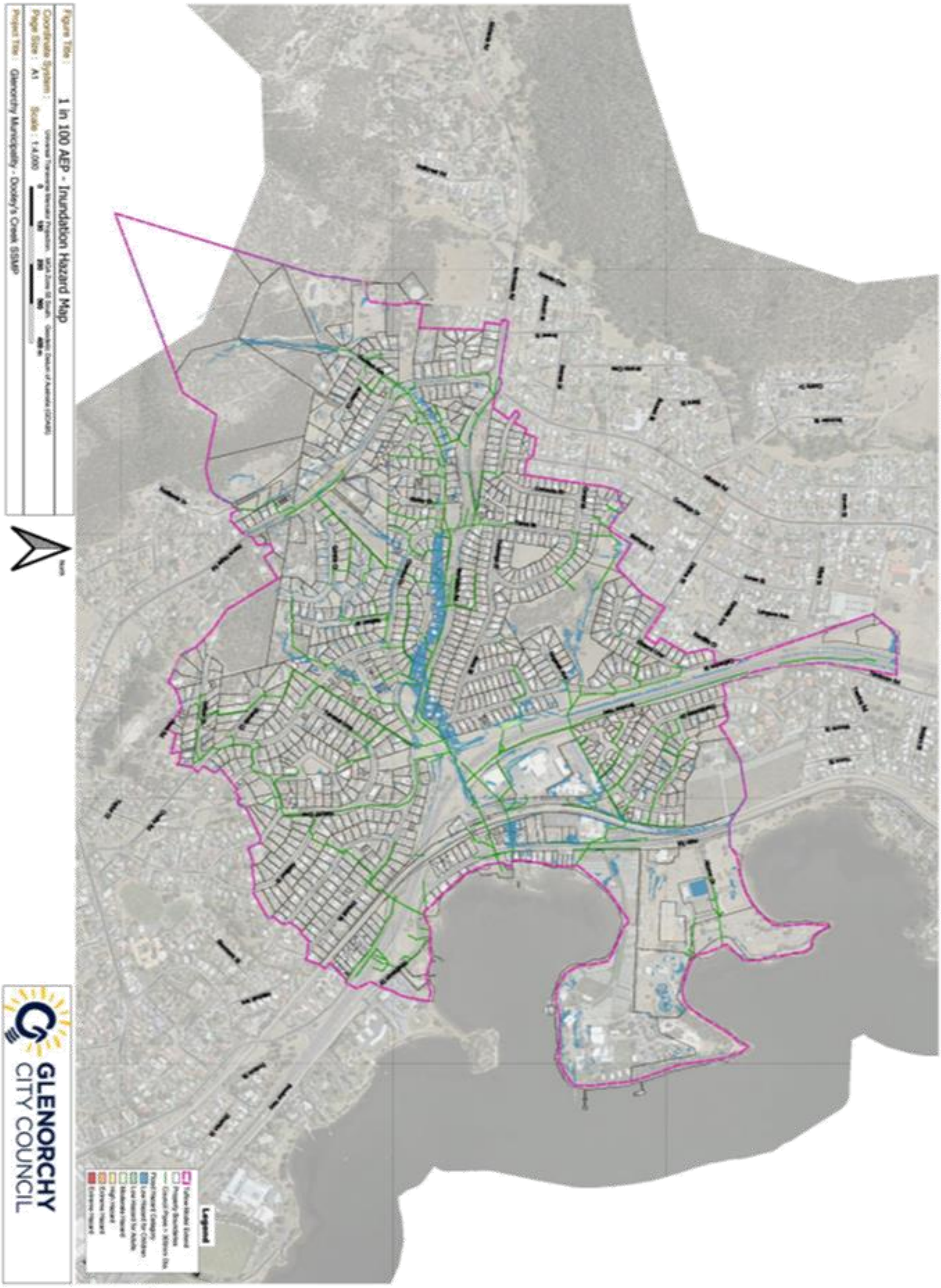

Beehams Bay – 1% AEP Inundation Hazard (DV) Map
1 in 100 AEP - Inundation Hazard Map
GLENORCHY CITY COUNCIL

Black Snake Rivulet – 1% AEP Inundation Hazard (DV) Map



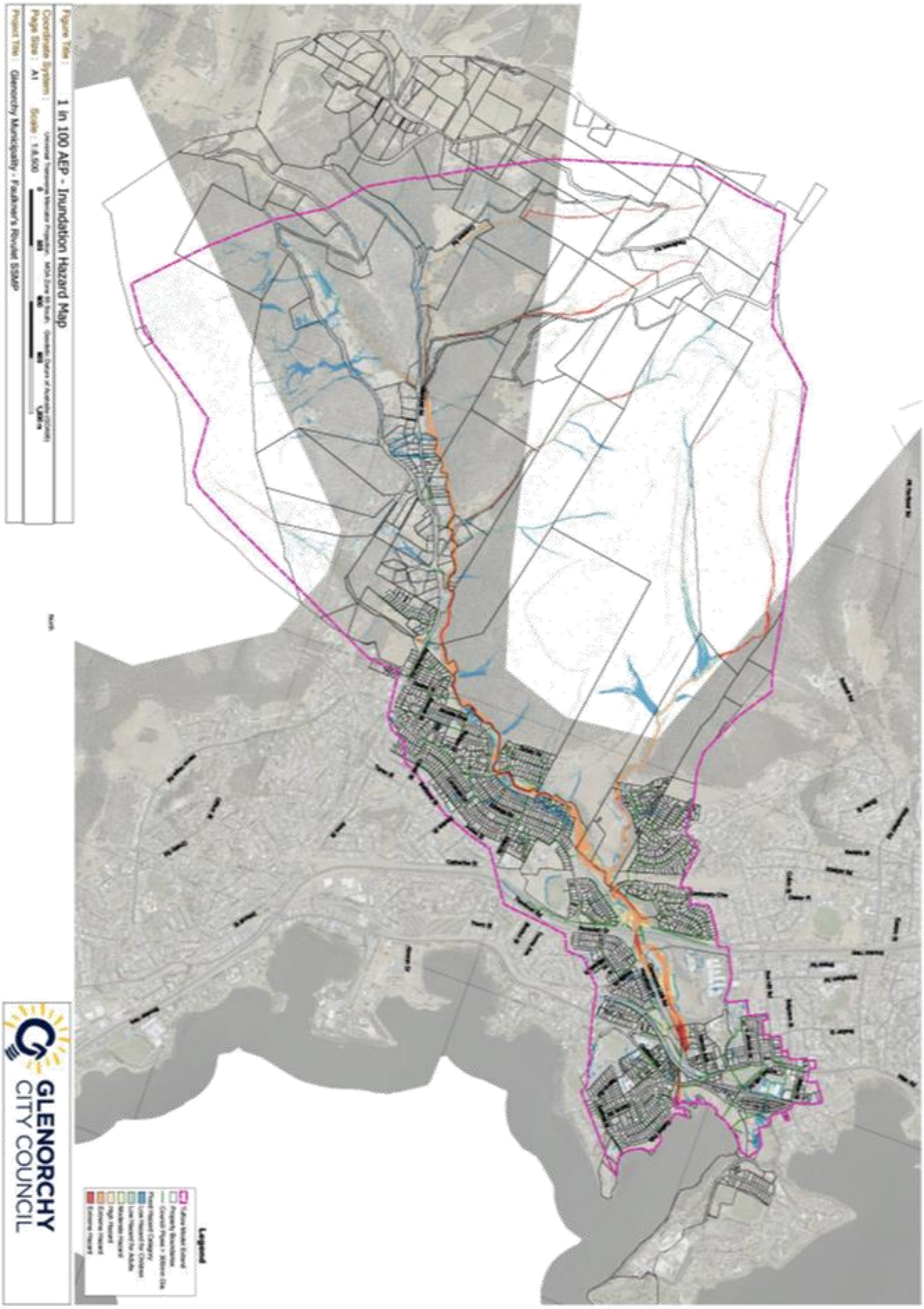
Connewarre Bay – 1% AEP Inundation Hazard (DV) Map

Dooleys Creek – 1% AEP Inundation Hazard (DV) Map

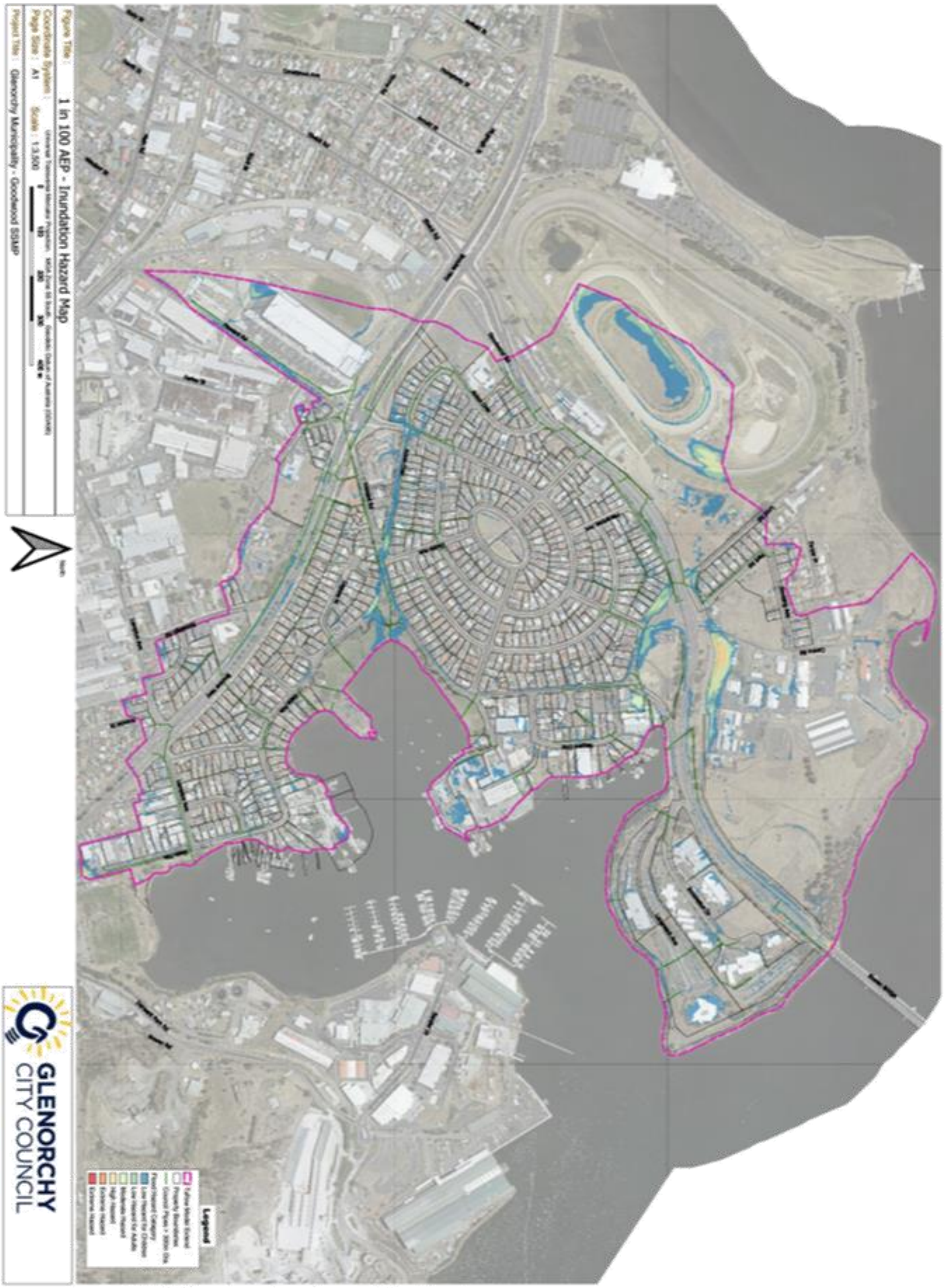


Dowsing Point – 1% AEP Inundation Hazard (DV) Map

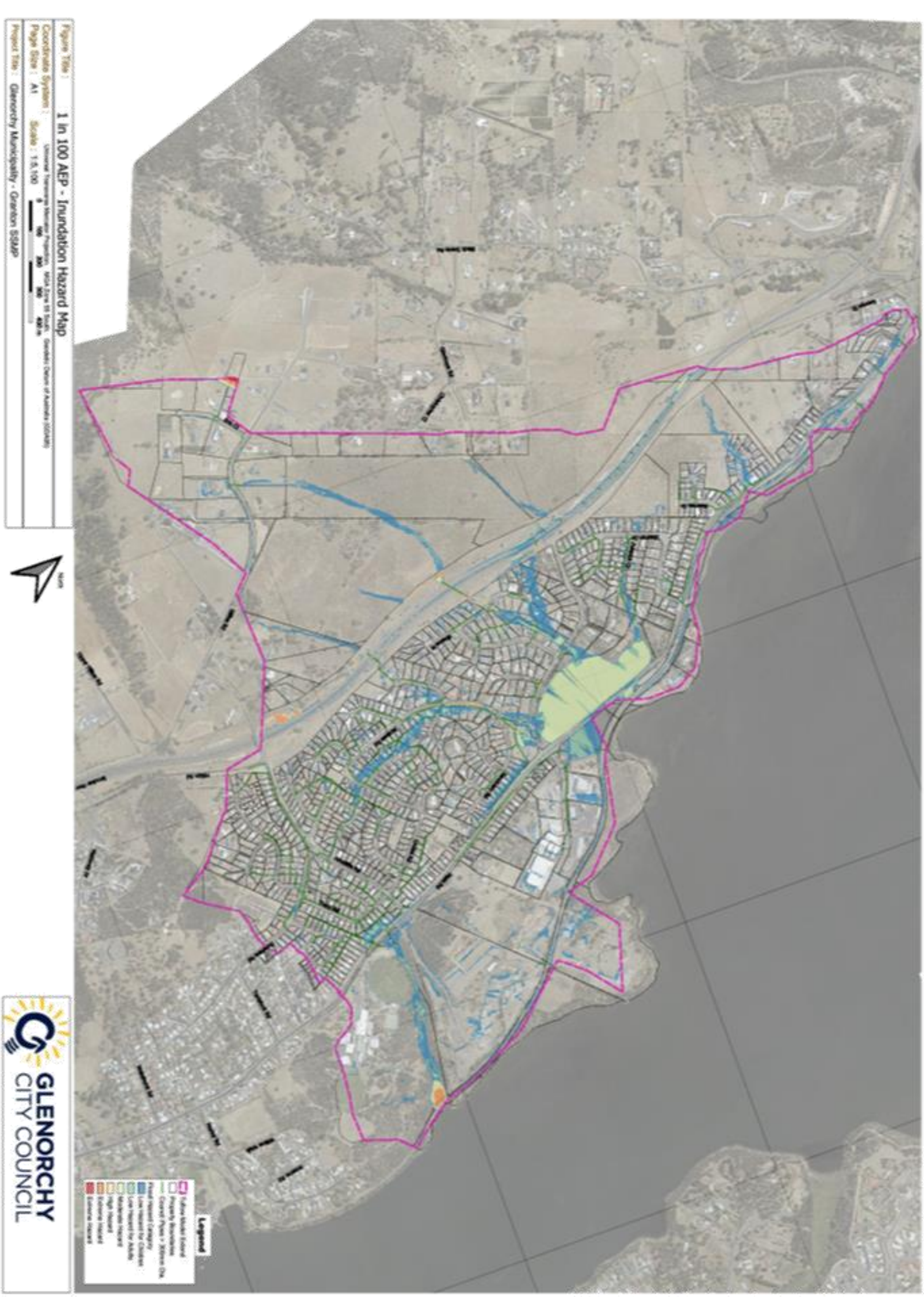
Faulkners Rivulet – 1% AEP Inundation Hazard (DV) Map



Goodwood – 1% AEP Inundation Hazard (DV) Map



Granton – 1% AEP Inundation Hazard (DV) Map



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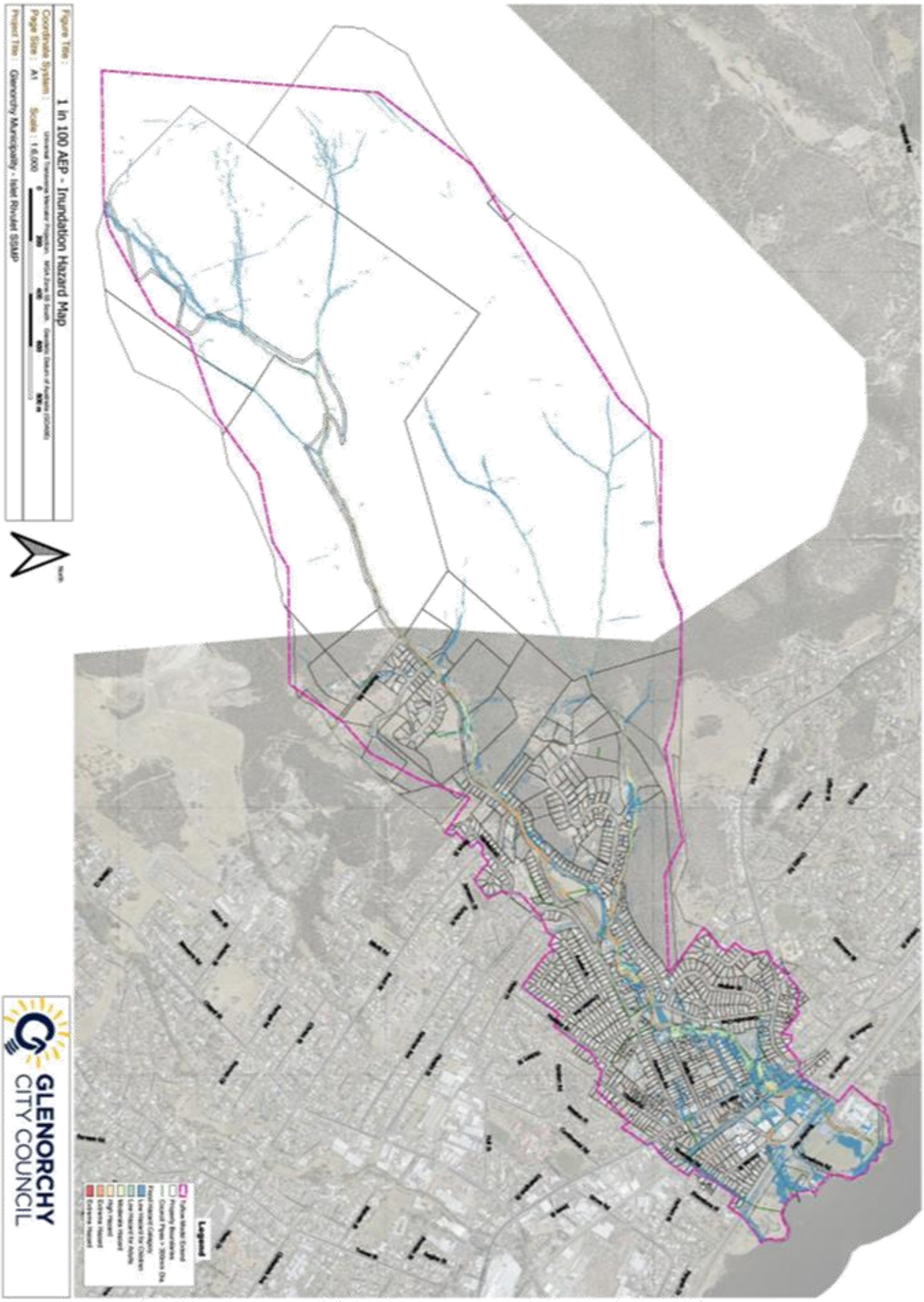

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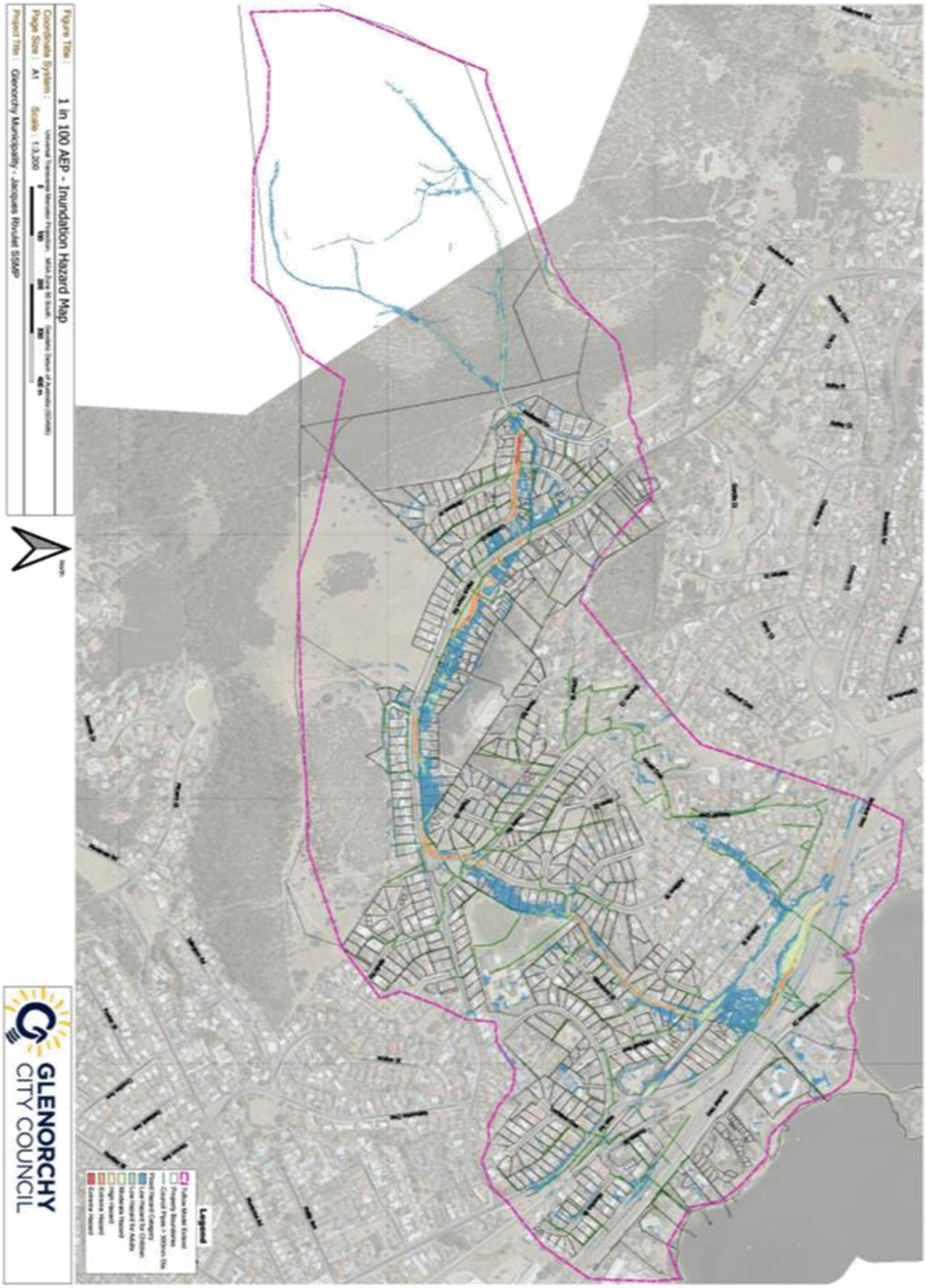
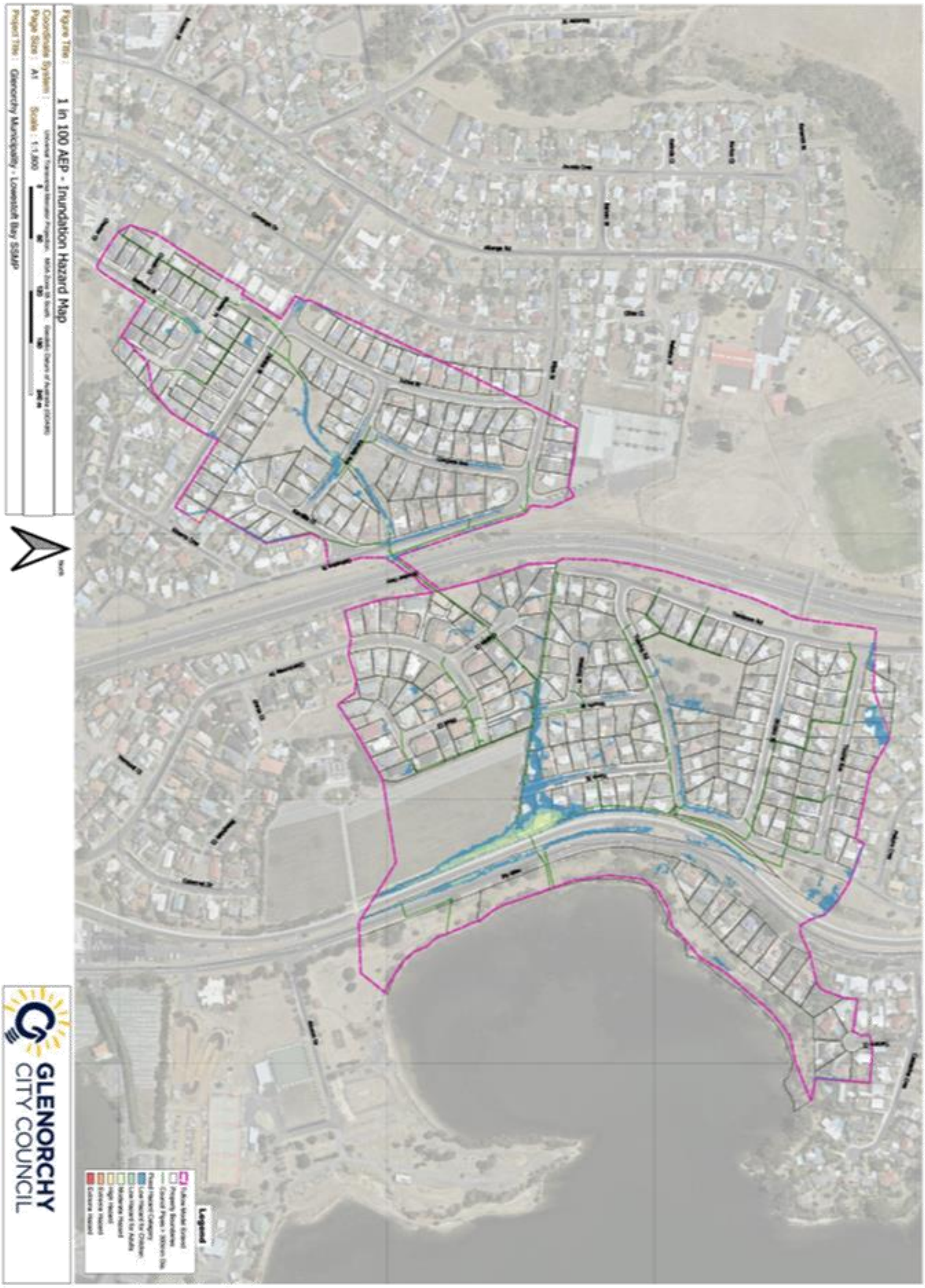
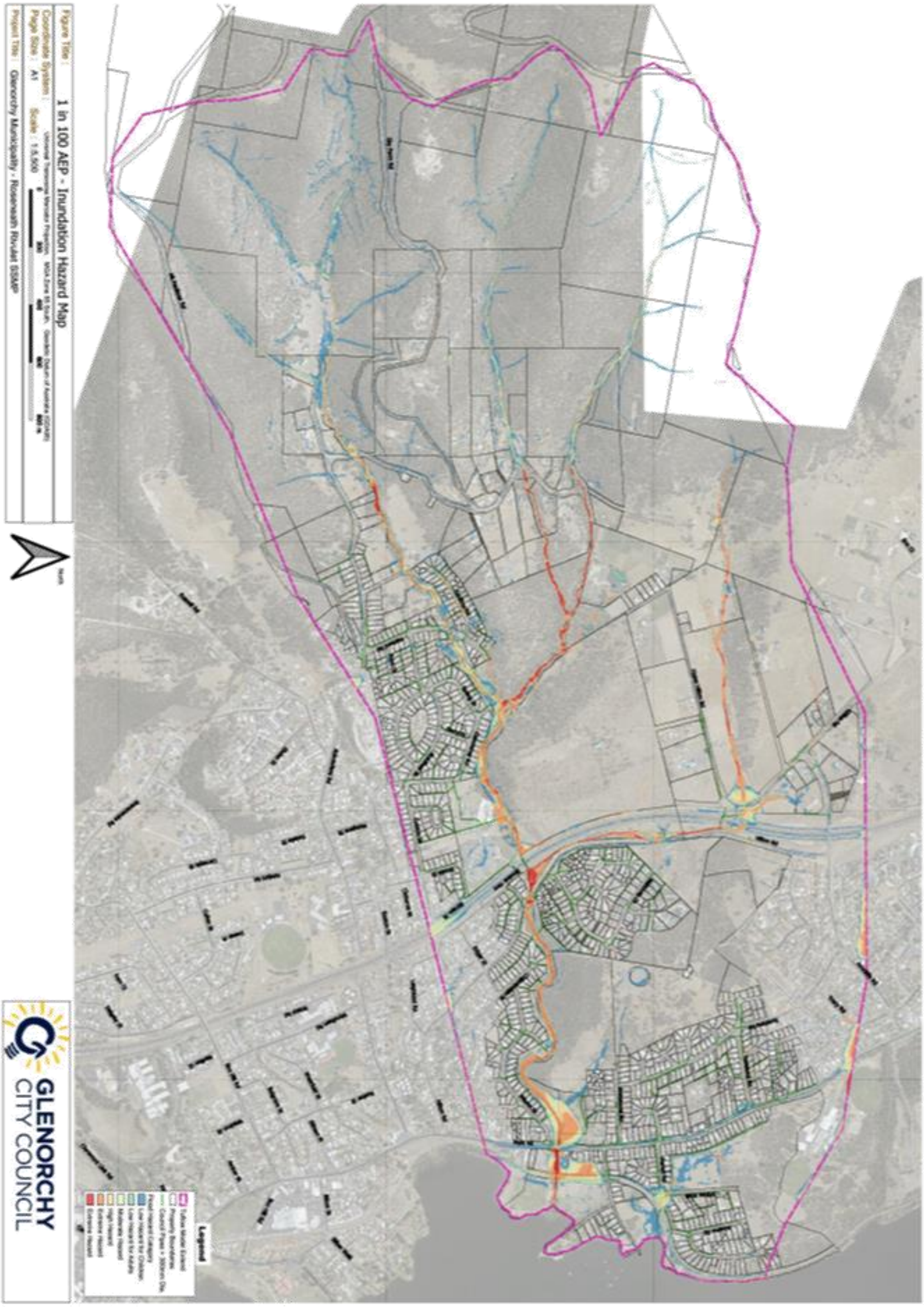


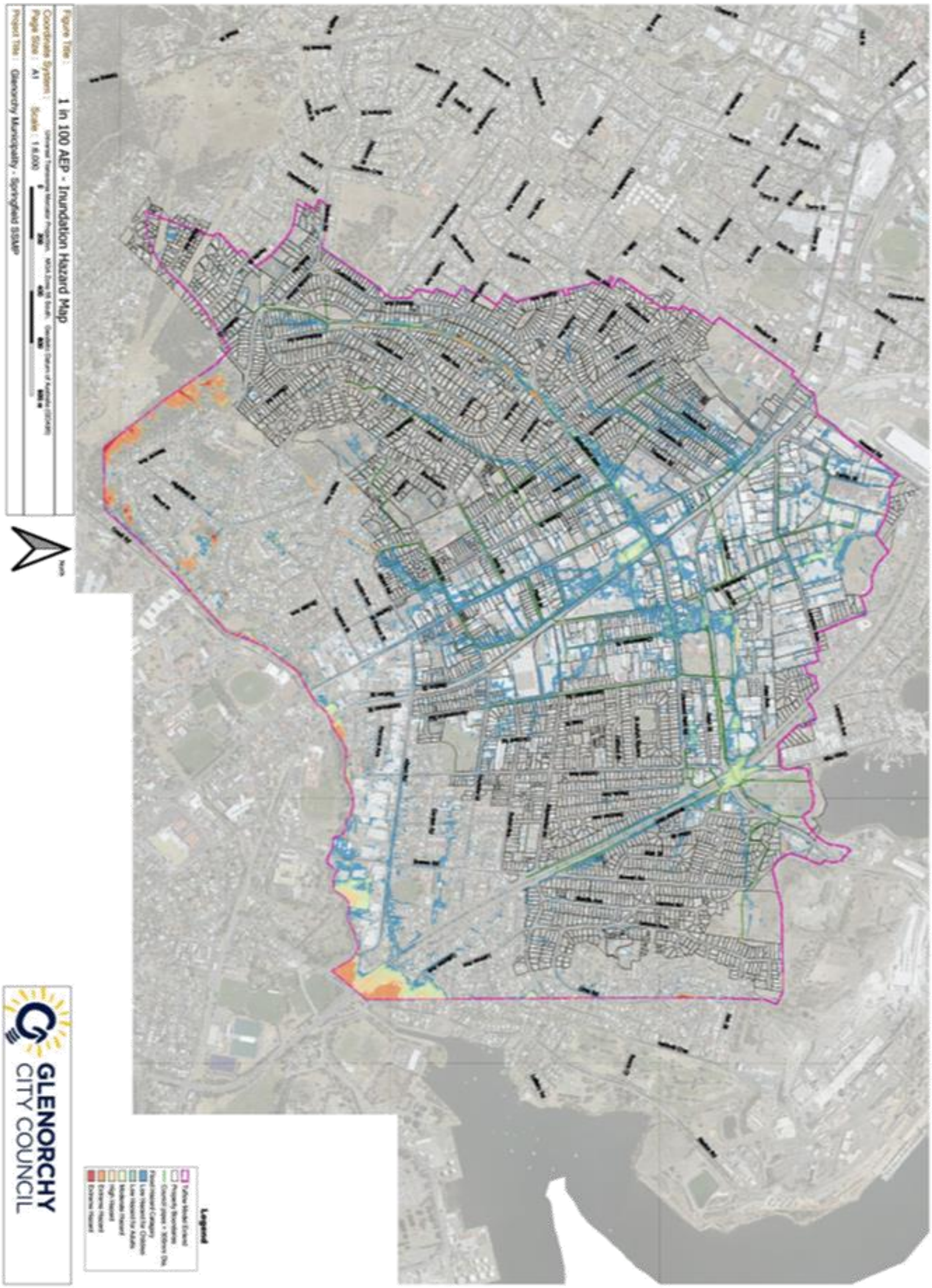
Lowestoft Bay – 1% AEP Inundation Hazard (DV) Map

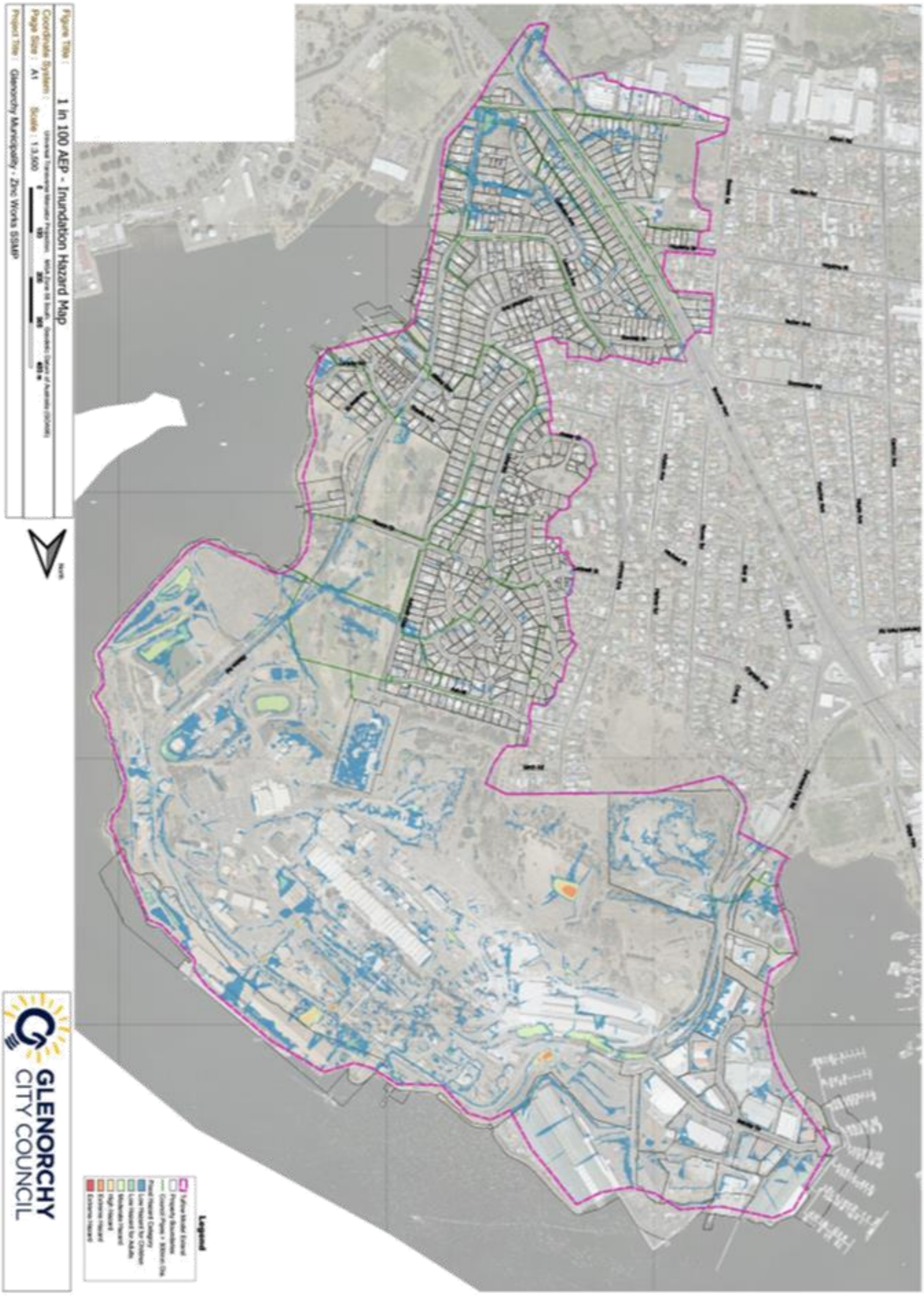


Roseneath Rivulet – 1% AEP Inundation Hazard (DV) Map



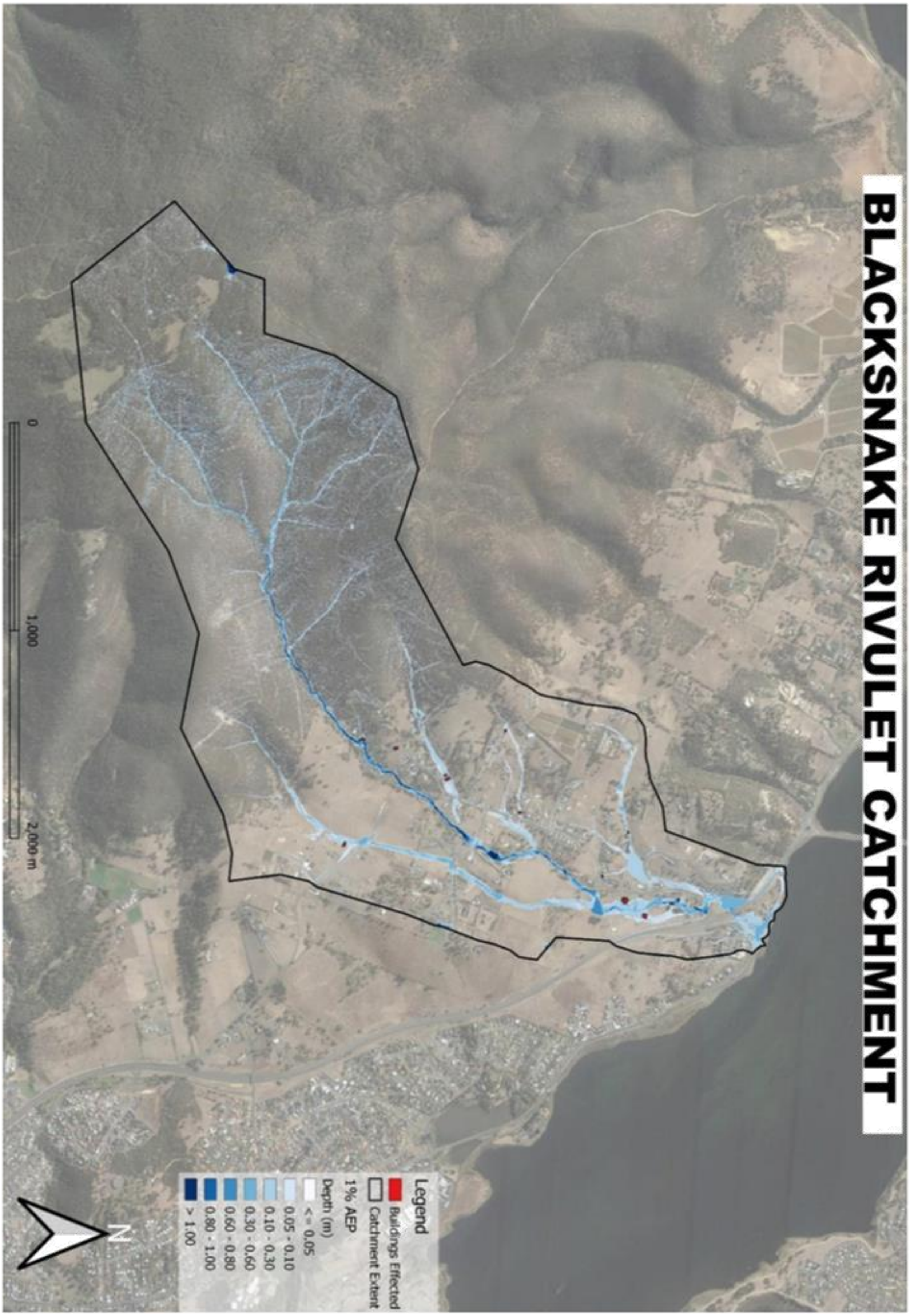
Springfield – 1% AEP Inundation Hazard (DV) Map





Zinc Works – 1% AEP Inundation Hazard (DV) Map


BEEDHAM'S BAY CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
N
0
1,000
2,000 m


BLACKSNAKE RIVULET CATCHMENT
0
1,000
2,000 m
N
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00


CONNEWARRE BAY CATCHMENT
0
300
600 m
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
N

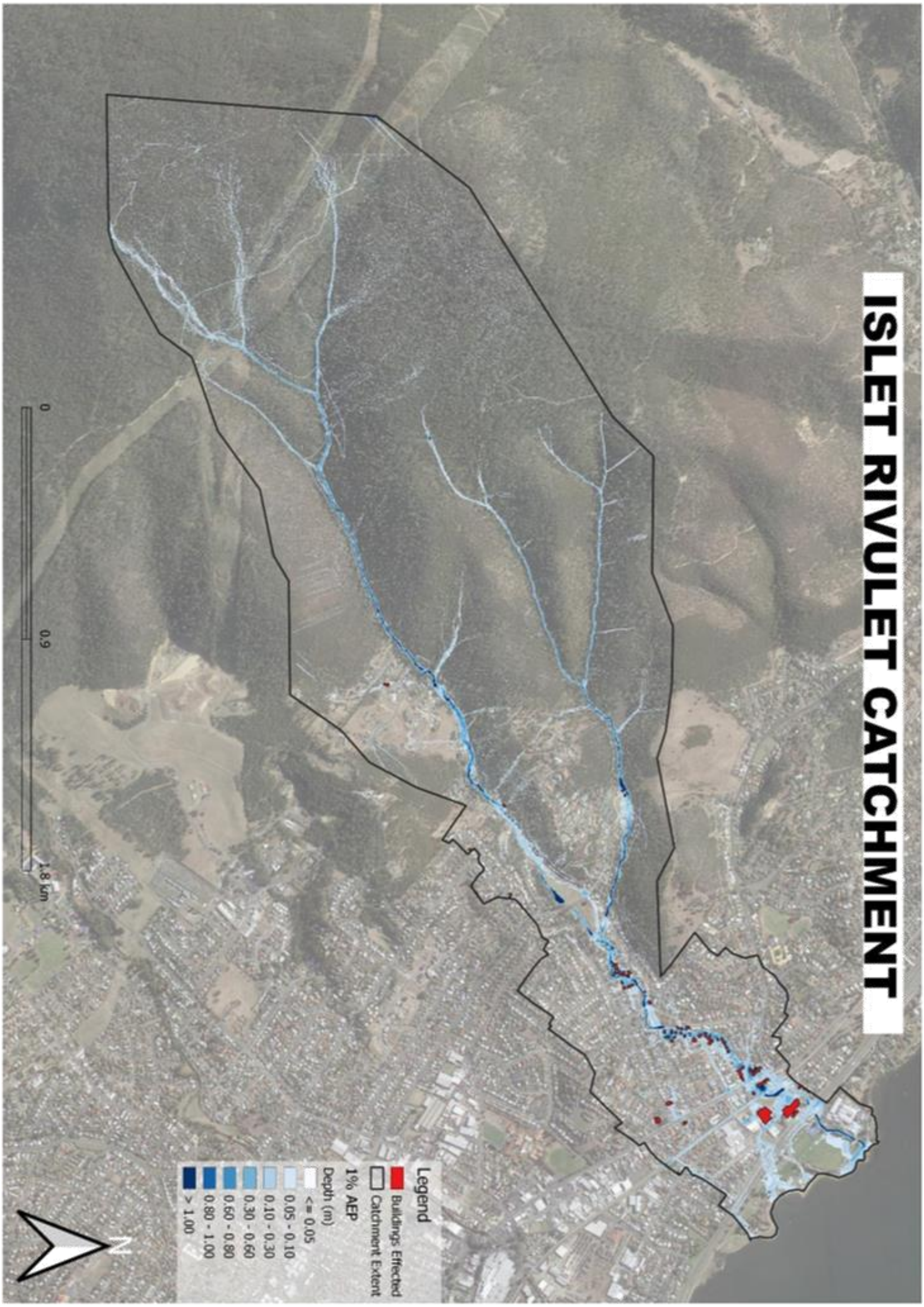

DOOLEY'S CREEK CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
600
1,200 m
N


DOWSINGS POINT CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
300
600 m
N


FAULKNERS RIVULET CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
1,000
2,000 m
N

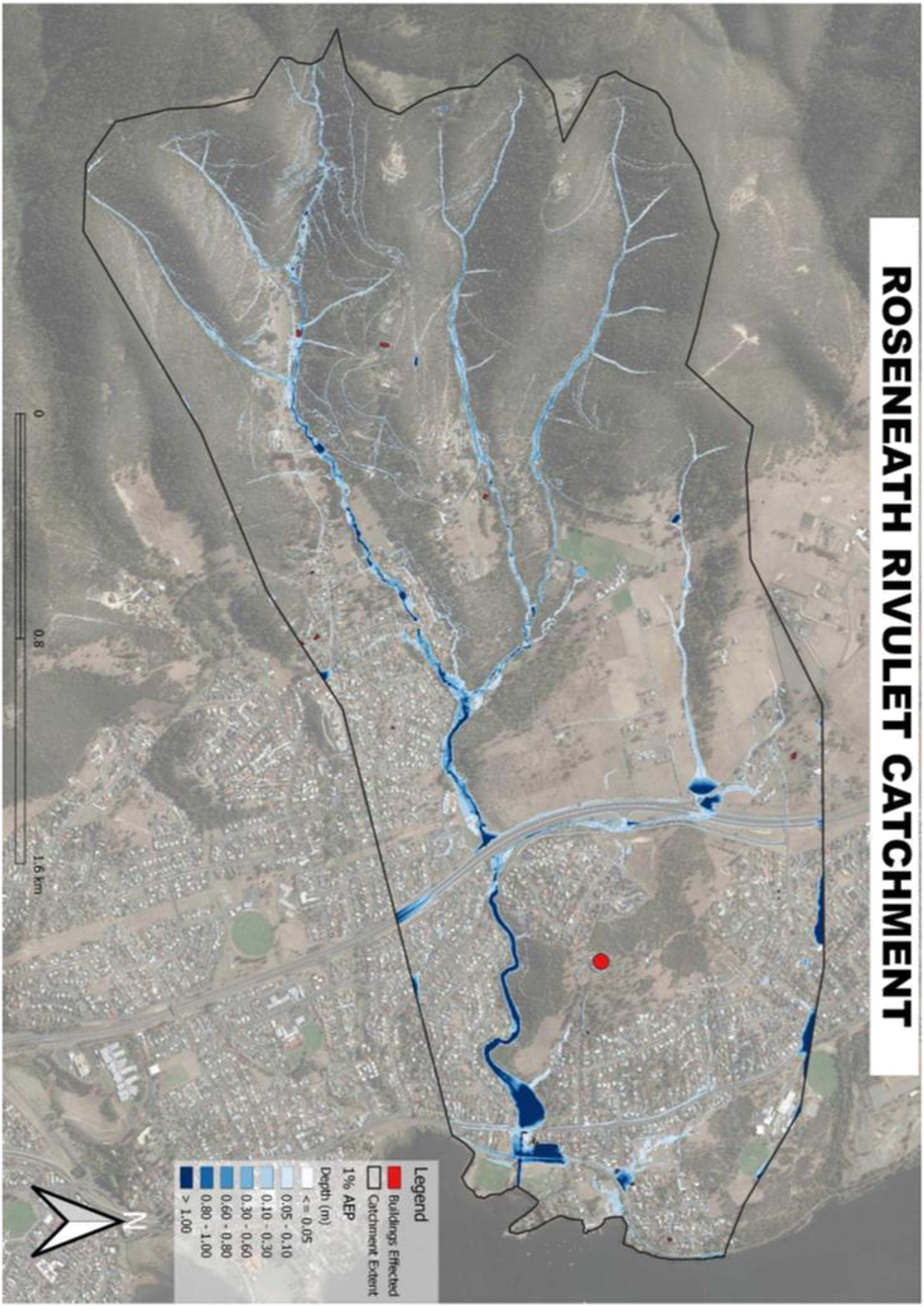

GOODWOOD CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
500
1,000 m
N

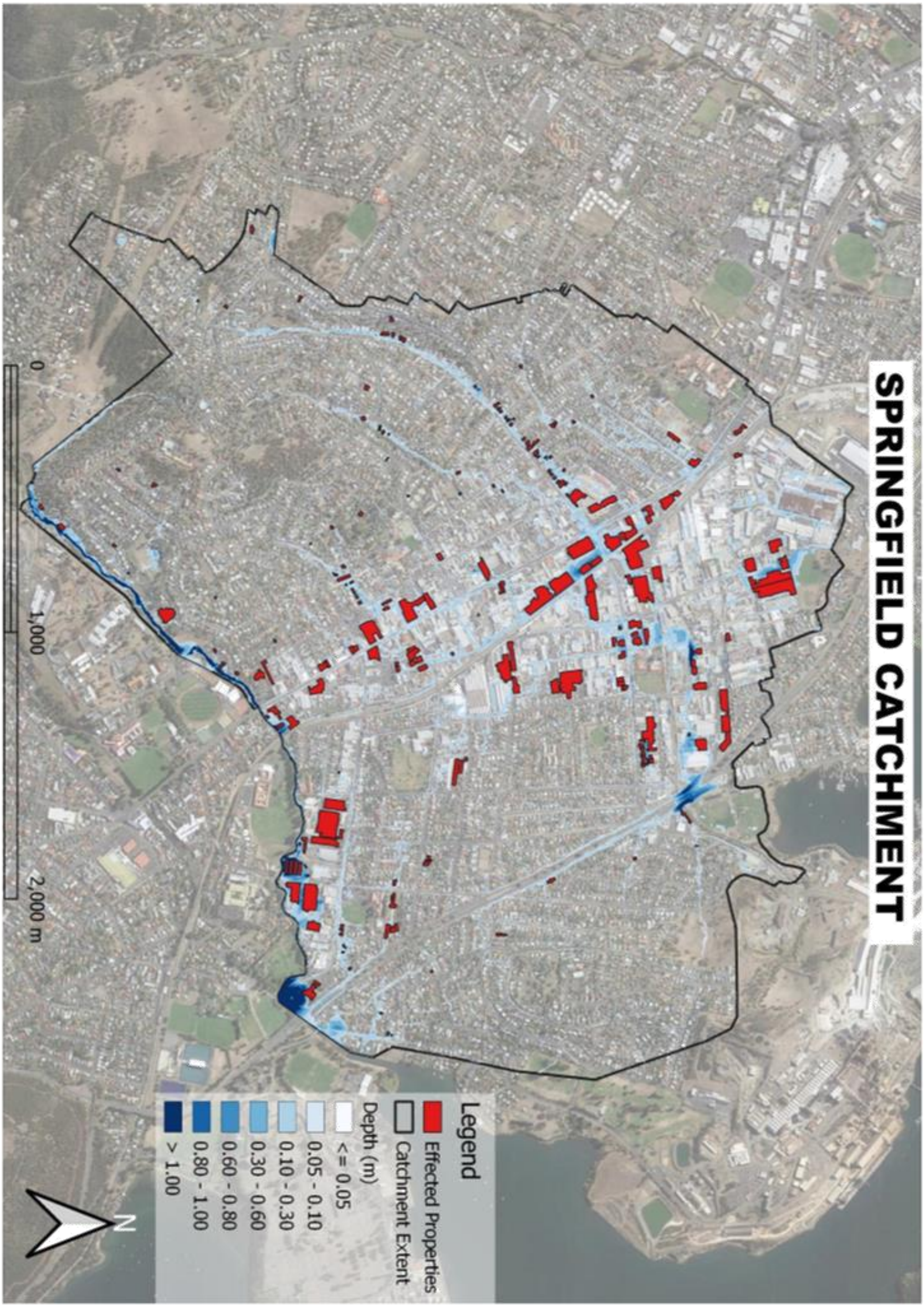

GRANTON CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
700
1,400 m
N


ISLET RIVULET CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
0.9
1.8 km
N


JACQUES RIVULET CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
400
800 m
N


LOWESTOFT BAY CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
200
400 m
N


ROSENEATH RIVULET CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
0.8
1.6 km
N


SPRINGFIELD CATCHMENT
Legend
Effected Properties
Catchment Extent
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
0
1,000
2,000 m
N

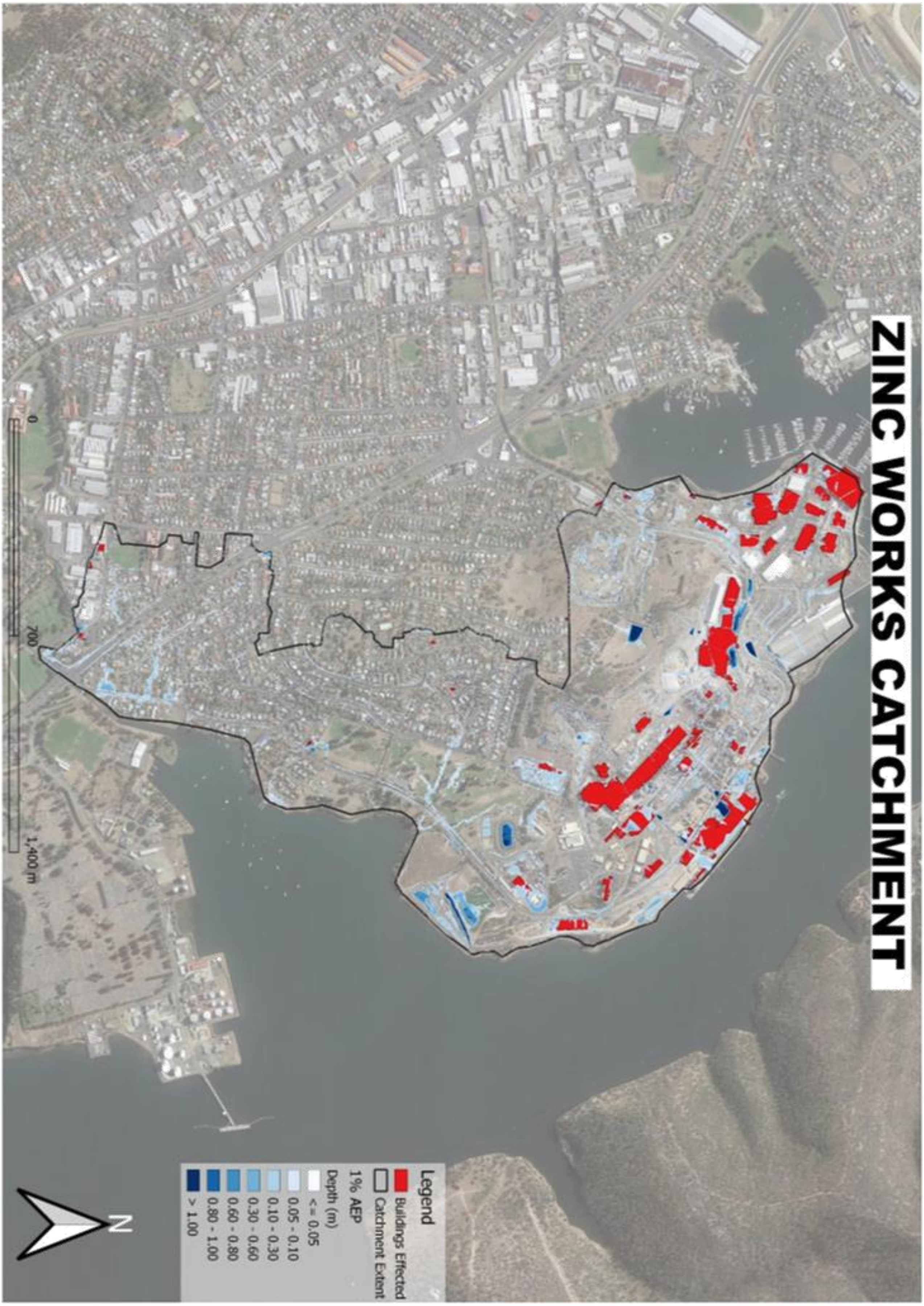

ZINC WORKS CATCHMENT
Legend
Buildings Effected
Catchment Extent
1% AEP
Depth (m)
<= 0.05
0.05 - 0.10
0.10 - 0.30
0.30 - 0.60
0.60 - 0.80
0.80 - 1.00
> 1.00
N
0
700
1,400 m

Figure 1.1 5% AEP Pre-Mitigation Option Area

Figure 1.2 1% AEP + CC Pre-Mitigation Option Area

Figure 1.3 5% AEP Post-Mitigation Option Area

Figure 1.4 1% AEP + CC Post-Mitigation Option Area

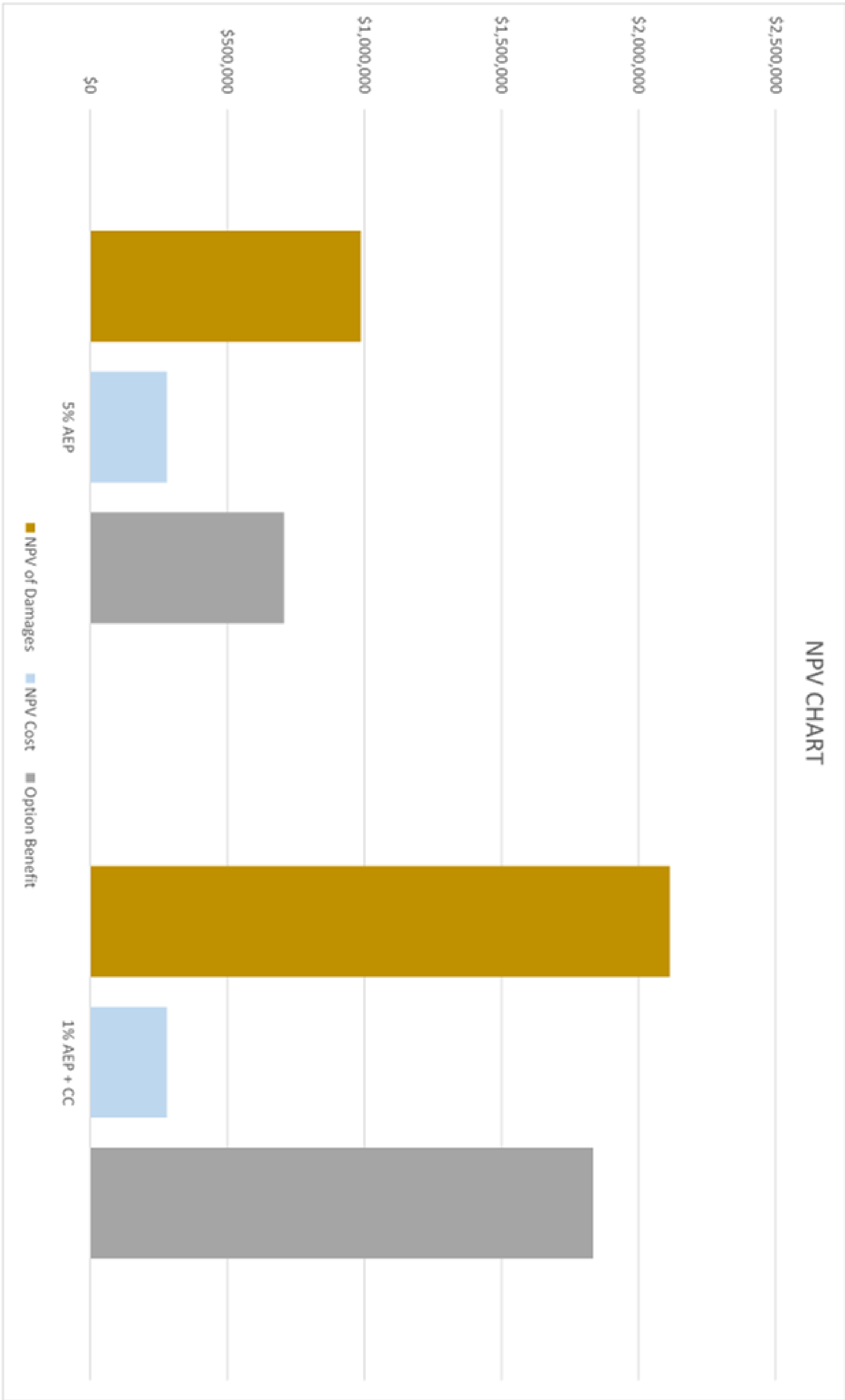


Figure 1.5 Benefit Cost Chart for Net Present Value (NPV)

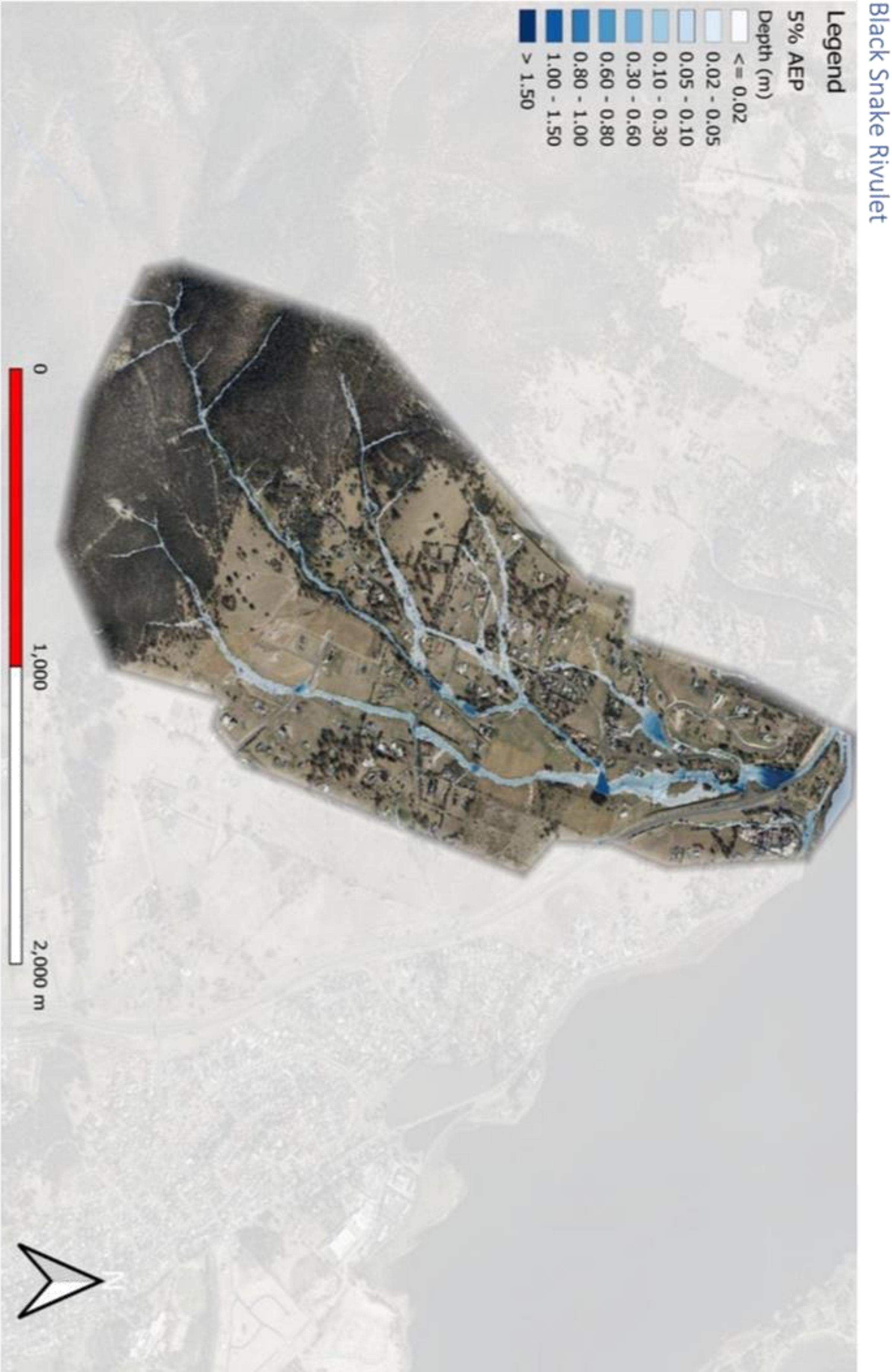


Figure 2.1 Mitigation Option Area- Black Snake Rivulet

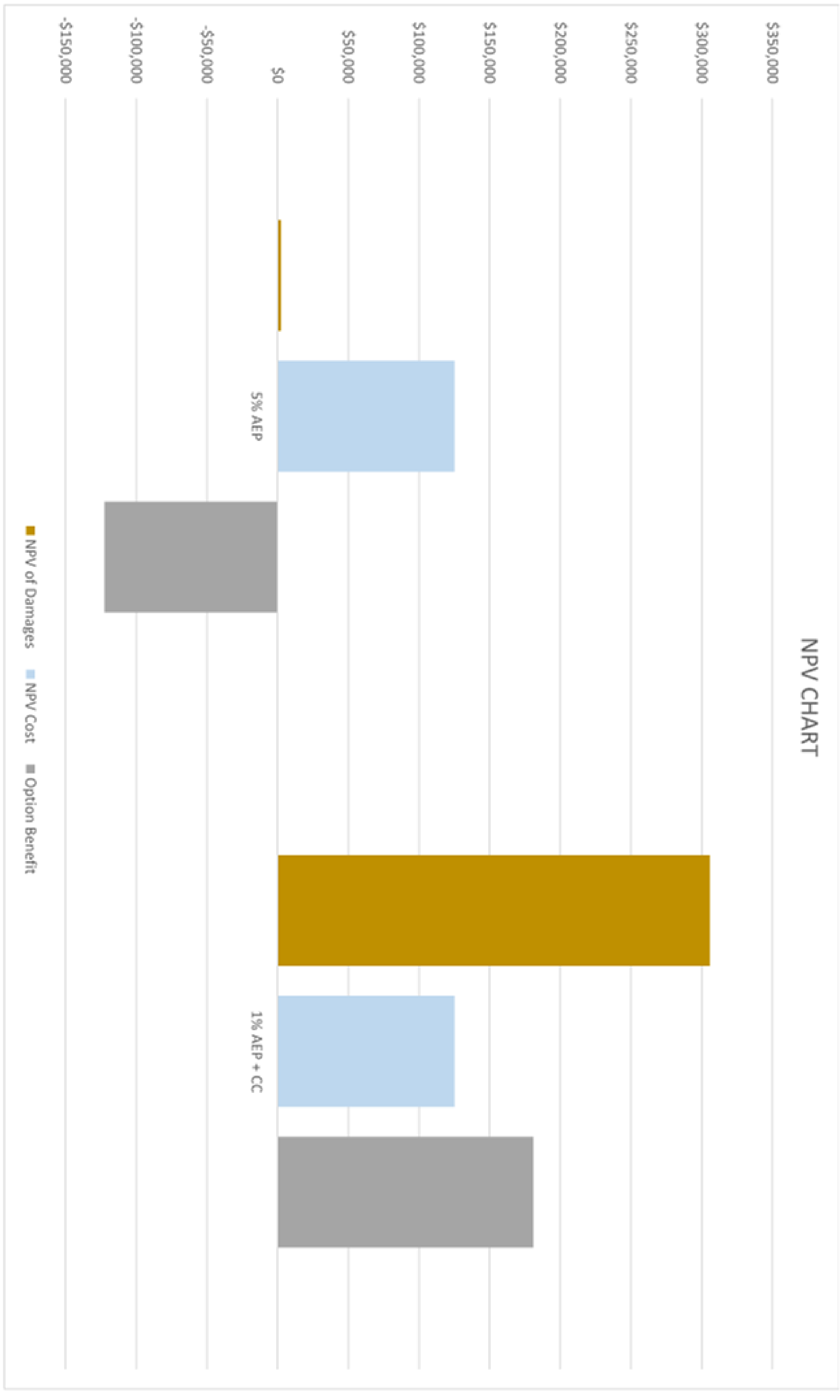


Figure 2.2 Benefit Cost Chart for Net Present Value (NPV)

Figure 3.1 5% AEP Pre-Mitigation Option Area

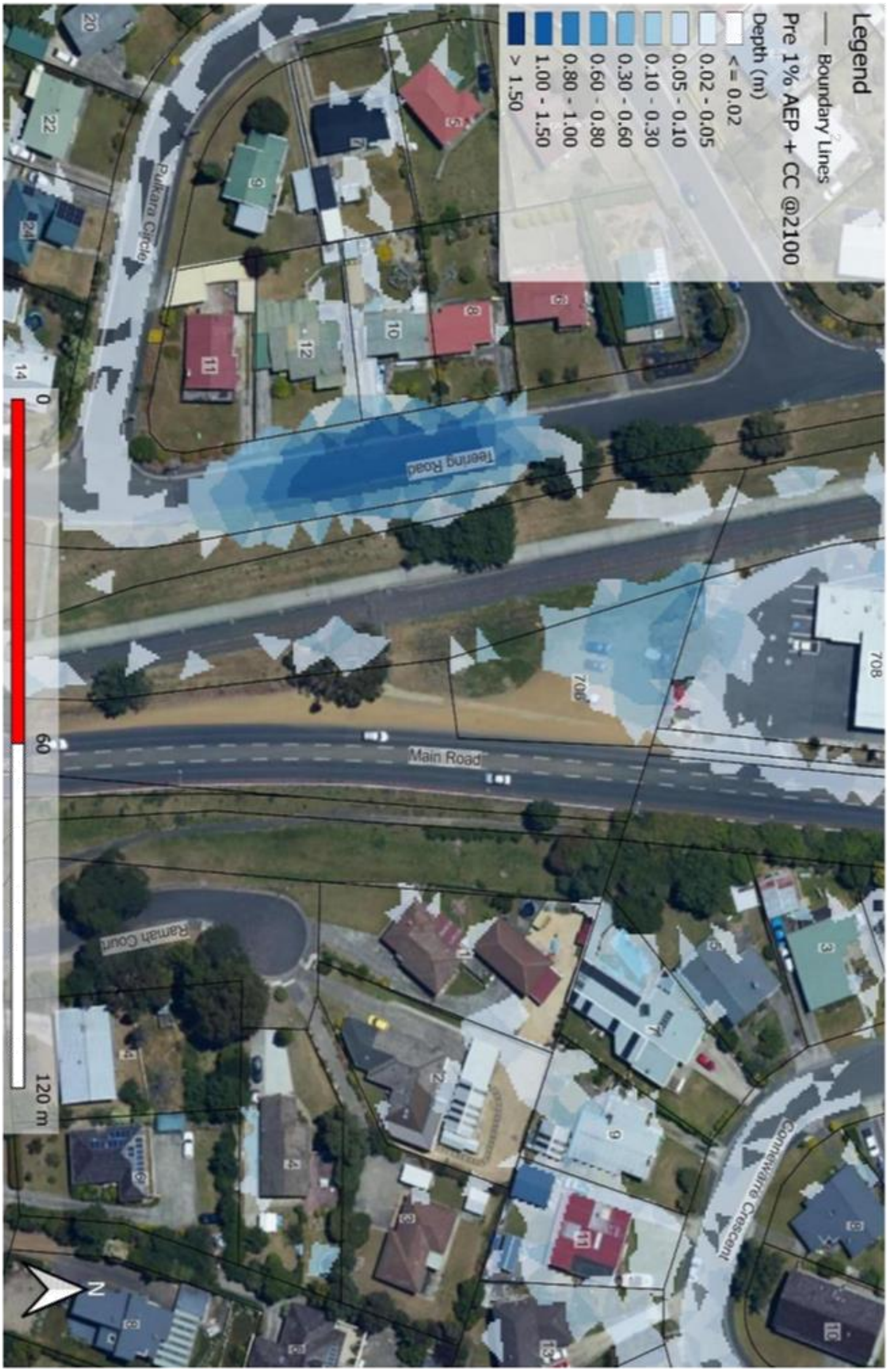


Figure 3.2 1% AEP + CC Pre-Mitigation Option Area

Figure 3.3 5% AEP Post-Mitigation Option Area

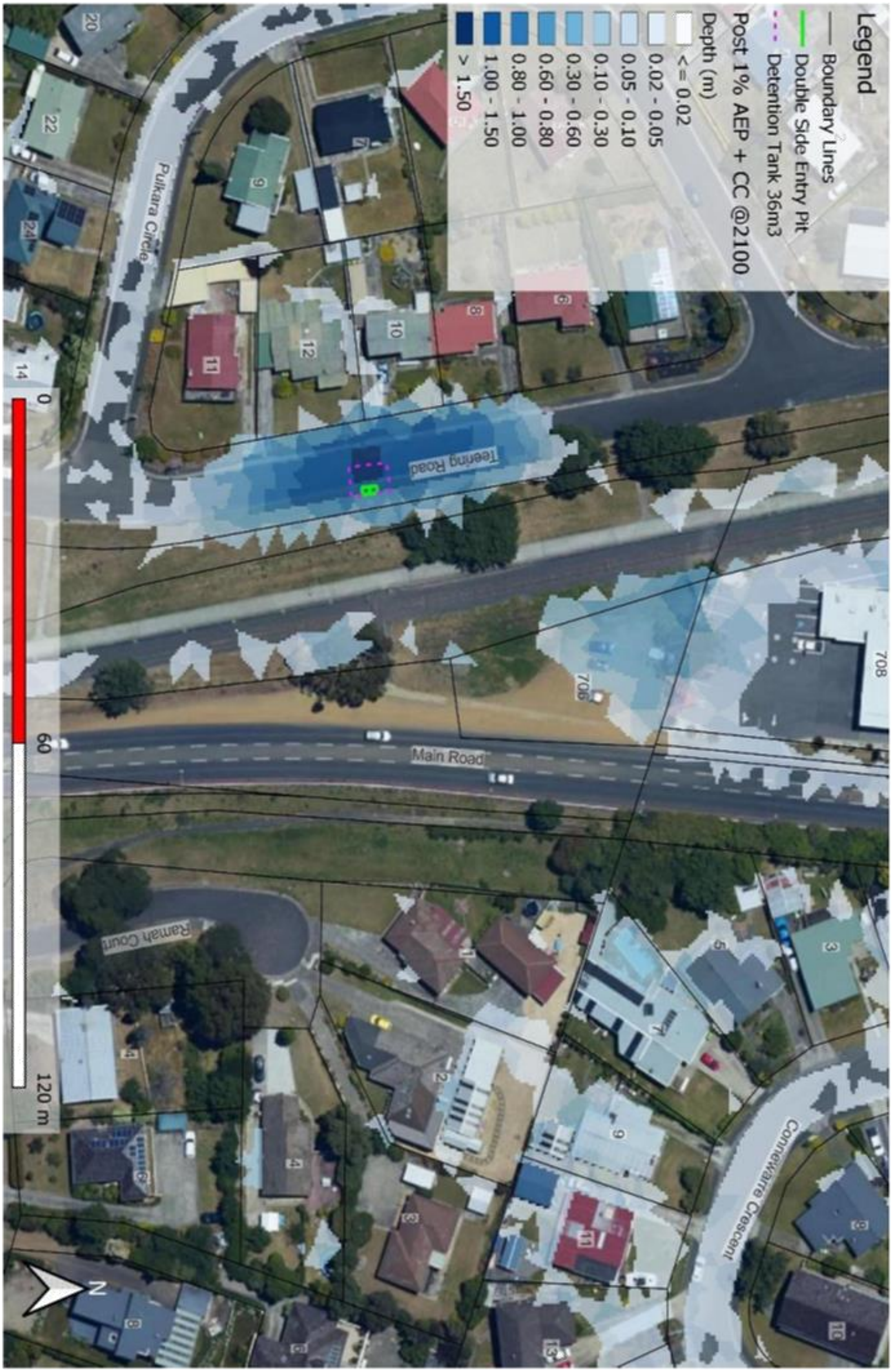


Figure 3.4 1% AEP + CC Post-Mitigation Option Area

Figure 3.5 Benefit Cost Chart for Net Present Value (NPV)

Figure 4.1 5% AEP Pre-Mitigation Option Area

Figure 4.2 1% AEP + CC Pre-Mitigation Option Area

Figure 4.3 5% AEP Post-Mitigation Option Area

Figure 4.4 1% AEP + CC Post-Mitigation Option Area

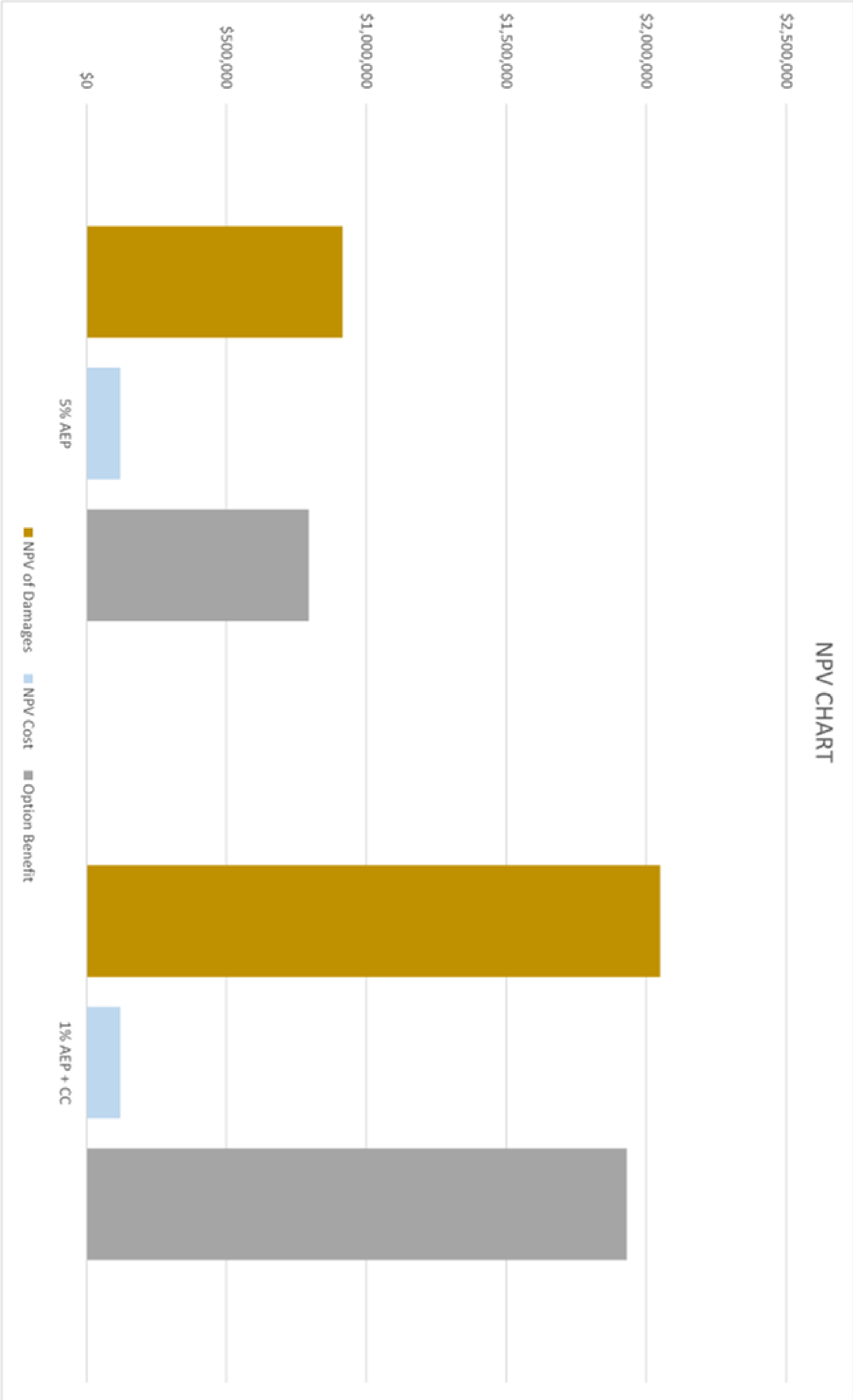


Figure 4.5 Benefit Cost Chart for Net Present Value (NPV)

Figure 5.1 Mitigation Option Area- Dowsing Point

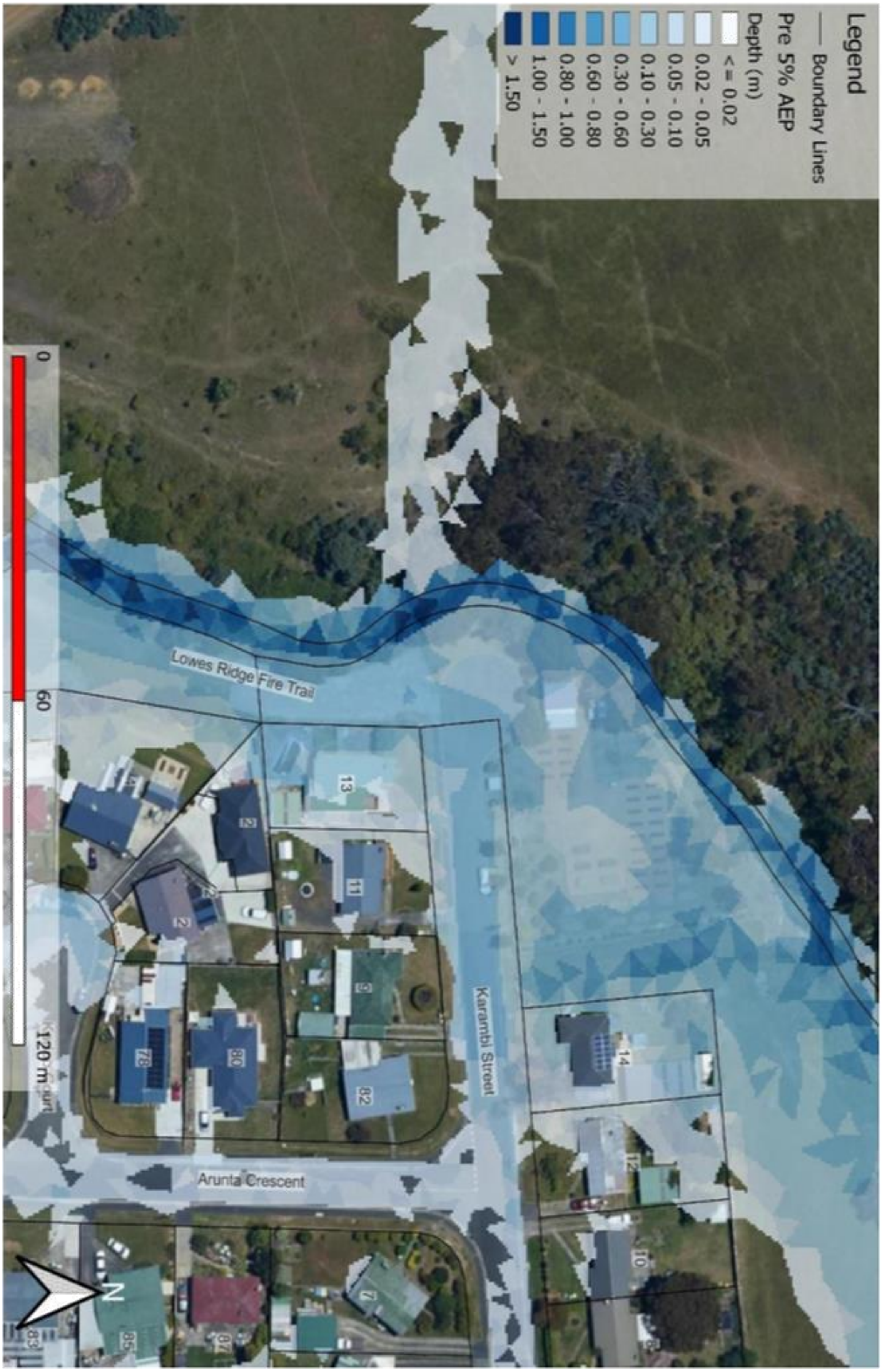


Figure 6.1 5% AEP Pre-Mitigation Option Area

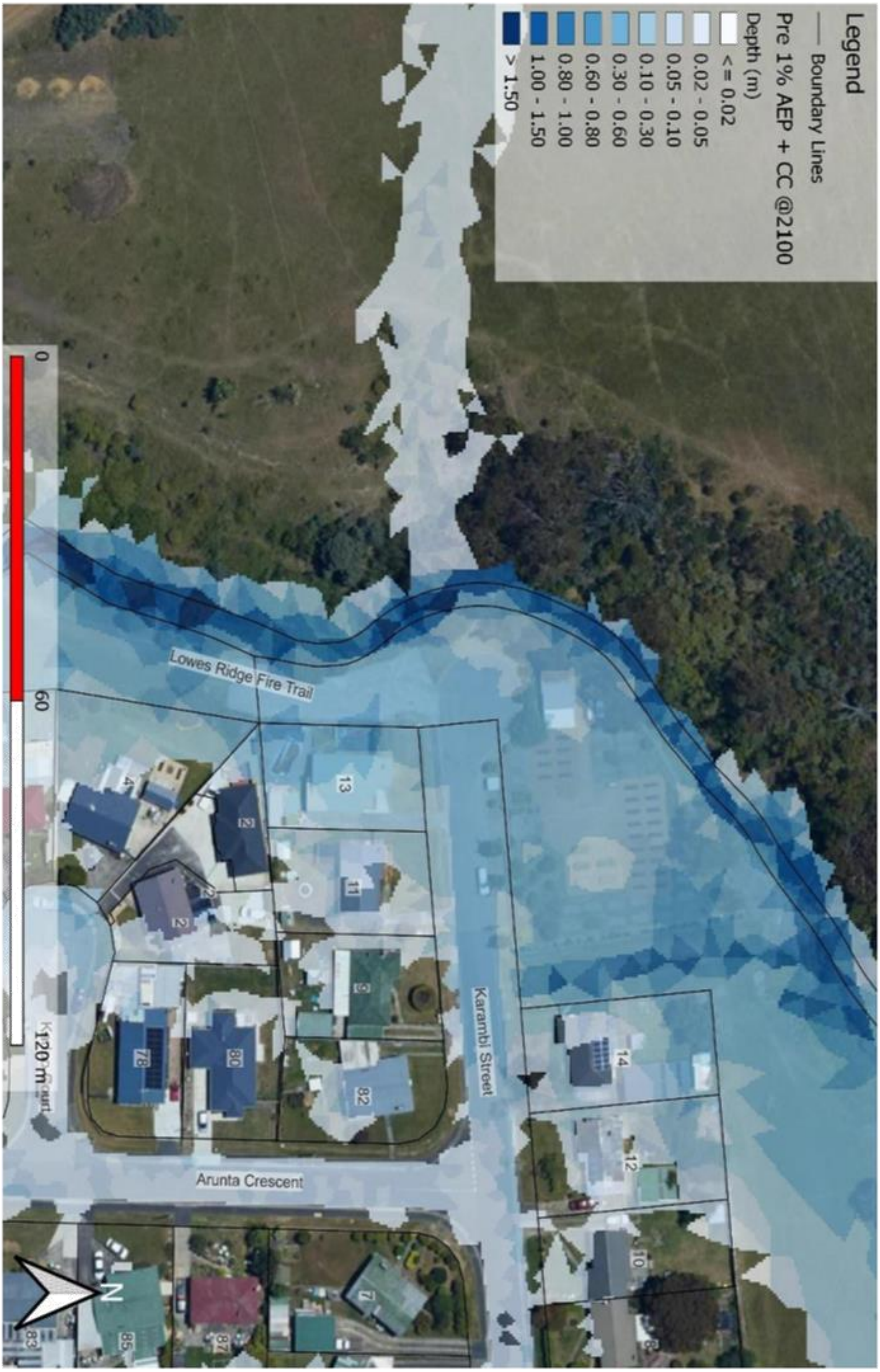


Figure 6.2 1% AEP + CC Pre-Mitigation Option Area

Figure 6.3 5% AEP Post-Mitigation Option Area

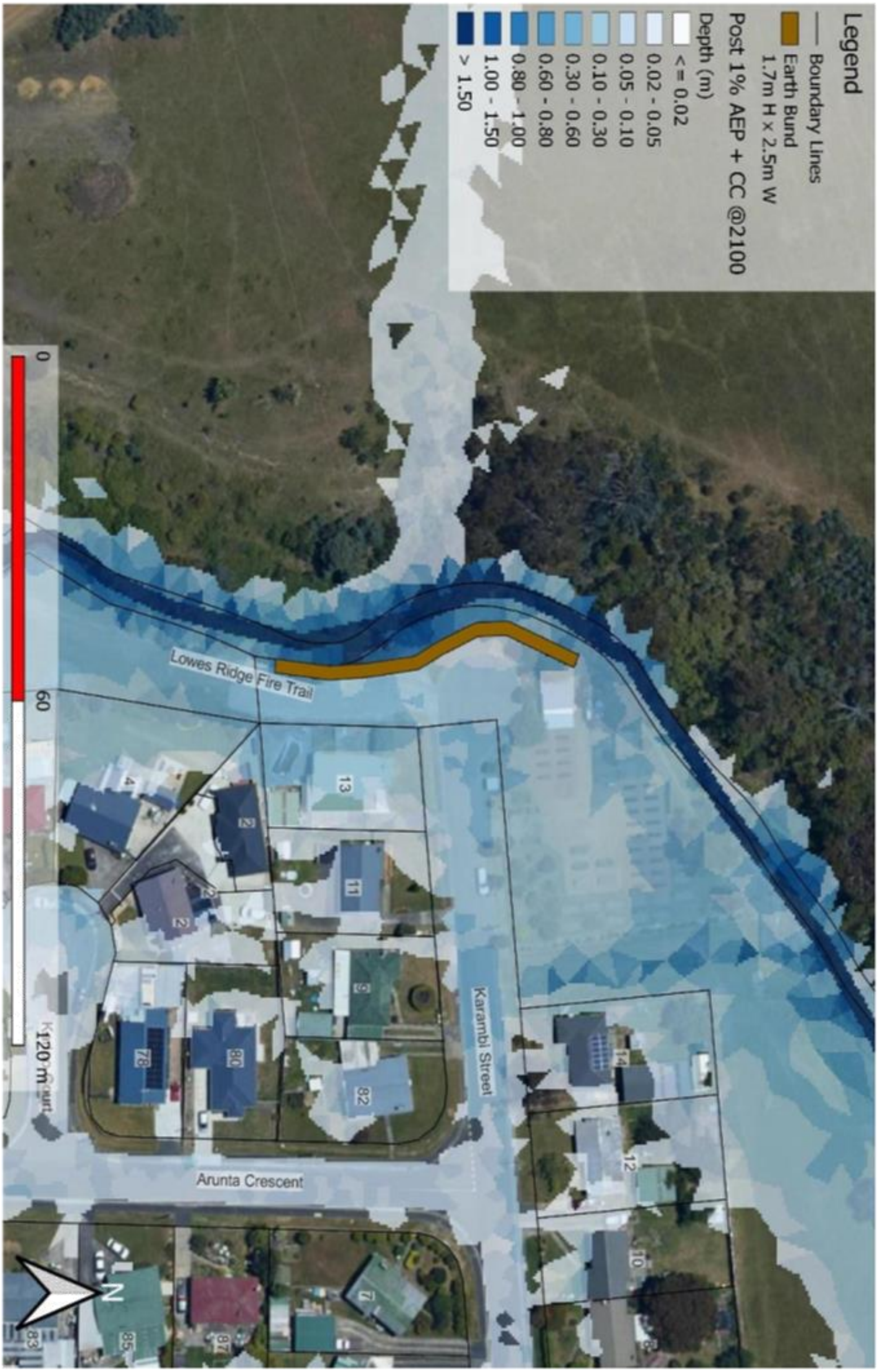


Figure 6.4 1% AEP + CC Post-Mitigation Option Area

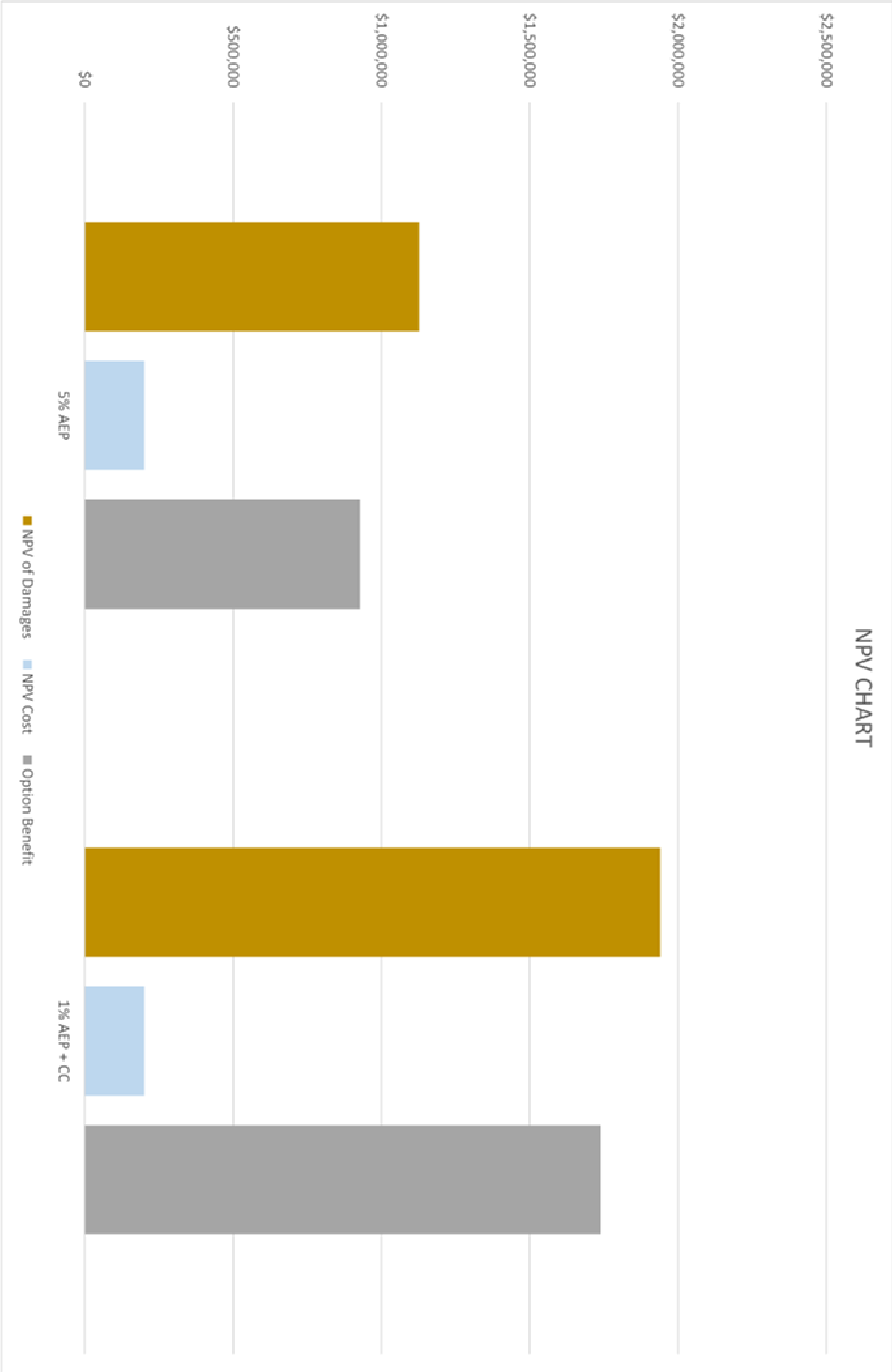


Figure 6.5 Benefit Cost Chart for Net Present Value (NPV)

Figure 7.1 Mitigation Option Area- Goodwood

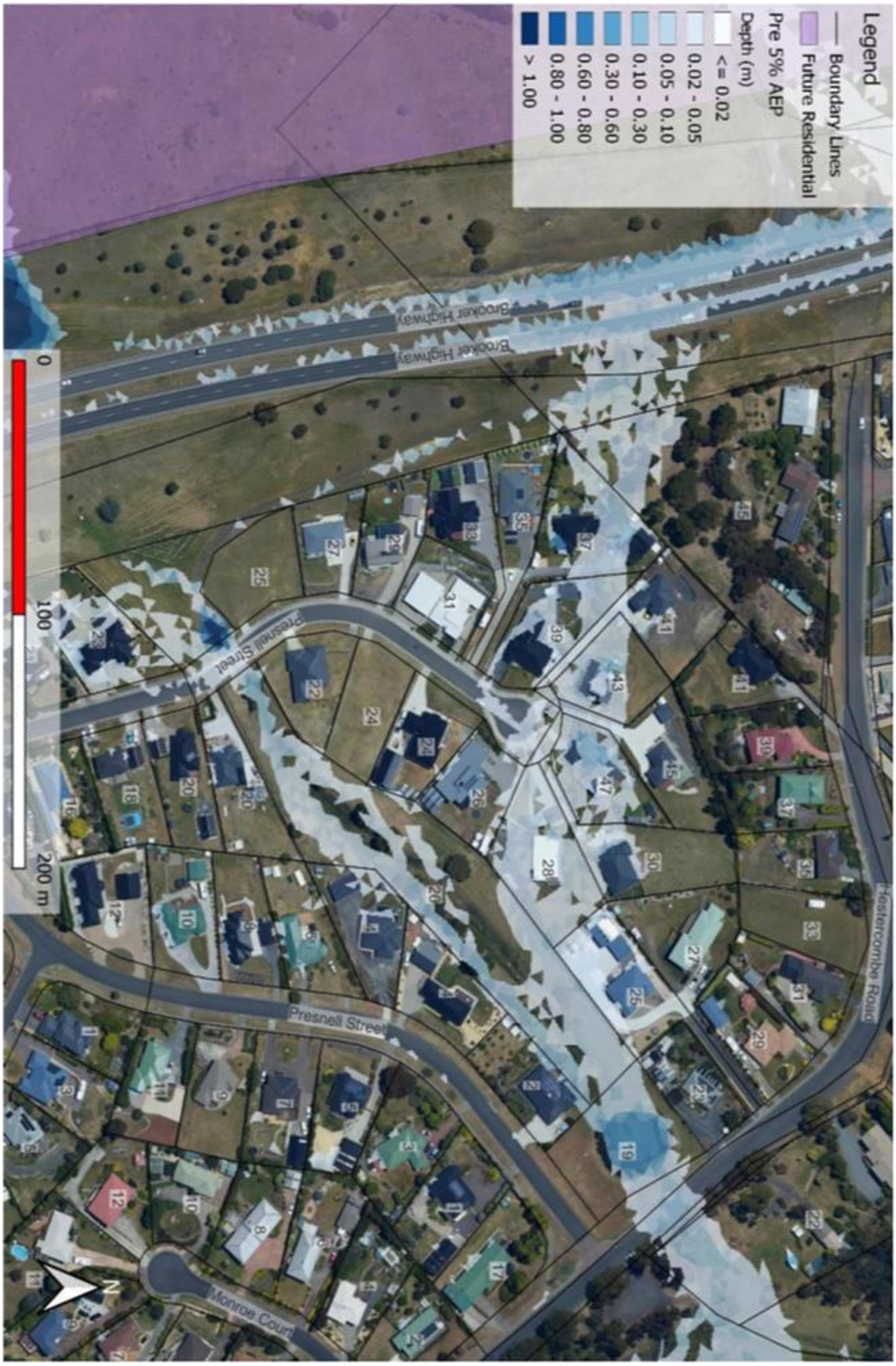


Figure 8.1 5% AEP Pre-Mitigation Option Area

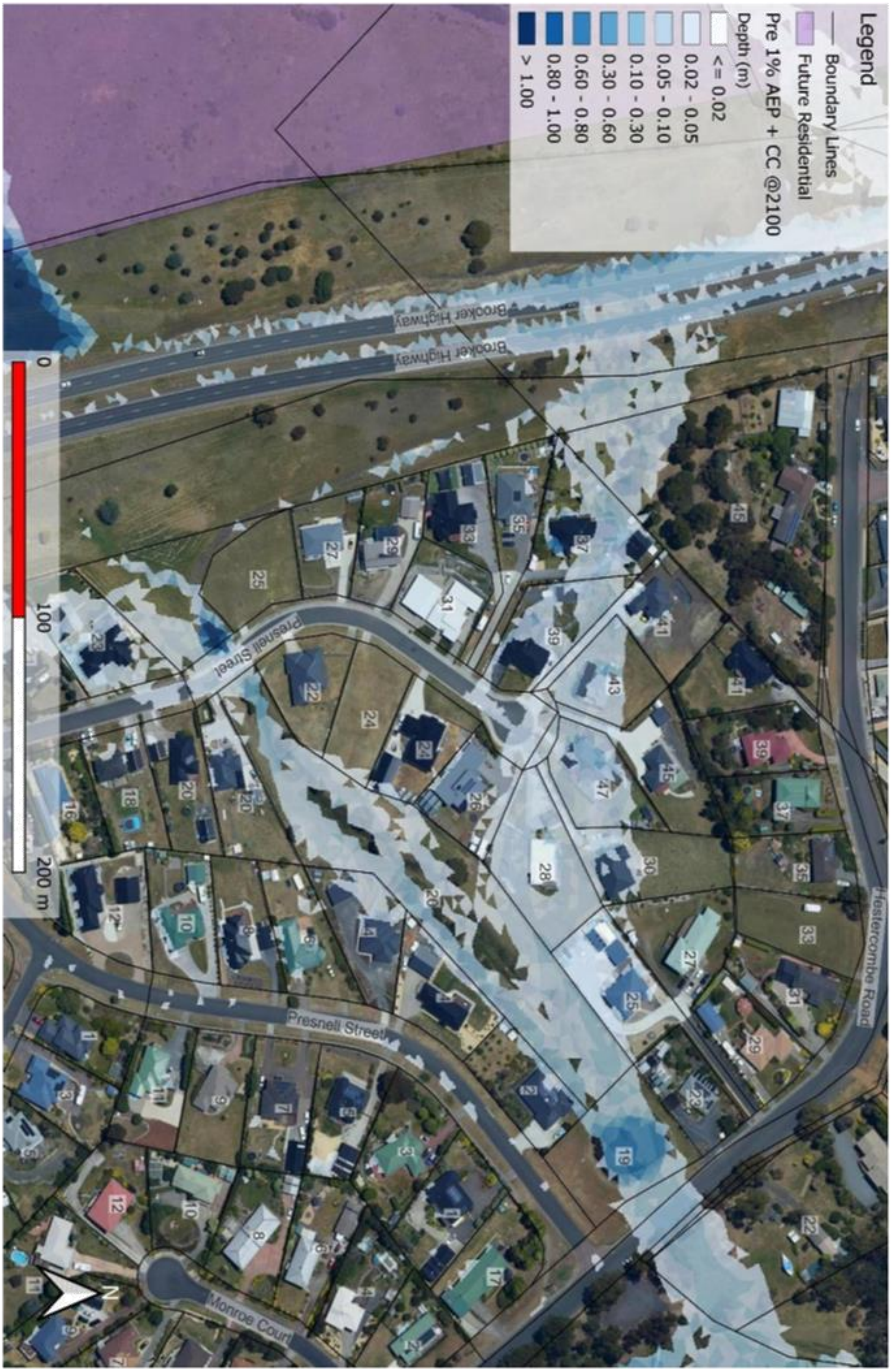


Figure 8.2 1% AEP + CC Pre-Mitigation Option Area

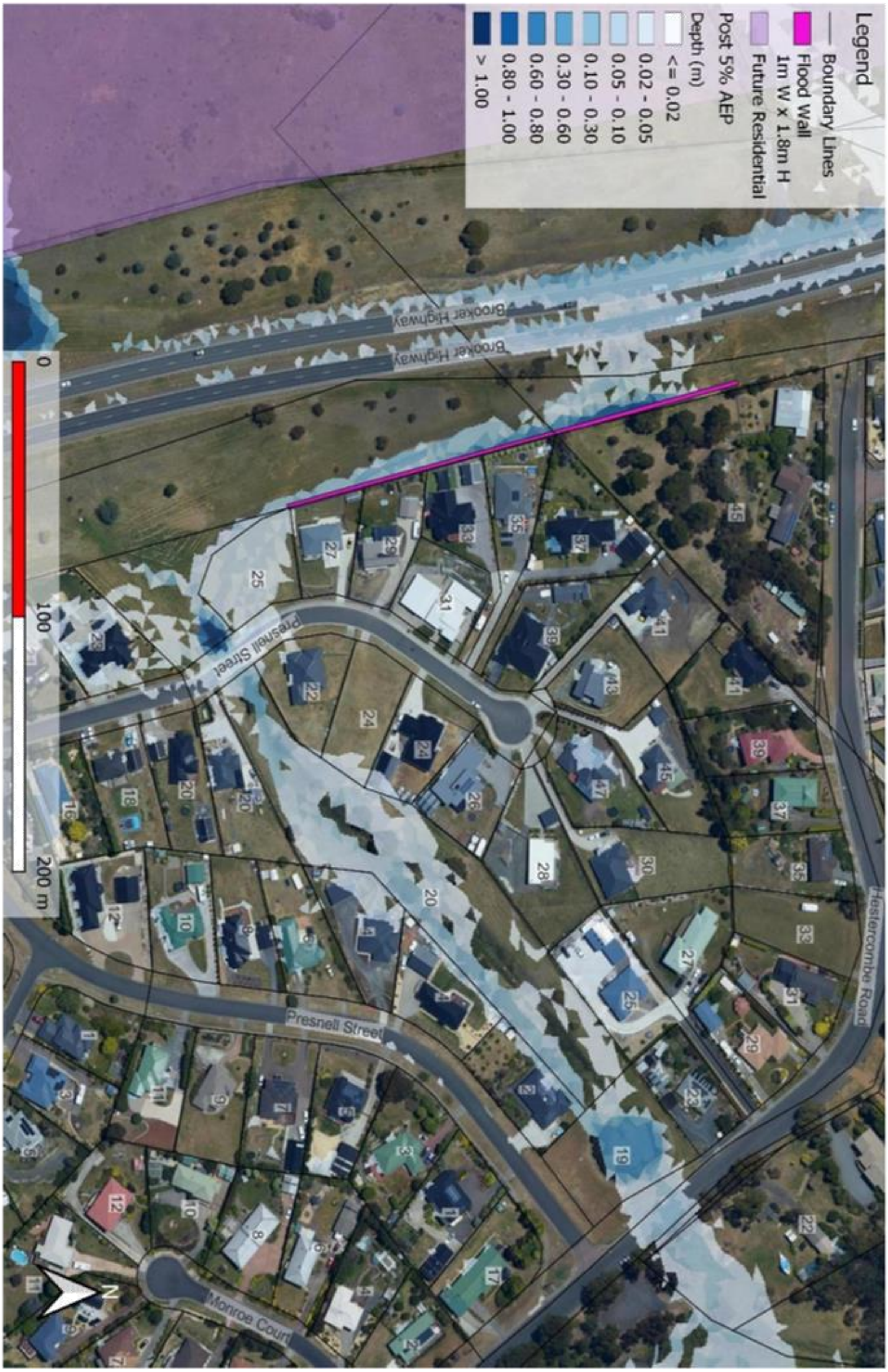


Figure 8.3 5% AEP Post-Mitigation Option Area

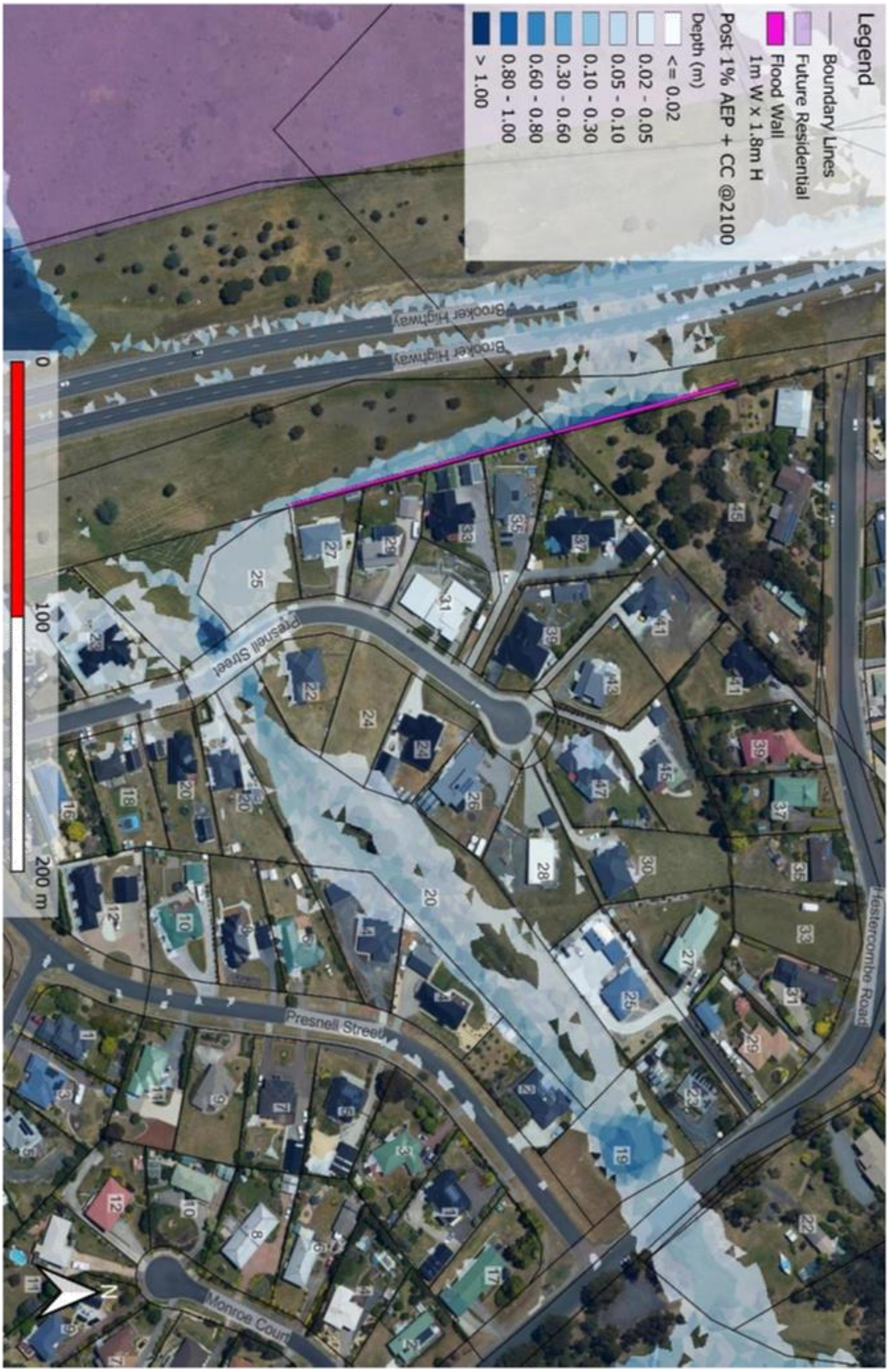


Figure 8.4 1% AEP + CC Post-Mitigation Option Area

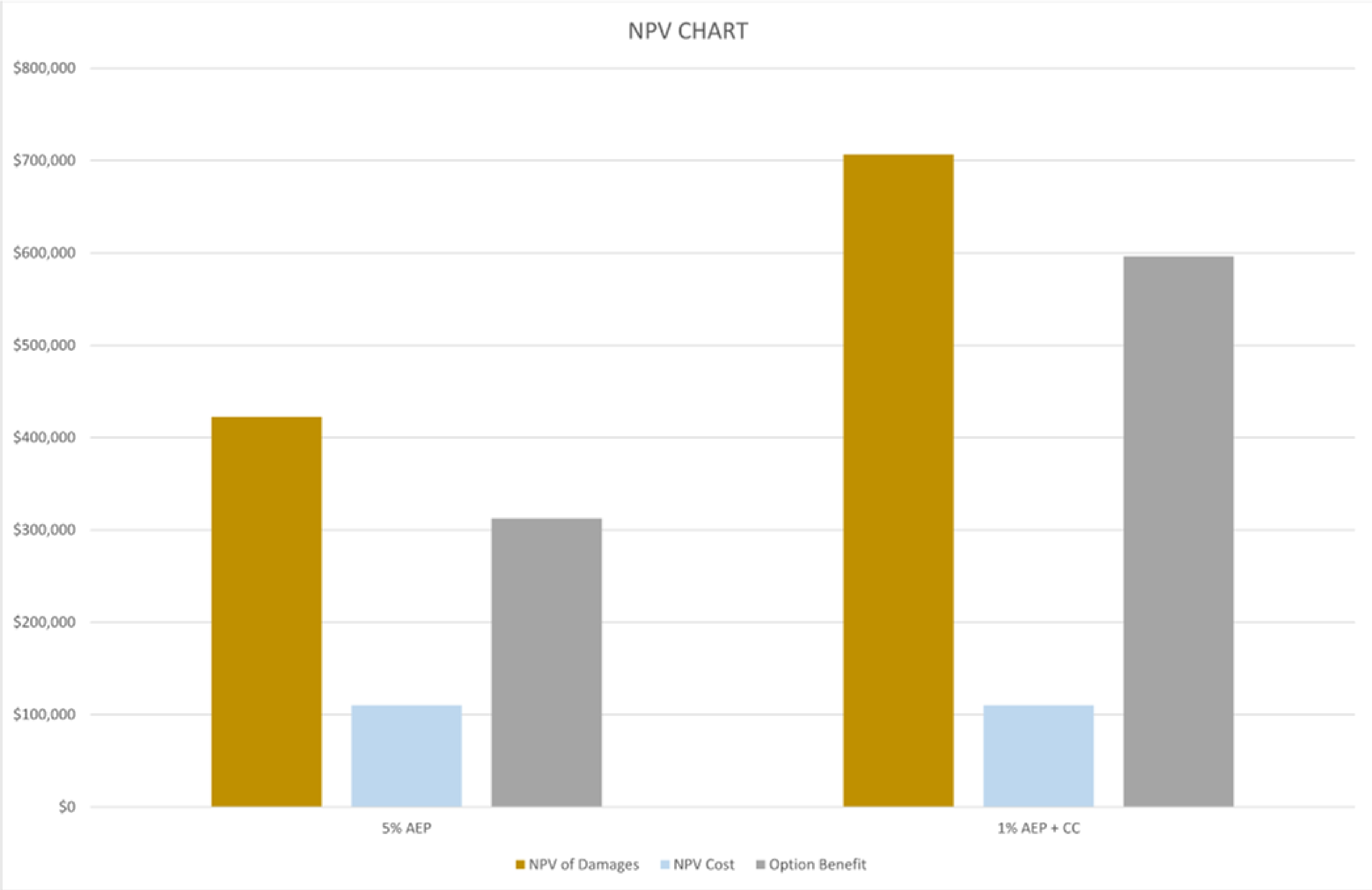


Figure 8.5 Benefit Cost Chart for Net Present Value (NPV)

Figure 9.1 5% AEP Pre-Mitigation Option Area

Figure 9.2 1% AEP + CC Pre-Mitigation Option Area

Figure 9.3 5% AEP Post-Mitigation Option Area

Figure 9.4 1% AEP + CC Post-Mitigation Option Area

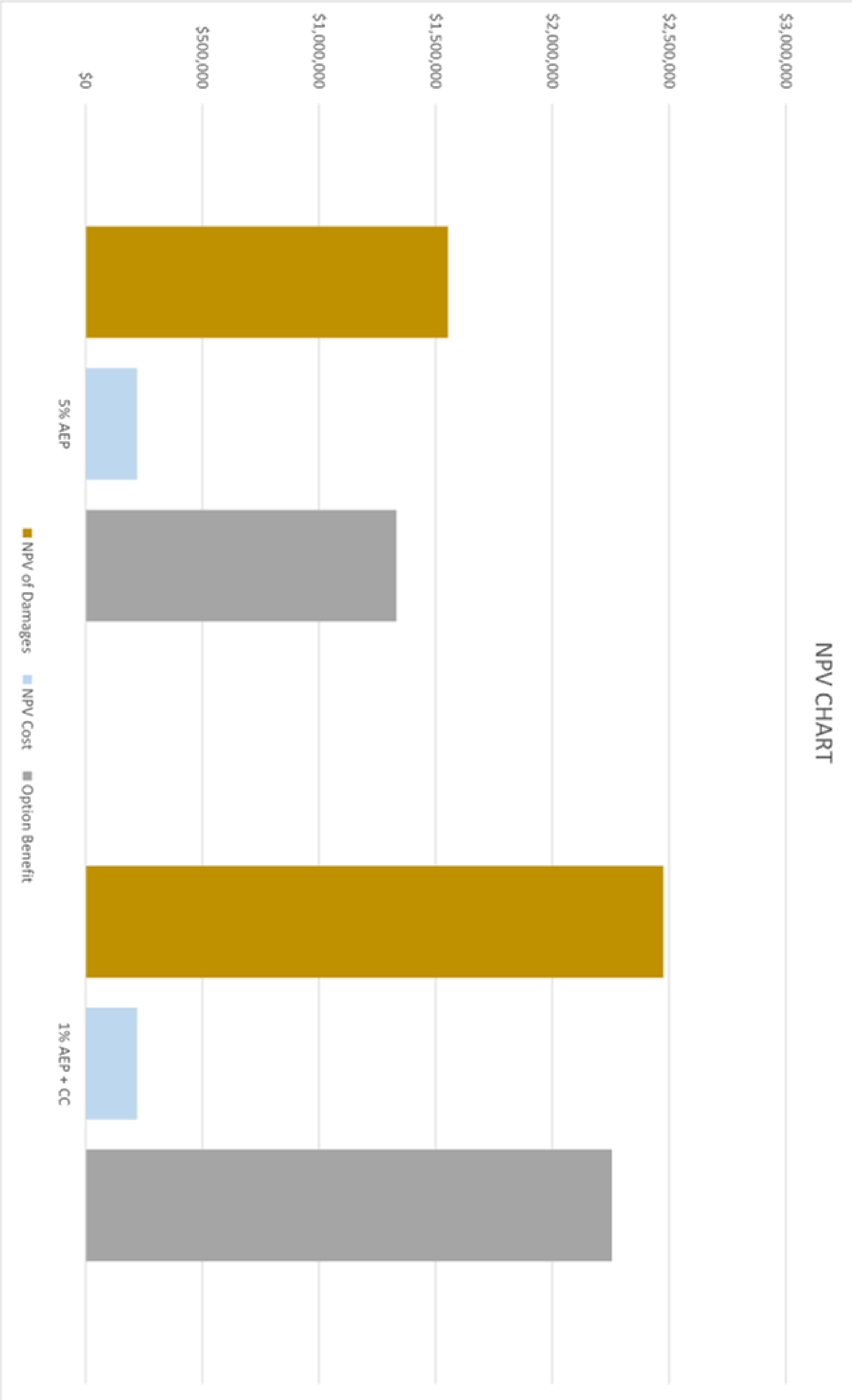


Figure 9.5 Benefit Cost Chart for Net Present Value (NPV)

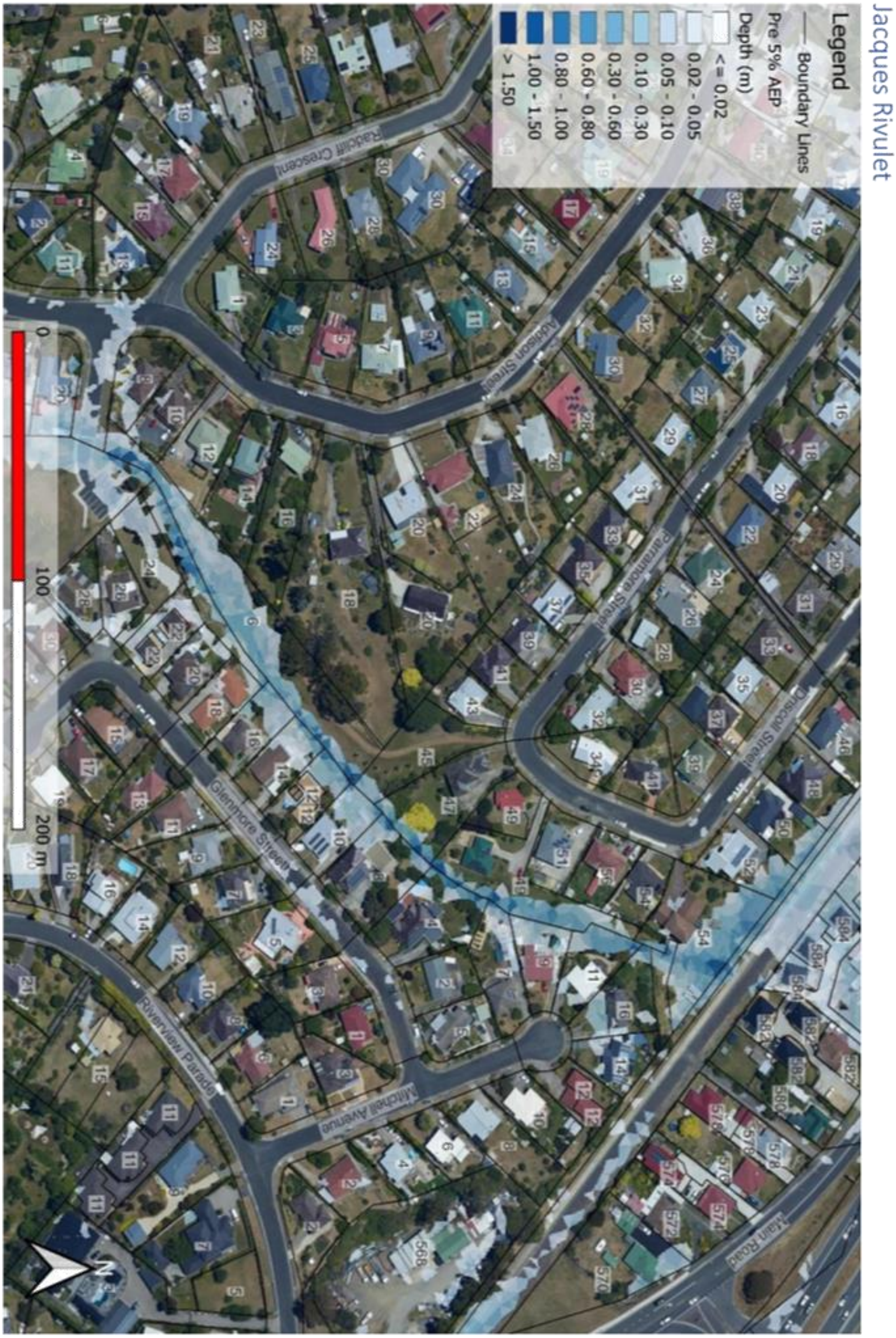


Figure 10.1 5% AEP Pre-Mitigation Option Area

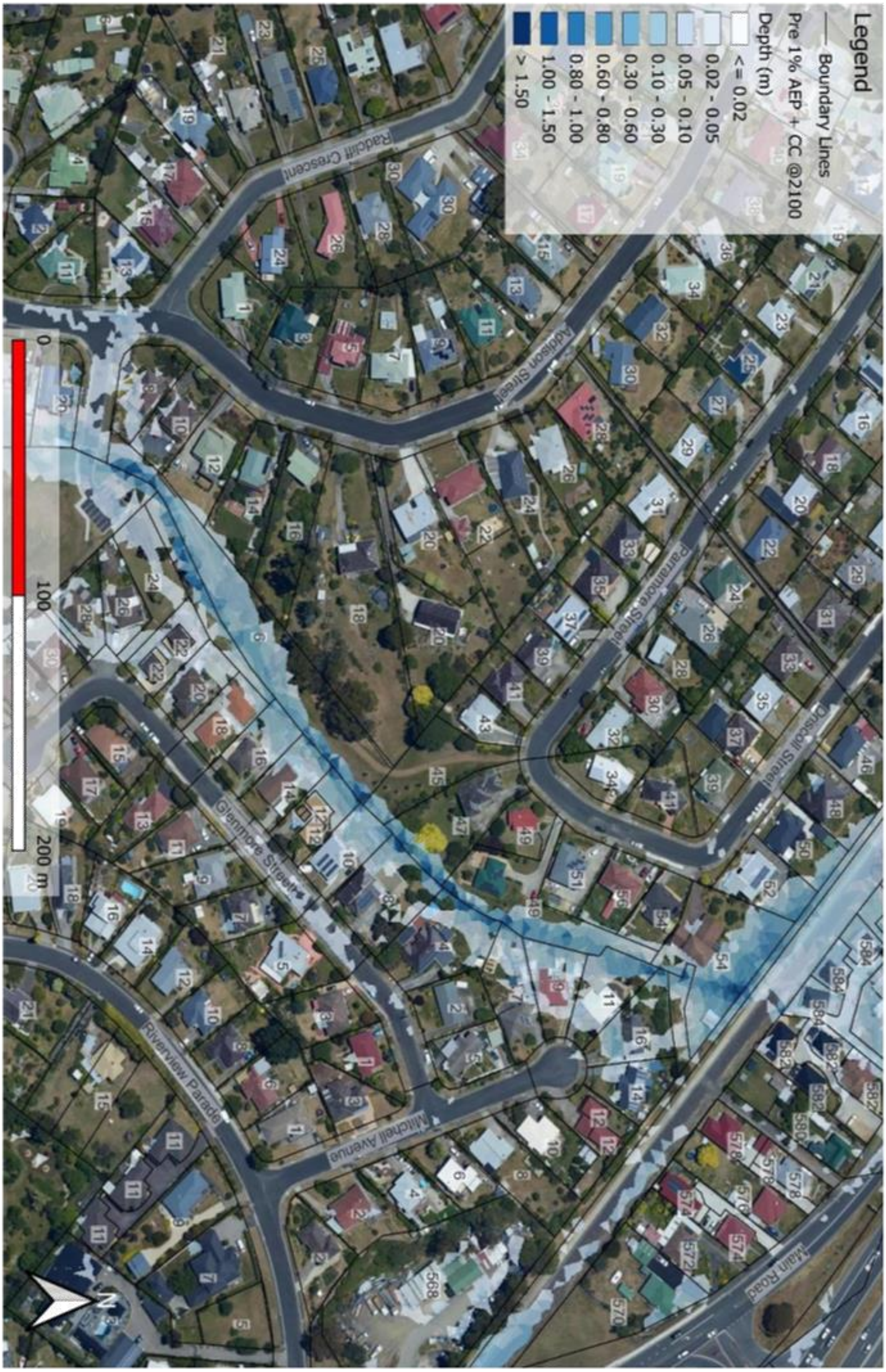


Figure 10.2 1% AEP + CC Pre-Mitigation Option Area

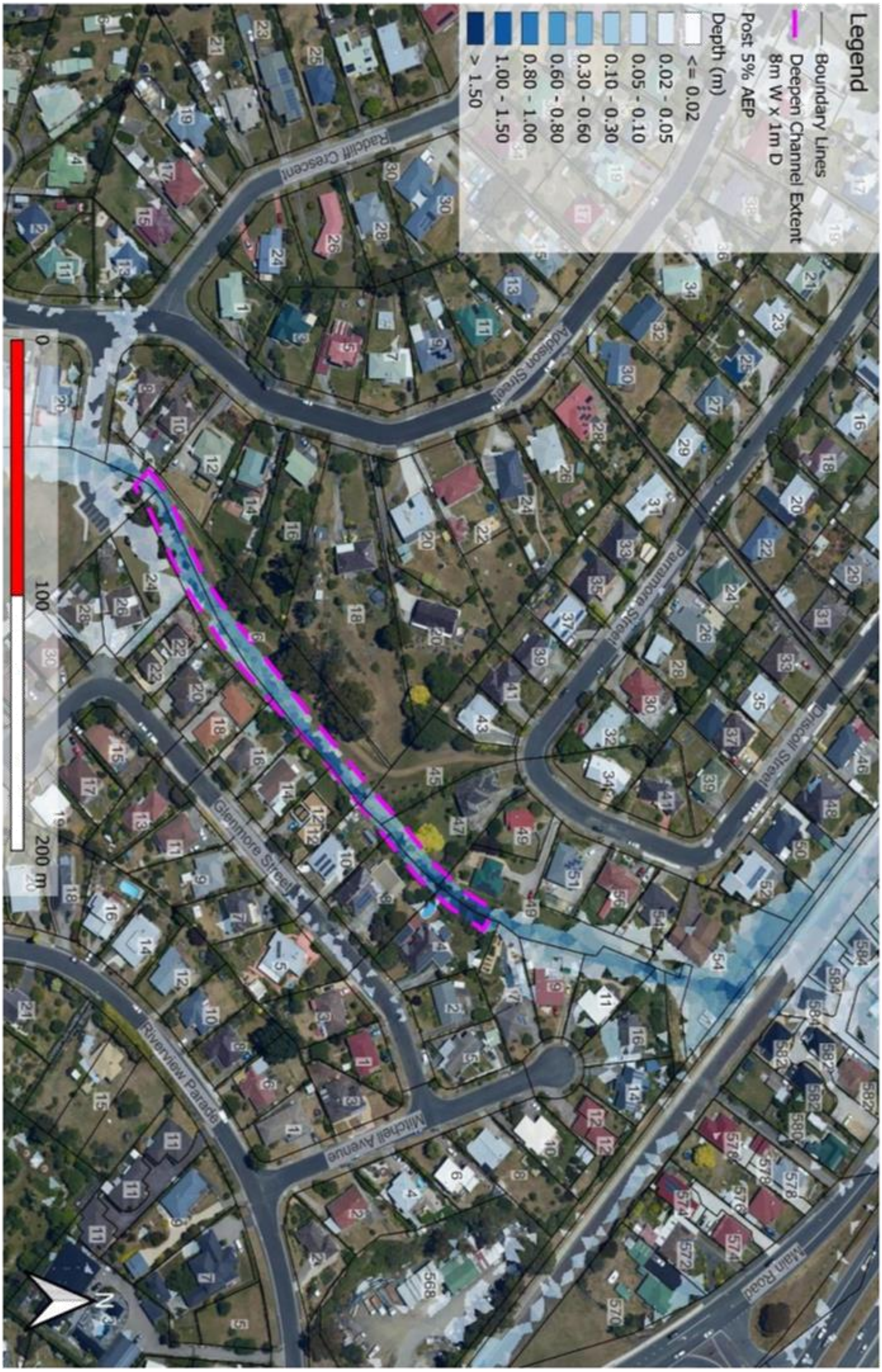


Figure 10.3 5% AEP Post-Mitigation Option Area

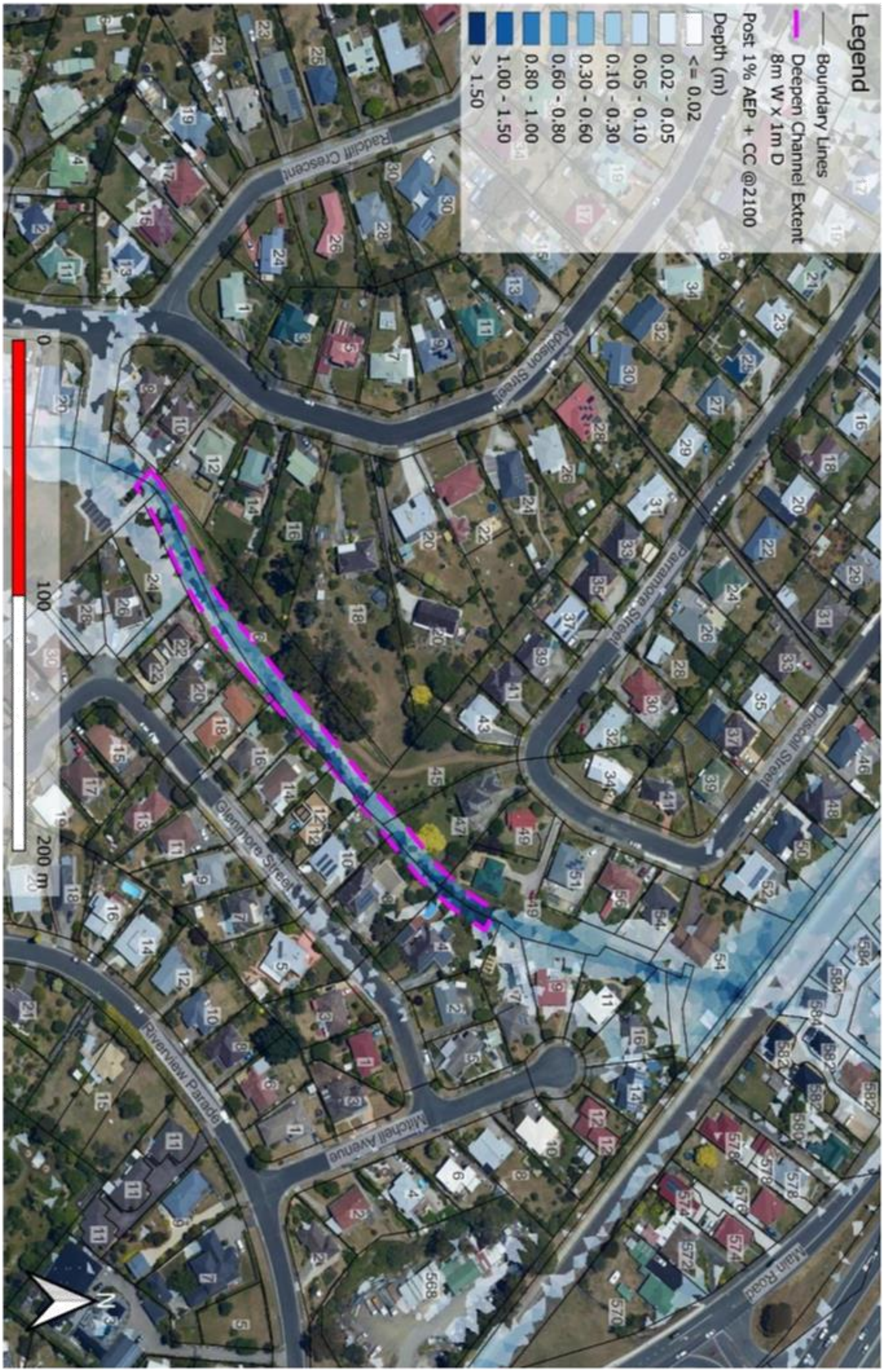


Figure 10.4 1% AEP + CC Post-Mitigation Option Area

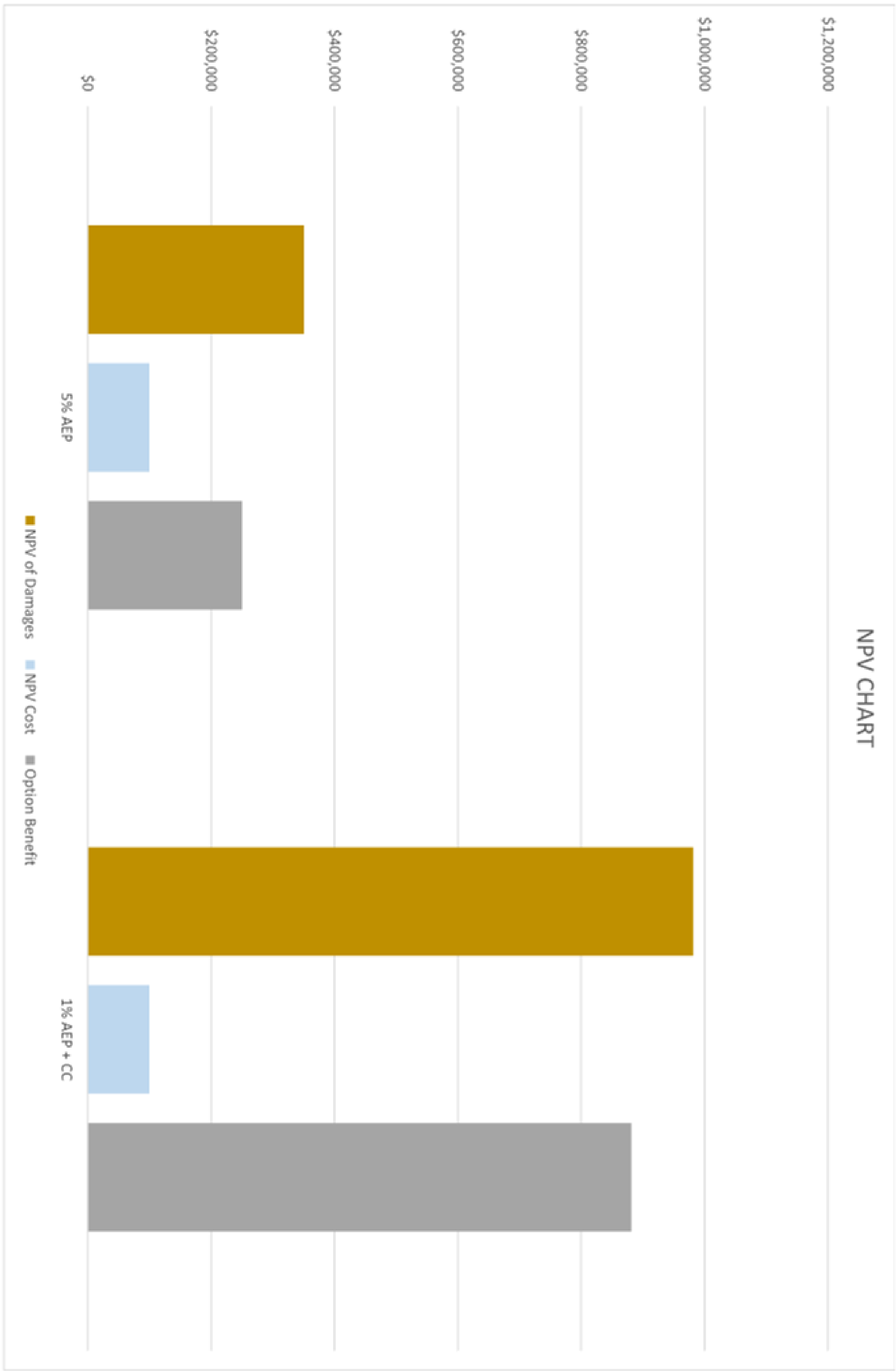


Figure 10.5 Benefit Cost Chart for Net Present Value (NPV)

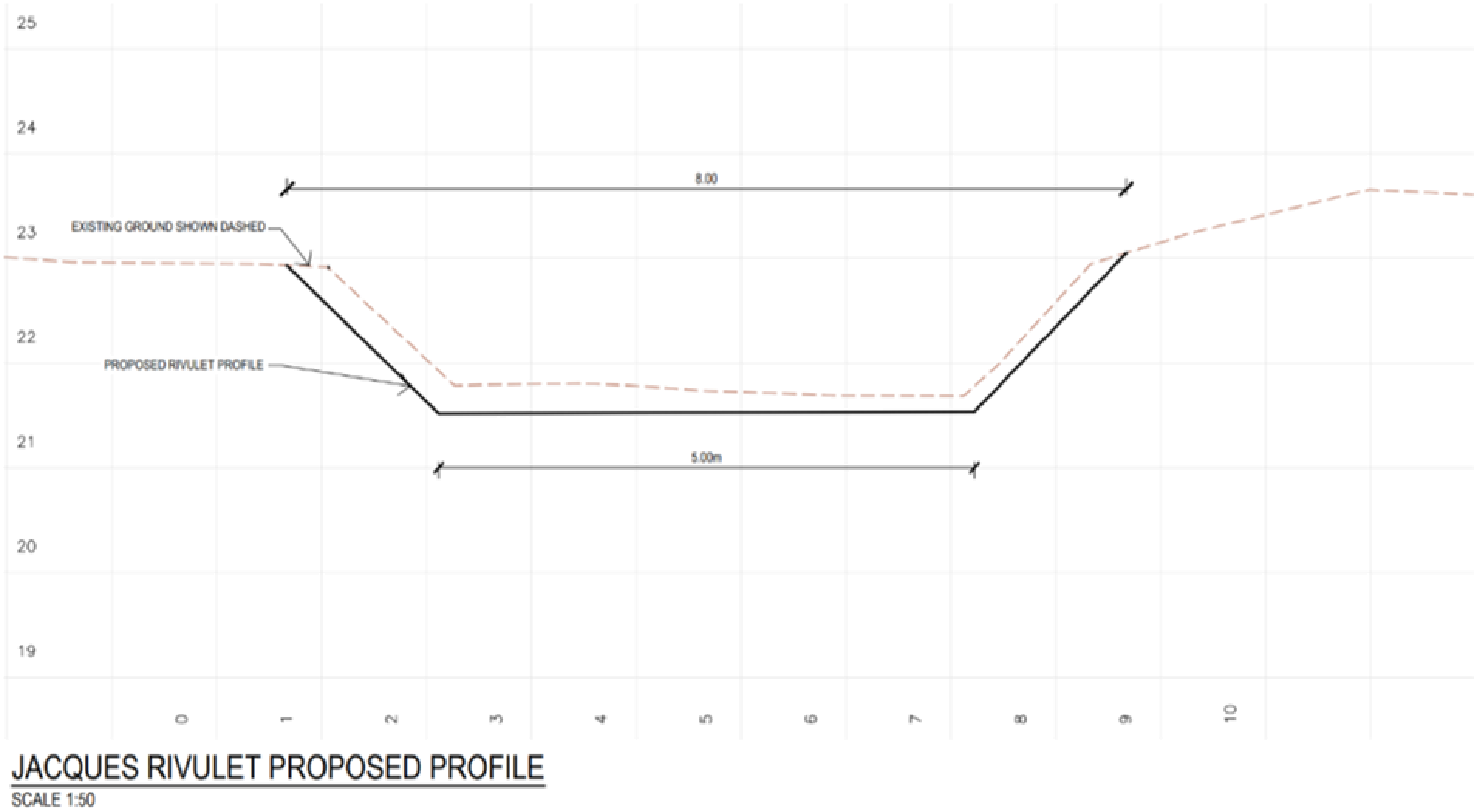


Figure 10.6 Cross Sectional Detail for the Proposed Mitigation Option

Figure 11.1 5% AEP Pre-Mitigation Option Area

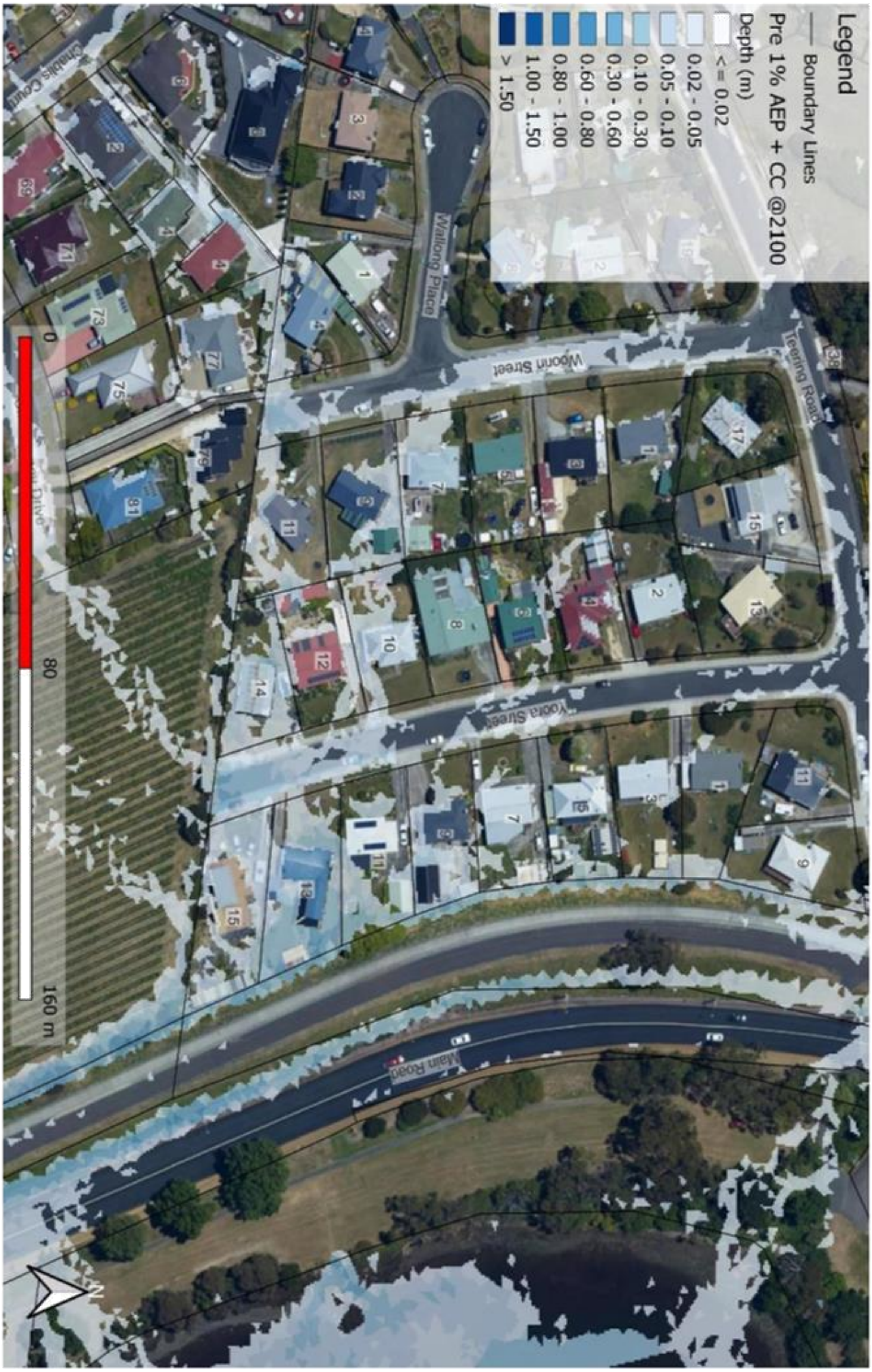


Figure 11.2 1% AEP + CC Pre-Mitigation Option Area

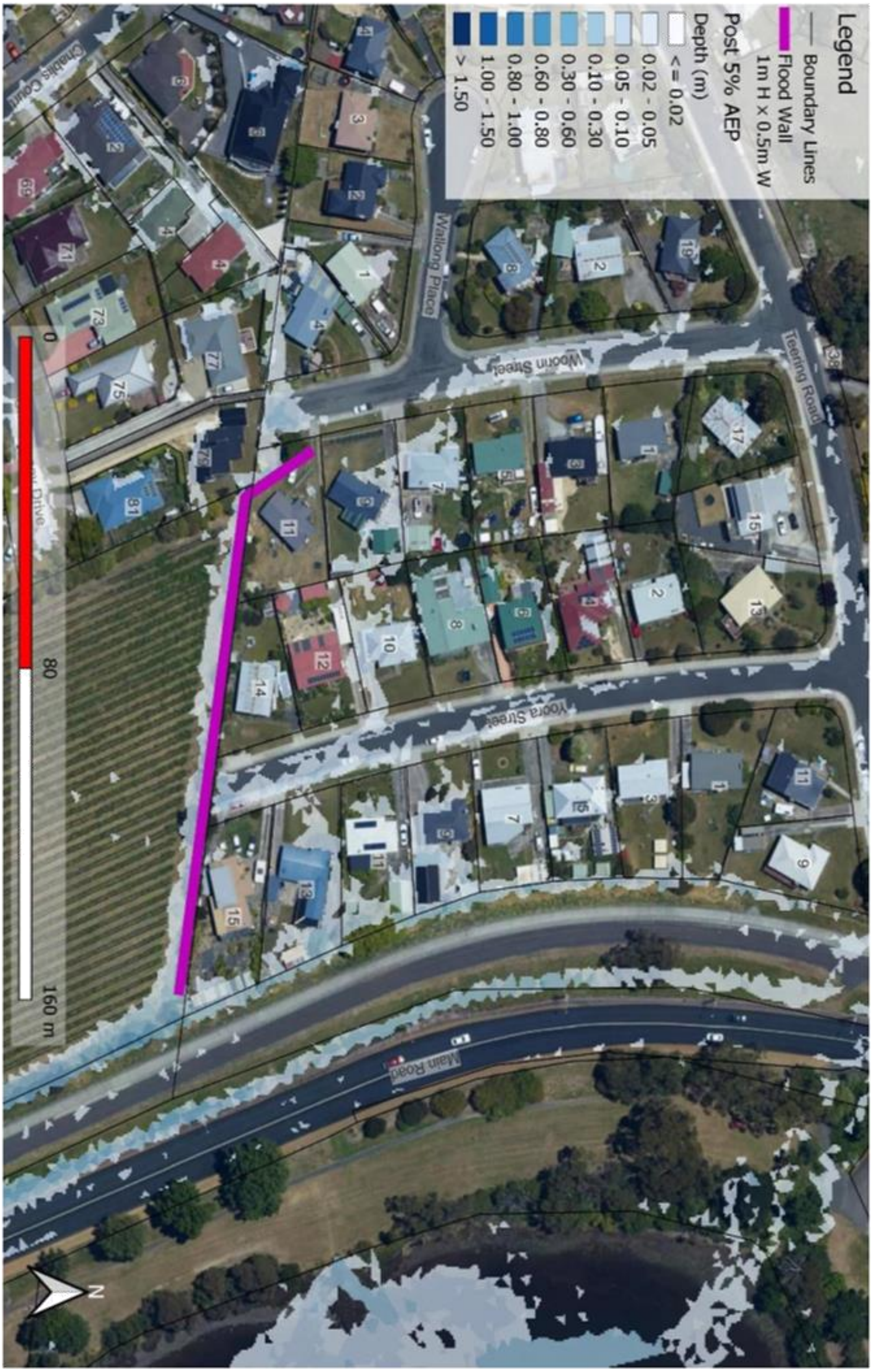


Figure 11.3 5% AEP Post-Mitigation Option Area

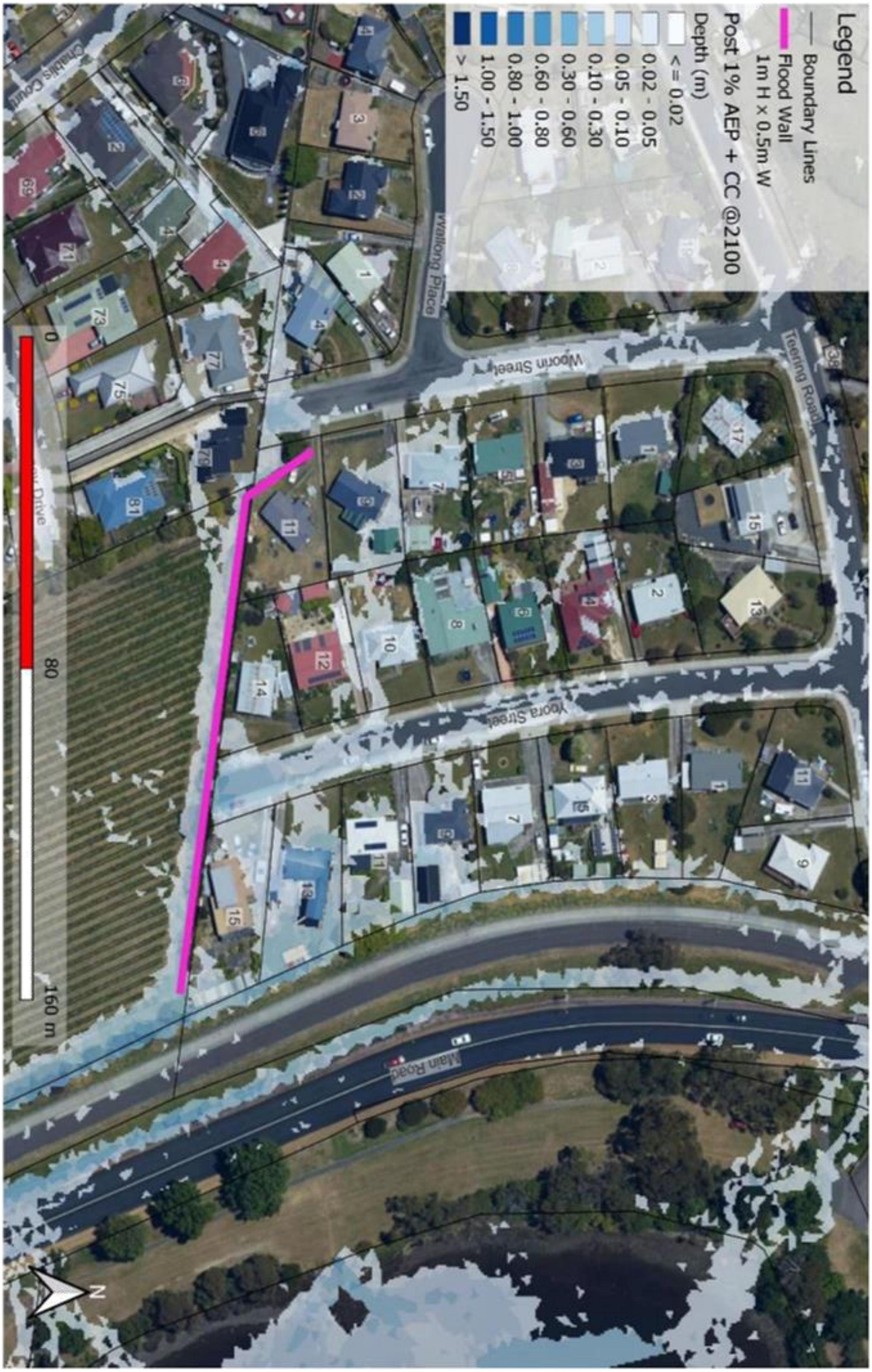


Figure 11.4 1% AEP + CC Post-Mitigation Option Area

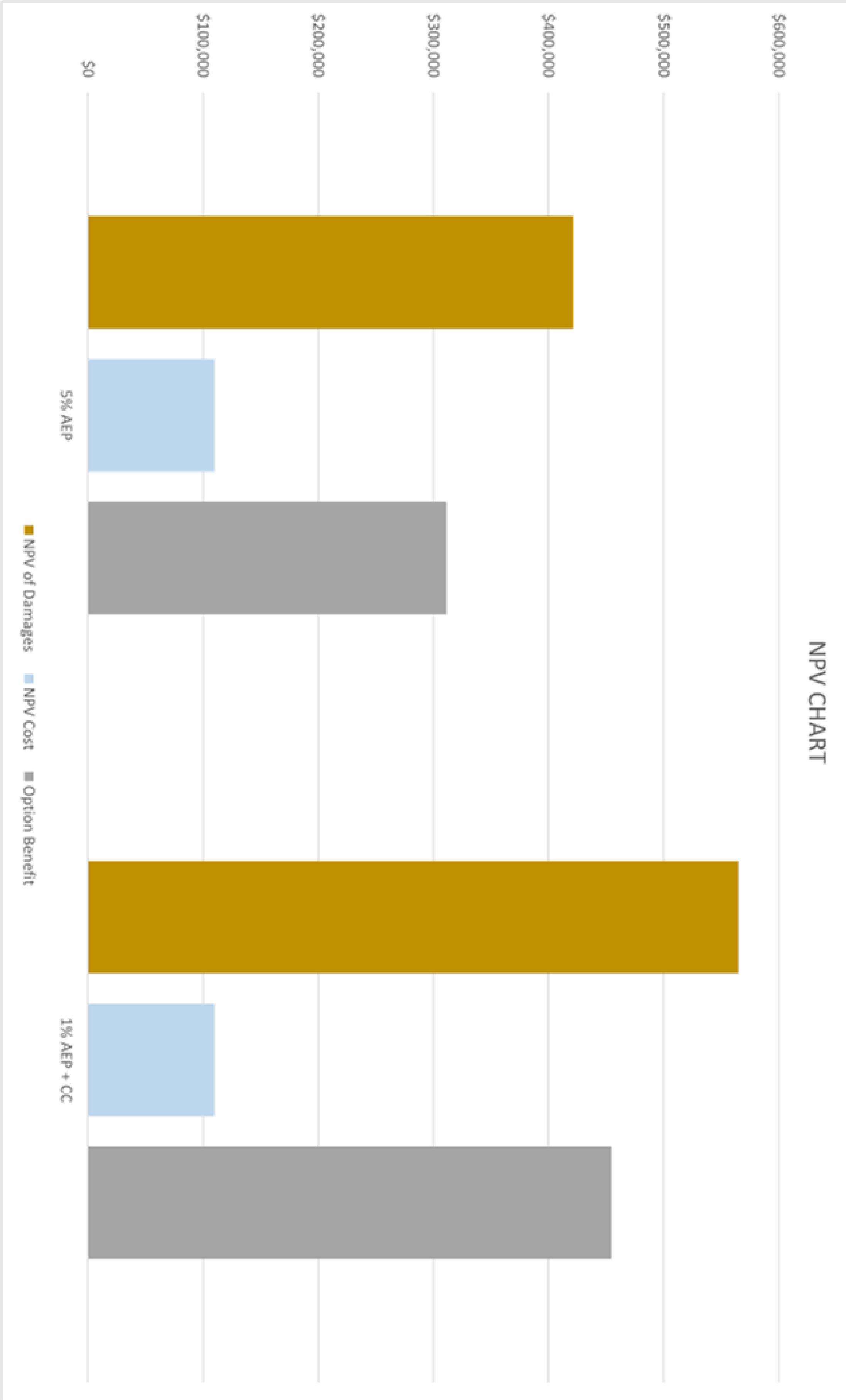


Figure 11.5 Benefit Cost Chart for Net Present Value (NPV)

Figure 12.1 Mitigation Option Area- Roseneath Rivulet

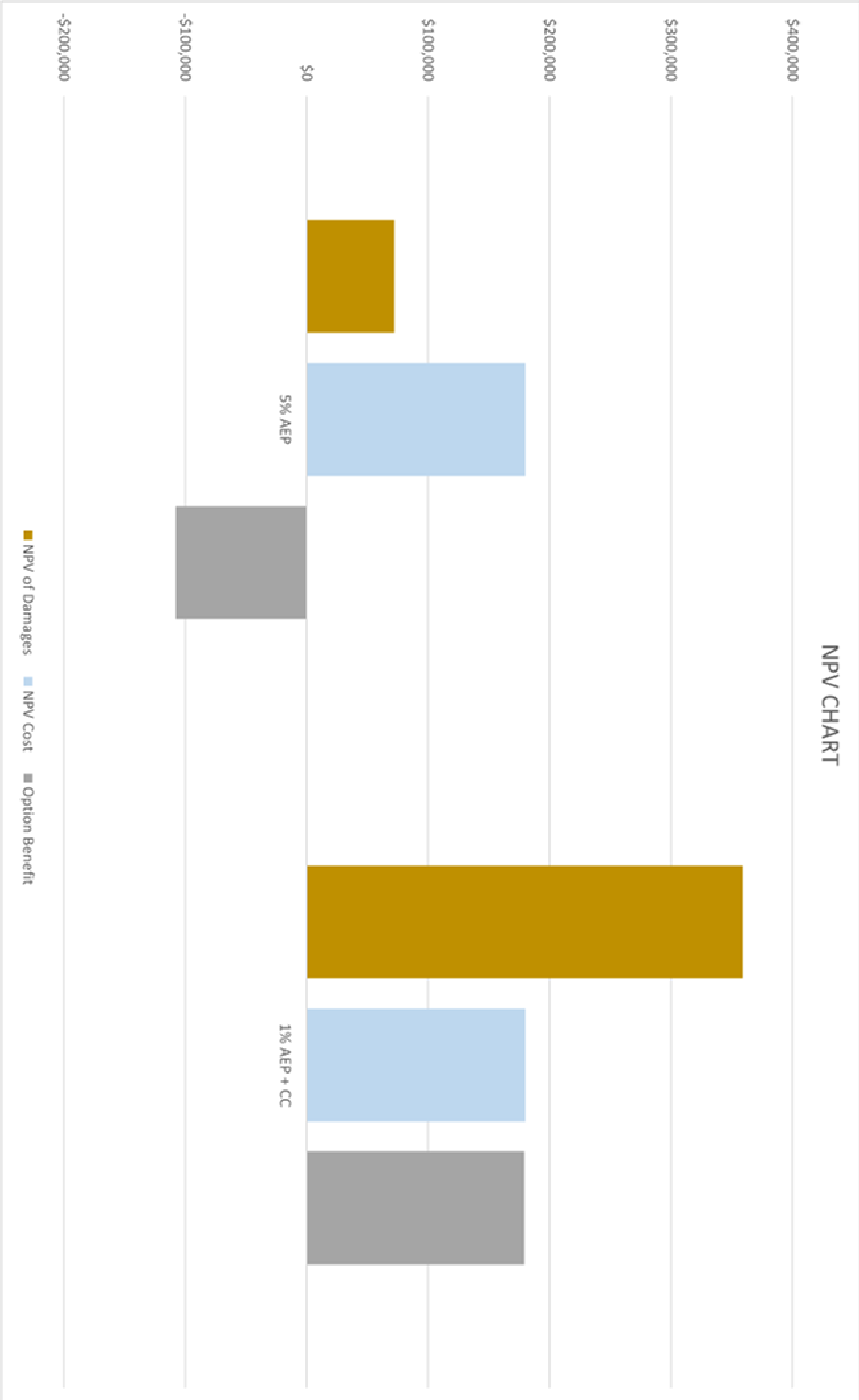


Figure 12.2 Benefit Cost Chart for Net Present Value (NPV)

Figure 13.1 5% AEP Pre-Mitigation Option Area

Figure 13.2 1% AEP + CC Pre-Mitigation Option Area

Figure 13.3 5% AEP Post-Mitigation Option Area

Figure 13.4 1% AEP + CC Post-Mitigation Option Area

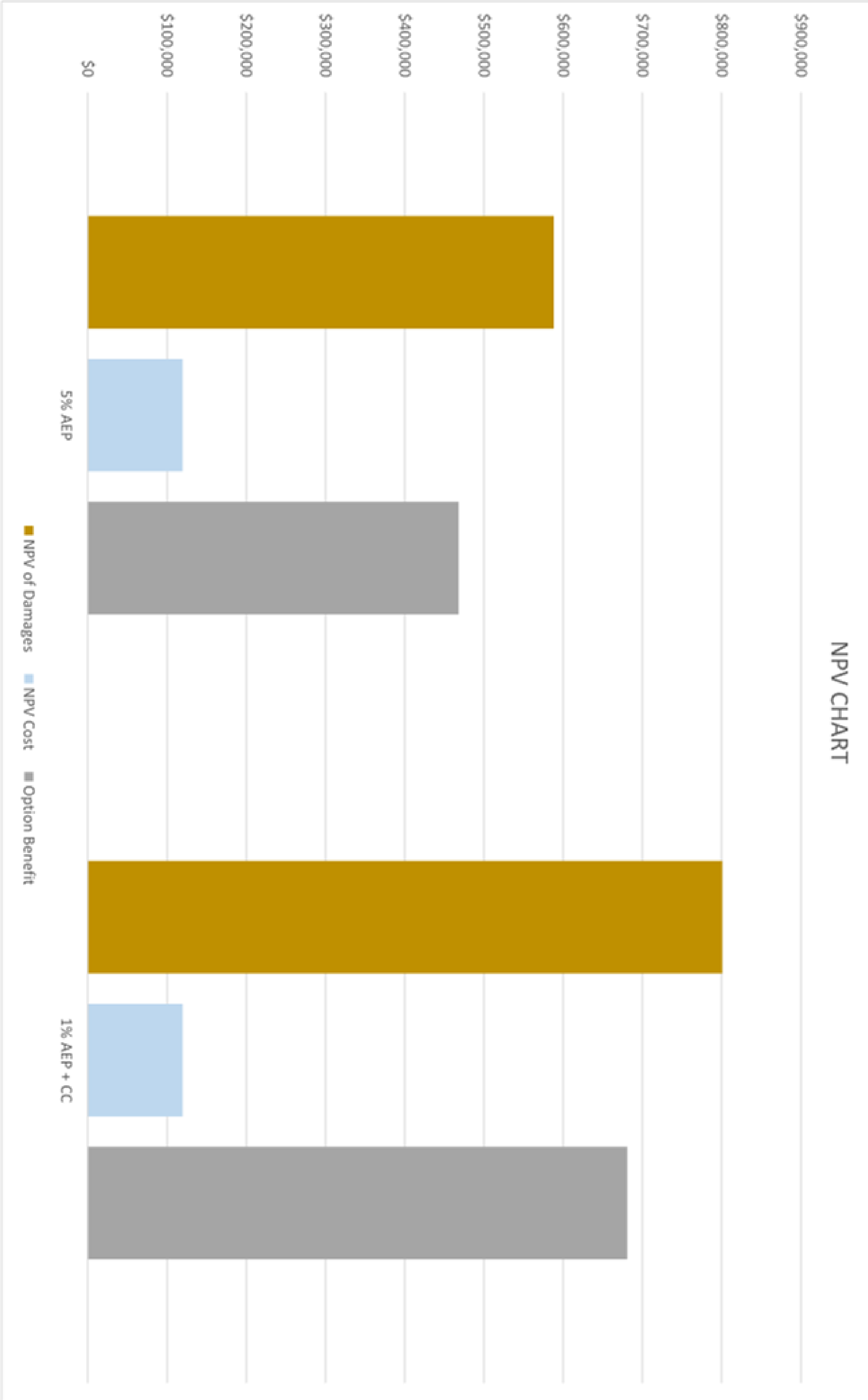


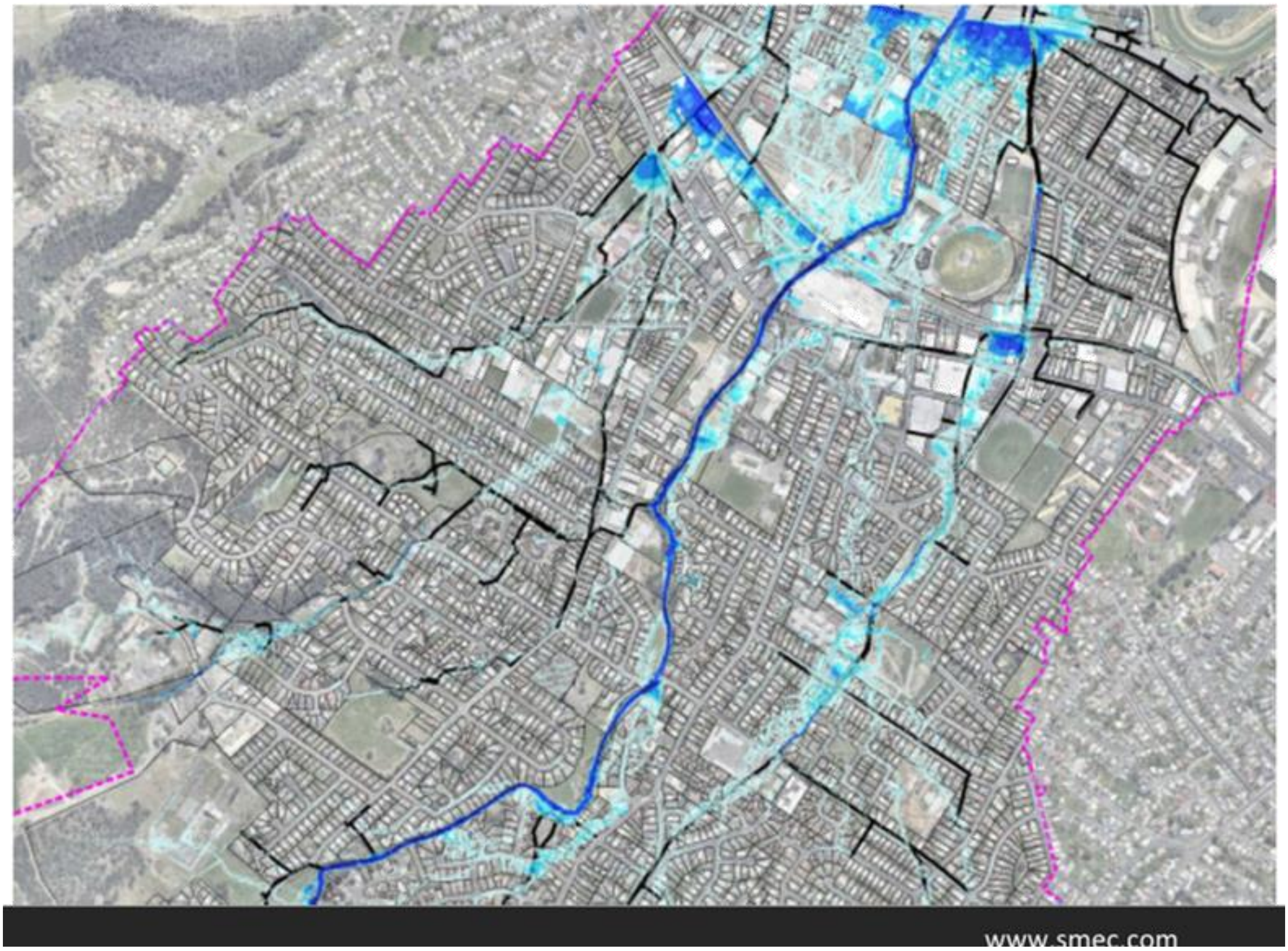
Figure 13.5 Benefit Cost Chart for Net Present Value (NPV)

Figure 14.1 Mitigation Option Area- Zinc Works

Member of the Surbana Jurong Group

Glenorchy CBD Stormwater System Management Plan

Report, November 2018



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EXECUTIVE SUMMARY

The Glenorchy CBD and its surrounding area lie within three catchments that drain to Elwick Bay: Humphreys Rivulet, Littlejohn Creek and Barossa Creek. Together these three catchments form the Study Area (27 km^2) for this stormwater system management plan.

Glenorchy City Council (GCC) engaged SMEC to undertake a detailed flood study of Glenorchy CBD and surrounding area, situated within one of the northern suburbs of Hobart, Tasmania.

This report documents the work undertaken to develop the plan, including:

- A review of the available data and historic flooding records
- Hydrological modelling
- Hydraulic modelling
- Calibration of the models to the 1996 flood event
- Flood damage assessment

A rainfall-runoff model has been set up to describe the Study Area. The model was then calibrated to water levels measured at various locations within the Study Area after the February 1996 flood event. The model was then used to estimate inundation extents for a range of design flood events including the 1 in 20 AEP, 1 in 100 AEP and the Probable Maximum Flood (PMF) for several development scenarios including the impact of climate change.

The rainfall-runoff model was set up as a hybrid of RORB and Tuflow 'rainfall-on-grid' to assess the breakout flood risk from Humphreys Rivulet, Barossa Creek and Little John Creek and the existing drainage system performance.

A set of inundation extent and hazard maps have been generated for the different flood scenarios modelled to provide GCC with estimates of inundation levels. These will allow for planning controls, floor level setting and a baseline to plan mitigation options.

From the flood damage assessment, the Average Annual Damages (AAD) are currently estimated at $3.4 million per year. The developed scenarios indicate that these annual damages may increase by between $0.6 million and $3 million. The climate change scenario for the year 2090 estimates the Average Annual Damages (AAD) increase to over $19 million per year.

It should be noted that the flood damage assessment is likely to be sensitive to the assumption that floor levels are 300 mm higher than property ground levels. It is recommended that a floor level survey be completed for properties modelled as flooded in the 1 in 100 AEP events and the damage assessment revised.

ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym	Description
AEP	Annual Exceedance Probability
ANCOLD	Australian National Committee on Large Dams Inc.
ARF	Areal Reduction Factor reduces the design rainfall as the catchment area increases
AVM	Average Variability Method uses a representative design rainfall temporal pattern per duration
BoM	The Australian Bureau of Meteorology
CFD	Computational Fluid Dynamics
CL	Continuing Loss (mm/hr)
DCF	Dam Crest Flood
DV	Product of depth and velocity (m^2/s)
FSL	Full Supply Level
GCC	Glenorchy City Council
GSAM	Generalised South Australia Method estimates PMP rainfall for durations equal or longer than 24 hours appropriate to the South East of Australia
GSDM	Generalised Short-Duration Method estimates PMP rainfall for durations equal to or shorter than 6 hours
HAT	Highest Astronomical Tide (mAHD)
IFD	Intensity Frequency Duration refers to statistics on design rainfall
IL	Initial Loss (mm)
IWL	Initial Water Level describing the first water level during a stormwater model simulation
k_c	Catchment routing parameter used in the rainfall-runoff model
PMF	Probable Maximum Flood is the theoretical largest discharge combining the most saturated catchment conditions with the largest rainfall (PMP) (m^2/s)
PMP	Probable Maximum Precipitation is the theoretical largest rainfall (mm)
Q	Discharge (m^3/s)
RCP	Representative Concentration Pathways are scenarios of future greenhouse gas trajectories
RFFE	Regional Flood Frequency Estimate
SLR	Sea Level Rise (m)
T_c	Catchment lag time used in the rainfall-runoff model (hr)

1. INTRODUCTION

1.1. General

SMEC Australia has been engaged by Glenorchy City Council (GCC) to undertake detailed flood study of Glenorchy CBD and its surrounding area, situated within one of the northern suburbs of Hobart, Tasmania. The study has been undertaken to advise future land use planning, emergency management, community consultation/education and capital expenditure planning.

The Study Area includes the Humphreys Rivulet, Barossa Creek and Little John Creek catchments with a focus on the breakout flooding from the waterways and the performance of the major stormwater system.

The objectives of the analysis as stated by GCC are as follows:

- Ensure an appropriate level of understanding and management of the flood risk and public stormwater systems within the Study Area.
- Evaluate the hydraulic performance of the major stormwater reticulation system.
- Identify the overland flow paths and associated hazard levels within the Study Area.

GCC wish to use the outcomes of the report to:

- Develop and prioritise future capital works, forecast and prepare budgets, and specify cost apportionment arrangements between GCC, State Government and other stakeholders (e.g. developers).
- Build resilience and consider climate change impacts to address future demands on the urban stormwater system.
- Integrate stormwater management into the urban water cycle to achieve the goals of social, environmental and economic sustainability.
- Enhance community awareness of, and participation in, appropriate management of stormwater.

1.2. Scope of Work

The scope of work includes the following tasks

- Collate data
- Hydrological modelling
  - Update and validate RORB model to Australian Rainfall and Runoff (Ball et al. 2016)
  - Sensitivity of RORB model parameters
  - Modelling event scenarios
- Hydraulic modelling
  - Update existing Tuflow model developed by SMEC for a previous study
  - Calibrate Tuflow model to historic event(s)
  - Complete a sensitivity analysis of selected Tuflow model parameters
  - Modelling events scenarios
- Flood damage assessment
- Reporting
  - Hydrology draft
  - Final study report (this document)

1.3. Peer Review

As recommended by SMEC, WMAwater was engaged by GCC to provide peer review for the flood study. Reviews were completed at the following stages of the project development:

- After completion of the RORB modelling and issue of the Hydrology Report
- After calibration of the Tuflow to measured water levels, as a hold point prior to commencing design runs
- Ongoing, as methodology is discussed and agreed upon.
- Prior to the issuing of the final study report.

2. DATA RECEIVED

A variety of documents were provided by GCC to assist in the analysis as follows:

- Humphreys Rivulet Flood Protection Assessment (Thompson & Brett, 1997)
- Barossa Creek Flooding Analysis (Thompson & Brett, 1999)
- Report on Flooding – Glenorchy Creeks (GCC Engineering Department, 1967)
- Report on Flood Protection, Hobart Rivulet (Hobart Rivulet Flood Protection Authority, 1963)
- Report of the Hobart Rivulet Advisory Committee (1960)
- City of Glenorchy Stormwater System Management Plan – Roseneath Rivulet Catchment Flood Study (GCC 2017)
- Flood Hazard Mapping Study for Humphreys Rivulet (BMTWBM, 2013)
- Drawings of bridge crossings over Humphreys Rivulet at Brent St, Grove Rd, Main Rd, and KGV
- GIS data
  - Pipe network
  - Pit network
  - Building outlines
  - Parcel data
  - Contours 2, 5, 10m
  - Planning Scheme Zoning regions
  - Road layout and names
  - Stormwater catchments
  - Digital elevation model (DEM)
- Rainfall data
  - From event on 21st January 2007

In addition, a range of data was downloaded from the Tasmania Government Department of Primary Industries, Parks, Water and Environment website (http://dpipwe.tas.gov.au/) as follows:

- Lidar with the following characteristics
  - 1 m resolution captured by Photomapping Services (2011),
  - Horizontal spatial accuracy is 0.30 m; Vertical accuracy is 0.15 m.
  - Map projection is GDAS94 MGA55.
  - from www.theLIST.tas.gov.au ©State of Tasmania
- October 2015 Aerial Imagery from www.theLIST.tas.gov.au ©State of Tasmania

3. DESCRIPTION OF CATCHMENTS

3.1. General

The Study Area is 27 km^2 including three catchments that drain to Elwick Bay: Humphreys Rivulet (19.3 km^2), Littlejohn Creek (2.7 km^2) and Barossa Creek (5.0 km^2). There is some interaction between the creeks during major flood events (refer to Figure 3-1). Knights Creek and Islet Rivulet are two tributaries of Humphreys Rivulet.

Most of the Study Area is rural forested catchment on the slopes of Mt Wellington. In the north of the Study Area is Glenorchy, Hobart. This region (8 km^2) consists of low and medium density residential and commercial/industrial businesses. There are also many parks and recreational facilities throughout the urban region.

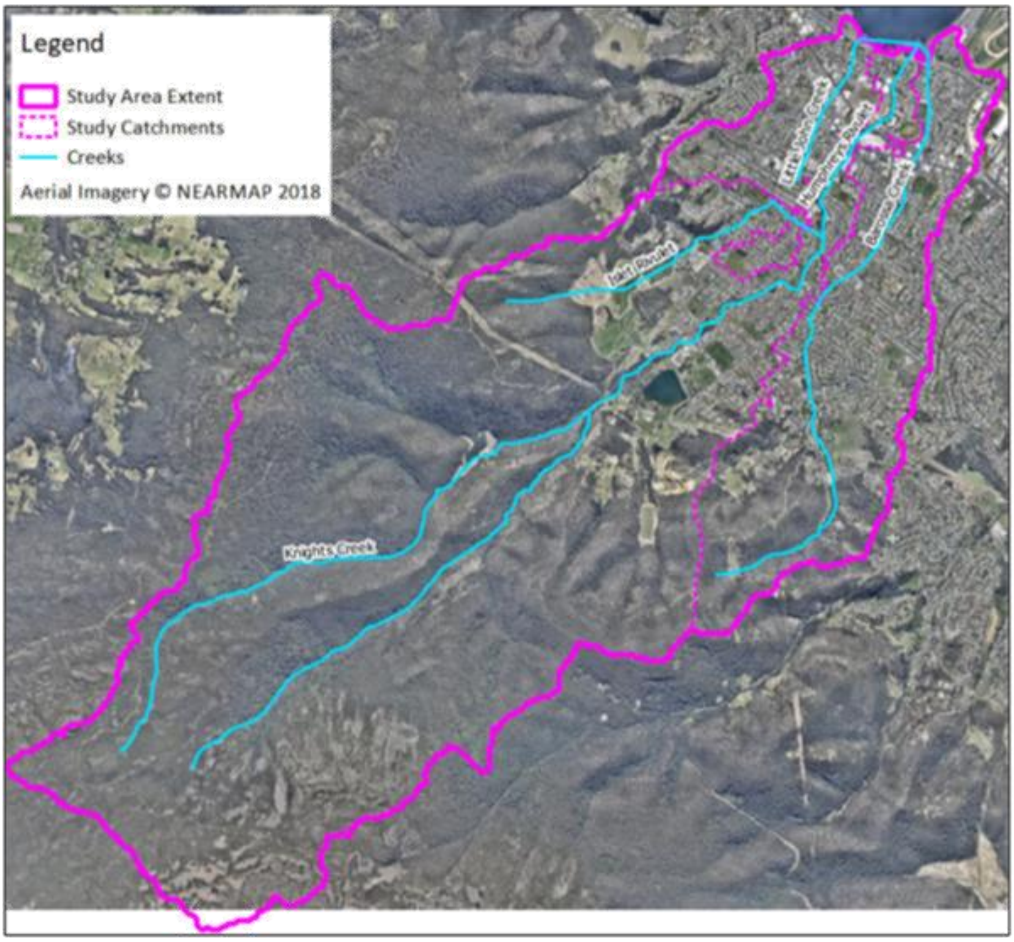


Figure 3-1 – Study Area Locality Plan.

To assess the flood risk of the Glenorchy stormwater system, a hydrology analysis is required to provide design hydrographs to input into a hydraulic model of the urban catchments of the Study Area. It is desirable to have the design hydrographs match the reality of major historic flood events to customise the flood model to match the real catchment conditions. This is done through calibration.

SMEC developed a hydrological model for the investigation of the dams on Knights Creek and Limekiln Gully and Tolosa Reservoir (SMEC 2017). That rainfall-runoff model was developed for the purposes of dam break modelling and consequence assessment. The definition of sub-catchments was fairly coarse through the urban areas. This definition was insufficient to provide direct inputs to the Glenorchy stormwater system.

In this study, the hydrological model previously developed by SMEC was updated and used to determine flows from the upper forested catchments (including the three dams, Knights Creek Dam, Limekiln Gully Dam and Tolosa Reservoir) only. The flows from the urban catchment was developed using the rainfall-on-grid method within a Tuflow model. This method is discussed in more detail in the Tuflow Model section (refer to Section 4.3).

The hydrology is, therefore, a hybrid of the two models, routed through the catchments using different mechanisms and computational methods, but calibrated to the same historic storms.

The hydrological analysis has comprised a range of sub tasks as follows:

- Update the rainfall-runoff model for the Study Area previously developed, and remove the urban sub-catchments
- Analyse regional rainfall data to develop an understanding of catchment runoff processes.
- Derive parameters for the updated rainfall-runoff model.
- Input dam storage and flow relationships
- Selection of model parameters
- Run the model with a range of scenarios
- Undertake sensitivity assessments

3.1.1. Catchment Hydrology

The Study Area encompasses the catchments of Humphreys Rivulet, Littlejohn Creek and Barossa Creek. The rainfall gauges in the region indicate that there is a strong orographic influence on rainfall (Table 3-1).

Table 3-1 – Orographic relationship between rainfall depth and elevation

Location	Elevation (m AHD)	Average Rainfall Depth (mm)
Hobart – Botanical Gardens	27	574
Hobart – Ellerslie Road	51	614
Glenorchy Reservoir	93	764
Mount Wellington – Kunanyi	1260	1,155

There are three dams within the Study Area, namely Knights Creek Dam, Limekiln Gully Dam and Tolosa Reservoir. These were previously water supply storages. It is understood that TasWater is intending to decommission Tolosa Reservoir in 2019.

3.2. Flood Frequency Analysis

Data from adjacent catchments has been analysed to develop an understanding of rainfall-runoff processes in the region and to further assist in developing rainfall-runoff model parameters for the Study Area.

A flood estimate for the 1 in 100 AEP event has been generated for the purposes of defining a target flow to use in RORB model calibration. The flow has been estimated through:

- Flood frequency analyses derived from peak observed flows from nearby catchments.
- A regional flood frequency analysis based on data across southeastern Tasmania.

In addition to the 1 in 100 AEP flood event flow estimation, the hybrid RORB/Tuflow model was calibrated to the flood levels recorded during the February 1996 event as documented by Thompson & Brett (1997).

3.2.1. Regional Analysis

Flow data was obtained for a range of gauging stations in the Hobart region and surrounds. Data for the majority of the catchments was obtained from the Water Information System of Tasmania (WIST) website which is managed by the Department of Primary Industries, Parks, Water and Environment (DPIPWE).

http://wrt.tas.gov.au/wist/ui?command=content&pageSequenceNo=41&click=[0].HomeLink#fopt

The catchment areas contributing to each gauge site were estimated using available contour data. Catchment areas were supplied for the Hobart Rivulet gauges by Hobart City Council. The data downloaded from the WIST website was supplemented in the case of the Hobart Rivulet @ Gore Street gauge by data sourced from HEC (1997). The available data for each gauge is listed in Table 3-2.

Table 3-2 – Streamflow Gauging Station Characteristics

Gauge Location	No.	Period of Record	Source
Hobart Rivulet @ Gore Street	353	1962-1985 (peak annual flow)	HEC (1997)
		1986-2016 (peak daily flow), 1997-06/2006 &1994 missing	HCC
Hobart Rivulet @Argyle Street.	354	1985-1994 (peak daily flow)	WIST
Peak Rivulet @ 3.5km upstream Esperence River	1012	1975-1997 (peak daily flow)	WIST
Jordan River @ Bridgewater	4210	1983-1992 (peak daily flow)	WIST
Browns River @ Summerleas Road	5200	1963-1992 (peak daily flow)	WIST
Mountain River @ Grundys Creek	6200	1968-1996 (peak daily flow)	WIST

Flood frequency analyses were undertaken on those data sets to obtain flow estimates for a range of probability events. The flood frequency analysis was undertaken applying the Tuflow-Flike software package. Flike is an extreme value analysis package that allows users to match a range of probability distributions (Generalised Extreme Value (GEV), Log Pearson three (LP3), Log Normal, Gumbel and Generalised Pareto) with a fitting method (Bayesian Inference Method and higher order (H) linear (L) Moment ratios). The fitting methods are used by Flike to fit the flow data to the probability distribution.

Multiple combinations of fitting method and probability distribution were trialled to select the best fit. Preference was made based on the current understanding of the best performing curve fitting techniques in South Eastern Australia (Rahman et.al. 2009).

In undertaking the analysis, the curve fit adopted was GEV with optimised LH moments. In a couple cases, Bayesian fitting or LH moments of zero provided a better fit, and these became the selected outcome.

The flood quantiles from the fitted distributions are listed in Table 3-3. Some gauge sites have a record length that was too short to give confidence to some flood quantiles and these cells have been greyed out in Table 3-3. Typically, confidence was given to record length (in years) that were roughly half or more than that of the AEP quantile (1 in y).

Graphs of the curve fits and text output are included as Appendix A.

Table 3-3 - Flood Frequency Analysis results for regional catchments

River	Catchment Area (km²)	Record Length (years)	Peak Flow (m³/s)			
			1 in 10 AEP	1 in 20 AEP	1 in 50 AEP	1 in 100 AEP
Hobart Rivulet @ Gore Street	16.3	47	27	35	48	61
Hobart Rivulet @Argyle Street.	19	10	60	75.7		
Peak Rivulet @ 3.5km upstream Esperence River	36.5	22	99	123	159	
Browns River @ Summerleas Road	11.1	29	20	28	42	
Mountain River @ Grundys Creek	40	28	61	75	93	

The outcomes presented in the above table are for a variety of different catchment areas. The flows from Table 3-3 have been modified in Table 3-4 to allow a direct comparison with the Study Area. The flows have been modified based upon catchment area by applying the following equation as described in Grayson et.al. (1996):

$$Q_{(Unregulated\ Catchment)} = Q_{(Gauged\ Catchment)} \times (A_{(Unregulated\ Catchment)} / A_{(Gauged\ Catchment)})^{0.7}$$

Where:

Q = Discharge (m³/s)
A = Catchment Area (km²)

Note: Exponent can vary between 0.5 and 0.85. If data is available, the exponent may be calibrated, otherwise, 0.7 is typically applied (Grayson et.al. 1996).

The exponent of 0.7 has been adopted as there is no flow record within the study area to calibrate the exponent. The Study Area catchment area (27.3 km²) versus each gauged catchment area ratio (i.e. the $(A_{(U)} / A_{(G)})^{0.7}$ portion of the equation above) has been calculated and listed in the second column of Table 3-4 as 'Multiplier'. These modified flow values are presented in Table 3-4.

Table 3-4 - Flood Frequency Adjusted for the Study Area Catchment Area (27.3 km²)

River	Grayson et. al 1996 Multiplier	Peak Flow (m³/s)			
		1 in 10 AEP	1 in 20 AEP	1 in 50 AEP	1 in 100 AEP
Hobart Rivulet @ Gore Street	1.43	38.7	49.6	68.6	87.5
Hobart Rivulet @Argyle Street.	1.29	77.3	97.6		
Peak Rivulet @ 3.5km upstream Esperence River	0.82	80.8	100.4	129.7	
Browns River @ Summerleas Rd	1.88	37.6	52.6	78.9	
Mountain River @ Grundys Crk	0.77	46.7	57.4	71.2	

Peak Rivulet is located in the Huon catchment and the flow conditions relating to the weather patterns of this catchment may not be representative of those in the Study Area. The Hobart Rivulet at Argyle Street gauge presents different outcomes to the Gore Street gauge despite being on the same watercourse and having similar catchment areas. It has been reported that following a review of the two gauges by Entura, the Gore Street gauge is considered to be more reliable (Fiona Ling, WMAWater, pers. comm.) After considering these exclusions, of the remaining observed flows above, it is considered that the most appropriate comparison gauges are Hobart Rivulet at Gore Street, Mountain River and Browns River.

Of the nearby gauges, the Gore Street gauge has the longest period of record and is the only gauge for which a 1 in 100 AEP flow estimate may be considered to be reliable. Notwithstanding this observation, it is noted that the rainfall of record for the Hobart Rivulet catchment occurred in 1960 is not captured in the flow data record. The Hobart Rivulet Advisory Committee (1960) estimates the 1960 flow as 2460 ft^3/s or 69.7 m^3/s. Without inclusion of that data point the 1 in 100 AEP flow estimate is 34.3m^3/s. With the 1960 data point included the flow estimate increases to 61m^3/s. There is confidence that this data point is not an outlier as similar depth rainfalls were recorded in pluvio records of 1854, 1954 and 1957.

While no 1 in 100 AEP flow estimates are available for the Mountain River and Browns River gauges, the 1 in 50 AEP estimates for those stations are substantially higher than the Hobart Rivulet gauge (without 1960) by factors of 1.4 and 1.8 respectively, but comparable when the 1960 data point is included. Overall, the available catchment data indicates that a 1 in 100 AEP flow for the Study Area is in the range of 80 m^3/s to 90 m^3/s.

3.2.2. Regional Flood Frequency Estimate (RFFE)

In addition to the outcomes described above, a regional analysis has been undertaken using a newly developed regional procedure called Regional Flood Frequency Estimate (RFFE) described in Ball et al. (2016). RFFE has been computed utilising the relevant website (accessed 7/11/16) as follows: http://rffe.arr-software.org/ The estimates from this analysis are presented in Table 3-5.

Table 3-5 – Regional Flood Frequency Estimate

Catchment Area (km^2)	Peak Flow (m^3/s)			
	1 in 10 AEP	1 in 20 AEP	1 in 50 AEP	1 in 100 AEP
27.3	25.4 (Range 10-64)	34.6 (Range 11-100)	48.3 (Range 12-170)	60.6 (Range 13-250)

The regional analysis draws upon nearby gauging stations from a database of catchments across Tasmania. In the case of this analysis, the outcomes from 15 catchments in central and eastern Tasmania have been drawn from.

The analysis provides a useful comparator, although the flow estimate is not considered to be highly accurate (note the wide confidence limits indicated by the range) for the Study Area given the wide variety of different hydrologic conditions in the 15 regional catchments. There are five nearby gauges used by RFFE that vary in area between 75% and 190% of the Study Area.

3.2.3. Previous Studies

A range of studies have been undertaken by others in the past which have applied various techniques to estimate flows in Humphreys Rivulet and nearby catchments.

Three studies have provided estimates for Humphreys Rivulet and one has provided an estimate for the nearby Browns Rivulet.

The various studies have reported on flows in different portions of the catchment. The flows have been documented in Table 3-6 along with the equivalent flow for the larger Study Area catchment at the downstream outlet to Elwick Bay. The flows have been altered for catchment area using the same formula described above.

Table 3-6 – Flow Comparison (other studies)

Study		1 in 100 AEP flow

	Catchment Area (km²)	Reported	27 km² Equivalent
Thompson & Brett (1997)	19	88	113
Thompson & Brett (2002)	18	108	145
BMTWBM (2012)	14	50	80
GHD (2016) – Browns Rivulet	12	47	84

The above-listed reports each incorporated the development of a rainfall-runoff model. Only GHD (2016) had sufficient data to undertake a calibration. Thompson and Brett (2002) validated modelled outcomes against limited observed flow depths for a few flood events in the mid-1990s. The model described in BMTWBM (2012) was not calibrated or validated. Of the above studies, therefore, the greatest confidence should be placed in the outcomes from GHD (2016). The result from GHD (2016) is within the 60 m^3/s to 100 m^3/s range suggested by the flood frequency analysis.

3.2.4. Summary of Flood Frequency Analysis

The outcomes from the analysis are presented in Table 3-7.

Table 3-7 - Flood Frequency Adjusted for Catchment Area

River	Catchment Area (km²)	Multiplier	Peak Flow (m³/s)			
			1 in 10 AEP	1 in 20 AEP	1 in 50 AEP	1 in 100 AEP
Hobart Rivulet @ Gore Street	27.3	1.43	38.7	49.6	68.6	87.5
Hobart Rivulet @Argyle Street.	27.3	1.29	77.3	97.6		
Peak Rivulet @ 3.5km upstream Esperence River	27.3	0.82	80.8	100.4	129.7	
Browns River @ Summerleas Road	27.3	1.88	37.6	52.6	78.9	
Mountain River @ Grundys Creek	27.3	0.77	46.7	57.4	71.2	
RFFE	27.3	-	25.4	34.6	48.3	60.6 (Range 13-250)
Thompson & Brett (1997)	27.3	1.29	55.4	70.9	92.8	113
Thompson & Brett (2002)	27.3	1.34			119	145
BMTWBM (2012)	27.3	1.60				80
GHD (2016) – Browns Rivulet	27.3	1.78		55.1	72.9	83.6

Based upon the outcomes of regional flood frequency analyses and studies undertaken by others, it is considered that the 1 in 100 AEP flow at the outlet of Humphreys Rivulet and inclusive of Littlejohn Creek and Barossa Creek is between 60 m^3/s and 100 m^3/s. It is considered that a flow towards the higher end of that range should be adopted based upon both recorded flows and the outcomes from other studies. A target 1 in 100 AEP peak flow of 80 m^3/s -90 m^3/s has been targeted for the purposes of calibrating the rainfall-runoff model.

3.3. Design Rainfall

3.3.1. General

Design rainfalls were developed for the Studay Area and applied to the RORB and Tuflow models.

In following the Generalised Short-Duration Method (GSDM), the Study Area was estimated to consist of 100% rough terrain to determine the PMP depths (BoM 2003).

3.3.2. Design Rainfall Estimation

Design rainfall depths used in the development of the RORB storm files were obtained as follows:

- 1 in 20 and 1 in 100 AEP design rainfalls were estimated using the online Bureau of Meteorology (BoM) website tool located at http://www.bom.gov.au/water/designRainfalls/ifd/index.shtml. It may be noted that currently there are two IFD relationships available on this website, being 1987 and 2016 data sets. The 2016 IFD data set has been applied in this analysis.
- Areal reduction factors (ARF) were applied to rainfalls using the procedure described in Ball et. al. (2016). Book 2, Section 2.4.3 Equation 2.4.1 was used for durations shorter than 24 hours and for durations of 24 hours and longer Equation 2.4.4 was used with the Tasmania region coefficients.
- Probable Maximum Precipitation (PMP) rainfall depths for durations up to 6 hours were developed using BoM (2003).
- Probable Maximum Precipitation (PMP) rainfall depths for durations greater than 6 hours were developed using the Generalised Southeast Australia Method (GSAM) described in BoM (2006).

Rainfall depths (including areal reduction factors (ARF)) for the study are included as Appendix B.

3.3.3. Losses

Ball et al. (2016) provide guidance on loss models to apply and values to adopt when undertaking rainfall-runoff modelling. When undertaking extreme flood analyses, it is preferred that the continuing loss model be used, since there is explicit guidance on how to evaluate continuing losses for extreme flood events. There is no similar guidance available in extreme events for the proportional loss model. In more frequent events, it is open to the practitioner as to which loss model to apply. Ball et al. (2016) recommend the use of continuing loss for ungauged catchments.

This analysis has considered both of the loss models. However, it has adopted the continuing loss model for all scenarios. Laurenson et al. (2010) recommend that the loss values should be determined through a calibration utilising rainfall and runoff data from selected historical storm events. Where there is insufficient data on or near the catchment under investigation, then the approach can be to apply regional values, to review available data from similar catchments or other studies and to undertake a reconciliation against independent flood frequency estimates.

There is insufficient data on the rural catchment in the Study Area to calibrate that model portion in isolation. However, water levels recorded after the February 1996 event allow for calibration of the entire model. See Section 5 for more details.

Regional Values

Ball et al. (2016) documents regional approaches to the estimation of initial and continuing loss. In addition, it documents outcomes from analysis of a select number of catchments, including the Hobart Rivulet Gauge and Argyle Street. The outcomes of the assessment are detailed in Table 3-8.

Table 3-8 – Regional Loss Values

Source	Initial Loss (mm)	Proportional Loss	Continuing Loss (mm/hr)
Regional Data	28	NA	3.8
Hobart Rivulet Data	1-18 (Range) 7.9 (average)	0.05-0.95 (Range) 0.55 (average)	1-5 (Range) 1.4 (average)

Other Studies

Losses on the Study Area and nearby catchments have been assessed as part of flood studies undertaken by others. The outcomes and adopted loss values are reported in Table 3-9.

Table 3-9 – Loss Comparison (other studies)

Study	Initial Loss (mm)		Continuing Loss (mm/hr)	
	Calibration	Adopted	Calibration	Adopted
Thompson & Brett (1997)	0-35	15	0-4	1.5 (calibration) 2.5 (design runs)
Thompson & Brett (2002)	NA	20-0 (varies)	NA	2.5-0 (varies)
BMTWBM (2012)	NA	15	NA	Not reported
Engineers Australia (2015)	0-8	8	0.9-7	2
GHD (2016) – Browns Rivulet	10-40	15	5-11	1.5

The previous studies applied burst temporal patterns, so the initial losses apply to the burst and cannot be directly applied to the complete storm temporal patterns used in this study. A larger storm initial loss is appropriate, to account for losses during pre-burst and burst portions of the storm.

Observed Data

A limited quantum of observed water level data was made available for Knights Creek Dam (TasWater water level telemetry from 2004-2016). This data was used to assess the quantum of runoff entering the reservoir as a proportion of the incident rainfall. Rainfall data from the closest available rainfall gauge was used in the analysis, and it was assumed that there was zero outflow from the dam during the event. The results of the analysis are presented in Table 3-10.

Table 3-10 – Observed Proportional Loss

Event date	Proportional Loss
22/07/2013	0.4
12/08/2010	0.6
15/01/2015	0.6
30/01/2004	0.7

Comparison of losses

The range of loss estimates as detailed above are presented in Table 3-11. 'Calibration' loss estimates are described in detail in Section 5 from the calibration of the hydrologic and hydraulic models to recorded water levels for a historic storm event.

Table 3-11 – Loss Estimates

Source	Initial Loss	Proportional Loss	Continuing Loss (mm/hr)
Regional Values	1-28	0.05-0.95	1-5
Other Studies	0-20	NA	0-11
Observed Data	NA	0.4-0.7	NA
Calibration (refer Section 5)	**28**	**NA**	**1.5**

For comparison, a flood frequency curve of the RFFE estimates, other regional estimates, previous studies estimates, and the final calibration outcomes are plotted in Figure 3-2. All these data sets of catchments different to the Study Area were scaled to the Study Area catchment area of 27.3 km^2 using the Grayson et. al. (1996) equation described in Section 3.2.1.

In sensitivity testing of the model parameters (refer to Section 4.4.2) other parameter sets were trialled, two of which are also plotted in Figure 3-2: continuing loss of 7.5 mm/hr, initial loss of 29 mm and k_c of 7.0; and proportional loss of 38%, initial loss of 29 mm and k_c of 7.0.

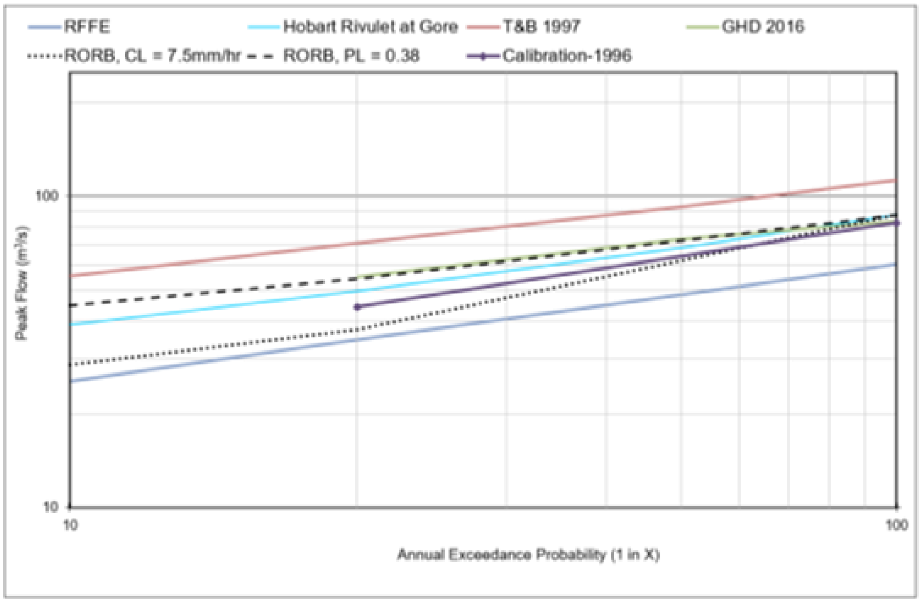


Figure 3-2 – FFC comparison of RORB flows using PL, CL, with other studies/data sets.

It was observed that the sensitivity test using proportional loss of 38% (refer to Section 4.4.2) and the calibration to 1996 event (using continuing loss of 1.5 mm/hr, refer to Section 5) provide the best match to the GHD 2016 and Hobart Rivulet gauge data.

Adopted Losses

After calibration to the 1996 event, these losses have been adopted for this study (Table 3-12).

Table 3-12 - Adopted Losses

Storm AEP	Initial Loss (mm)	Continuing Loss (mm/hr)
Calibration	28.0	1.5
20	28.0	1.5
100	28.0	1.5
PMF	0.0	1.0

3.3.4. Rainfall Temporal Patterns

Ball et al. (2016) recommends that consideration should be given to the impact which a variety of temporal patterns may have on the modelled outcomes from design event rainfall-runoff modelling. It is suggested that this ensemble approach represents an advance on the previous technique of using an averaged representative pattern or the Average Variability (AVM) method.

Ball et al. (2016) further recommends the use of complete storm temporal patterns as representative of actual storm events. The complete storm pattern consists of an initial period of lesser intensity rainfall called the pre-burst providing a pre-wetting of the catchment. The pre-burst is followed by a period of highly intense rainfall called the burst pattern. The duration label applied to any given design storm relates to the duration of the burst period. The complete storm is a much longer duration.

Despite recommending the use of an ensemble of complete storms, the current version of the Ball et al. (2016) datahub (http://data.arr-software.org/), which provides the regional data to apply the improved method, only provides a variety of storm burst patterns.

For this study SMEC has assembled complete storm temporal patterns by combining the variety of temporal patterns for eastern Tasmania (Southern Slopes Tasmania) (Ball et al. 2016) with an extreme AVM pre-burst patterns for short (Jordan et al. 2005) and long durations (BoM 2006). The AVM pre-burst pattern has been scaled to match the Ball et al. (2016) datahub median depths appropriate to each storm event probability and duration.

The result of this combined complete storm temporal pattern ensemble is illustrated in Figure 3-3 for the 1 in 20 AEP, and in Figure 3-4 for the 1 in 100 AEP. The ten (10) largest GSAM source storms (BoM 2006) have been used as an ensemble of PMP temporal patterns in combination with the GSAM AVM pre-burst for use in the PMP event (Figure 3-5).

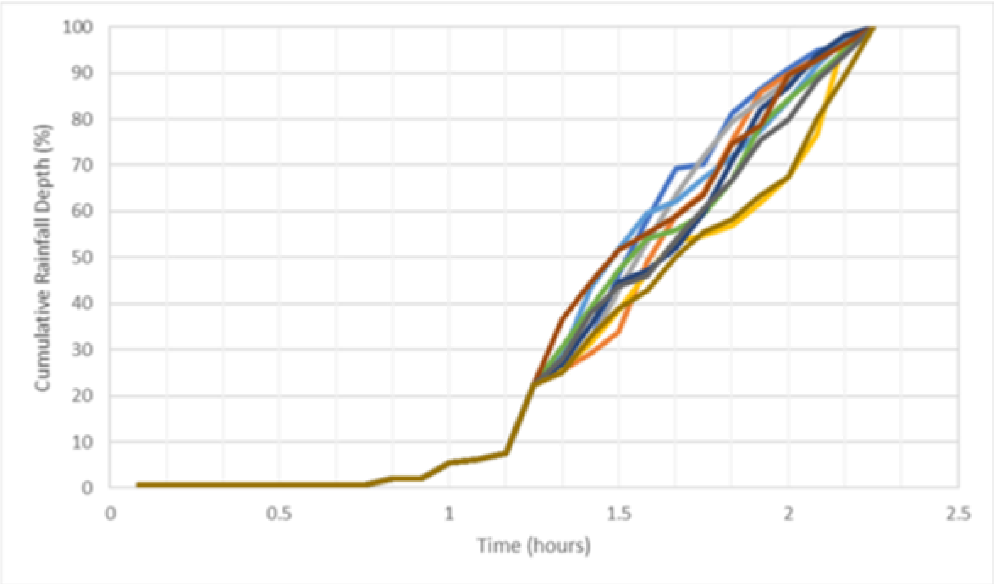


Figure 3-3 – 1 hour duration 1 in 20 AEP ensemble of temporal patterns

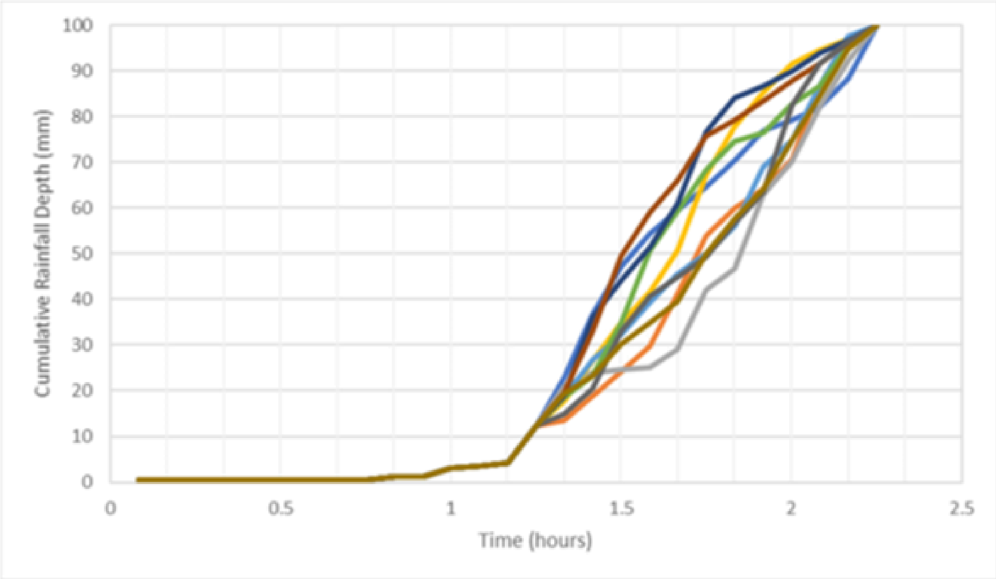


Figure 3-4 – 1 hour duration 1 in 100 AEP ensemble of temporal patterns

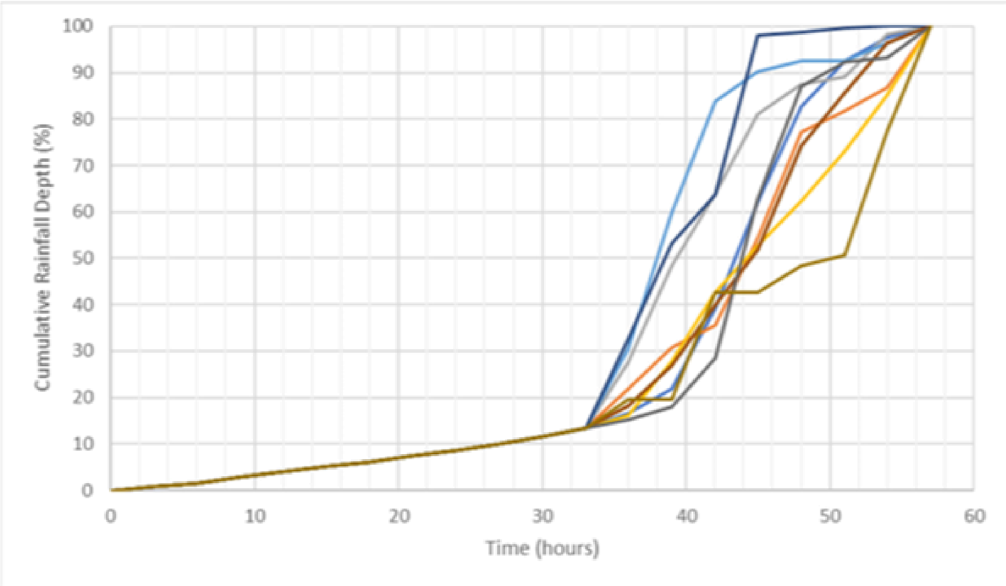


Figure 3-5 – 24 hour duration PMP ensemble of temporal patterns

3.3.5. Rainfall Spatial Patterns

3.3.5.1. General

As discussed in Section 3.1.1, the Study Area has a strong orographic influence on rainfall. The very large range of topographic elevations from Mount Wellington (1,260 mAHD) to sea level affects how much rain falls on different parts of the Study Area.

3.3.5.2. Spatial Pattern from the BoM IFD Design Rainfall Grid

BoM (2006) provides guidance for extreme rainfall using a topographic adjustment factor for long-duration extreme/PMP storms. Ball et al. (2016) recommend that for catchments larger than 20 km^2 spatial patterns be estimated from the design rainfall grids (Book 2, Section 6.3.2) used by BoM to generate the Intensity-Frequency-Duration (IFD) curves.

Figure 3-6 – Location of design rainfall grid points.
Black Circles show grid points; RORB subareas in red; Tuflow rainfall-on-grid extent shown in blue.

Analysis of these rainfall grid depths show a 33% difference between higher rainfall at Mt Wellington peak (higher elevation) and lower rainfall over Glenorchy CBD (lower elevation) for the critical duration. The design rainfall grids would produce a coarse spatial pattern relative to the Study Area.

Instead, a custom spatial pattern was adopted based on the largest storm rainfalls recorded by nearby rainfall gauges.

3.3.5.3. *Creation of Custom Spatial Pattern*

A procedure was developed to create a spatial pattern from the analysis of the rainfall gauges around the Study Area. The BoM rainfall gauges used in this procedure are illustrated in Figure 3-7.

Figure 3-7 – Location of rainfall gauges relative to the Study Area

The procedure applied to create the spatial pattern was:

- Analyse the BoM daily rainfall gauge data to compile a list of the biggest storm events across the region
- Plot each storm event showing the rainfall values for each gauge spatially (see Appendix D)
- Calculate an average percentage relative to the catchment-representative gauge (i.e. Tolosa Reservoir)
  - Isolate the rainfall events that show orographic related spatial variability (refer to the seven events in Appendix D)
  - For each gauge calculate the ratio of rainfall depth to the Tolosa Reservoir gauge rainfall depth as a percentage
  - Calculate the (mean) average of the ratios of the previous step for each gauge. These are illustrated in Figure 3-8 by the yellow points.
- Connect the gauge points with 'contour' lines of equal percentage roughly following the alignment of the actual elevation contours. Refer to green lines of Figure 3-8)
- Apply a percentage value from the 'contours' to each sub-catchment

The mean value is adjusted to achieve an areal-weighted pattern by the formula:

$$\frac{\sum(SubArea \times PatternFactor)}{TotalArea} = 100$$

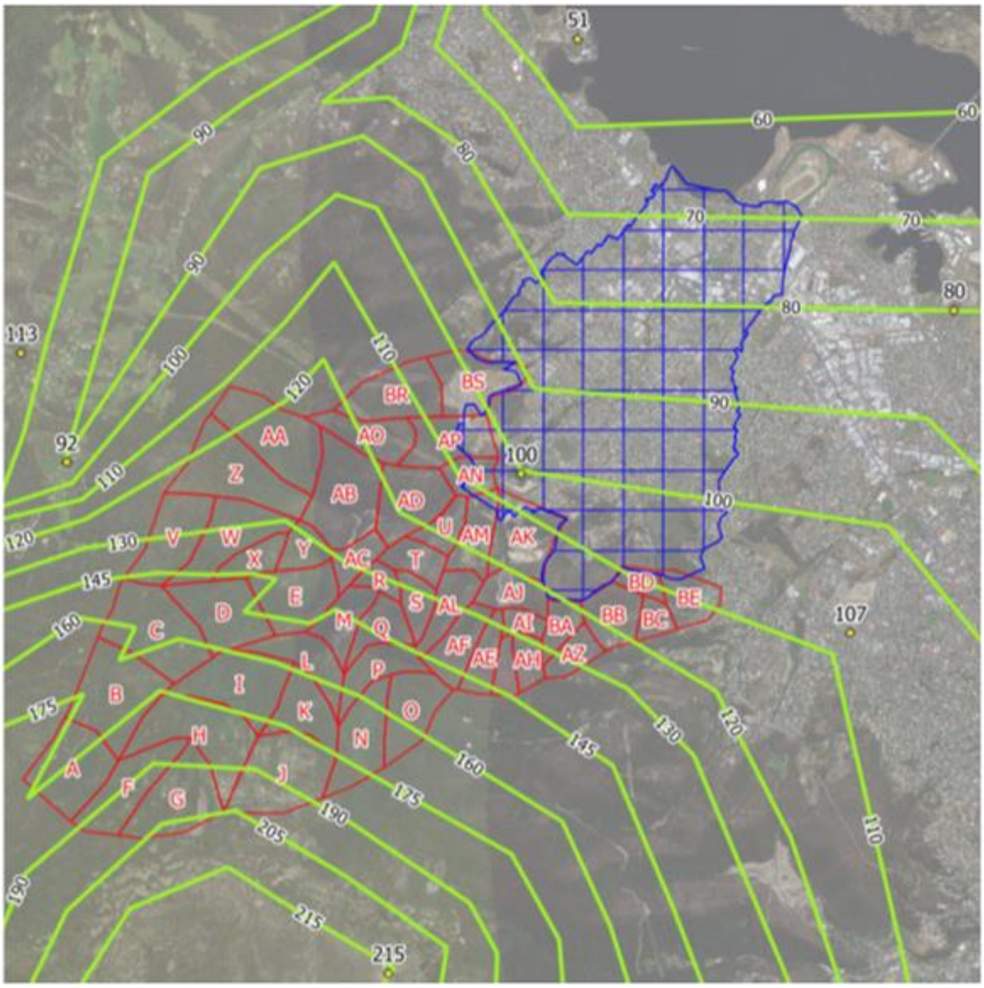


Figure 3-8 – Intermediate/Rare spatial pattern.
Green contours show percentages of average rainfall depth. Red regions are RORB sub-areas. The blue hatching shows the extent of the Tuflow model (slightly larger than where rainfall is applied to improve hydrograph inflows from the forested RORB model. Refer to Section 4).

In compiling the biggest storms, there was no strong indication that the orographic feature of the catchment strongly influenced most major storms. Half of the dozen events examined showed a strong orographic influence, and the other half showed no influence or a slight reverse trend. It is thought that the approach direction of the storms influences the spatial distribution of rainfall for the Study Area via a varied influence from the varied ground elevations.

Section 4.4.3 describes the calibration of the model with and without this spatial pattern. The outcome was very sensitive to the pattern. The calibration demonstrated that applying more rain over rural catchment, using a custom spatial pattern, lead to greater runoffs. These greater runoffs better represented the flow conditions and levels observed during the 1996 Calibration flood event.

3.3.5.4. Adopted Spatial Patterns

The Study Area was modelled in RORB and Tuflow using a variety of spatial patterns depending upon the application of the model. When running the model for:

- The 1 in 20 AEP and 1 in 100 AEP events, the custom spatial pattern (Section 3.3.5.3) was applied.
- For short duration PMF events, the GSDM spatial pattern was applied over the Study Area. In these cases, the storm was centred over the Glenorchy CBD area. (Refer to Figure 3-9).
- For long duration PMP events, the GSAM spatial pattern was applied over the Study Area. This pattern applies an orographic influence on rainfall. See the pattern illustrated in Figure 3-10.

Figure 3-9 – GSDM spatial pattern centred on Glenorchy CBD.
Red labels are sub-areas. Black labels are Ellipse IDs. The blue hatching shows the extent of the Tuflow model (slightly larger than where rainfall is applied to improve hydrograph inflows from the forested RORB model. Refer to Section 4).

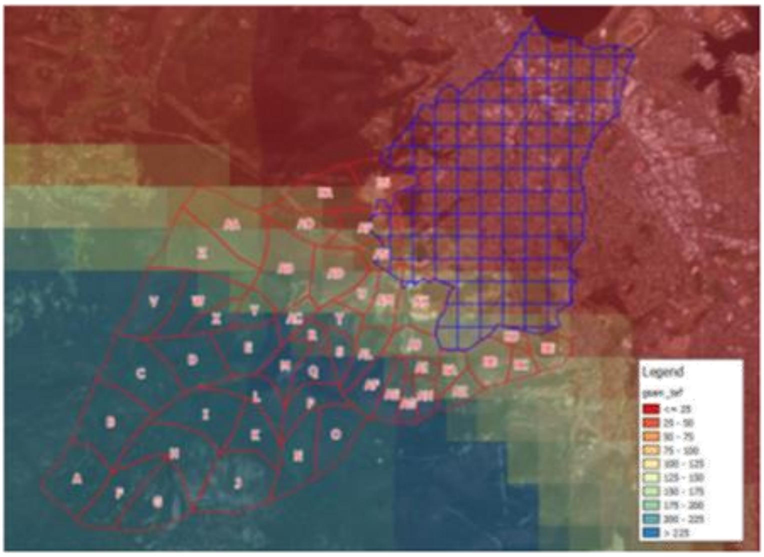


Figure 3-10 – GSAM spatial pattern based on the ratio of sub-area TAF to catchment TAF

4. MODEL SETUP

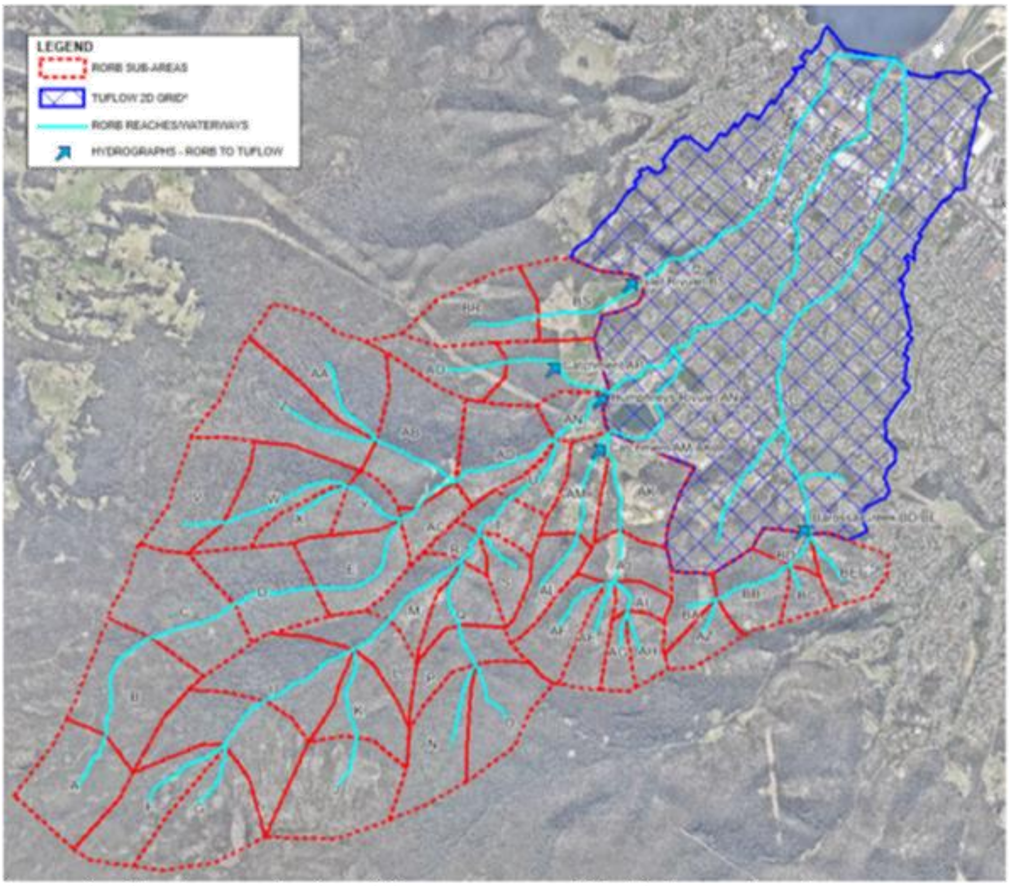
4.1. Hybrid Model

4.1.1. General

A rainfall-runoff model has been set up to describe the Study Area, and the layout diagram is shown as Figure 4-1.

The Study Area has been divided into two types, namely 'rural' and 'urban'.

- The rural catchment has been modelled utilising RORB – a 1D, non-linear, runoff routing model.
- The urban catchment was modelled using rainfall-on-grid with Tuflow HPC (Heavily Parallelised Compute), a dynamic hydraulic model which combines 1D calculation for pit and pipe flow with 2D overland flow calculations.



*square hatching is cosmetic only and does not represent 2D grid size or orientation

Figure 4-1 – Hybrid model layout - RORB sub area break up and Tuflow domain.

4.1.2. Model Scenarios

The hybrid model was run for a set of scenarios required by GCC to assess the breakout flood risk from the three watercourses and the drainage system performance (see Table 4-1). As noted in Ball et al. (2016), rainfall-on-grid is "a relatively recent development in 2D hydraulic modelling" and "where possible models should be calibrated to measurements". Section 5 describes the calibration to water levels measured after the February 1996 flood event (described in T&B 1997).

Table 4-1 – Model Scenarios

Scenario	Events Modelled	Catchment Condition	Rainfall	Dams Water Level
Calibration Scenario	1996 Event (Refer Section 0)	existing	recorded rainfall	Full Supply Level
Scenario 1	1 in 20 AEP, 1 in 100 AEP and PMF	existing	design rainfall	reduced operating level (drawn down)
Scenario 2	1 in 20 AEP, 1 in 100 AEP and PMF	developed	design rainfall	Full Supply Level Tolosa decommissioned
Scenario 3	1 in 20 AEP, 1 in 100 AEP and PMF	developed	design rainfall	reduced operating level (drawn down) Tolosa decommissioned
Scenario 4	1 in 20 AEP and 1 in 100 AEP (refer Section 4.1.5)	developed	design rainfall increased by Climate Change factor	existing dam draw down water levels Tolosa decommissioned

For each event duration, the ensemble method of 10 complete storms produced 10 flow outcomes. The closest flow to the mean of these 10 was selected as the event duration flow estimate.

4.1.2.1. Dams Initial Water Level

There are three dams in the Study Area: Limekiln Gully Dam, Knights Creek Dam and Tolosa Reservoir. The starting water level in each of the three dams varied by scenario (refer Table 4-1).

These starting conditions were based on TasWater's planned operating regimes for the dams (refer to Table 4-2 for specific water levels). SMEC's understanding of these expected operating regimes was based on recent studies completed by SMEC for TasWater (SMEC 2017).

Table 4-2 – Model Scenarios

Dam	Full Supply Level (mAHD)	Reduced Operating Level (mAHD)
Knights Creek Dam	189.43	184.13
Limekiln Gully Dam	166.42	161.92
Tolosa Reservoir	107.02	102.02

4.1.3. Existing Scenario

For Scenario 1 the rural and urban environments were modelled as they are at present. The fraction impervious value was selected based upon the degree of development. The impervious value was set in accordance with the values presented in Figure 4-2 and Table 4-3.

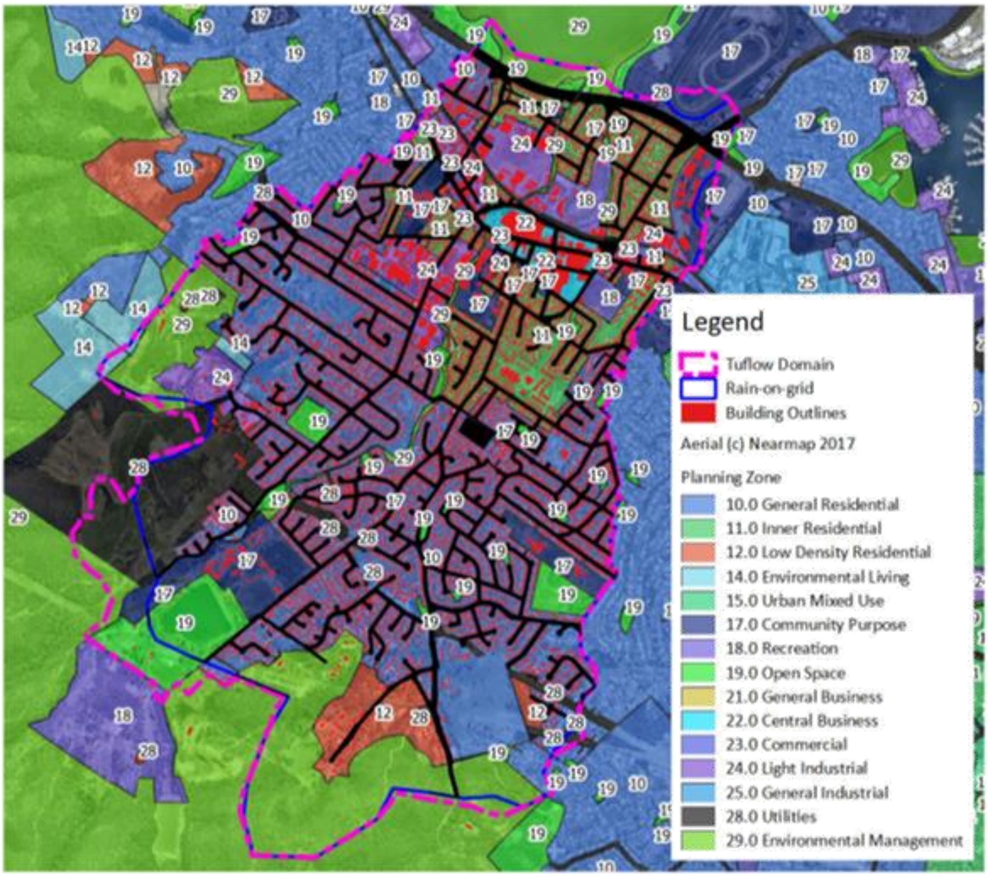


Figure 4-2 – Study Area Planning Scheme Zoning.

The land type/planning zone for each location was determined through interrogation of information on the interactive planning scheme maps on following website (accessed January 2018): http://iplan.tas.gov.au/pages/plan/book.aspx?exhibit=maps&hid=225916

All subareas of the RORB hydrological model fall within the environmental management zone. A fraction impervious value of 0.05 was used for all RORB subareas in the existing scenario.

Table 4-3 – Adopted Zoning Imperviousness

Land Type/Planning Zone	Typical Fraction Impervious Range	Adopted Fraction Impervious
General residential	0.5 - 0.8	0.6
Inner Residential	0.5 – 0.9	0.8
Low density / Environmental Living	0.1 – 0.3	0.2
Community Purpose	0.0 – 0.2	0.1
Recreation	0.0 – 0.2	0.1
Open Space	0.0 – 0.2	0.1
Local Business / Central Business / Commercial / Light Industrial	0.7 – 0.95	0.9
Utilities*	0.0 – 0.2	0.1
Environmental Management	0.0 – 0.05	0.05
Roads	0.5 – 0.8	0.8
Waterbodies/Rivulets	1.0	1.0

*Main roads (e.g. Brooker Hwy) are listed: 'Utilities'. Fraction impervious of roads supersede other land uses

4.1.4. Developed Scenario

For scenarios 2 to 4, the urban environment was modelled as 'developed'. As the urban landscape undertakes infill development, the impervious portion of the Study Area increases leading to greater runoff rates and volumes. It was understood that changes to land use zones are not expected for the developed conditions. Changes to the imperviousness were limited to the potential for infill development.

The detail of the future changes to the urban landscape was unknown. To model this scenario, existing model roughness values were maintained, whilst losses were reduced relative to the potential maximum increase in the fraction impervious.

Table 4-4 compares the existing and developed fraction impervious values (based on Table 4-3) and lists the developed losses calculated from the developed fraction impervious.

Table 4-4 – Developed Losses by Land Use

Land Type/Planning Zone	Tuflow Material ID	Existing Fraction Impervious	Developed Fraction Impervious	Initial Loss (mm)	Continuing Loss (mm/hr)
10 General residential	1	0.6	0.8	5.6	0.30
11 Inner Residential	7	0.8	0.8	1.4	0.30
12 Low Density Residential	11	0.2	0.3	19.6	1.05
17 Community Purpose	14	0.1	0.2	22.4	1.20
18 Recreation	3	0.1	0.2	22.4	1.20
19 Open Space	4	0.1	0.2	22.4	1.20
21 General Business	8	0.9	0.9	2.8	0.15
28 Utilities	4	0.1	0.2	22.4	1.20
29 Env. Management	10	0.05	0.05	26.6	1.425
Roads	2	0.8	0.8	5.6	0.30
Waterbodies/Rivulets	13	1.0	1.0	0.0	0.00

All subareas of the RORB hydrological fall within the environmental management zone. A fraction impervious value of 0.05 has been used for all RORB subareas in the developed scenarios.

4.1.5. Climate Change Scenarios

The climate change scenario for this study was based on:

- Southern Slopes Tasmania Natural Resource Management Cluster
- Interest in 1 in 100 AEP places planning horizon out to the year 2090; and
- Practitioner assumption: high emissions (RCP8.5) scenario (IPCC 2013).

Ball et al. (2016) provides guidance for climate change impact on rainfall intensities at a regional level (allocating Tasmania to a region with Southern Victoria and NSW).

It is worth noting that the flood mitigation infrastructure resulting from this study will have design lives out to 100 years, and therefore adequate justification for the long-term planning horizon needs to be considered and adopted.

The Climate Futures for Tasmania (CFT) study used a downscaling approach to create climate projections from the IPCC Special Report on Emissions Scenarios (SRES) (Nakićenović N & Swart R (IPCC) 2000) at a finer grid scale over Tasmania (ACE CRC 2010). ACE CRC (2010) reports the temperatures slightly lower than the Ball et al. (2016) values. ACE CRC (2010) reports that in the high emissions scenario the 2090 temperature rise for Tasmania is 2.6 to 3.3 °C, and rainfall depth increases 12-30% seasonally and 24% average increase annually.

Ball et al. (2016) uses the (more recent) IPCC (2013) Representative Concentration Pathways (RCPs) compared to ACE CRC (2010) use of SRES, and its climate change chapter is based on coarser scale regional climate modelling by CSIRO and BoM (2015).

Ball et al. (2016) allows practitioner judgement of choice between Representative Concentration Pathways (RCPs) (IPCC 2013) of RCP4.5 and RCP8.5. RCP8.5 has been selected based on the most current CO_2 trajectories, and USA withdrawal from Paris COP21 2015 Agreement.

Following the Ball et al. (2016) procedure on the basis of these inputs, the CSIRO and BoM (2015) estimates that on average the Tasmanian region will be more than 3°C hotter and a median temperature of 3.6°C hotter in 2090. From this temperature, the Intensity factor (F_{CC}) calculation gives a multiplicative factor of 1.19, or a 19.2% increase in rainfall intensity (Ball et al. 2016).

The results (and emissions pathways selected) between the two studies are reasonably comparable. Table 4-5 summarises the climate change scenario parameters adopted for this study.

Table 4-5 – Climate Change Scenarios

Climate Scenario	AEP	Rainfall Intensity (mm/hr)	Sea Level (mAHD)	Storm Surge (m)	Water Level Adopted (mAHD)
CC1	1 in 20	1 in 20 Intensity x F_{CC}^*	2010 HAT + SLR 0.8 + 0.82 = 1.62	0.0	1.62
CC2	1 in 100	1 in 100 Intensity x F_{CC}^*	2010 HAT = 0.8	0.0	0.80
CC3	1 in 100	1 in 100 Intensity x F_{CC}^*	2010 HAT + SLR = 1.62	0.0	1.62
CC4	1 in 100	1 in 100 Intensity x F_{CC}^*	2010 HAT + SLR = 1.62	0.4	2.02

*F_{CC} adopted is 1.24.

This study proposed an approach of adopting the local climate change model study, the Climate Futures report (ACE CRC 2010). Therefore, a rain depth increase of 24% (F_{CC} = 1.24) was applied.

It is noted that this is comparable but slightly more than the estimate of 20% increase used in the Roseneath Rivulet flood study (GCC 2017).

The base tide level adopted was the 2010 Highest Astronomical Tide (HAT) of 0.8mAHD (GCC 2017). The adopted sea level rise (SLR) is 1.6mAHD, and 2.0mAHD for SLR plus storm surge (GCC 2017).

These values match with the range of 2090 values for the Hobart 20year SLR and storm surge presented in McInnes et al. (2012).

4.2. RORB Model

4.2.1. General

A RORB rainfall-runoff routing model has been used to simulate the hydrologic performance of the rural catchment of the Study Area. The model has been used to provide inflow hydrographs from the forested upper catchment into the Tuflow hydraulic model to assess flood hazard within the Glenorchy CBD and surrounding area.

The RORB (Laurenson et. al. 2010) model simulates the catchment routing characteristics utilising a representation of the stream network and the parameters k_c and m. The effect of the catchment in delaying the runoff response from rainfall is represented by k_c and the non-linearity in the storage discharge relationship for the catchment is represented by m. The RORB model also incorporates a loss model to account for rainfall lost to groundwater stores, evaporation and various other sinks.

A RORB model was previously developed for the Study Area as part of the SMEC (2017) study of Knights, Limekiln Gully, and Tolosa Dams. The sub-catchment layout of the developed region of Glenorchy in that model was too coarse for this assessment. Those sub-catchments have been ignored in the model. Instead, the developed region was modelled using Tuflow rainfall-on-grid (Section 4.3). The hybrid model configuration is shown in Figure 4-1.

4.2.2. Sub-catchment layout

The Study Area model (including Humphreys Rivulet, Barossa Creek and Little John Creek) consists of an area of 27 km^2, which was previously delineated into 78 sub-catchment areas ranging in size from 0.1 km^2 to 1.3 km^2. The stream network was established based upon the overland flow paths as indicated by surface contour information.

The layout of sub areas for the model have a number of competing influences, including:

- A preference for between 3 and 5 sub-areas upstream of any point where flow measurements are required.
- A preference to keep sub areas across the catchment to as similar a size as possible.
- A preference to reduce the impact of large point source inflows to the downstream inundation area when modelling inundation consequences.

The 27 sub-catchments across the developed lower catchment region in the previous RORB model have been removed from the updated RORB model in this study. Instead, the Tuflow model was developed to cover these sub-catchments, as shown in Figure 4-1.

4.2.3. Dams

4.2.3.1. General

As part of the RORB modelling, it was necessary to include the relevant dam characteristics for Knights Creek, Limekiln Gully and Tolosa Dams. The elements of relevance to the hydrologic modelling are as follows:

- Elevation-Discharge Relationship
- Elevation-Storage Relationship

These details were included in the original model (SMEC 2017) and were not modified for this study, except to set appropriate initial water levels (IWL). See Section 4.1.2.1 for details of IWL. The methodology applied for modelling the three dams is included in Appendix C.

4.2.4. Selection of RORB Model Parameters

4.2.4.1. General

In the absence of rainfall and flow data across the Study Area for calibration, parameters have been determined by considering past studies and data from adjacent catchments. In determining the appropriate parameter set for the RORB model, an early iteration of the model was used, where all dams were removed from the model and coarse sub-catchments out to Elwick Bay were included.

The model parameters were validated using the design storm rainfall to achieve an appropriate match to 1 in 100 AEP flow estimates as determined using a range of regional estimation techniques described above (refer to Section 3.3). After development of the Tuflow model, the RORB model parameters were updated via calibration to the 1996 event water levels (refer to Section 5).

4.2.4.2. K_C Value

Laurenson et al. (2010) recommended the approach for selecting RORB model runoff routing parameters k_c and m is to calibrate the catchment file utilising rainfall and runoff data from selected historical storm events. Where there is insufficient data within or nearby the Study Area, then the approach can be to apply regional equations, to review available data from similar catchments, and also to review outcomes from other studies.

Regional Equations

A range of regional equations can determine the catchment delay which typically take the form of:

$k_c = b \times A^d$

Where: A = area in (km^2)
b = Coefficient
d = Coefficient

It is common practice to apply relationships derived in Victoria for Tasmanian conditions due to the broad hydrologic similarity in the two states and also because there are few similar studies of catchment delay for Tasmanian conditions. A number of different k_C estimates were considered during this study, which are outlined Table 4-6.

Table 4-6 - Estimate k_C parameter equations

Estimate	Equation	Kc
Dandenong Creek and Westernport Catchments	$k_c = 1.53 * A^{0.55}$	9.4
Yarra and Maribyrnong Catchments	$k_c = 1.19 * A^{0.56}$	7.5
Victoria (MAR>800mm)	$k_c = 2.57 * A^{0.45}$	11.3
Victoria (MAR<800mm)	$k_c = 0.49 * A^{0.65}$	4.2
Recommended for Tasmania (Ball et.al. 2016)	$k_c = 0.86 * A^{0.57}$ – (m = 0.75)	5.6
	$Q_{100} = 80\ m^3/s$, (m = 0.8)	4.7

The k_c value recommended for Tasmania has been developed with an m value of 0.75. An adjustment can be applied to determine an equivalent value with an m value of 0.8, but it varies with the model peak discharge (Laurenson et.al. 2010). The k_c value can be adjusted by a factor:

$$\left(\frac{Q_p}{2}\right)^{m-m'}$$

Where Q_p = peak discharge (m^3/s)
m = old value of the m parameter
m' = new value of the m parameter

An equivalent k_c value has been presented above for a 1 in 100 AEP flow estimate of 80 m^3/s using the determined factor of 0.83.

The derivation of the Victorian equations (referred to in Table 4-6) are described in Hansen (1986). The equations for Dandenong Creek and the Yarra River (major Melbourne River catchments) have been derived internally by Melbourne Water and are unpublished.

The results from the analysis indicated the range of k_c values that would be expected for the catchment were between 4.2 and 11.3.

Adjacent Catchments

The Hobart Rivulet catchment is located within close proximity to the Study Area and it has a reletively reliable and long rainfall and runoff record. The data from Hobart Rivulet has been used to assist in understanding the potential hydrologic characteristics of the Study Area.

Hobart Rivulet has a catchment area of 16.3 km^2 at the comparison streamflow gauge and its catchment centroid is located a distance of around 6 km from the Study Area.

The delay parameter for the catchment as applied in RORB is a quantification of storage delay throughout the catchment. This delay was discussed in Laurenson et al. (2010) and it was noted that the storage delay and the peak runoff delay can be assumed to be equivalent for the catchment.

The runoff delay can be expressed in the form:

$T_c = k_c \times Q^P$

Where T_c = lag (hrs)
Q = mean outlet discharge (m^3/s)
P & k_c = constant ($p = -0.25$)

It may be noted that the lag is defined as the delay between the centroid of the rainfall excess and the centroid of the resulting surface runoff. The peak runoff delay can be estimated from observed hydrograph and rainfall data and can, in turn, be used to estimate the mean and variability in catchment delay. This in turn can be used to infer the appropriate storage delay parameter to be applied to the RORB model.

The available flow and rainfall data from the Hobart Rivulet catchment were collated and the largest hydrographs and rainfall hyetographs were extracted from the data set. The delay was estimated for a range of events. An example extracted hydrograph is presented in Figure 4-3 and the plot of all events is included as Figure 4-4.

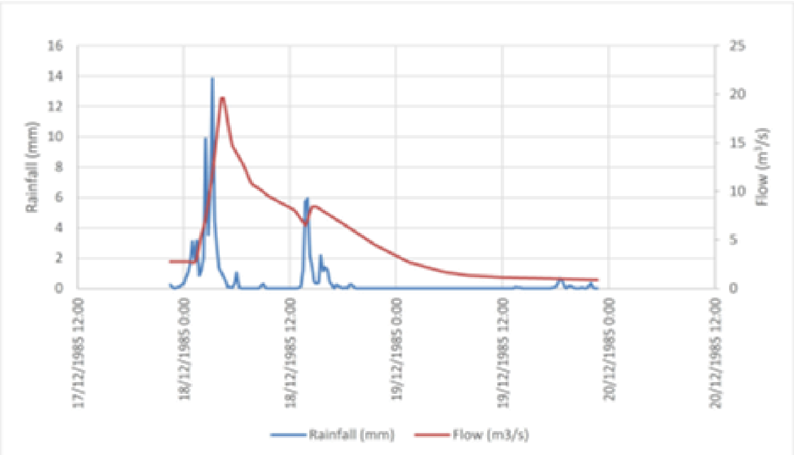


Figure 4-3 – Observed Rainfall-Runoff Event

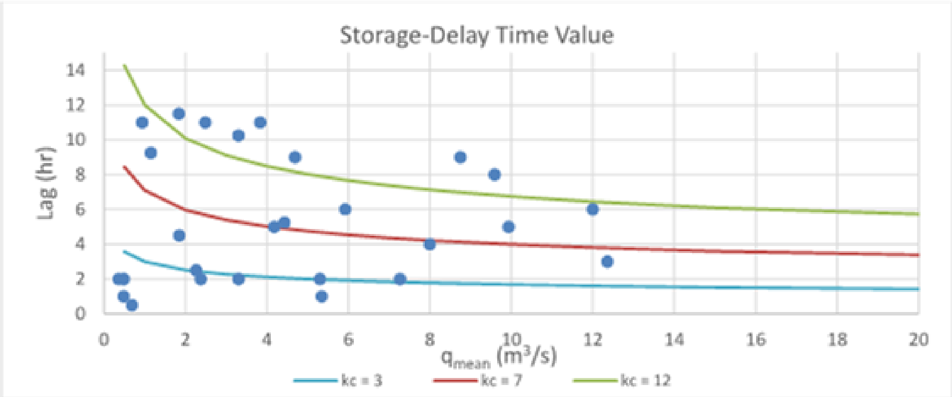


Figure 4-4 – Hobart Rivulet Observed Storm Delay

In determining the mean flow certain portions of the events were censored. Any flow at the start of the event (baseflow) was ignored. Additional inflow due to secondary rainfall peaks during the event were subtracted from the subsequent hydrograph tail. The impact of rainfall loss on the data points was ignored, since it is judged that it would not have a significant impact on the delay estimate in most cases. The data from some events was too noisy to allow the delay for a single event to be determined and in such cases the data was not included in the analysis. Events that were 'too noisy' were multi-peak events where it was unclear which rainfall peak corresponded to which runoff peak.

It is recognised that the process of deriving the delay incorporates some subjective judgement on the part of the analyst, however, the variability in the outcomes is consistent with a similar analysis described in Kjeldsen et.al. (2016) with a more rigorous methodology.

Figure 4-4 includes a range of lines representing the range within which the average delay could be expected to fall. The Hobart Rivulet catchment area associated with the above delay times is 16.3 km^2. The Study Area has a catchment area of 27 km^2 which is larger and the delay may be expected to be proportionately larger. The various equations included in Table 4-6 suggest that the delay time for the Study Area catchment should be around 30% larger than the smaller Hobart Rivulet catchment. This equates to a catchment delay kc value in the range of 4 - 16.

Other Studies

Engineers Australia (2015) in part considered delay parameters for the adjacent Hobart Rivulet. The analysis includes a calibration for a number of large rainfall events for Hobart Rivulet. The rainfall-runoff model was different to RORB, although similar in concept to RORB. That rainfall-runoff model uses a calibration parameter 'alpha' which is the RORB equivalent of the ratio of two variables: i.e. $\alpha \approx k_c/D_{av}$. The alpha parameter adopted for use in Engineers Australia (2015) for Hobart Rivulet is 1.3. The Study Area RORB model has a D_{av} value of 5.54. An equivalent alpha value of 1.3 for the Study Area would result in a k_c value of 7.2 (i.e 1.3x5.54=7.2).

Adopted Parameter

The range of delay parameters which may be considered applicable to Humphreys Rivulet along with the parameter adopted for this study are detailed in Table 4-7.

Table 4-7 – Streamflow Gauging Station Characteristics

Source	Delay Parameter (k_c)
Regional Equations	4.2-11.3 (Range) 7.8 (average)
Hobart Rivulet Observed Flow Data	4-16 (Range) 10 (average)
Hobart Rivulet Study	7.2
Adopted from Calibration	**4.0**

It is of interest to note that both the range of delay parameters from regional equations and the observed data are similar. The observed data indicates that the delay can vary substantially between events and that no single delay parameter with the rainfall-runoff model is likely to represent the range of conditions that may occur over the catchment.

Current accepted practice is, nevertheless, to apply a single parameter for analyses. The adopted delay parameter was determined through calibration of the 1996 event. This indicates that during that event the catchment was very responsive, indicative of a saturated catchment.

4.2.4.3. m Value

Although, the m parameter can vary in the range of 0.6 to 1.0, it is recommended in Ball et al. (2016) that a value of 0.8 be used for ungauged catchments in the absence of evidence supporting an alternative value. Therefore, the value of 0.8 has been adopted for the purposes of developing design storm hydrographs.

4.2.4.4. Losses

This analysis has considered both continuing and proportional loss models, however, has adopted the continuing loss model for all scenarios. See Section 3.3.3 for a detailed assessment of losses.

After calibration to the 1996 event, these losses have been adopted for this study (Table 4-8).

Table 4-8 - Adopted Losses

Storm AEP	Initial Loss (mm)	Continuing Loss (mm/hr)
Calibration	28.0	1.5
20	28.0	1.5
100	28.0	1.5
PMF	0.0	1.0

4.2.4.5. Adopted Model Parameters

The adopted parameters for the RORB model are outlined in Table 4-9.

Table 4-9 - Adopted RORB parameters

Parameter	Value
m	0.8
K_C	7.0
Initial Loss (mm)	28 (0.0 in PMF)
Continuing Loss (mm/hr)	1.5 (1.0 in PMF)

Note that the runoff coefficient is computed as being 1 minus the proportional loss.

4.3. Tuflow Model

4.3.1. General

The urban catchment of the Study Area has been modelled using Tuflow HPC hydraulic model. The Tuflow model utilises input hydrographs developed from the rural model at the five locations shown in Figure 4-5.

The Tuflow model represents the urban catchment using 2D surface terrain, surface roughness, and a 1D pit and pipe network (no less than 450mm diameter or equvilent). Tuflow version 2018-03-AB single precision has been used with HPC GPU settings.

HPC, Heavily Parallelised Compute, allows very large models with a fine grid size to be run in shorter timeframes. The model domain covers an area of 8.8 km², which includes a small overlap with the rural catchment. The rainfall is applied 'rainfall-on-grid' to only the urban catchment of 8.3 km², with no 'rainfall-on-grid' layer applied to the small overlap (illustrated by the magenta and blue lines in Figure 4-5).

To balance runtime and model definition a grid size of 2x2 m was used, specifically to enhance the detail of some narrow rivulet channels modelled using the 2D grid surface. A grid size this fine for an area this large has recently become possible through the HPC version of the model.

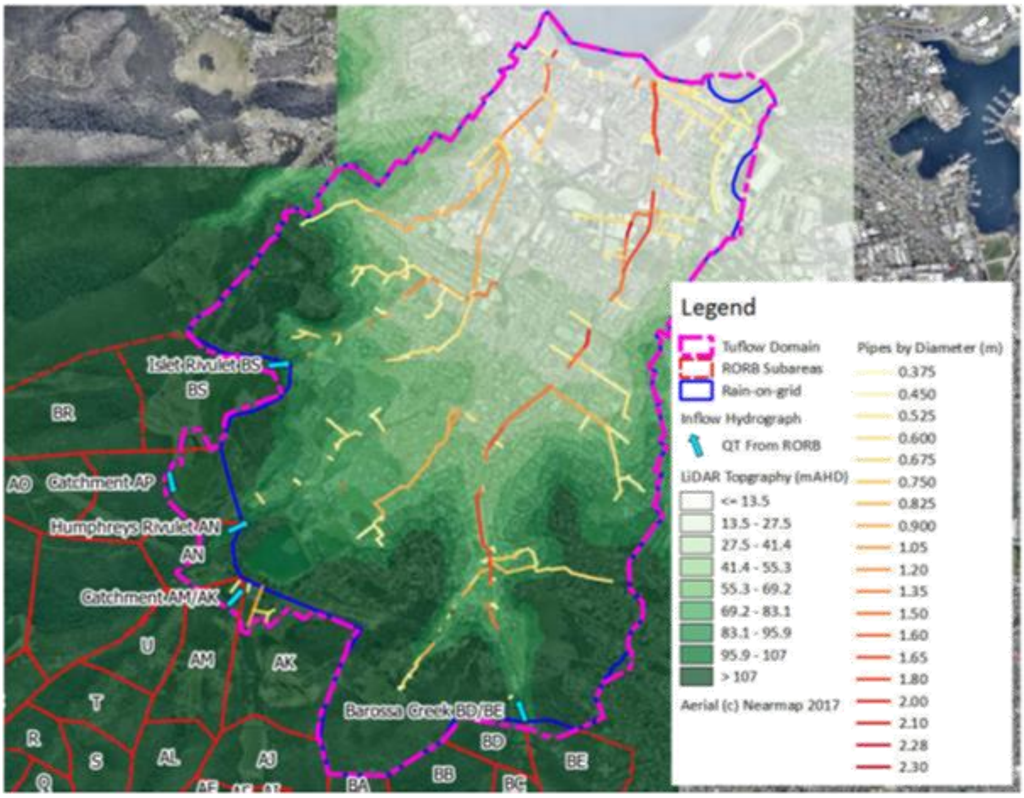


Figure 4-5 –Tuflow model Layout

4.3.1.1. Surface Elevation - LiDAR

LiDAR DEM was supplied (Figure 4-5) by GCC and was used as the basis for the representation of the catchment surface terrain within the Tuflow model. Modifications to the LiDAR-based surface were made to represent elements in the catchment as follows:

- Tolosa Reservoir bathymetry has been estimated and applied
- in some instances, additional elevation geometry has been used to reduce the riverbed elevation to the invert level recorded (in GIS) for the culvert outlet.
- Additional geometry adjusted the channel beds in some locations connecting low elevations in channel beds that may have become 'blocked' by the elevation sampling of the grid points.
- Elevations were reduced (as channels) at the bed levels for culvert outlets to the bay

4.3.1.2. Mannings 'n' Roughness

The land type/planning zone for each sub-area was determined through interrogation of information on the interactive planning scheme maps on the following website (accessed September 2016): http://iplan.tas.gov.au/pages/plan/book.aspx?exhibit=maps&hid=225916
The impervious value was set (Table 4-10) in accordance with the figures presented in Figure 4-6.

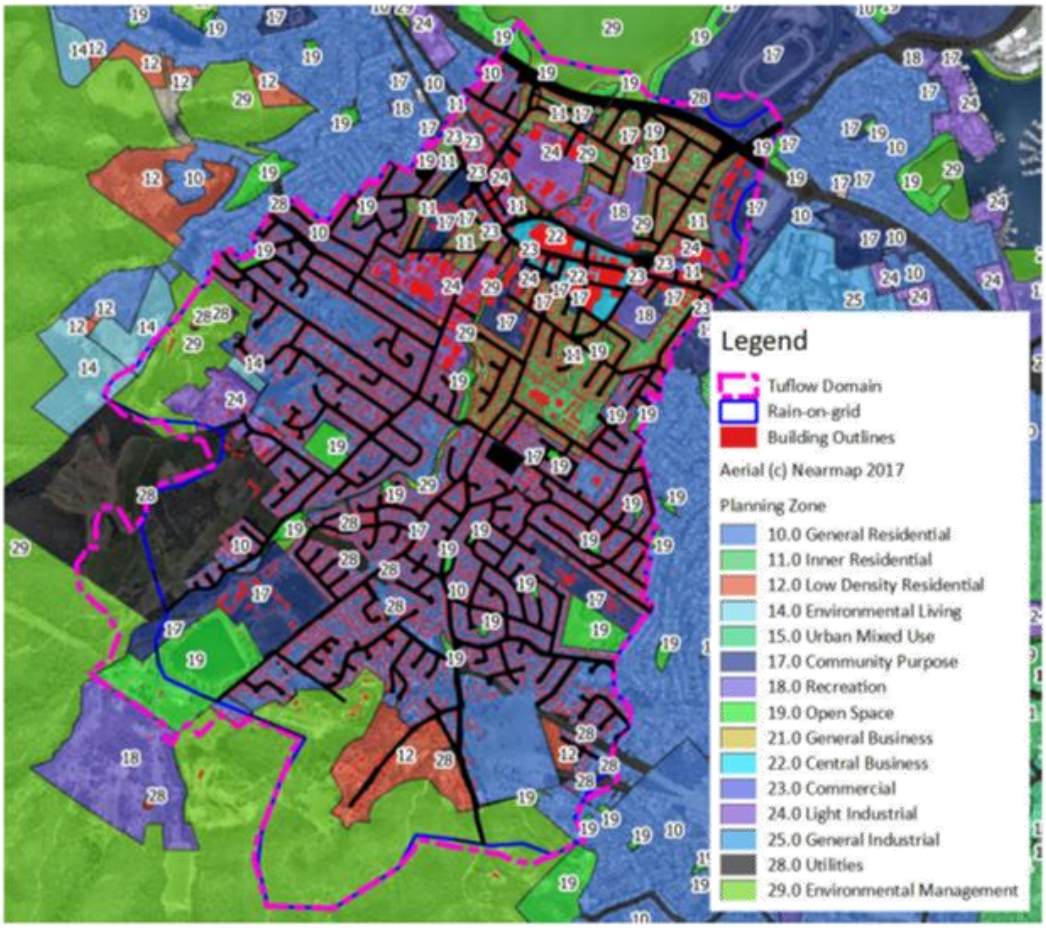


Figure 4-6 – Study Area Planning Scheme Zoning.

A Mannings roughness was selected for each land use and for the building outlines (provided as a GIS cadastral layer). In most cases, a single roughness value was selected (Table 4-10).

Rainfall-on-grid models have large amount of time where the water is very shallow and standard Mannings roughness values would be inappropriate. Hence, in some cases, a variable (varies with water depth) roughness was applied in line with Tuflow's industry guidance for rainfall-on-grid models (*https://wiki.tuflow.com/index.php?title=Tutorial_Module08*).

For residential land use (of all densities) a depth-varying Mannings has been applied in three partitions:

- Less than 100 mm constitutes shallow water depth. This partition assesses the water that is highly impeded by garden beds, fences, etc. and is therefore highly attenuated. For this partition, a higher Mannings value is applied.
- Between 100 mm depth and 500 mm depth, the Manning's roughness transitions via a linear interpolation from a higher value to a lower value (simulating the increasingly destructive nature of the water as it begins to move obstructions out of its way).
- Above 500 mm depth the floodwater a lower Mannings value is selected to represent the greater destructive power of the floodwaters as it can remove obstructions in its way, for example, by knocking down fences and trees, and generally making the landscape smoother for it to pass over.

For buildings, depth varying roughness has been applied in three partitions:

- Less than 40 mm constitutes very shallow water depth. This partition assesses rooftop runoff from a roof. Rooftops typically have a greater slope than the topography. For this partition, a very low Mannings value is applied.
- Between 40 mm depth and 500 mm depth, the Manning's roughness transitions via a linear interpolation from a very low value (simulating rooftop runoff) to a high value (simulating the obstruction that the building gives to floodwaters).
- Above 500 mm depth, a very high Mannings value is selected to represent the attenuation of deeper water attempting to pass through (or under) the walls, doors, or windows.

Table 4-10 – Mannings n Roughness by Land Use

Land Type/Planning Zone	Fraction Impervious	Tuflow Material ID	Manning's n n value (depth m)
10 General residential	0.6	1	0.08 - 0.045 (0.1-0.5)
11 Inner Residential	0.6	1	0.08 - 0.045 (0.1-0.5)
12 Low Density Residential	0.2	11	0.15-0.045 (0.5-1.0)
14 Environmental Living	0.1	11	0.15-0.045 (0.5-1.0)
17 Community Purpose	0.1	14	0.030
18 Recreation	0.1	3	0.035
19 Open Space	0.1	4	0.045
21 General Business	0.9	8	0.045
22 Central Business	0.9	8	0.045
23 Commercial	0.9	8	0.045
24 Light Industrial	0.9	8	0.045
28 Utilities*	0.05	4	0.045
29 Environmental Management	0.05	10	0.150

Land Type/Planning Zone	Fraction Impervious	Tuflow Material ID	Manning's n n value (depth m)
Roads	0.8	2	0.020
Buildings	N/A	12, 15-21	0.02-0.5 (0.04-0.2)
Waterbodies – waterways/bay	1.0	13	0.040

*Some roads (e.g. Brooker Hwy) are listed: 'Utilities'. Fraction impervious of roads supersede other land uses

4.3.1.3. Losses

The losses selected (Table 4-9) were applied as parameters within Tuflow to the full rainfall hyetograph. Setup of the model this way means that the calibration model is identical to the design storm model, with only a change of the rainfall, inflow and tidal inputs.

For impervious surfaces, the storm initial loss was zero (to be consistent with the built-in RORB calculation, noting that 1 mm is more typical in Tuflow models). For pervious surfaces, 28 mm initial loss was applied (Table 4-9).

For each land use, a fraction impervious was selected (Table 4-11). That fraction impervious set what percentage of that area is impervious (and thus impervious losses are applied) and what percentage is pervious (where the Table 4-9 losses are applied).

For example, General Residential planning zone was given a fraction impervious of 0.6. For all catchment areas designated by this zone, 60% is impervious (0mm initial loss), and 40% is pervious (28 mm initial loss). Averaging these two fractions together gives a total initial loss of that land type of 11.2 mm. Table 4-11 summarises this calculation for all initial loss and continuing loss values.

Table 4-11 – Losses by Land Use

Land Type/Planning Zone	Tuflow Material ID	Fraction Impervious	Initial Loss (mm)	Continuing Loss (mm/hr)
10 General residential	1	0.6	11.2	0.60
11 Inner Residential	7	0.6	11.2	0.30
12 Low Density Residential	11	0.2	22.4	1.20
14 Environmental Living	11	0.2	22.4	1.20
17 Community Purpose	14	0.1	25.2	1.35
18 Recreation	3	0.1	25.2	1.35
19 Open Space	4	0.1	25.2	1.35
21 General Business	8	0.9	2.8	0.15
22 Central Business	8	0.9	2.8	0.15
23 Commercial	8	0.9	2.8	0.15
24 Light Industrial	8	0.9	2.8	0.15
28 Utilities	4	0.1	25.2	1.35
29 Environmental Management	10	0.05	26.6	1.425
Roads	2	0.8	5.6	0.30
Waterbodies/Rivulets	13	1.0	0.00	0.00

4.3.1.4. Bridges

The 2D layered flow constriction bridge method has been applied for all bridges within the model based on available drawings and site photos. Layered Flow Constrictions include four layers (Figure 4-7):

- waterway below bridge deck (below red line);
- bridge deck (between red and blue lines);
- bridge railings (between blue and purple lines);
- and above railings (above purple line).

Additional geometry layers have been used to smooth the road surface (blue line) over the bridge and river bed surface (green line) under the bridge removing transition instabilities due to missing lidar data beneath the bridge (Figure 4-7).

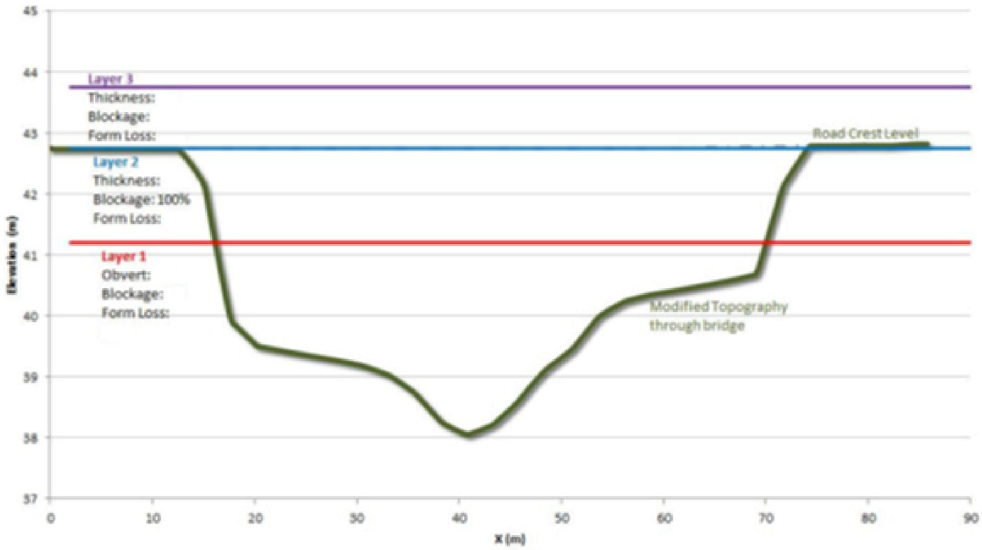


Figure 4-7 – Typical Bridge Cross Section showing 2D Layered Flow Constriction Layers.

4.3.1.5. 1D Network – Pipes and Pits

The GIS pit/pipe information provided by GCC has been used to set up the 1d pipe network. The trunk drainage system of pipes 450 mm diameter and larger has been included. All pits were modelled as rectangular opening 'R' type as 1.5 m wide by 0.2 m opening height. All headwalls were modelled as 'Node' type. Some pits have been shifted slightly to ensure maximum connection to the closest 2D drainage paths. Where parallel pipes of equal depth and size were observed in the GIS information, they have been replaced by a single object with its attribute describing the number of parallel pipes.

4.3.2. Boundary Conditions

4.3.2.1. Tidal Boundary

A tidal boundary condition (elevation versus time) has been applied where the rivulets discharge to Elwick Bay. A historical relation has been used for the calibration model, whilst a fixed water level is applied to the design model runs and varied for each scenario.

Table 4-12 – Tidal Boundary Condition Levels

Model Scenario	Tidal Boundary Condition (mAHD)
Calibration	Varies with time Hobart Tide Gauge, 1996
Existing	0.16
Developed with Full Dams	0.16
Developed with Dams at Existing Water Levels	0.16
Climate Change	Varies with each sub-scenario See Section 4.1.5 for more details.

It is considered that selecting the average conditions for the Elwick Bay water level is more appropriate than the worst case. Any given design storm event has an independent probability to the tide level in Elwick Bay at the moment of maximum flow. Without conducting a joint probability assessment, the average conditions are considered to be most likely during a storm event.

Tidal gauges around Tasmania were assessed to augment understanding of tidal conditions in the Derwent River. A comparison of Hobart tidal data with Spring Bay over the same time series suggested that they share the same amplitude but differ slightly in mean (Spring Bay is higher by 0.2 m). Both gauges are somewhat sheltered from the open ocean with minimum water levels around 0.0 mAHD compared with, for example, the Burnie tidal gauge with typical -1.0 mAHD minimum tide levels.

The selected tidal boundary level of 0.16 mAHD is based on the average level of ~30 years of continuous recordings at Spring Bay of 0.36mAHD (mean and median are the same for the 2 gauges; adjusted down by 0.2 m to 0.16mAHDfor Hobart).

4.3.2.2. Inflow Boundary

Flood inflow hydrographs have been applied to the Tuflow model at the locations illustrated in Figure 4-5 (labelled as 'QT from RORB'; 'QT' is flow (Q) versus time (T), also known as a hydrograph). These locations provide the connection points between the RORB model and the Tuflow model and are the points where the hybrid model switches from 1D to 2D rainfall-runoff routing.

4.3.2.3. Rainfall Boundary

The rainfall is applied to every model grid-cell with the rainfall-on-grid region shown in Figure 4-5. The boundary of the model extends slightly further than this region (indicated by 'Tuflow Domain' on the same figure). A single temporal pattern is selected for each model run and is applied consistently across the entire model.

The rainfall depth is reduced differently, for different portions of the Study Area as discussed below. The rainfall depth is reduced by a combination of losses (initial and continuing) and by the custom spatial pattern (Figure 3-8). The losses are varied using fraction impervious which is selected based on the planning zone (see Table 4-11 for all loss rates applied).

4.3.3. Model Convergence/Adaptive Timestep

Healthy models are those that demonstrate model convergence. Traditionally model convergence of Tuflow models has been examined through interrogation of the Mass Balance Error. This is still appropriate when using Tuflow Classic calculation scheme. However, Tuflow HPC calculation scheme has a 2D mass error of 0% as momentum and volume are conserved between cells.

Model convergence of HPC models is examined through interrogation of the timestep length. The HPC calculation scheme reduces and repeats timesteps as required to maintain stability. The model was checked for repeating timesteps and found that they occurred at a regular interval to synchronise the model time with the output time. These were not due to stability concerns and therefore the model has been confirmed to be stable for all model runs.

4.3.4. Depression Storage

A concern relating to rainfall-on-grid models is "that the topographic information included in the model means that the model can include relatively large depression storage areas which interact with losses" (Ball et. al. 2016).

With this model grid size (2m x 2m), 100mm of depression storage within a single grid cell is 400 litres. If not accounted for these depressions can cause double-counting of losses and under-estimate the magnitude of flood impacts.

An analysis of depression storage with the LiDAR topography was conducted to assess model losses that are not controlled by the modeller. With the full Tuflow model, a 6-hour model run was used to assess the extent of depression storage.

Within the first minute of the model, 500 mm of rainfall depth was applied across the whole model (without the losses applied), and then no further water added for the rest of the run. The total water volume in the model over time (i.e. total rainfall volume minus model outflows) is presented in Figure 4-8).

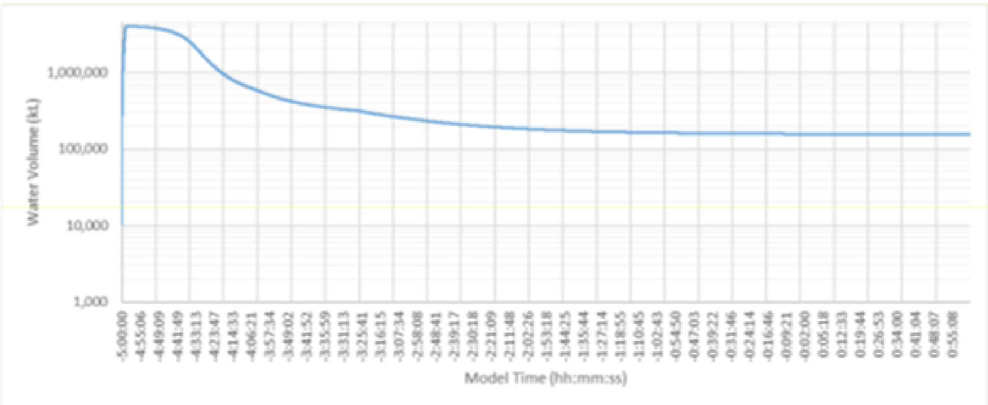


Figure 4-8 – Analysis of LiDAR depression storage volume

The water volume remaining within the model at the end of its run is considered to be equivalent to the depression storage in the model.

The outcomes of the depression storage analysis are:

- 6 hours is enough to estimate resulting volume no longer draining from the model (asymptote of volume line at the end of model runtime (i.e at 1hr).
- The total water volume captured by the model (154 ML) of ~18.5mm uniform depth across the urban catchment. However, 115 ML relates to water volume stored in Tolosa Reservoir,

30 ML within Elwick Bay at 0 mAHD, and captured by depression storage is 9 ML (~1mm uniform depth across urban catchment)

- This volume of depression storage is equivalent to 0.7% of calibration event rainfall depth before applied losses.
- Volumes will vary depending on the tidal level selected in the model run (due to water volume in Elwick Bay).

It was considered that this volume (as 0.7% of calibration event rainfall depth before applied losses) is negligible and unlikely to affect outcomes or objectives.

An approach to filtering out the effects of depression storage could be to run the model with depressions filled as an initial condition, however, given the minor nature of this issue and the effort required, this approach was not adopted.

Instead, volumes were tracked in the calibration model run (Figure 5-4) and in design runs to confirm that peak inundation outcomes were not affected.

4.4. Sensitivity Analysis

4.4.1. General

As part of the model parameter selection process, the sensitivity of the modelled outcomes to a range of different parameters was trialled. The parameters were tested either in isolation within the RORB model or Tuflow, or in combination across the two models.

The elements which were reviewed for sensitivity in RORB included proportional loss, delay and spatial pattern. Note that the sensitivity of parameters was conducted on the model with the dams relationships removed to be consistent with the calibration.

In Tuflow, the parameter sensitivity assessment was conducted in the context of achieving calibration water levels. The conventional parameters originally applied did not provide sufficiently high water levels. The commentary on the Tuflow sensitivity was whether the model responded by changing the water levels at the observed and recorded locations (See Section 5 for more detailed discussion on the model calibration).

4.4.2. RORB Sensitivity

4.4.2.1. Delay

It is recognised that there are a variety of different parameter combinations which can produce similar modelled outcomes. The impact of reducing or increasing the delay value was considered, since the proportional loss adopted falls in the middle of the range of expected values. The parameters required to achieve validation of model parameters to the target 1 in 100 AEP flow were determined with a fixed initial loss. The outcomes are presented in Table 4-13.

Table 4-13 – Delay and Loss Relative Sensitivity

Delay (kc)	Initial Loss (mm)	Proportional Loss	Peak flow (m^3/s)	Critical Duration (hr)
5	8	0.63	81.7	6
7	8	0.56	80.5	6
9	8	0.48	80.2	3
11	8	0.42	81.7	3

The outcomes demonstrate that an increased delay results in a reduction in proportional loss and likewise, a reduced delay results in an increase in proportional loss. The variety of delays trialled represent most of the plausible range. The proportional loss values associated with each of the modelled delays lie within the observed range and as such, each of the parameter sets are considered viable. Table 4-13 offers a variety of parameter sets which may be trialled.

The outcomes of Table 4-13 indicates the relative uncertainty between variables. The impact of varying just one parameter provides an indication of the absolute uncertainty of that parameter on the model outcomes. The outcomes of varying the delay parameter are presented in Table 4-14.

Table 4-14 – Delay Sensitivity

Delay (kc)	Initial Loss (mm)	Continuing Loss (m^3/s)	Peak flow (m^3/s)	Critical Duration (hr)
4	28	1.5	160	3
7	28	1.5	138	3
11	28	1.5	116	3

The peak 1 in 100 AEP flow varies by 16% within the plausible range of delay values indicating the level of uncertainty.

4.4.2.2. Continuing Loss

The outcomes of varying the continuing loss parameter are presented in Table 4-15

Table 4-15 – Continuing Loss Sensitivity

Continuing Loss (m^3/s)	Delay (kc)	Initial Loss (mm)	Peak flow (m^3/s)	Critical Duration (hr)
1.5	7	28	138	3
2.5	7	28	132	3
3.8	7	28	124	3
7.5	7	28	88	3

The peak flow reduces by 4% - 10 % within the plausible range of continuing loss values indicating the level of uncertainty.

4.4.2.3. Spatial Pattern

Section 3.3.5 details creation of a custom spatial pattern to model the orographic impact of the great variability of ground elevation through the Study Area. In that assessment, there was no clear indication in the rainfall gauge history that the orographic impact affected every storm, with only half exhibiting the trend. The other half of the events showed no orographic trend, or even a slight reversed trend.

The model was calibrated, in Section 4.2.4.4, with both the custom spatial pattern and a uniform pattern. The outcome was that the model was not sensitive to that orographic spatial pattern for the loss/delay set adopted. The model was tested to see if it was sensitive for a set of longer delay/smaller loss. The outcomes of the assessment are presented in Table 4-16.

*Table 4-16 – Spatial Pattern Sensitivity (Initial loss fixed at 8mm except for *)*

Spatial Pattern	Delay (kc)	Proportional Loss	Peak flow (m^3/s)	Critical Duration (hr)
Rare Storms	7	0.59	81.7	6
Uniform	7	0.56	80.5	6
Rare Storms	7	0.42* (IL = 28mm)	87.5	6
Uniform	7	0.38* (IL = 28mm)	87.0	6
Rare Storms	11	0.46	81.0	6
Uniform	11	0.42	81.7	3

The outcomes demonstrate that the model is not sensitive to that spatial pattern, independent of loss and delay. This is discussed further, in the context of the hybrid model, in Section 5.2.3.

4.4.3. Tuflow/Hybrid Model Sensitivity

Through the course of achieving the calibration, different parameter variations were trialled to attempt to match water levels observed in 1996, without resorting to unreasonable values. The following is a summary of the parameters assessed and the resulting model sensitivity to variation in that parameter (Table 4-17).

Table 4-17 – Parameter Sensitivity from Calibration of Hybrid model

Model Parameter	Comments	Sensitivity	Adopted Model Parameter
Rainfall temporal pattern Trialled historic measurements from Hobart RO & Mt Wellington	Better calibration with Mt Wellington and with consistent pattern between rural forested and urban catchments	Sensitive	Mt Wellington
Inflow hydrographs from rural forested catchment into the upstream end of the urban catchment	Calibration only able to be achieved with large inflows from the forested catchment	Very sensitive	N/A
Spatial pattern Uniform or custom	The custom pattern provided more inflows from the forested catchment. NB this is discussed in Section 5.2.3 in relation to RORB (no) sensitivity.	Very sensitive	Custom Spatial Pattern
Losses	The catchment needed to be saturated in order to respond to the water levels observed. A very small loss was required to achieve the calibration water levels. The very small loss values required are the equivalent rainfall excess of using standard antecedent catchment conditions (from the RORB validation) and increasing the rainfall depth by 50%	Very sensitive	IL_S = 28mm; CL = 1.5mm/hr
RORB routing parameter K_c – 7.0 or 4.0	The K_c was reduced to 4.0, speeding up the forested catchment response and increasing the flow rate at the upstream end of the urban catchment. The reduction improved the calibration	Sensitive	4.0
Pit losses Constant K of 0.5 for all pits, or varied according to pipe inlet/outlet configuration	Very little calibration improvement from changes to the runoff routing speed from an urban catchment	Not sensitive	Varied K according to pipe inlet/outlet configuration
Grid size 4m or 2m	The 2m grid size better represented the Rivulet channel capacities – increasing the channel capacities and reducing the modelled water levels	Sensitive	2m
Mannings n Constant vs variable with depth	Constant Mannings n provided worse calibration by a negligible amount. Very little calibration change from changes to the runoff routing speed from an urban catchment	Not sensitive	Depth varying
Mannings n Waterway roughness (rivulets and Elwick Bay) trialled with 0.022, 0.025, 0.03, and 0.04	Mannings n of 0.04 provided the best calibration outcome by a negligible amount. Very little calibration change from changes to the runoff routing speed from an urban catchment	Not sensitive	Waterway roughness = 0.04

Model Parameter	Comments	Sensitivity	Adopted Model Parameter
Mannings n Building roughness with water depth less than 40mm trialled with 0.005, 0.01, and 0.02	Mannings n of 0.02 provided the best calibration outcome by a negligible amount. Very little calibration change from changes to the runoff routing speed from an urban catchment	Not sensitive	Building roughness = 0.02
Mannings n Residential roughness (i.e front/back yards) with water depth less than 100mm trialled with 0.06, 0.07, 0.08, 0.10, 0.15, and 0.20	Mannings n of 0.08 provided the best calibration outcome by a negligible amount. Very little calibration change from changes to the runoff routing speed from an urban catchment	Not sensitive	Residential roughness = 0.08
Mannings n Different combinations of waterway, buildings, and residential roughness values from above trialled together	Very little calibration change from changes to the runoff routing speed from an urban catchment	Not sensitive	N/A
Bridge definition Different arrangements of the layered flow constriction trialled to attempt to keep the bridge deck and waterway channel smooth and reduce instability	Bridges smoothed to reduce constriction of flows, which cause significant breakout flooding from Humphreys Rivulet	Sensitive	N/A
1D pipe network 700x pipes of 450mm diameter or larger compared to no 1D network (zero pipes)	Removing the entire 1D pipe network made the calibration worse, but by a negligible amount. Very little calibration change from changes to the runoff routing speed from an urban catchment	Not sensitive	700x pipes of 450mm diameter or larger
1D pipe network 700x pipes of 450mm diameter or larger; 1000x pipes 300mm diameter or larger; and 3000x pipes of 100mm or larger	Keeping all pipes in the GIS database connected to the model caused widespread instability and significantly increased runtimes. Needed to cut back to just trunk network to remove most of instability within the 1D network	N/A	700x pipes of 450mm diameter or larger
Tidal boundary condition – trialled fixed 0 mAHD level and historic recorded levels	All calibration levels lie higher than the tidal levels	Not sensitive	Historic recorded levels
Z shapes to smooth channel beds or add levees along rivulet banks	These changes changed the capacity of the channels and in some places prevented large portions of flood volume from spilling from the waterway into the urban landscape	Sensitive	N/A

5. CALIBRATION OF HYBRID MODEL

5.1. General

As part of the T&B (1997) study, a flooding survey allowed members of the community to provide inputs to the study. GCC received 57 submissions. From that survey information on property inundation from three events was obtained. After the survey follow-up visits were made to 13 landowners, who said that they had recorded flood marks. These observed flood locations are indicated in Figure 5-1.

Figure 5-1 – Location of observed water levels during Feb 1996 event (T&B 1997). Blue line marks Tuflow model extent.

5.2. 1996 Event Rainfall

5.2.1. General

A rainfall hyetograph at Glenorchy was not available for the calibration event for this study. The February 1996 event was recorded over Hobart (at Ellerslie Rd) and Mt Wellington (T&B 1997) and as daily totals at Tolosa Reservoir in Glenorchy (Table 5-1).

5.2.2. 1996 Event Rainfall Depth

The (daily totals) rainfall depth recorded at Tolosa Reservoir, Glenorchy provided a rainfall depth of 119 mm used in the calibration process. Other rainfall depths were recorded at three other rainfall gauges (Table 5-1), ranging from 83.1mm to 256mm.

Calibration to the 1996 event was achieved using a custom spatial pattern (refer to Sections 3.3.5.3 and 5.2.3) which is an areal weighted average with a factor applied over Tolosa Reservoir that reduces the rainfall depth.

Applying an average rainfall depth of 157 mm, with the custom spatial pattern, gives a rainfall depth over Tolosa Reservoir of 119 mm (spatial pattern factor over Tolosa Reservoir of 0.77).

Table 5-1 – Rainfall Depth 08-09/02/1996 (T&B 1997)

Location	Rainfall Depth (mm)
Glenorchy – Tolosa Reservoir	119
Hobart R O (Ellerslie Rd)	83.1
The Springs	201
Mt Wellington	256
Custom Spatial Pattern	157

Figure 5-2 illustrates the calibrated rainfall depth applied to both RORB and Tuflow using the Mt Wellington temporal pattern (NB the first 0.19 mm (0.1%) of the event was skipped to optimise runtime (it would require a further 5 hours of model time for negligible benefit)).

A sensitivity run was conducted using a uniform spatial pattern. For that model-run, the rainfall depth of 119 mm was applied.

5.2.3. Rainfall Spatial Pattern

Section 3.3.5 details the procedure to determine the spatial pattern in Figure 3-8. That section details how the RORB model was not sensitive to the selection of any temporal pattern. However, noting the particularly strong orographic influence on the three temporal patterns recorded for the 1996 calibration event (T&B 1997), this spatial pattern was applied during the calibration run.

To apply the spatial pattern within Tuflow the areal weighted spatial factor (as applied in RORB) was applied to the rainfall regions as a multiplicative factor 'f2' (Table 5-2).

Table 5-2 – Spatial Pattern Factor

Mean Rainfall Depth (Figure 3-8) (%)	Areal Weighted Factor (%)
120	91.9
110	84.2
100	76.5
90	68.9
80	61.2
70	53.6

The February 1996 event was one of the events analysed to determine the custom spatial pattern as it showed strong orographic spatial variation. The probability of the rainfall for the 1996 event can be estimated (e.g. T&B 1997 as 30yr ARI). However, the calibration of this event required that catchment conditions for the peak runoff from the event were near fully saturated (1.5 mm/hr CL, PMF events assume full saturation using 1 mm/hr CL). This model loss parameter corresponds to the real observations of the 24 to 36 hours of significant rainfall prior to the burst period from 10am to 7pm on 9/2/1996 (using the Mt Wellington Pattern; or 40mm rainfall (of 120mm) in the day previous, using the daily data at Glenorchy Reservoir Gauge). Using the probability neutral perspective of design AEPs, despite not having flow gauge records for this Study Area to verify, the '30yr ARI rainfall' produced less frequent than 1 in 30 AEP runoff.

Whilst the RORB model was not sensitive to the selection of any temporal pattern (Section 4.4.2.3), sensitivity of the hybrid model (refer to Section 4.4.3) indicated that it was highly sensitive to the spatial pattern. Given that the purpose of model calibration is to obtain model parameters and outcomes that best match the real catchment, the custom spatial pattern was applied to 1 in 20 AEP and 1 in 100 AEP design runs, and the GSDM (BoM 2003) spatial pattern centred on Glenorchy CBD was applied for PMF design runs.

5.2.4. Rainfall Temporal Pattern

Temporal patterns were available from Hobart Regional Office and Mt Wellington rainfall gauges (refer to Figure 5-2). The Mt Wellington temporal pattern was selected for the entire Study Area (refer to the grey lines: 'Calibration' in Figure 5-2). The daily totals at Glenorchy (Tolosa Reservoir) showed two-thirds of the rain occurred on the second day. Mt Wellington pattern was consistent with this proportion. However, the Hobart pattern had most of the rain occurring on the first day.

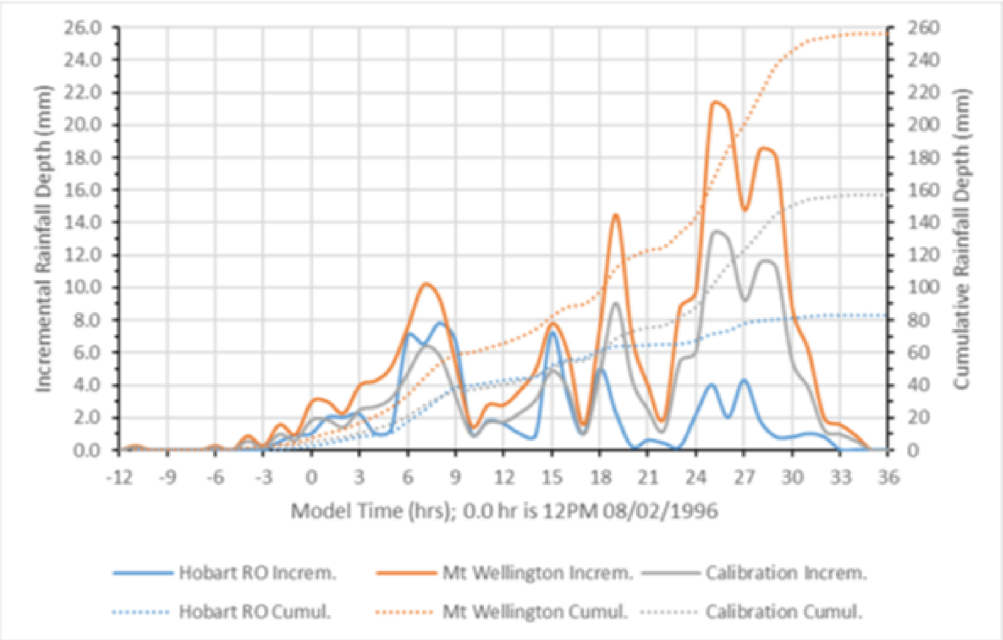


Figure 5-2 - Rainfall (hyetograph) depth time-series 08-09/02/1996 applied in calibration (T&B 1997). Incremental rainfall depths (solid lines) are plotted on the primary (left) axis. Cumulative rainfall depths (dotted lines of same colour) are plotted on the secondary (right) axis.

5.2.5. Rainfall Losses

The storm initial loss has been applied to Tuflow through the materials files. For impervious surfaces, the initial loss was zero (to be consistent with the built-in RORB calculation, noting that 1 mm is more typical in Tuflow models). For pervious surfaces, 28 mm initial loss was applied. For each land use, a fraction impervious was selected, and the initial loss was calculated as the proportion of the two values (i.e. 0 and 28 mm).

Table 5-3 – Losses by Land Use

Land Type/Planning Zone	Tuflow Material ID	Fraction Impervious	Initial Loss (mm)	Continuing Loss (mm/hr)
10 General residential	1	0.6	11.2	0.60
11 Inner Residential	7	0.8	11.2	0.30
12 Low Density Residential	11	0.2	22.4	1.20
14 Environmental Living	11	0.2	22.4	1.20
17 Community Purpose	14	0.1	25.2	1.35
18 Recreation	3	0.1	25.2	1.35
19 Open Space	4	0.1	25.2	1.35
21 General Business	8	0.9	2.8	0.15
22 Central Business	8	0.9	2.8	0.15
23 Commercial	8	0.9	2.8	0.15
24 Light Industrial	8	0.9	2.8	0.15
28 Utilities	4	0.1	25.2	1.35
29 Environmental Management	10	0.05	26.6	1.425
Roads	2	0.8	5.6	0.30
Waterbodies/Rivulets	13	1.0	0.00	0.00

The on-going losses were applied within Tuflow to the complete storm rainfall hyetograph. Setup of the model this way means that after calibration the design rainfalls were applied by changing the rainfall file alone.

The RORB/Tuflow hybrid model was found mostly insensitive to any parameter change except the increase of rainfall volume through reduction in losses (see Section 4.4.3). The 1.5 mm/hr CL was trialled (as per the T&B 1997 calibration), and the model found to be sensitive with improved calibration levels. For the Tuflow model, 0.0mm/hr CL was adopted for impervious surfaces (Ball et al. 2016).

It is noted that T&B 1997 increased the CL to 2.5 mm/hr for their design runs. It is thought that the small loss required for the calibration is due to the event being multiple peaked with a large rainfall depth prior to the final peak at 28hrs, 4pm on 9/2/1996 (largest intensity and volume). Study of the largest events with hyetographs (at Hobart) between 1854 and 2018 show that more than half are multiple peaked events and/or with a large volume of rainfall prior to the largest event peak. It is suggested that the meteorology of Hobart, including the orographic influence of Mt Wellington, would cause multiple peak events to occur with reasonably high probability.

It is intended that CL of 1.5mm/hr be applied to the initial design runs of 1 in 20 AEP and 1 in 100 AEP and the PMF CL of 1.0mm/hr be applied in the PMF runs. A decision on what losses to actually apply was made once the impacts of these very small losses were observed on the 1 in 100 AEP inundation extent. The design runs will be assessed prior to a recommendation being made as to what losses be applied in the design runs.

5.3. Water Levels within Reservoirs

According to T&B (1997) the water levels within Limekiln Gully Dam, Knights Creek Dam and Tolosa Reservoir were not measured before, during or after the February 1996 event. It is reported (anecdotally) that of these three, only Tolosa did not spill. Therefore, Knights Creek and Limekiln Gully Dams were modelled with initial water levels at FSL (within RORB, to ensure spilling) and Tolosa Reservoir at Reduced Operating Level (refer to Table 4-2 in Section 4.1.2 for these water levels).

5.4. Boundary Conditions

T&B (1997) present a tidal relationship in Figure A.4 for historical tide levels for the Hobart Tide Gauge (supplied by Marine Board of Hobart). The tidal relationship is only provided for the 09/02/1996. The historical tide level data for the previous day was not available for this study.

Given that the peak flow was recorded at about 4pm on the 09/02/1996, it is considered unlikely that the outcomes will not be sensitive to the tidal levels on the 08/02/1996. A water level has been applied by taking the first tide level in the record (a high tide level) and projecting the level through the previous day (Figure 5-3). This level may cause higher levels in Elwick Bay and the lower drainage channel at the beginning of the model run, however, there is 14 hours for that water to flow out to Elwick Bay prior to the peak Study Area water levels.

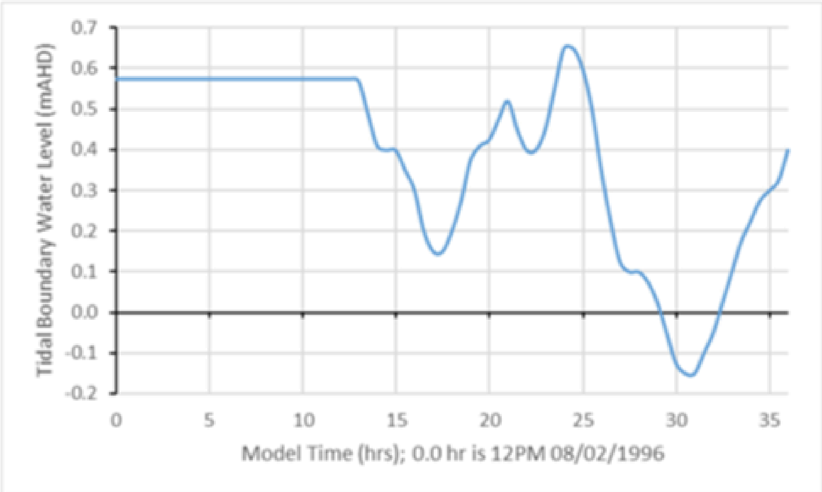


Figure 5-3 - Tidal relationship in Derwent River on 09/02/1996 (Figure A.4 T&B 1997).

Flood hydrographs have been applied to the Tuflow model at the locations illustrated in Figure 4-5.

5.5. Depression Storage Check

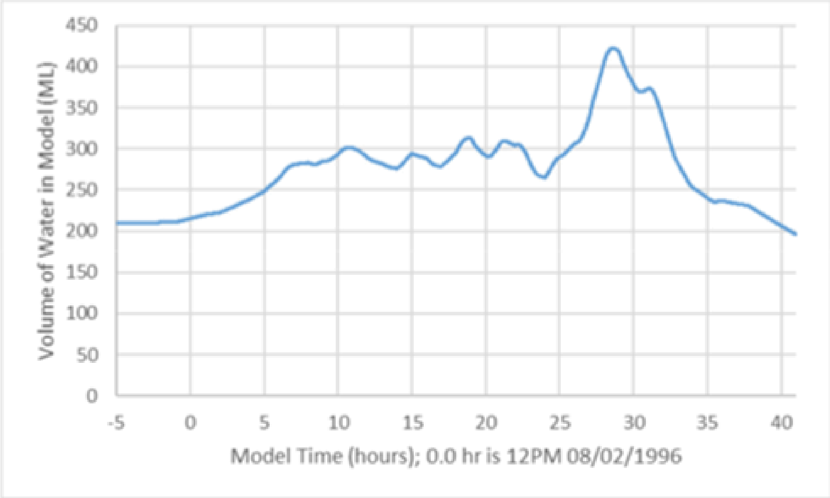


Figure 5-4 – Water volume in Tuflow during calibration run (start = 208 ML; end = 196 ML)

The final water volume in the Calibration model is smaller than the starting volume due to a different water level at the tidal boundary condition. The entire inflow volume of the calibration storm event is accounted for.

5.6. Modelling the Calibration Locations

Plot output (PO) lines have been digitised to provide time-series model output (level and flow) close to the locations (Figure 5-1) where water levels were observed in 1996 (T&B 1997). The maximum of the time series provided a first-pass estimate of the water level.

For many locations the precise measurement location is unclear, so the region where the location was possible was interrogated. For each region interrogated, a range of water levels from the model were extracted from the maximum gridded water level outputs. The water level ranges estimated from the model are listed in Table 5-4 compared to the levels measured and the levels that T&B (1997) achieved from their model. Comments are provided to give indication on where the water levels were taken from the model (refer to Table 5-4).

5.7. Calibration Outcomes

As recommended by SMEC (and mentioned in Section 1.3), WMA Water were engaged by GCC to provide peer review for this flood study. Two reviews were completed after calibration of the Tuflow to measured water levels. On 31/07/2018, WMA Water approved the calibration and adopted parameters (later summarised in this report) for use in the design runs.

The water levels estimated from the model are listed in Table 5-4 compared to the levels measured and the levels that T&B (1997) achieved from their model.

Table 5-4 – Calibration Water Levels

Address	Description of Level Location (T&B 1997)	Flood Level Observed (mAHD)	T&B '97 Calibration		This Study Calibration		Comment
			Level (mAHD)	Difference (m)	Model Water Level (mAHD)	Difference b/w Model and Observed (m)	
40 Anfield Street	mark on door frame of garage door	2.844	2.904	0.060	(2.834)	(-0.010)	Garage is visible on aerial. Model water level is constant for the entire length. Most clear point for calibration.
55a Grove Road	bottom rail on side fence	4.335	4.245	-0.090	4.190 to 4.415	-0.145 to 0.080	Unclear what location along the side fence was measured. Water level range output from model taken from fence portion visible from house.
55 Grove Road	mark on shed wall	4.262	4.212	-0.050	4.205 to 4.283	-0.057 to 0.021	Current aerial does not show a shed, but instead shows this property has been subdivided into 3 units. Older 2008 Google Streetview shows the location of the garage when the property was a single dwelling. Assumed this garage is the referenced 'shed'. Model water levels taken over the region of the previous garage.
1 Young Street	mark on cupboard in garage	6.853	6.833	-0.020	6.295 to 6.478	-0.558 to -0.375	T&B 1997 report on a 'breach' of the levee near Olympic Pool. The breach (or low point overtopping) has since been repaired. The dimensions of the breach are unclear. A breach has been modelled and will be removed (filled in) for the design runs. The modelled breach is underestimating flow for 1 Young Street but is providing reasonable water levels at 2 Young Street and 40 Anfield Street.
2 Young Street	mark on dog kennel	7.948	8.088	0.140	7.560 to 8.110	-0.388 to 0.162	
21 Balmain Street	mark on top of bank	31.462	31.502	0.040	(31.429)	(-0.034)	During site inspection with Mathew Brockman, Drainage Works Officer GCC (06/12/2017) anecdotal information was shared that the Humphreys Rivulet waterway downstream of Brent St was realigned following the 1996 event when properties to the north were threatened. T&B 1997 likely had access to the channel bed topography that was current at the time of the event. The LiDAR of this model has the current waterway alignment. As such, it is not considered possible to get a match to the 4 locations downstream of Brent St bridge: 21 Balmain St, 5 Chelmsford Pl, 28 Barrett St and 11 Farnell St. T&B (1997) provided the measured water level at 11 Farnell St but did not record model calibration at it (Table C.2 includes the 'Flood level observed' with blank space for 'Predicted' and 'Diff' columns). No comment made by T&B in explanation.
5 Chelmsford Place	top stone wall RHS	37.404	37.364	-0.040	(36.704)	(-0.700)	
28 Barrett Street	100 mm above GL next to tree	38.755	38.755	0.000	(38.646)	(-0.110)	
11 Farnell Street	200 mm above wall at kennel	34.934			(34.700)	(-0.234)	

Address	Description of Level Location (T&B 1997)	Flood Level Observed (mAHD)	T&B '97 Calibration		This Study Calibration		Comment
			Level (mAHD)	Difference (m)	Model Water Level (mAHD)	Difference b/w Model and Observed (m)	
Brent Street Bridge	left side abutment upstream	42.235	41.535	-0.700	42.210 to 42.420	-0.025 to 0.185	During site inspection with Mathew Brockman, Drainage Works Officer GCC (06/12/2017) anecdotal information was shared that Brent St bridge overtopped in Feb 1996 and that the gabion U/S of Brent St has been installed since the 1996 flood. Model channel shape is likely different to 1996 so a good match is unlikely, however, model shows bridge slightly (<0.2m) overtops.
1/12 Brent Street	mark on side fence	42.644			42.345 to 42.400	-0.299 to -0.244	During site inspection with Mathew Brockman, Drainage Works Officer GCC (06/12/2017) anecdotal information was shared that Brent St bridge overtopped in Feb 1996 and that the gabion U/S of Brent St has been installed since the 1996 flood. Model channel shape is likely different to 1996 so a good match is unlikely, however, model shows bridge slightly (<0.2m) overtops. T&B (1997) provided the measured water level at 1/12 Brent St but did not record model calibration at it (Table C.2). No comment is made by T&B in explanation.
171a Chapel Street	top bank of Rivulet	65.615			65.630 to 66.900	0.015 to 1.285	It is unclear from the aerial or lidar where along the top of the bank is referenced. A calibration to this point is not considered precise. T&B (1997) provided the measured water level at 171a Chapel St but did not record model calibration at it (Table C.2). No comment is made by T&B in explanation.
2/16 Whitbread Crescent	top Telstra conduit back unit	70.052			69.460 to 70.460	-0.592 to 0.408	It is unclear from the aerial or Google Streetview where the Telstra conduit is or was in 1997. Property varies in level by 1.0 m from front to back, so calibration is not precise at this property. T&B (1997) provided the measured water level at 2/16 Whitbread Cr but did not record model calibration at it (Table C.2). No comment is made by T&B in explanation.

6. MODEL RUNS OF DESIGN SCENARIOS

6.1. General

Once calibrated, the hybrid model was run for a set of scenarios required by GCC to assess the breakout flood risk from Humphreys Rivulet and the system performance. The four key scenarios modelled include:

- Scenario 1 – existing
- Scenario 2 – developed with the dams at Full Supply Level (i.e. completely full without spilling)
- Scenario 3 – developed with the existing dam draw down water levels:
- Scenario 4 – developed with climate change impacting rainfall intensity and ocean water levels

6.2. Model Outcomes

6.2.1. Critical durations

Each of the probability storm events was run for nine storm durations ranging from 30 minutes to 24 hours. Each duration was run in RORB ten times, each with a different temporal pattern. The pattern that produced a peak flow at the RORB/Tuflow boundary closest to the mean average of the ten was selected to be run within Tuflow. Table 6-1 and Table 6-2 summarise the critical duration and flow at each of the boundary locations for design and climate change rainfall intensities.

Table 6-1 – RORB model results at a range of locations connecting the RORB and Tuflow

Location	1 in 20 AEP		1 in 100 AEP		PMF	
	Peak FLow	Critical Duration	Peak FLow	Critical Duration	Peak FLow	Critical Duration
Islet Rivulet at BS	2.69	6 hour	4.66	3 hour	107	1 hour
Catchment AP	2.52	6 hour	4.13	3 hour	84.8	1 hour
Humphreys Rivulet at AN	44.8	2 hour	76.0	6 hour	884	1.5 hour
Catchment AK/AM	4.08	6 hour	6.34	3 hour	126	1 hour
Barossa Creek at BD/BE	4.59	6 hour	7.08	3 hour	147	30 minute

Table 6-2- RORB results at locations connecting RORB and Tuflow with climate change rain intensity

Location	1 in 20 AEP		1 in 100 AEP		PMF	
	Peak FLow	Critical Duration	Peak FLow	Critical Duration	Peak FLow	Critical Duration
Islet Rivulet at BS	4.00	6 hour	6.17	3 hour	107	1 hour
Catchment AP	3.92	2 hour	5.56	3 hour	84.8	1 hour
Humphreys Rivulet at AN	69.5	1 hour	105	6 hour	884	1.5 hour
Catchment AK/AM	6.23	2 hour	8.98	2 hour	126	1 hour
Barossa Creek at BD/BE	7.09	2 hour	10.2	2 hour	147	30 minute

These tables above summarise the critical flows at these locations. However, nine different hydrographs were fed into the Tuflow model, one for each duration (the average peak flow of the ensemble of temporal patterns) at each location matching to the rainfall-on-grid hyetographs duration.

To identify the critical storm duration across the urban region of the Study Area the maximum inundation extents for each storm duration were compared and presented in the Critical Event Map (Figure 6-1 presents the Existing Scenario 1 in 20 AEP event; Figure 6-2 presents the Existing Scenario 1 in 100 AEP event).

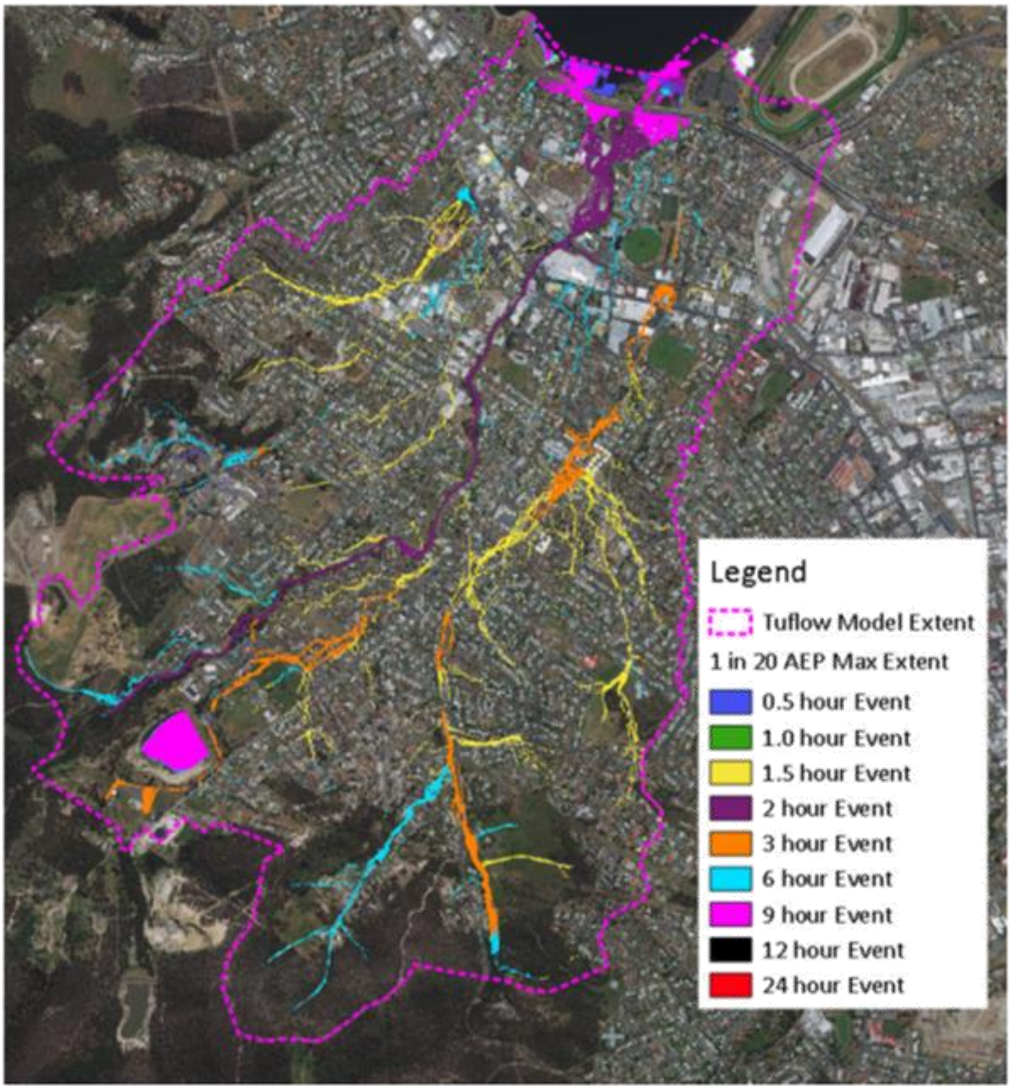


Figure 6-1 – Critical Event Map for Existing Scenario 1 in 20 AEP Inundation Event

Figure 6-1 indicates that rainfall duration has an impact on the maximum inundation extents across the Study Area.

In the 1 in 20 AEP event, Humphreys Rivulet reaches maximum inundation depth in the 2-hour event, whilst the Barossa and Little John Creeks reach maximum depth in the 90 minute and 3-hour events respectively. For the upper parts of the Study Area and central CBD, the 6-hour event causes the maximum flood depth.

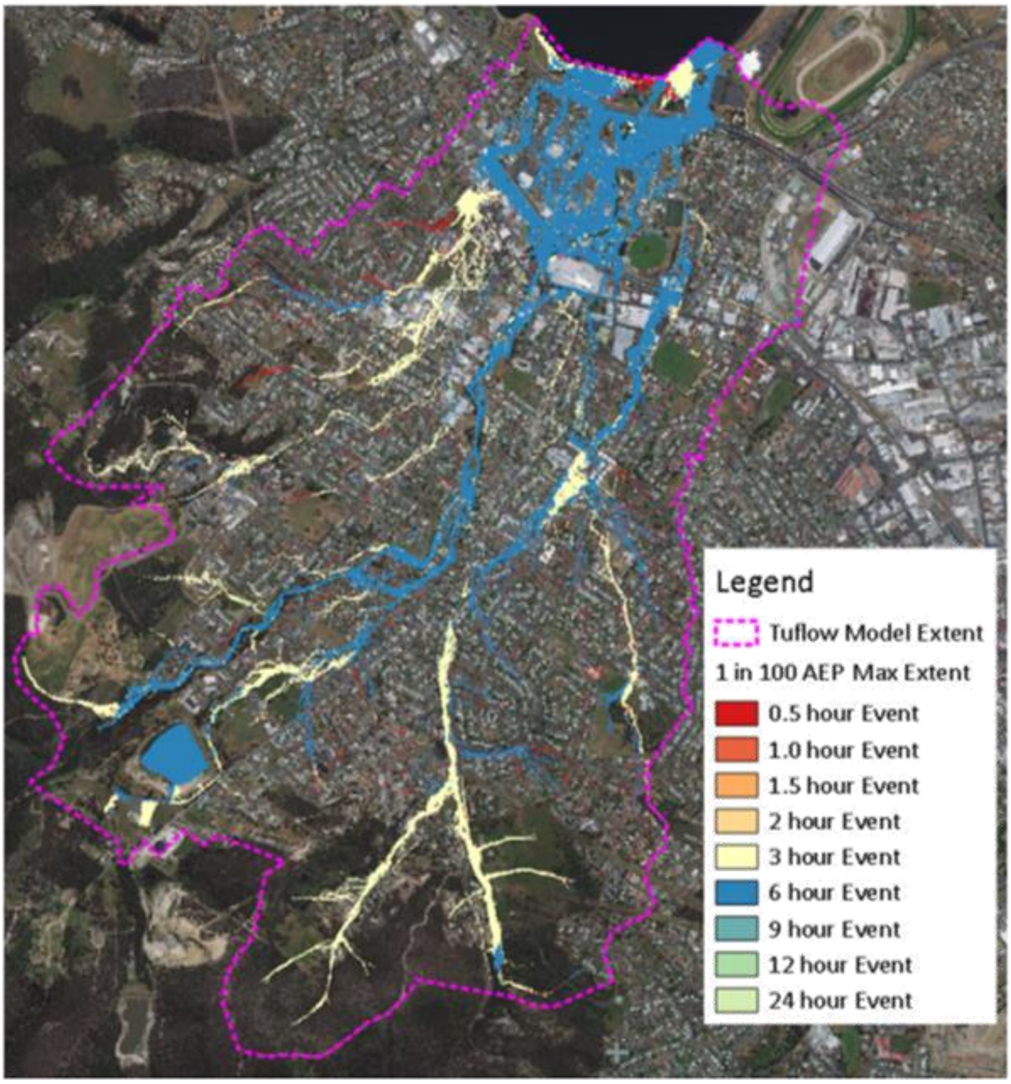


Figure 6-2 – Critical Event Map for Existing Scenario 1 in 100 AEP Inundation Event

The 6 hour 1 in 100 AEP causes maximum inundation depths throughout much of the Study Area (Figure 6-2), especially along Humphreys Rivulet. The upper catchment of Barossa Creek and Islet Rivulet reach maximum depth in the 3-hour event.

For some parts of the Study Area flash flooding occurs in the 30-minute event causing maximum inundation depth along local streets (red).

6.2.2. Filtering of Results

The rainfall-on-grid rainfall-runoff process applies the rainfall in a distributed manner across the entire catchment and then leaves the routing to hydraulic processes across the grid surface. This can leave behind small clusters of flooding up to a dozen grid cells within localised depressions in the model grid that are not necessarily representative of the real topography. These small water clusters, or 'puddles', produce a speckled effect on the inundation maps that distract from the information being presented and so require removal.

Melbourne Water (2012) guidelines on minimum requirements for Flood Mapping Projects provide guidance on the inundation map filtering parameters expected for projects within their jurisdiction. "The filtering parameters were that all points with a depth greater than or equal to 50mm AND a velocity times depth product greater than 0.008 would be used for the flood extent determination."

Similar filtering criteria were applied to this study. To account for Glenorchy's on average steeper topography, a depth criterion of 30mm was applied in addition to the product of depth and velocity (DV) of 0.008 m^2/s.

The adopted filtering parameters are:

- Remove all inundated area with water depth less than 30mm and with DV (depth times velocity) less than 0.008 m^2/s
- Remove all separate 'puddles' with an area of 5 grid cells (i.e. 21 m^2) or smaller

6.3. Flood Mapping Outcomes

Inundation depth, flood hazard (DV) and hazard category (low to extreme) maps for all scenarios are included in Appendix E.

Flood hazard category maps are presented using Ball et. al. (2016) Book 6, Section 7.2.3 Flood Hazard for People Stability, using Table 6.7.1 hazard regimes for adults. Flood hazard categories include Low, Moderate, Significant and Extreme. Moderate and Significant categories do not include depths above 1.2 m or velocity above 3.0 m/s, which were categorised as Extreme as per Table. 6.7.1.

It is noted that the flood hazard categories of the maps is for adults (not children, vehicles, buildings, et. cetera which have different categories). For example, flood hazard categories Moderate, Significant and Extreme are all considered to be categorised as 'Extreme' for Children between 25 to 50 m.kg (height x mass).

Some key results of the flood mapping outputs are:

- Significant property flooding in the Study Area with the following number of properties modelled as flooded:
  - 1 in 20 AEP: 40 properties
  - 1 in 100 AEP: 84 properties
  - PMF: 1,630 properties
- Significant flooding of key community infrastructure in 1 in 100 AEP:
  - Northgate Shopping Centre
  - Glenorchy Pool
  - KGV Oval
  - Glenorchy Plaza
  - Barossa Park Lodge aged care service
  - Tiny Tackers Children Centre
  - Dominic College

It should be noted that the inundation extent is likely to be sensitive to the assumption that floor levels are 300 mm higher than property ground levels. Many property buildings on the inundation maps show flooding depths of less than 300 mm, and so lower than floor levels. It is recommended that floor level survey should be completed for properties modelled as flooded in the 1 in 100 AEP event prior to use of these maps for other purposes (e.g. flooding overlays on planning maps.

6.4. Future Development Scenarios

Three scenarios have been developed to assess the outcomes to different future development impacts within the Study Area. The two key future impacts on the Study Area tested in this study are the impact of the water level in Knights Creek and Limekiln Gully Dams, and of climate change.

6.4.1. Storage Level in Dams

For the 1 in 20 AEP and 1 in 100 AEP events, there is very little difference between the Existing Scenario and the Developed with Dams at Drawdown. This outcome is related to the very low continuing loss required to match calibration to the 1996 event.

There is a marked difference between the two Developed Scenarios with different dams storage levels. The 1 in 20 AEP for Dams Full (Scenario 2) flood impact is very similar to the 1 in 100 AEP with Dams at Drawdown Levels (Scenario 3). This outcome demonstrates how effective the two dams are at attenuating the impact of intermediate and rare storm events on the Study Area urban catchment. However, any future proposal with regards to utilising these two dams for flood attenuation purpose needs to be carefully considered from not only a hydraulic perspective but also from a dam safety and asset management perspective.

6.4.2. Climate Change

The climate change scenarios show substantially more impact than the Existing or other Developed Scenarios, especially along the coastline of Elwick Bay.

The 1 in 20 AEP flood impact is greater than the Existing or Developed 1 in 100 AEP event. However, it is difficult to divide the coastal flooding impact between the Sea Level Rise (SLR) and the storm-related water level due to catchment flooding, storm surge and high tide.

Part of the inundation extent along the coast should be considered the 'new coastline' and the remainder, impact from the flood event. This is especially applicable in the flood damage assessment as the Climate Change damage costs will include inundated property damage costs from prior to the flood event (from the SLR).

6.5. Flood Damage Assessment

6.5.1. General

A flood damage assessment was undertaken to estimate the monetary costs of flooding impact. The flood damages assessment was conducted following the industry standard method to establish the relative damage costs experienced within the Study Area for all flood events modelled under existing and developed scenarios. Flood damages at properties were estimated using the averaging approach method presented in the Disaster Loss Assessment Guidelines (2002) and Floodplain Management in Australia (SCARM 2000).

The damage costs estimated in this study represent a potential approximation only, determined following the standard methodology. The damages are not intended to be an exhaustive assessment of the full economic impact of a flood event. Nor does this assessment account for situations where people may attempt to protect their property from damage during the event and reduce the monetary impact.

Building damages have been based on standard recommended 'damage curves' rather than historical or real-time insurance data. Nevertheless, this methodology is considered appropriate for the intended purpose of providing relative cost comparisons between scenarios and providing a benchmark for comparing mitigation options against.

Damages from a disaster can be classified as direct (i.e. damages resulting from the action of floodwaters and flow) or indirect (i.e. disruption to daily activities due to the disaster or relief aid and clean-up costs). Damages can also be sub-classified as tangible (i.e. can be assigned a monetary value) or intangible (e.g. loss of life or injury). This study will limit the scope of assessment to tangible (monetary) costs of flooding.

The comparative indicator between scenarios that is derived from this assessment is the Average Annual Damage (AAD). AAD is the total damage caused by floods over a long period of time divided by the number of years in that period (SCARM 2000). It is calculated by plotting loss estimates for the flood hazard at a range of magnitudes (i.e. inundation depth), against the probability of occurrence of the flood event (i.e. the AEP). AAD represents the area under this curve, an estimated monetary impact of the flood damage sustained every year on average (mean) over an extended period.

All monetary values have been adjusted to 2018 dollars using information published by the Australian Bureau of Statistics.

6.5.2. Procedure

The flood damage assessment required the following input data:

- Property boundaries (supplied by GCC as GIS layers)
- Design flood depths for a range of probability events
- Floor levels at each property (approximated by adding 300 mm to ground level data at each property from LiDAR (2011) supplied by GCC).

The key steps involved in the flood damage assessment are:

1. Create a database of residential, commercial, industrial, and community buildings and their respective floor levels.
2. For each zone type of property, determine a depth-cost relationship for flooding based on accepted methods/resources.
3. For each property in the Study Area, assign a damage cost based on the modelled inundation depth and the appropriate depth-cost curve.
4. Repeat step 3 for each scenario and flood event.
5. Calculate the Average Annual Damages (AAD).

6.5.3. Damage Assessment Outcomes

The flood damage assessment results are summarised in Table 6-3 for all scenarios and flood events modelled. The final Average Annual Damages (AAD) for each scenario is also included. The damage cost curves are plotted in Figure 6-3.

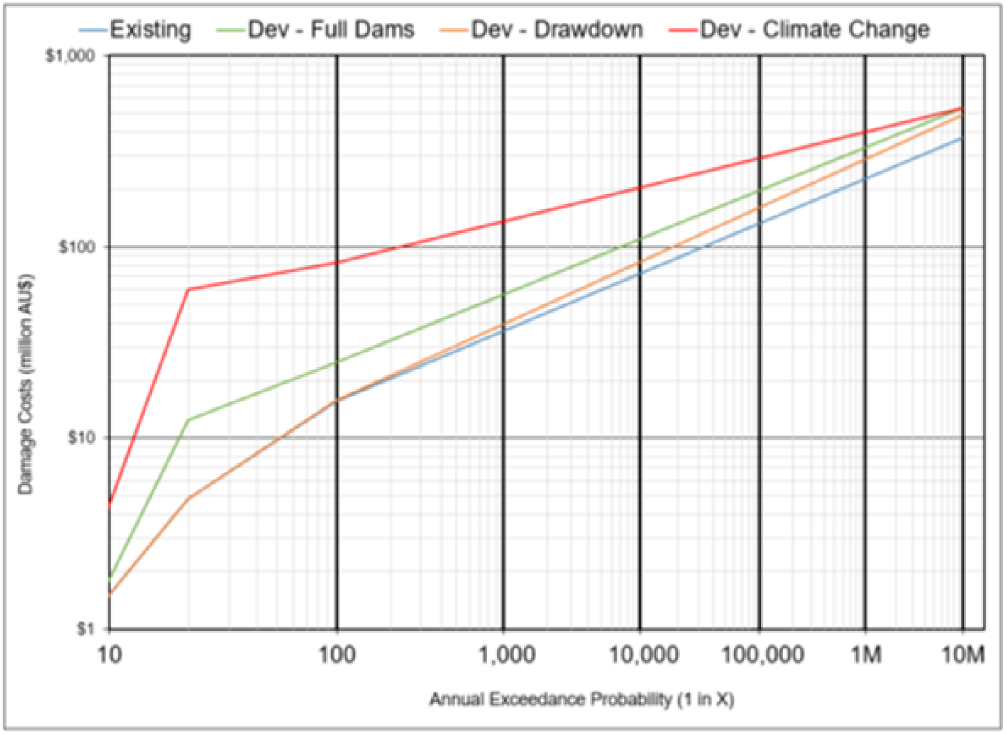


Figure 6-3 –Damage Costs Against Flood Probability

It should be noted that the flood damage assessment is likely to be sensitive to the assumption that floor levels are 300 mm higher than property ground levels, and it is recommended that a floor level survey should be completed for properties modelled as flooded in the 1 in 100 AEP event and the damage assessment revised.

Reviewing the outcomes, it is expected to observe that there is substantially more damage in the developed scenarios where there is increased rainfall (climate change), and reduced flood protection from the three dams (Tolosa decommissioned and 'Full Dams').

The outcome showing Existing and Developed (dams at drawdown levels) as similar for the more frequent events suggests that the Glenorchy community does not face substantial increased flood risk from additional infill development.

The Climate Change outcomes show an increase of $16 million average annual damages. Of this increase, an unknown portion (related to roughly half of the water level increase at Elwick Bay) comes from the sea level rise impact prior to the flood event. These are displacement damages rather than flood damages, but are difficult to remove from the outcome.

Table 6-3 – Summary of Flood Damage Costs

Scenario	AEP (1 in Y)	Residential		Commercial		Community		Structural Damages	Total	AAD Total
		Number of Dwellings	Damages	Number of Dwellings	Damages	Number of Dwellings	Damages			
Existing	20	22	$1,519,000	10	$976,000	8	$1,192,000	$0	$4,776,000	$3,411,000
	100	48	$2,931,000	27	$5,894,000	9	$1,769,000	$122,000	$15,566,000	
	PMF	1185	$115,529,000	265	$103,929,000	180	$47,511,000	$5,246,000	$370,207,000	
Developed - Full Dams	20	41	$2,656,000	26	$4,808,000	8	$1,011,000	$0	$12,390,000	$6,317,000
	100	87	$4,956,000	45	$10,064,000	9	$1,578,000	$122,000	$24,763,000	
	PMF	1377	$153,614,000	304	$160,087,000	180	$57,758,000	$14,762,000	$532,202,000	
Developed - Dams at Draw Down	20	22	$1,523,000	10	$1,030,000	8	$1,192,000	$0	$4,789,000	$4,025,000
	100	50	$2,958,000	27	$6,097,000	9	$1,578,000	$122,000	$15,721,000	
	PMF	1341	$145,363,000	292	$142,576,000	191	$57,758,000	$13,420,000	$491,400,000	
Developed - Climate Change	20 (CC1)	157	$21,406,000	26	$5,075,000	23	$8,237,000	$14,518,000	$59,412,000	$19,289,000
	100 (CC3)	224	$28,371,000	51	$10,102,000	34	$9,918,000	$18,788,000	$82,812,000	

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APPENDIX A FLOOD FREQUENCY CURVES

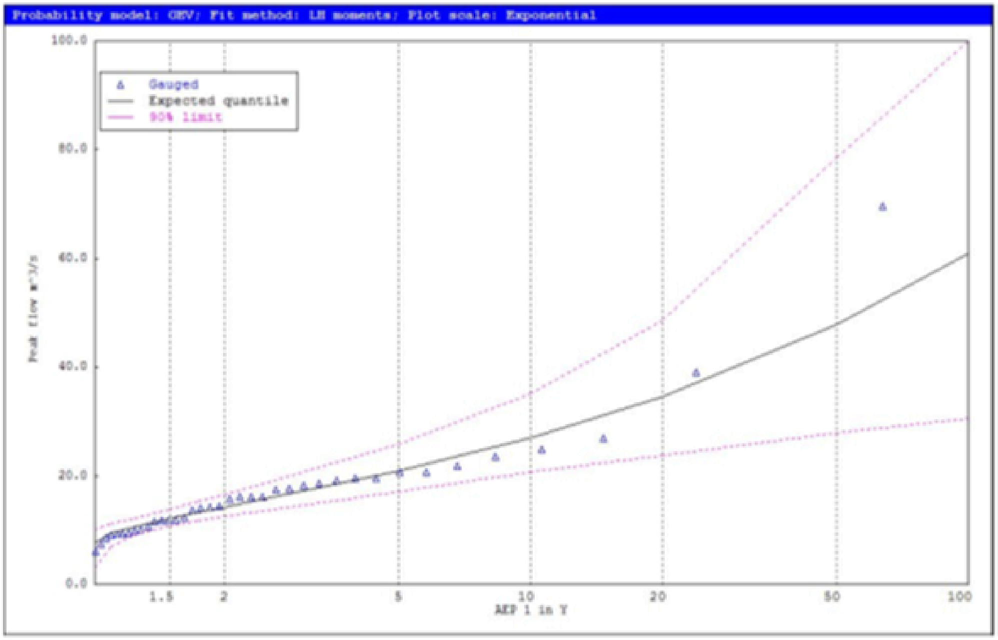


Figure A-1: #353-Hobart Rivulet, Gore Street Flood Frequency Curve

Title: #353-Hobart Rivulet at Gore Street
Optimized L moment shift = 1

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	12.581	12.619	0.799	1.000		
a	4.181	4.401	1.150	0.405	1.000	
k	-0.354	-0.288	0.190	0.219	0.501	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	7.6	3.0	10.1	1.53
1.10	9.4	7.1	11.2	0.87
1.25	10.7	9.2	12.2	0.48
1.50	12.2	10.8	13.8	0.09
1.75	13.3	11.8	15.3	-0.17
2.00	14.2	12.5	16.6	-0.37
5.00	20.9	17.1	25.9	-1.50
10.00	27.0	20.6	35.1	-2.25
20.00	34.6	23.8	48.6	-2.97
50.00	47.8	27.8	78.6	-3.90

100.00 61.0 30.5 117.0 -4.60

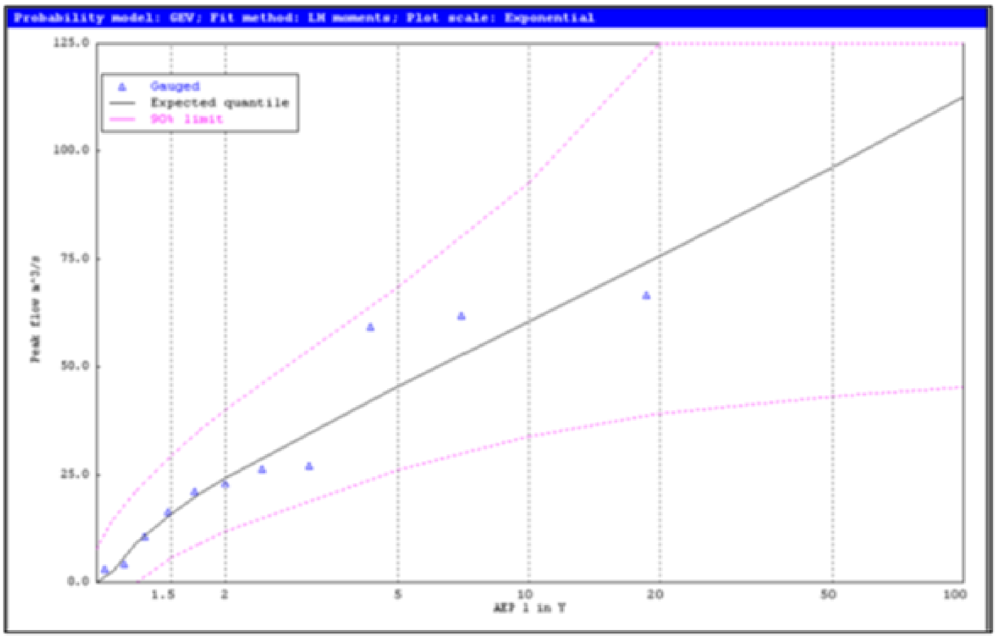


Figure A-2: #354- Hobart Rivulet, Argyle Street Flood Frequency Curve

Title: #354- Hobart Rivulet at Argyle Street
Optimized L moment shift = 0

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	17.617	18.031	6.295	1.000		
a	17.710	17.507	5.204	0.441	1.000	
k	-0.065	-0.013	0.272	0.392	0.351	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	-8.2	-31.8	7.9	1.53
1.10	2.6	-8.4	14.8	0.87
1.25	9.3	-0.2	21.4	0.48
1.50	16.0	5.6	29.5	0.09
1.75	20.6	9.1	35.3	-0.17
2.00	24.2	11.8	40.0	-0.37
5.00	45.5	26.2	68.5	-1.50
10.00	60.5	33.9	92.8	-2.25
20.00	75.7	39.1	124.9	-2.97

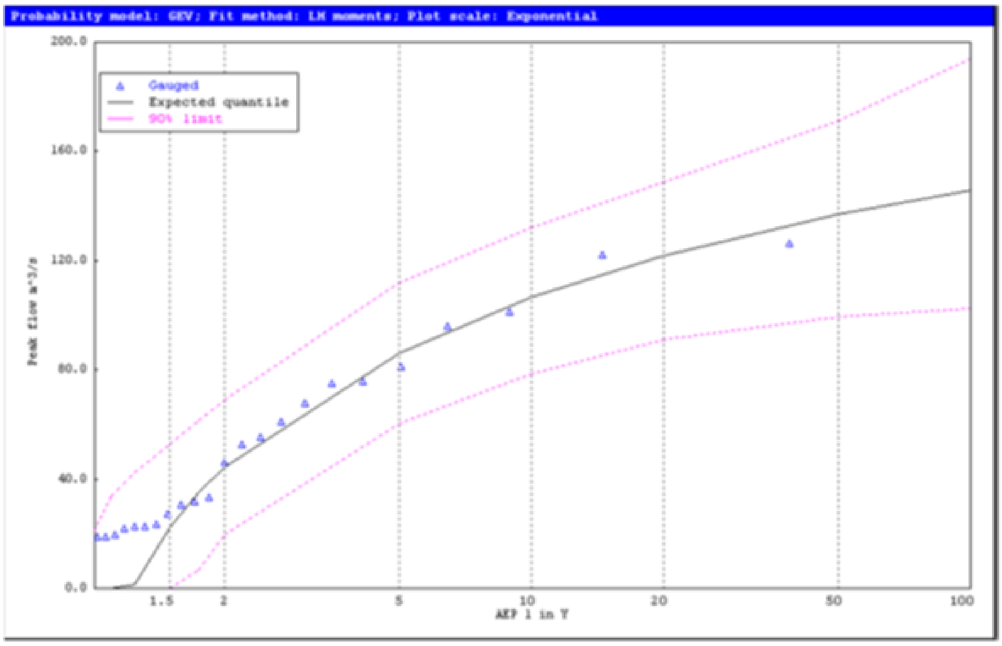


Figure A-3: #1012 Peak Rivulet, 3.5km Upstream Esperence River Flood Frequency Curve

Title: #1012 Peak Rivulet 3.5km Upstream Esperence River
Optimized L moment shift = 4

L moment	Value
1	59.300
2	8.046
3	-1.888
4	-3.523

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	27.295	25.831	16.095	1.000		
a	49.727	55.463	26.285	-0.611	1.000	
k	0.326	0.367	0.308	-0.346	0.863	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	-71.3	-408.6	21.3	1.53
1.10	-23.0	-157.8	33.9	0.87
1.25	1.7	-70.1	42.6	0.48
1.50	22.5	-17.0	52.8	0.09
1.75	35.3	6.8	61.3	-0.17
2.00	44.5	19.6	68.9	-0.37
5.00	86.3	60.5	112.0	-1.50
10.00	106.6	78.5	132.1	-2.25
20.00	121.9	90.9	148.6	-2.97
50.00	137.1	99.6	171.3	-3.90

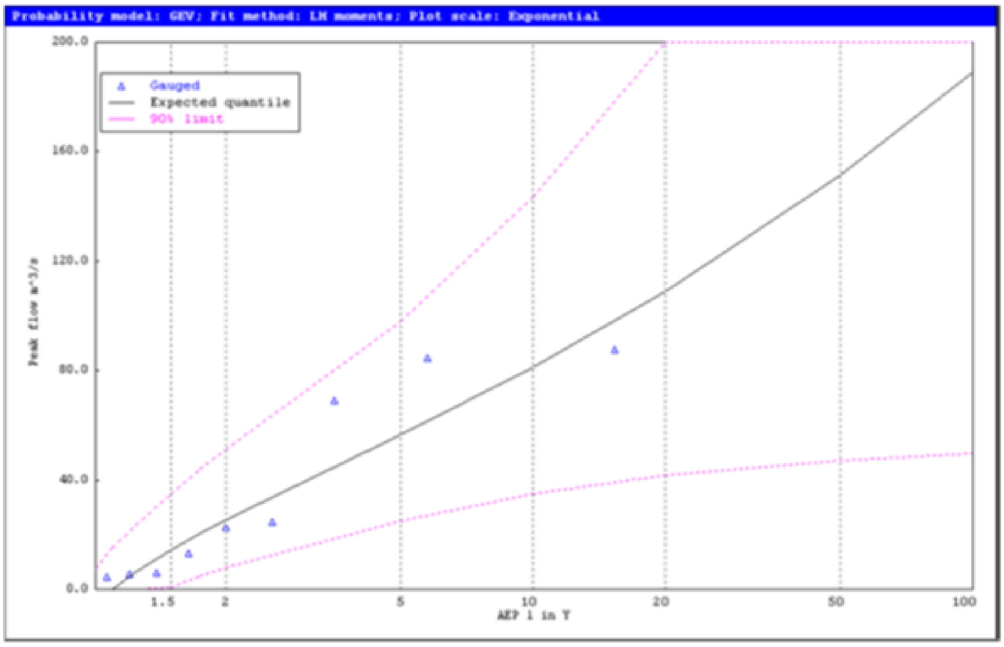


Figure A-4: #4210 Jordan River, Bridgewater Flood Frequency Curve

Title: #4210 Jordan River Bridgewater
Nominated L moment shift = 0

L moment	Value
1	35.404
2	19.657
3	6.002
4	-2.453

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	16.723	17.678	9.216	1.000		
a	22.608	22.531	8.387	0.552	1.000	
k	-0.203	-0.107	0.317	0.383	0.302	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	-13.0	-46.7	7.5	1.53
1.10	-1.4	-15.5	15.3	0.87
1.25	6.5	-5.7	23.7	0.48
1.50	14.6	0.9	35.1	0.09
1.75	20.5	5.0	44.1	-0.17
2.00	25.3	8.0	51.2	-0.37
5.00	56.4	25.1	98.1	-1.50
10.00	81.2	34.8	143.5	-2.25
20.00	108.9	41.7	208.7	-2.97

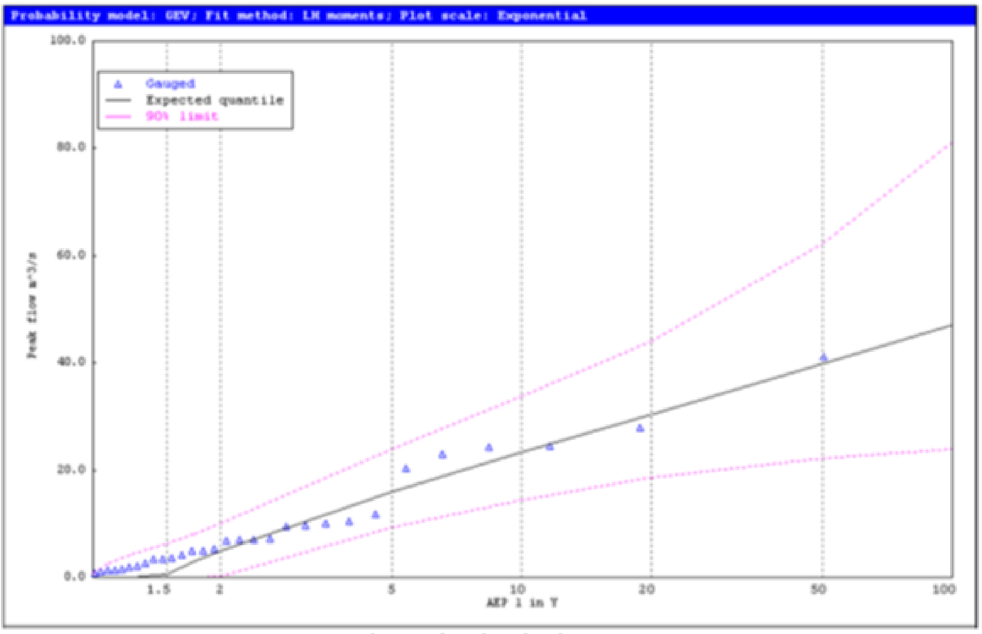


Figure A-5: #5200 Browns River, Summerlease Rd Bridge Flood Frequency Curve

Title: 5200 Browns River at Summerleas Road Bridge
Optimized L moment shift = 4

L moment	Value
1	9.443
2	4.973
3	2.028
4	0.949

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	1.420	0.969	3.102	1.000		
a	9.505	10.828	4.973	-0.585	1.000	
k	-0.019	0.041	0.268	-0.407	0.811	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	-12.9	-57.0	0.8	1.53
1.10	-6.8	-28.7	2.7	0.87
1.25	-3.1	-16.2	4.3	0.48
1.50	0.5	-7.1	6.3	0.09
1.75	3.0	-2.5	8.2	-0.17
2.00	4.9	0.2	10.0	-0.37
5.00	15.9	9.3	24.0	-1.50
10.00	23.3	14.4	33.7	-2.25
20.00	30.4	18.6	44.1	-2.97
50.00	39.9	22.2	62.2	-3.90

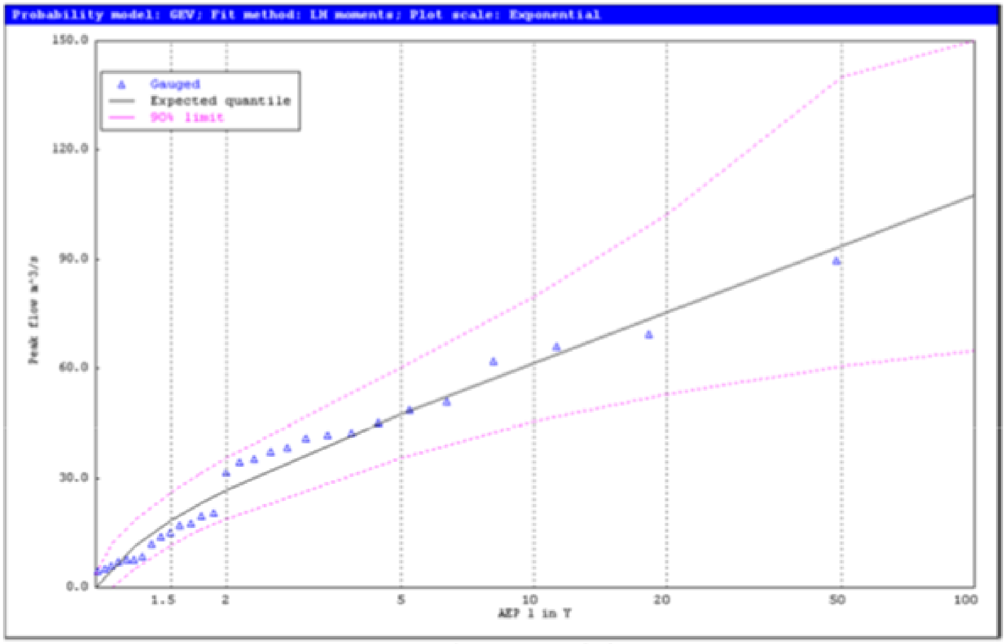


Figure A-6: #6200 Mountain River, Downstream of Grundys Creek Flood Frequency Curve

Title: 6200 Mountain River Ds Grundys Creek
Nominated L moment shift = 0

L moment	Value
1	30.919
2	12.679
3	2.369
4	0.630

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	20.123	20.191	3.784	1.000		
a	17.799	17.686	2.972	0.409	1.000	
k	-0.029	-0.014	0.150	0.364	0.346	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	-6.5	-18.4	3.7	1.53
1.10	4.8	-2.0	12.1	0.87
1.25	11.7	5.5	18.8	0.48
1.50	18.5	11.8	26.1	0.09
1.75	23.1	15.8	31.4	-0.17
2.00	26.7	18.8	35.6	-0.37
5.00	47.4	35.6	60.4	-1.50
10.00	61.5	45.5	79.6	-2.25
20.00	75.3	53.0	102.2	-2.97
50.00	93.6	60.5	140.1	-3.90

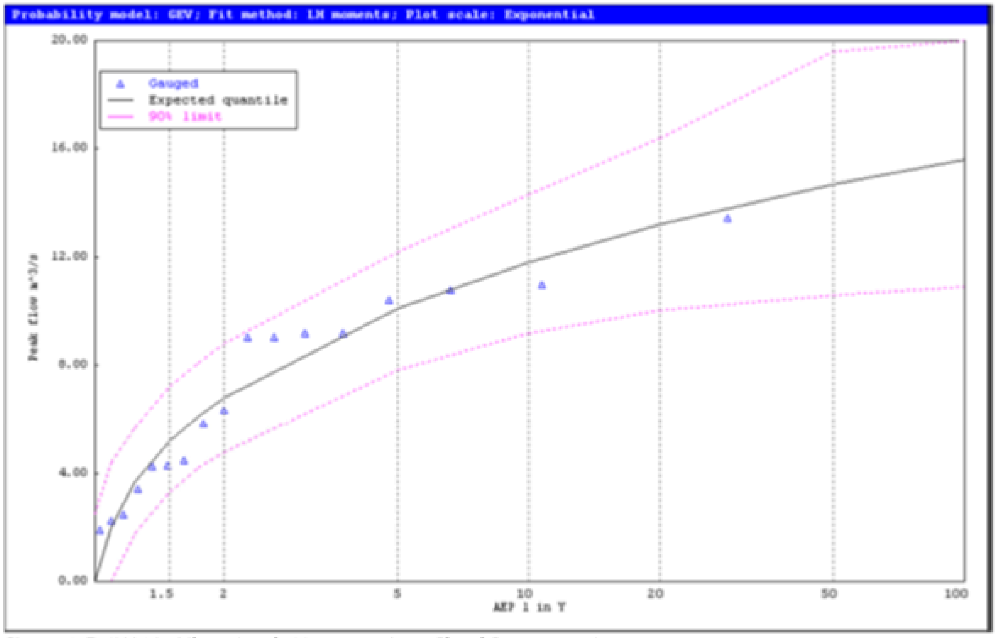


Figure A-7: #6202- Rileys Creek, Upstream Dam Flood Frequency Curve

Title: 6202- Rileys Creek Upstream Dam
Nominated L moment shift = 0

L moment	Value
1	6.897
2	2.093
3	0.059
4	-0.068

GEV Fit Results

Parameter	LH	Mean	Std dev	Correlation		
tau	5.512	5.539	0.993	1.000		
a	3.596	3.552	0.727	0.097	1.000	
k	0.234	0.245	0.205	0.415	0.488	1.000

AEP 1 in Y	Quantile	5%	95%	Gumbel reduced variate
1.01	-1.1	-5.8	2.5	1.53
1.10	2.0	-0.3	4.4	0.87
1.25	3.7	1.8	5.7	0.48
1.50	5.2	3.3	7.2	0.09
1.75	6.1	4.2	8.1	-0.17
2.00	6.8	4.8	8.8	-0.37
5.00	10.1	7.8	12.2	-1.50
10.00	11.8	9.2	14.3	-2.25
20.00	13.2	10.0	16.4	-2.97
50.00	14.7	10.6	19.6	-3.90

APPENDIX B RAINFALL DEPTHS

Table B.1 - Rainfall Depths for Humphreys Rivulet and Barossa Creek for selected exceedance probabilities and durations

Areal rainfall depth (mm)

Duration			Annual Exceedance Probability (1 in X)			
(hrs)	(mins)		20		100	
	Burst	Complete	Burst	Complete	Burst	Complete
0.5	30	105	17.4	24.0	24.4	28.7
1.0	60	135	22.9	29.5	30.9	35.2
1.5	90	165	27.0	32.0	35.8	41.3
2.0	120	195	30.5	37.6	40.0	45.5
3.0	180	405	36.7	45.0	47.7	68.6
6.0	360	585	51.3	65.3	66.7	94.7
9.0	540	990	62.6	76.7	82.2	104
12	720	1,170	71.7	85.9	95.2	111
24	1,440	2,340	95.7	108.9	130	141

Table B.2 - Rainfall Depths for Humphreys Rivulet and Barossa Creek for PMF and selected durations

Areal rainfall depth (mm)

Duration			Annual Exceedance Probability (1 in X)	
(hrs)	(mins)		10,000,000	
	Burst	Complete	Burst	Complete
0.5	30	75	145.0	149.5
1.0	60	150	220.0	226.8
1.5	90	225	270.0	278.4
2.0	120	300	310.0	319.6
3.0	180	315	370.0	381.5
6.0	360	630	485.0	500.0
9.0	540	945	583.8	753.2
12	720	1,260	682.5	880.6
24	1,440	3,420	880.0	1017

Table B.3 - Rainfall Depths for Humphreys Rivulet and Barossa Creek for selected complete storm exceedance probabilities and durations with an intensity climate change factor of 1.24 applied

Areal rainfall depth (mm)

Duration			Annual Exceedance Probability (1 in X)	
(hrs)	(mins)		20	100
	Burst	Complete	Complete	Complete
0.5	30	105	29.8	35.6
1.0	60	135	36.6	43.6
1.5	90	165	39.7	51.2
2.0	120	195	46.6	56.4
3.0	180	405	55.8	85.1
6.0	360	585	81.0	117
9.0	540	990	95.1	129
12	720	1,170	107	138
24	1,440	2,340	135	175

Table B.4 - Rainfall Depths for Humphreys Rivulet and Barossa Creek for PMF and selected durations with an intensity climate change factor of 1.24 applied

Areal rainfall depth (mm)

Duration			Annual Exceedance Probability (1 in X)
(hrs)	(mins)		10,000,000
	Burst	Complete	Complete
0.5	30	75	185.4
1.0	60	150	281.2
1.5	90	225	345.2
2.0	120	300	396.3
3.0	180	315	473.1
6.0	360	630	620.0
9.0	540	945	934.0
12	720	1,260	1092
24	1,440	3,420	1261

APPENDIX C HYDROLOGY PROCEDURE FOR MODELLING THE DAMS

C.1. Knights Creek Modelling

C.1.1. Elevation Discharge Relationship

Table C-7-1 – Knights Creek Spillway Elevation Discharge Relationship (SMEC 2017)

Elevation (mAHD)	Discharge (m^3/s)		
	Spillway	Embankment Overtopping	Total
189.60	0	0	0
189.78	3	0	3
189.99	10	0	10
190.19	20	0	20
190.39	33	0	33
190.57	47	0	47
190.85	63	0	63
191.47	80	0	80
192.14	100	0	100
192.66	120	0	120
193.02	135	0	132
193.52	148	0	148
193.61	161	9	170
193.80	170	47	217
194.31	195	225	420
194.63	211	372	583
194.89	225	510	735
195.33	250	777	1,027
195.82	280	1,120	1,400
196.10	310	1,323	1,633
196.48	345	1,626	1,971
196.82	380	1,920	2,300
197.15	420	2,216	2,636
197.45	460	2,495	2,955

Table C-7-2 – Knights Creek Low-Level Outlet Elevation Discharge Relationship (SMEC 2017)

Elevation (mAHD)	Discharge (m^3/s)
167	0
168	0.083
169	0.118
170	0.145
171	0.167
172	0.187
173	0.204
174	0.221
175	0.236
176	0.250
177	0.264
178	0.277
179	0.289
180	0.470
181	0.488
182	0.505
183	0.522
184	0.538
185	0.553
186	0.568
187	0.583
188	0.596
189	0.610
190	0.619

C.1.2. Elevation Storage Relationship

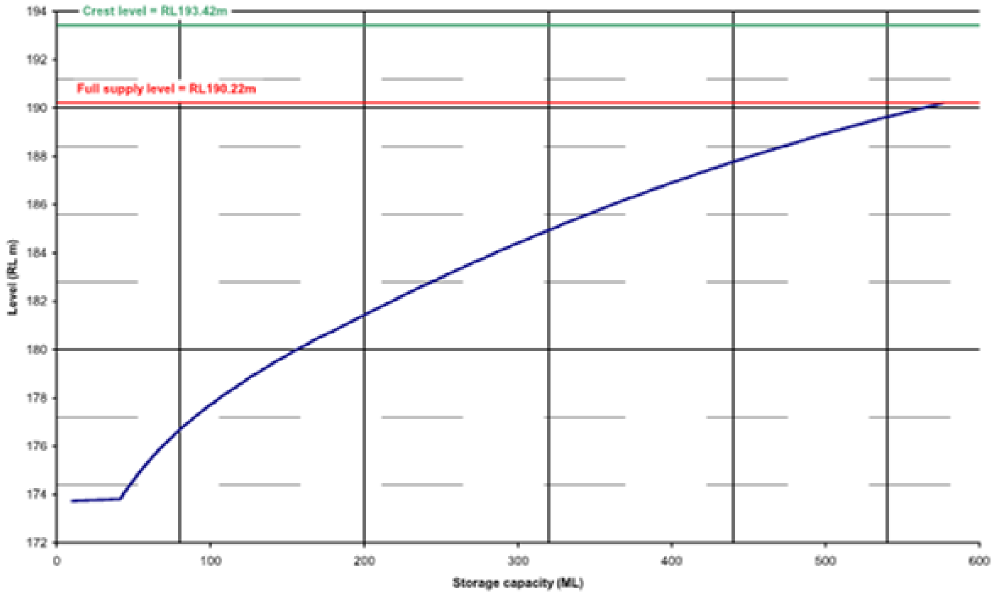


Figure C-7-1: Knights Creek Elevation Storage Relationship (SMEC 2017)

C.1.3. Flood Frequency Curve

Table C-7-3 - Results for Knights Creek (SMEC 2017)

AEP (1 IN X)	Peak Rain Depth (mm)	Peak Storage Elevation (m)	Inflow (m^3/s)	Peak Outflow (m^3/s)	Critical Duration (hrs)
2	31.6	189.9	9.9	8.4	9
5	43.9	190.0	14.2	12.6	9
10	52.0	190.1	17.0	15.2	9
20	59.8	190.1	19.8	17.7	9
50	69.7	190.2	23.8	20.8	9
100	77.2	190.2	26.9	23.4	9
1,000	160	190.7	67.3	55.9	12
10,000	239	191.7	120.7	88.3	12
50,000	314	192.8	177.2	126.9	12
100,000	352	193.3	207.0	146.8	12
200,000	102	193.4	241.3	171.7	1
500,000	122	193.7	295.1	249.4	1
1,000,000	139	193.8	342.8	304.8	1
10,000,000	185	194.3	554.3	540.2	0.75

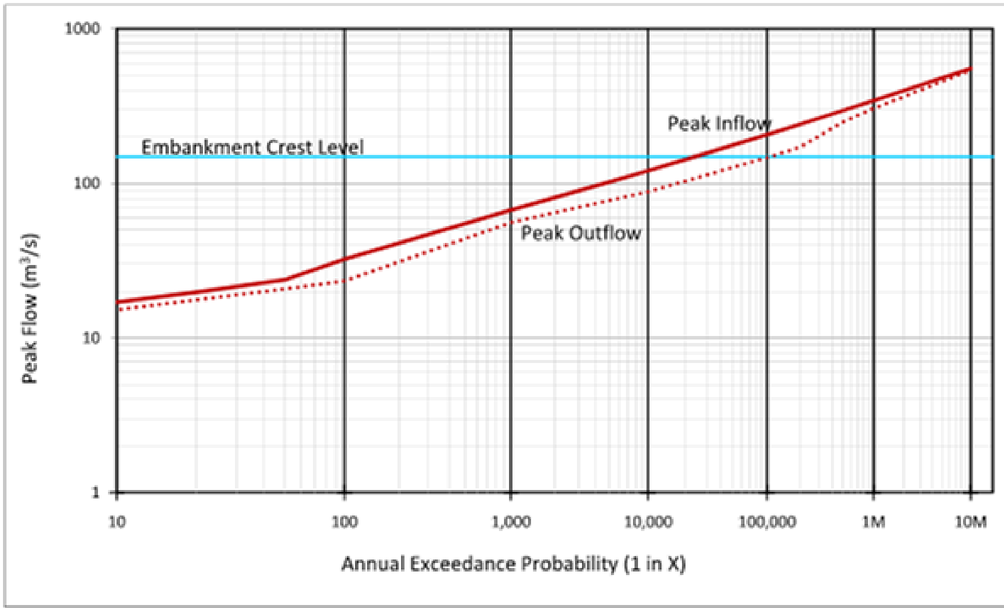


Figure C-7-2: Knights Creek Dam Inflow and Outflow flood frequency Curves (SMEC 2017)

C.2. Limekiln Gully Modelling

C.2.2. Elevation Discharge Relationship

Figure C-7-3: Limekiln Gully Spillway Rating Curve, (SMEC 2017)

Table C-7-4 – Limekiln Gully Low-Level Outlet Elevation Discharge Relationship (SMEC 2017)

Elevation (mAHD)	Discharge (m^3/s)
144.1	0
145	0.178
146	0.259
147	0.320
148	0.371
149	0.416
150	0.456
151	0.493
152	0.528
153	0.560
154	0.591
155	0.620
156	0.648
157	0.674
158	0.700
159	0.725
160	0.749
161	0.772
162	0.794
163	0.816
164	0.838
165	0.856
166	0.877
166.4	0.885

C.2.3. Elevation Storage Relationship

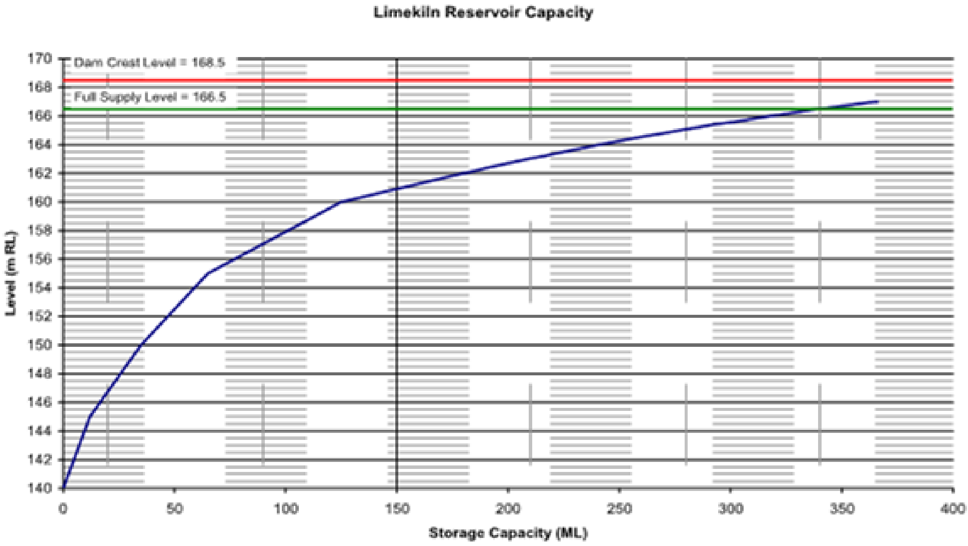


Figure C-7-4: Limekiln Gully Elevation Storage Relationship (SMEC 2017)

C.2.4. Flood Frequency Curve

Table C-7-5 - Results for Limekiln Gully (SMEC 2017)

AEP (1 IN X)	Peak Rain Depth (mm)	Peak Storage Elevation (m)	Inflow (m^3/s)	Peak Outflow (m^3/s)	Critical Duration (hrs)
2	35.8	166.6	1.8	0.7	12
5	43.9	166.7	2.8	1.0	9
10	52.0	166.8	3.8	1.3	9
20	59.8	166.8	5.0	1.5	9
50	69.7	166.8	6.4	1.9	9
100	77.2	166.9	9.7	2.1	9
1,000	233	167.3	18.6	6.6	12
10,000	239	167.7	32.3	11.8	12
50,000	314	168.1	46.1	17.0	12
100,000	352	168.2	53.1	19.6	12
200,000	392	168.4	61.6	22.4	12
500,000	451	168.6	74.7	26.3	12
1,000,000	499	168.8	86.0	29.5	12
10,000,000	270	169.7	132.7	47.5	1.5

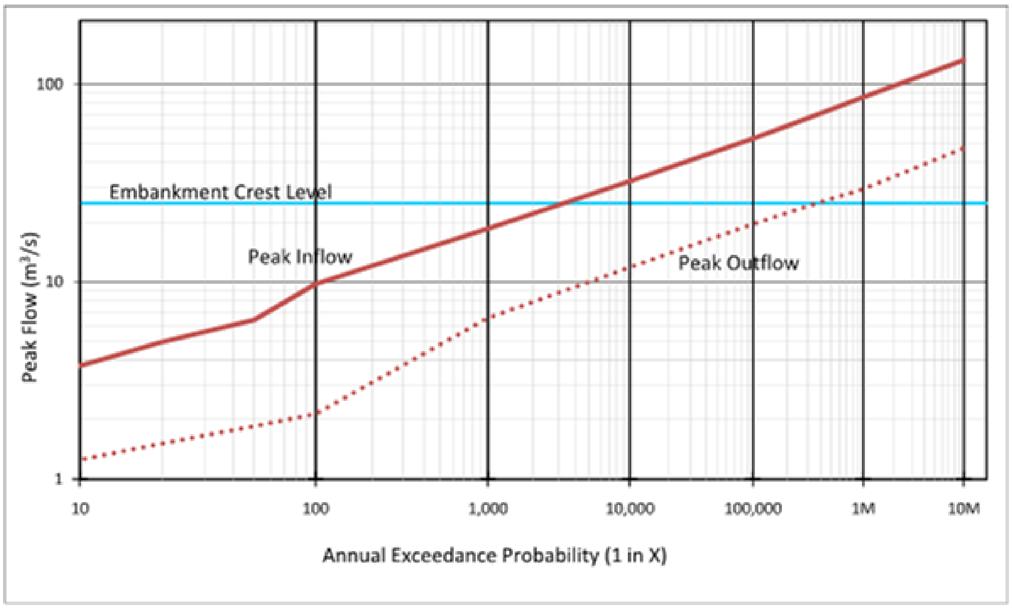


Figure C-7-5: Limekiln Gully Inflow and Outflow flood frequency Curves (SMEC 2017)

C.3. Tolosa Modelling

C.3.2. Elevation Discharge Relationship

Table C-7-6 – Tolosa Reservoir Elevation Discharge Relationship (SMEC 2017)

Elevation (mAHD)	Discharge (m^3/s)
107.00	0.0
107.87	1.4
107.92	2.88
107.97	6.69
108.02	12.89
108.07	22.2
108.12	35.06
108.17	51.88
108.21	72.32
108.26	96.51
108.31	123.48
108.36	153.14
108.40	185.3
108.45	219.88
108.50	257.29

C.3.3. Elevation Storage Relationship

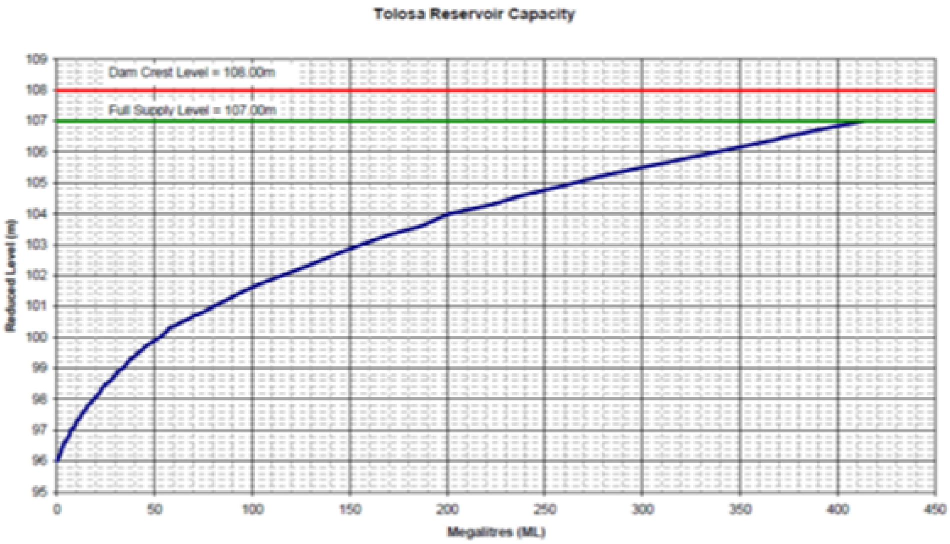


Figure C-7-6: Tolosa Reservoir Elevation Storage Relationship (SMEC 2017)

C.3.4. Flood Frequency Curve

Table C-7-7 - Tolosa flood frequency relationship (SMEC 2017)

AEP (1 IN X)	Peak Rain Depth (mm)	Peak Storage Elevation (m)	Inflow (m^3/s)	Peak Outflow (m^3/s)	Outflow Critical Duration (hrs)
2	52.1	107.03	0.46	0.6	36
5	74.3	107.05	0.68	0.8	36
10	89.8	107.06	0.83	0.10	36
20	105	107.07	0.96	0.11	36
50	127	107.09	1.14	0.14	36
100	143	107.10	1.28	0.15	36

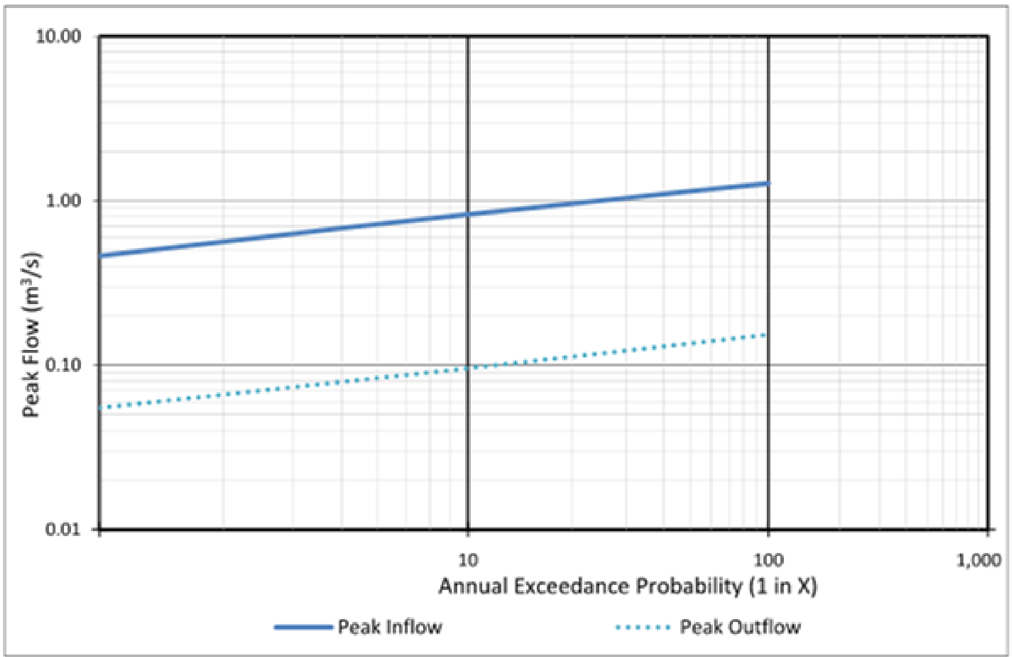
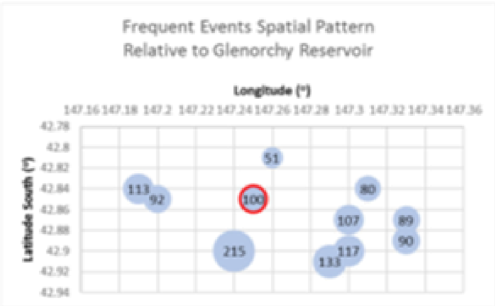
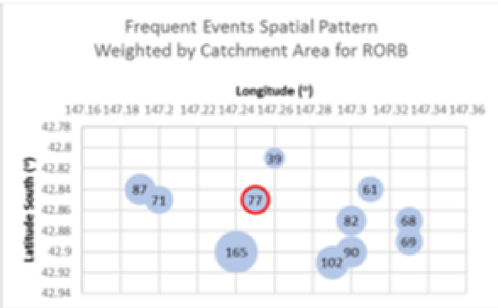


Figure C-7-7: Tolosa Inflow and Outflow flood frequency Curves (SMEC 2017)

APPENDIX D SPATIAL PATTERN ASSESSMENT

Gauge Name	Longitude (°)	Latitude South (°)
Glenorchy Reservoir	147.25	42.85
Glenorchy - Murrayfield (closed)	147.27	42.84
Moonah East (closed)	147.30	42.85
Hobart - Ellerslie Rd	147.33	42.89
Hobart Botanical Gardens	147.33	42.87
Lenah Valley - Augusta Rd (closed)	147.30	42.87
Hobart - Waterworks Res	147.29	42.91
Kunanyi Mt Wellington Pinnacle	147.24	42.90
Collinsvale	147.19	42.84
Berriedale - Moorilla Estate	147.26	42.81
South Hobart - Hillborough Rd	147.30	42.90
Rosetta (closed)	147.25	42.83
Lutana - Bowen Rd (closed)	147.31	42.84
Collinsvale (closed)	147.20	42.85





See Figure 3-7 for the names of the gauges.

The gauge circled red is the reference Glenorchy Reservoir gauge

The black text (and size of the blue circle) is the spatial pattern (on the left) relative to Glenorchy Reservoir, the percentage of the Glenorchy Reservoir rainfall to apply at that gauge; (on the right) the same percentage weighted by sub-catchment area summing to 100 for RORB.

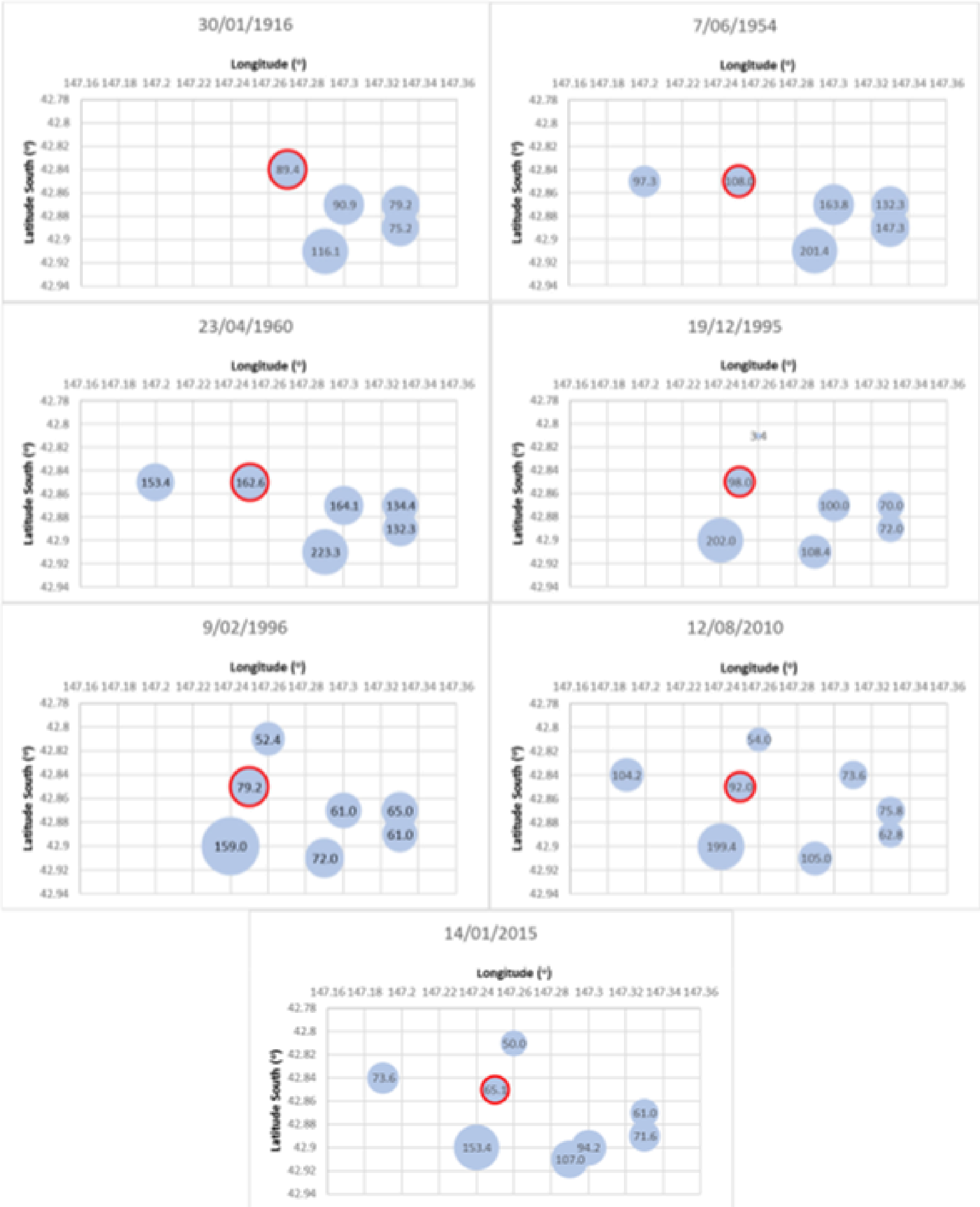
This (left image) value is calculated by:

6. Isolate the rainfall events that show orographic related spatial variability (the seven events on the next page)
7. For each gauge calculate the ratio of rainfall depth to the Glenorchy gauge rainfall depth as a percentage (shown as the size of blue circles on following pages)
8. Calculate the (mean) average of those step 2 ratios for each gauge.

For the (right image) value:

9. The value from step 3 is adjusted by the formula: sum(SubArea x pattern)/TotalArea=100

Events with obvious orographic spatial gradient:

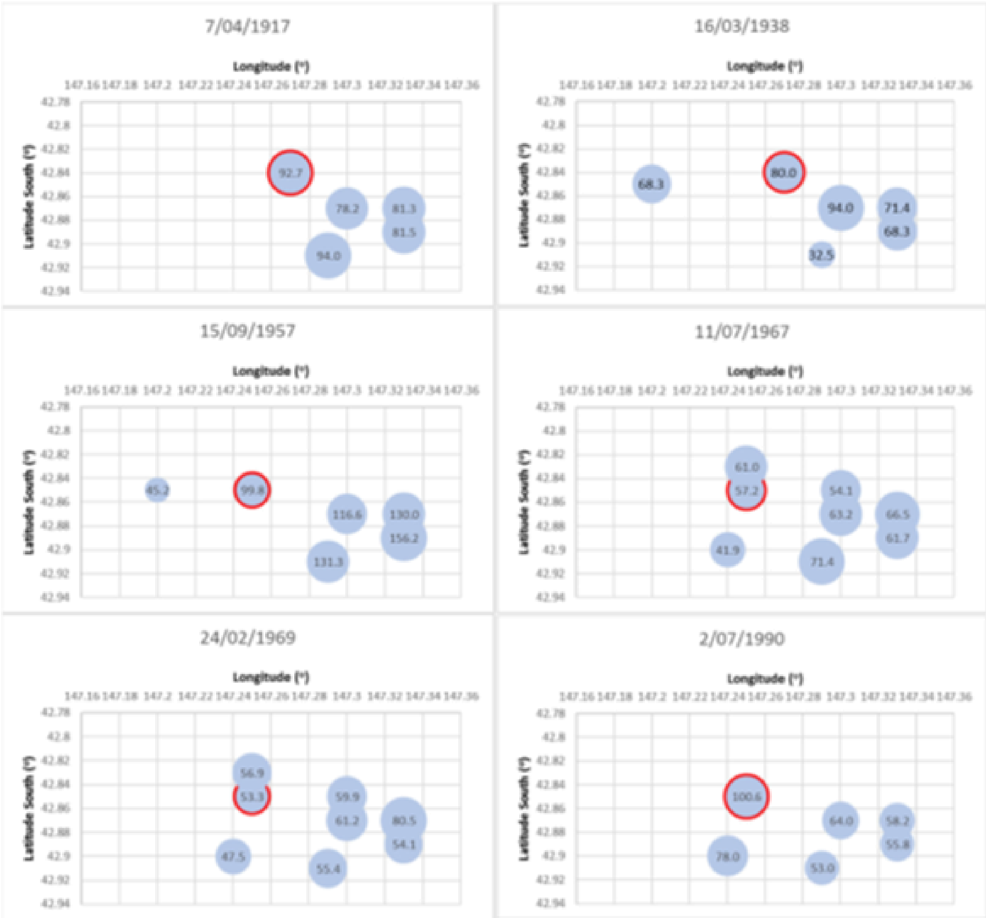


The gauge circled red is the reference Glenorchy gauge (at Reservoir/Murrayfield depending on year)

The black text is the daily total rainfall depth at that gauge.

The size of the blue circle shows the ratio of that gauge rainfall depth to the Glenorchy reference gauge.
See Figure 3-7 for the names of the gauges.

Events with neutral or reverse orographic gradient:

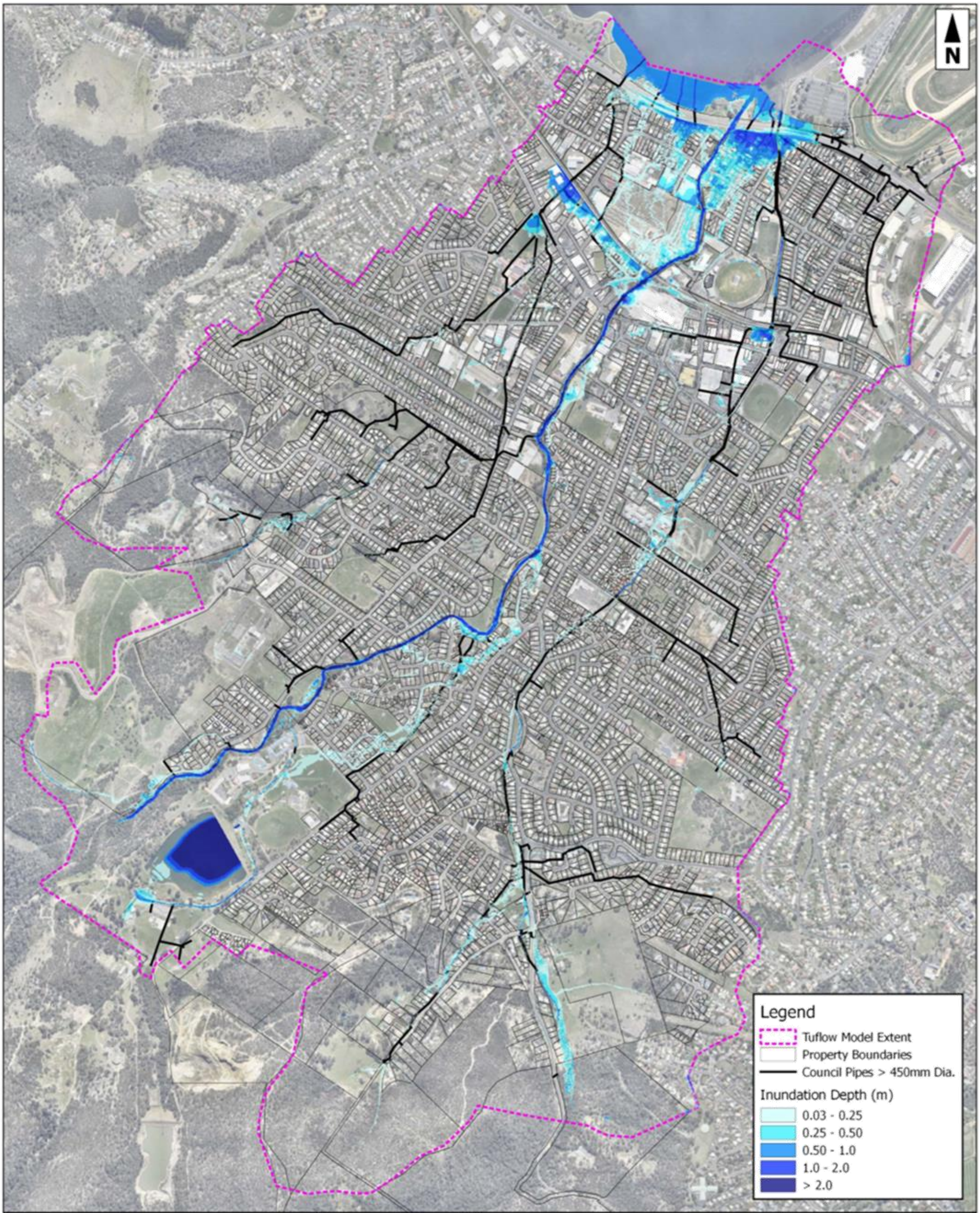


The gauge circled red is the reference Glenorchy gauge (at Reservoir/Murrayfield depending on year)

The black text is the daily total rainfall depth at that gauge.

The size of the blue circle shows the ratio of that gauge rainfall depth to the Glenorchy reference gauge.
See Figure 3-7 for the names of the gauges.

APPENDIX E INUNDATION MAPS (DEPTH AND DV)



REVISION: A
AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-cal1
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1996 CALIBRATION EVENT - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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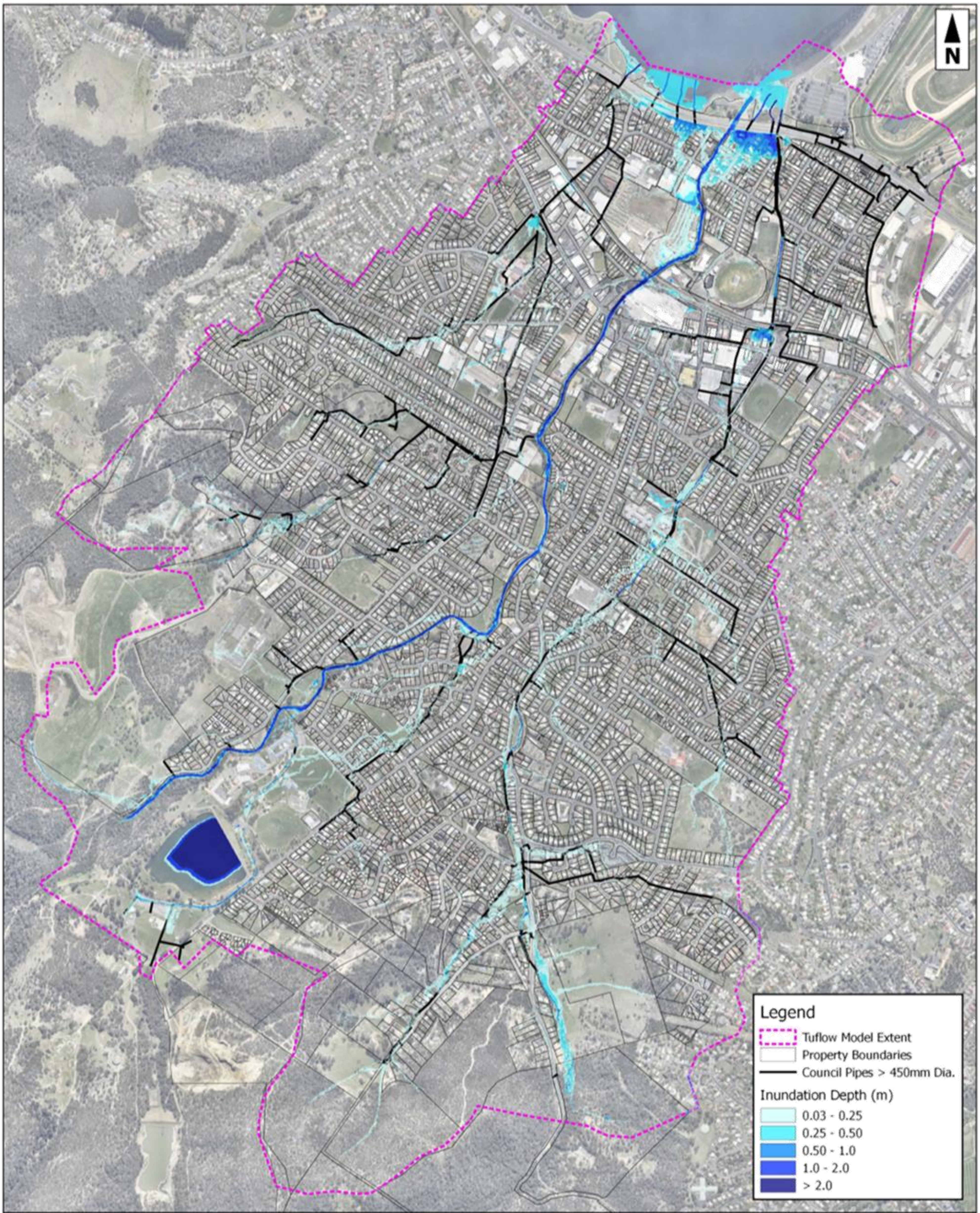

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-ex1

FIGURE TITLE: 1 in 20 AEP EXISTING - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

CLIENT: GLENORCHY CITY COUNCIL

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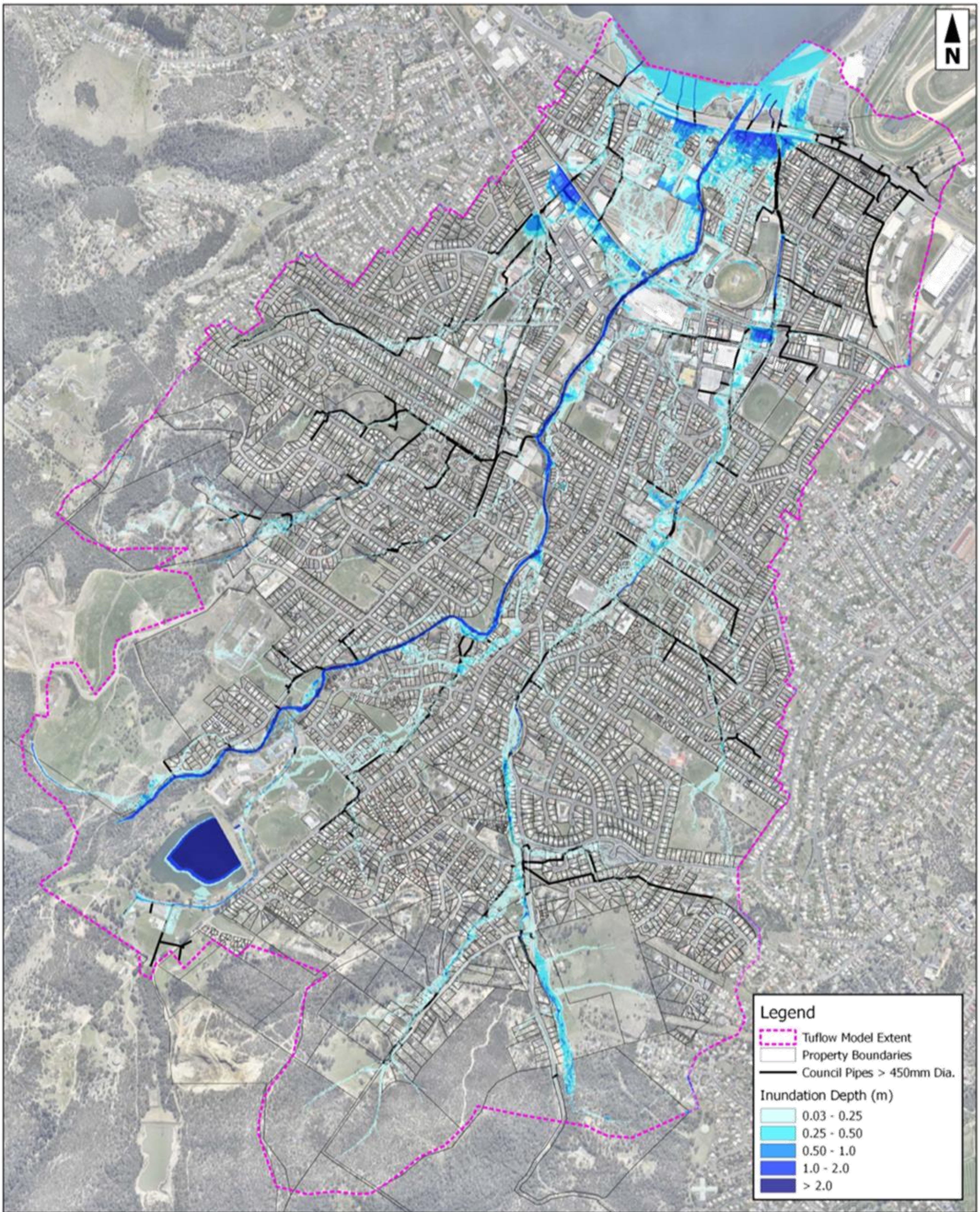

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018		CLIENT: GLENORCHY CITY COUNCIL
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-ex3		
FIGURE TITLE: 1 in 100 AEP EXISTING - Innundation Depth Map				
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55		0 200 400 600 m		SMEC Member of the Surbana Jurong Group SMEC AUSTRALIA PTY LTD ABN 47 065 475 149
PAGE SIZE: A3	SCALE: 1:13,000			
PROJECT NO: 30041618	PROJECT TITLE: GLENORCHY CBD SSMP			

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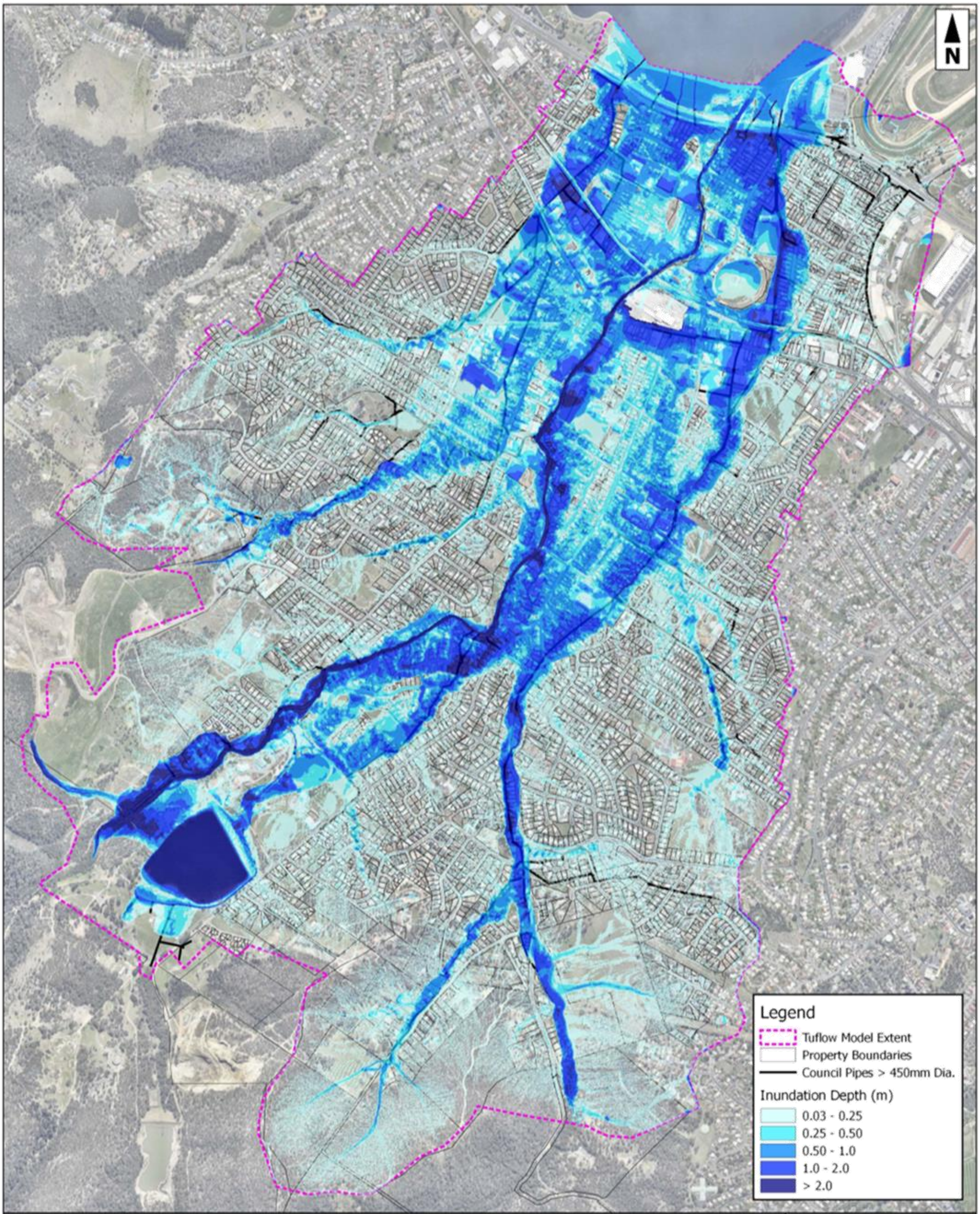

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-ex5

FIGURE TITLE: PMF EXISTING - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

CLIENT: GLENORCHY CITY COUNCIL

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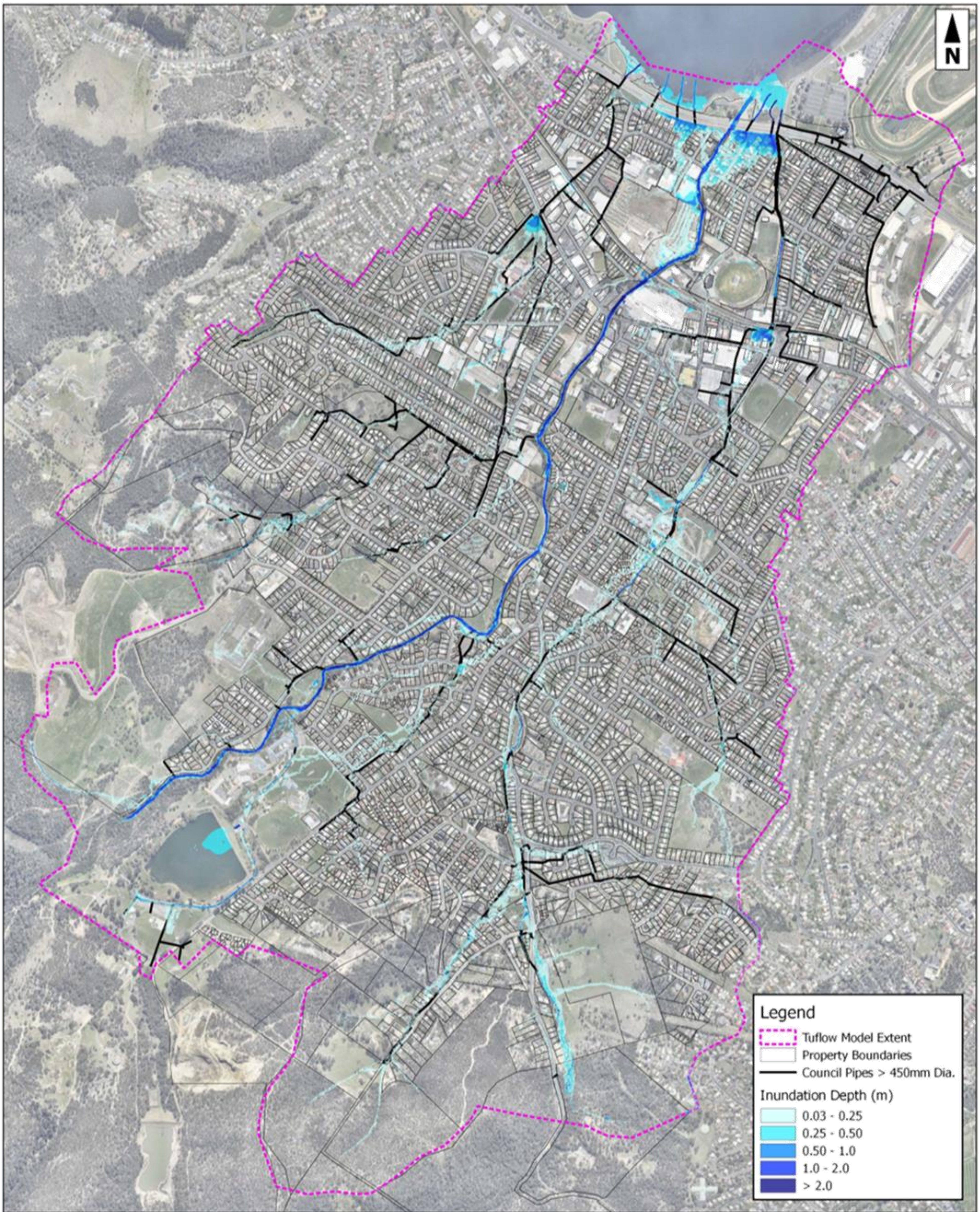

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018	CLIENT: GLENORCHY CITY COUNCIL
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-dr1	
FIGURE TITLE: 1 in 20 AEP DEVELOPED - EXIST DAMS LEVEL - Innundation Depth Map			
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55	0 200 400 600 m		SMEC Member of the Surbana Jurong Group SMEC AUSTRALIA PTY LTD ABN 47 065 475 149
PAGE SIZE: A3	SCALE: 1:13,000		
PROJECT NO: 30041618	PROJECT TITLE: GLENORCHY CBD SSMP		

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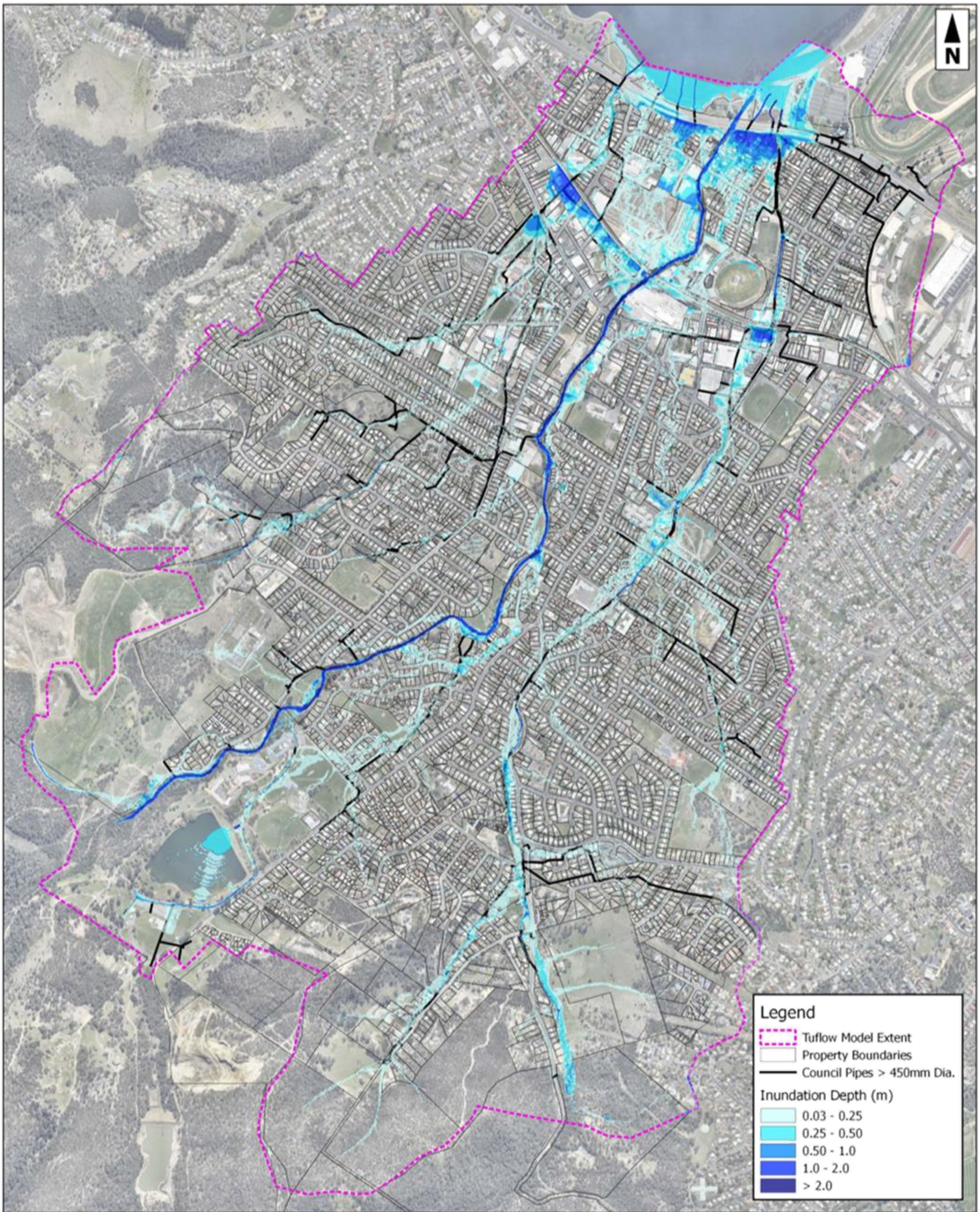

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-dr3

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - EXIST DAMS LEVEL - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

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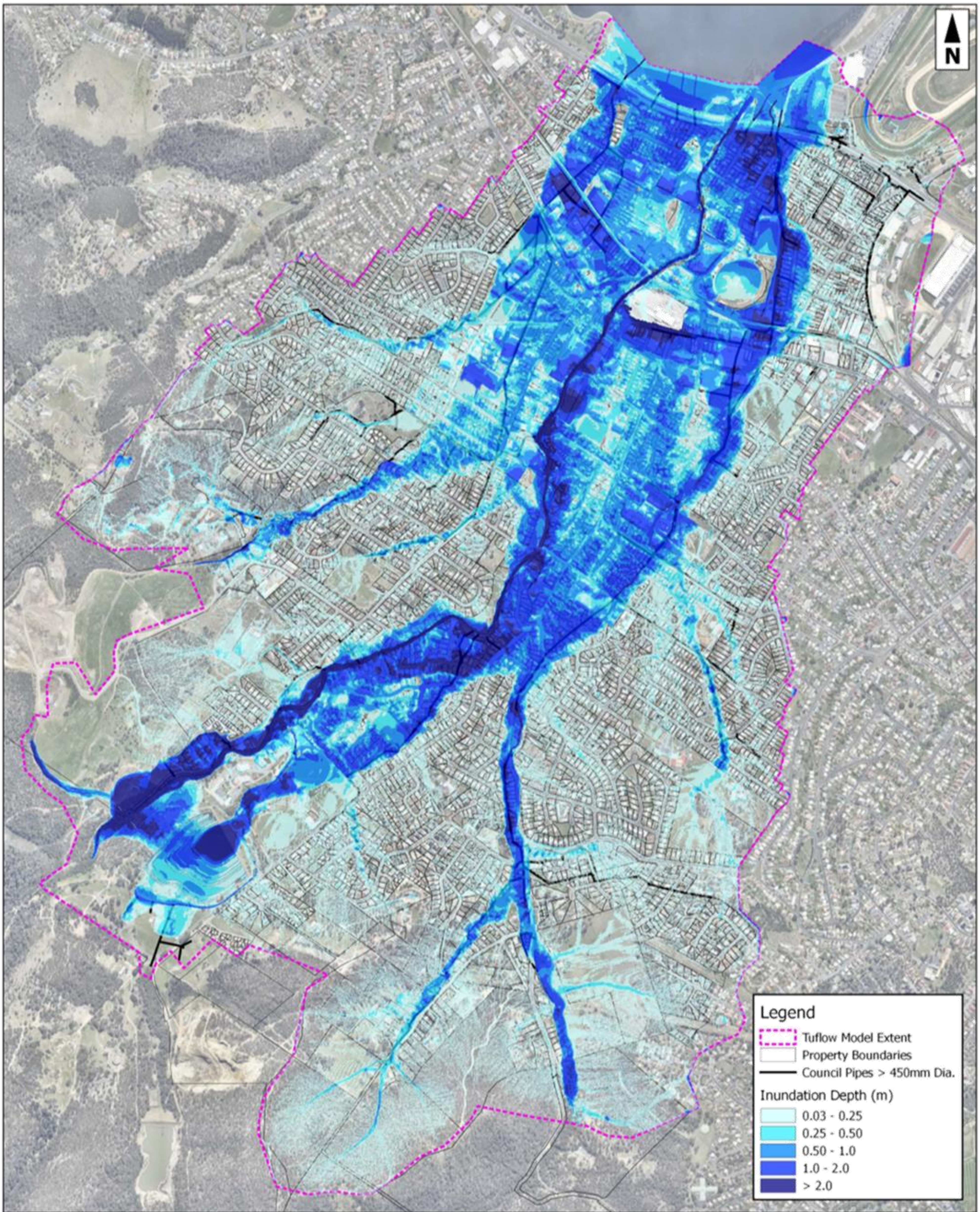

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AUTHOR: H. Nguyen-Mallen DATE: 7/09/2018 FIGURE: 30041618-E-dr5

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: PMF DEVELOPED - EXIST DAMS LEVEL - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55 0 200 400 600 m

PAGE SIZE: A3 SCALE: 1:13,000

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

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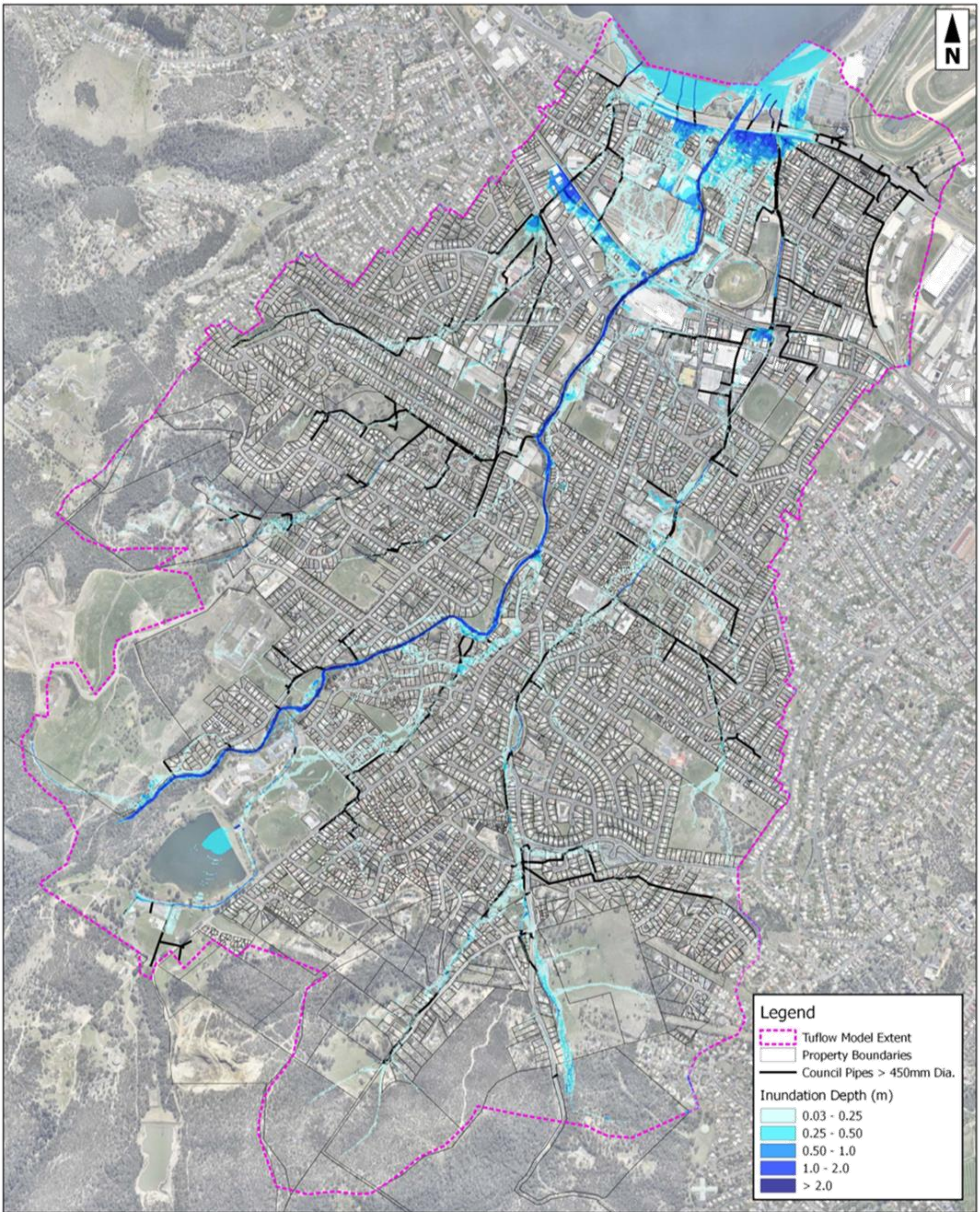

REVISION: A
AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-de1

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 20 AEP DEVELOPED - DAMS FULL - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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PROJECT NO: 30041618
PROJECT TITLE: GLENORCHY CBD SSMP

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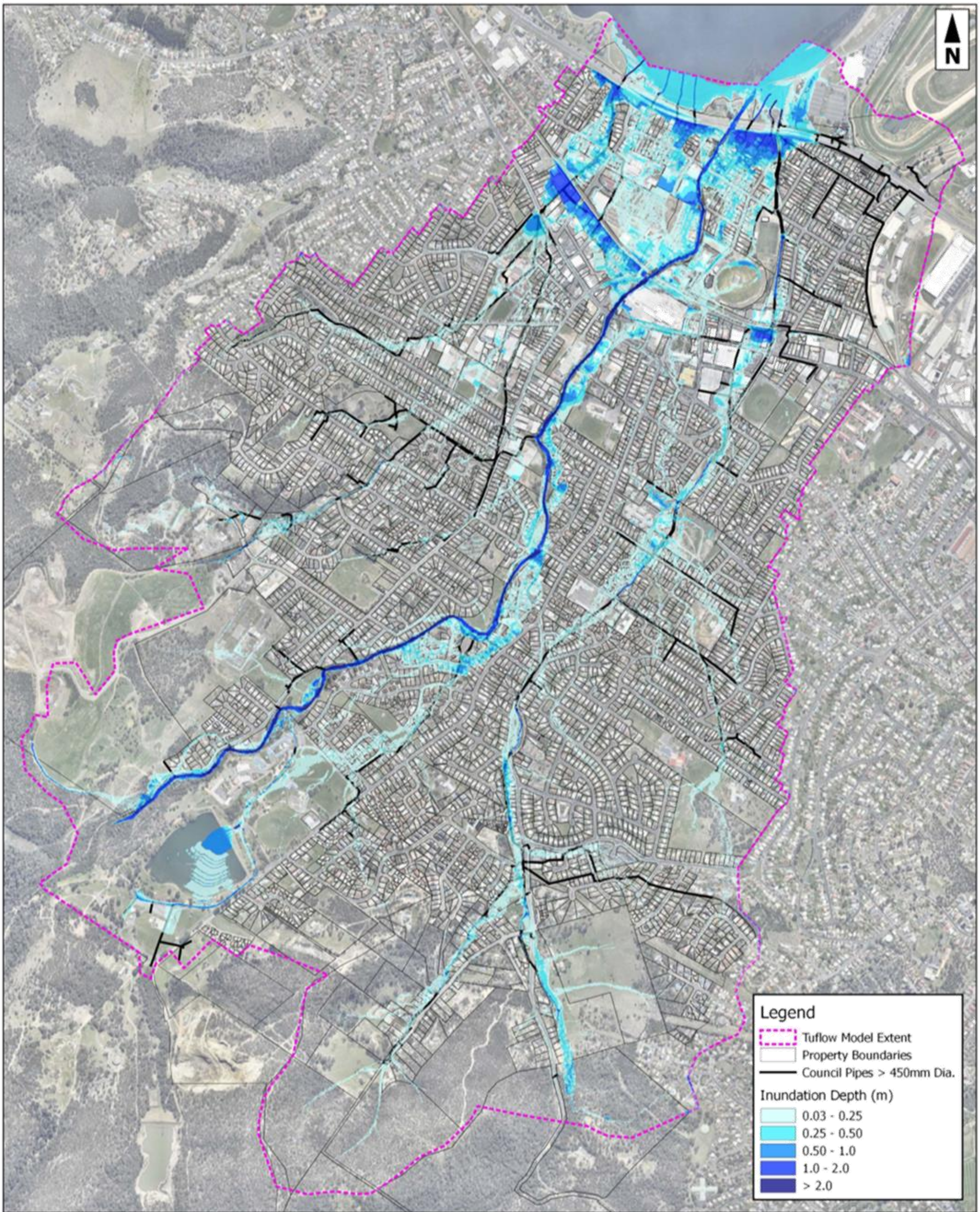

REVISION: A
AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-de3
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - DAMS FULL - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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PROJECT NO: 30041618
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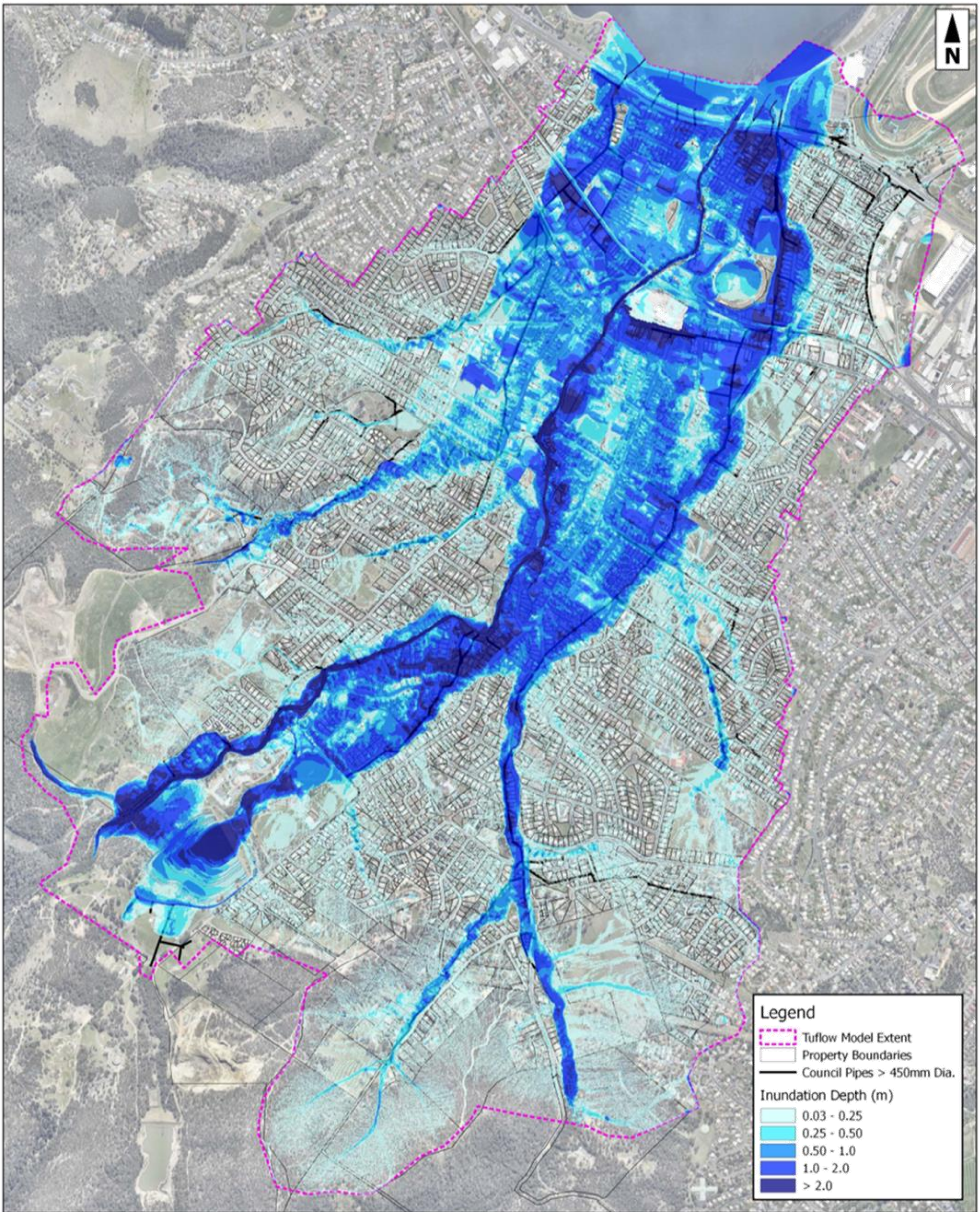

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018	CLIENT: GLENORCHY CITY COUNCIL
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-de5	
FIGURE TITLE: PMF DEVELOPED - DAMS FULL - Innundation Depth Map			
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55	0 200 400 600 m		SMEC
PAGE SIZE: A3	SCALE: 1:13,000		Member of the Surbana Jurong Group
PROJECT NO: 30041618	PROJECT TITLE: GLENORCHY CBD SSMP		SMEC AUSTRALIA PTY LTD ABN 47 065 475 149

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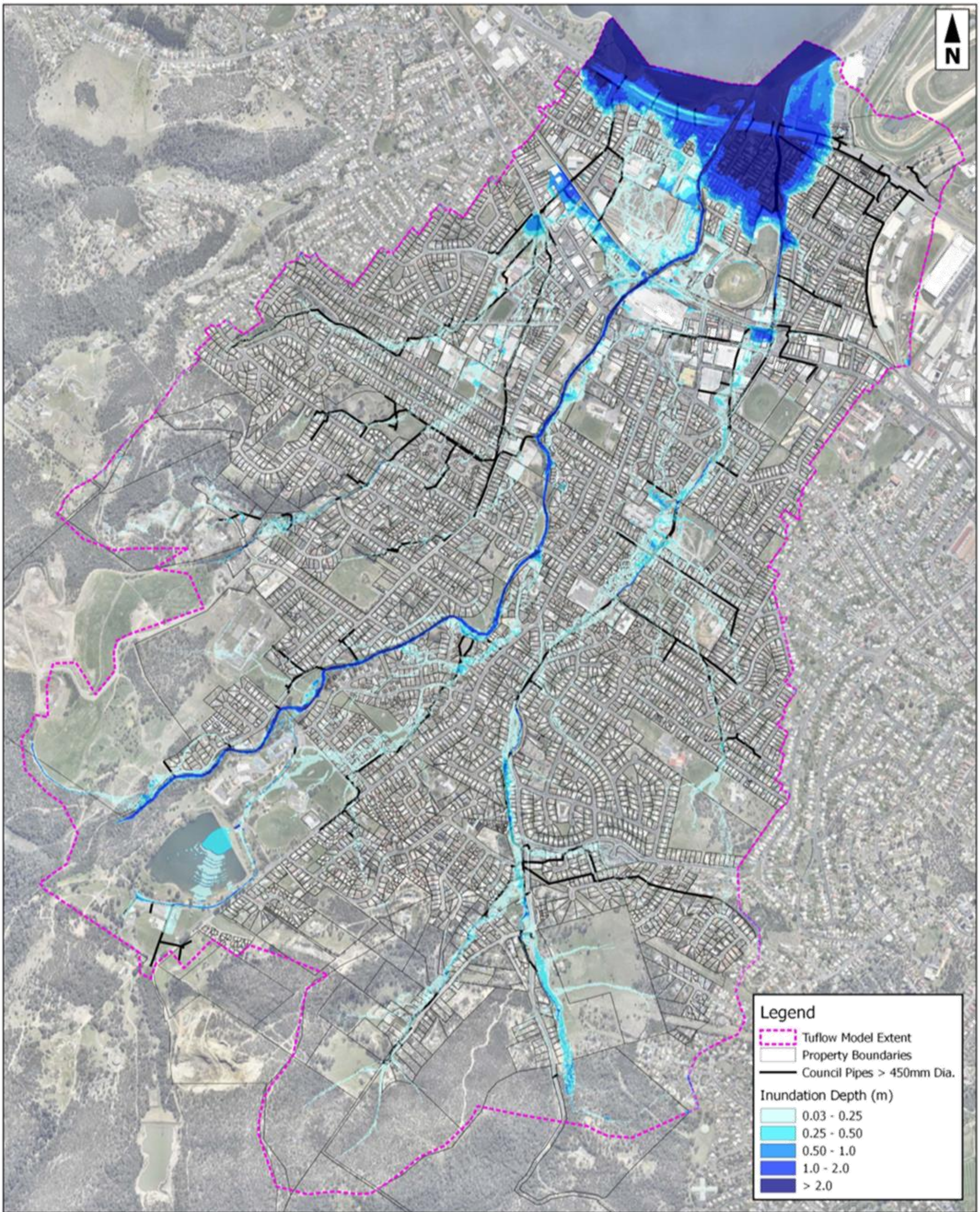

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-cc1

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 20 AEP DEVELOPED - CLIMATE CHANGE 1 - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

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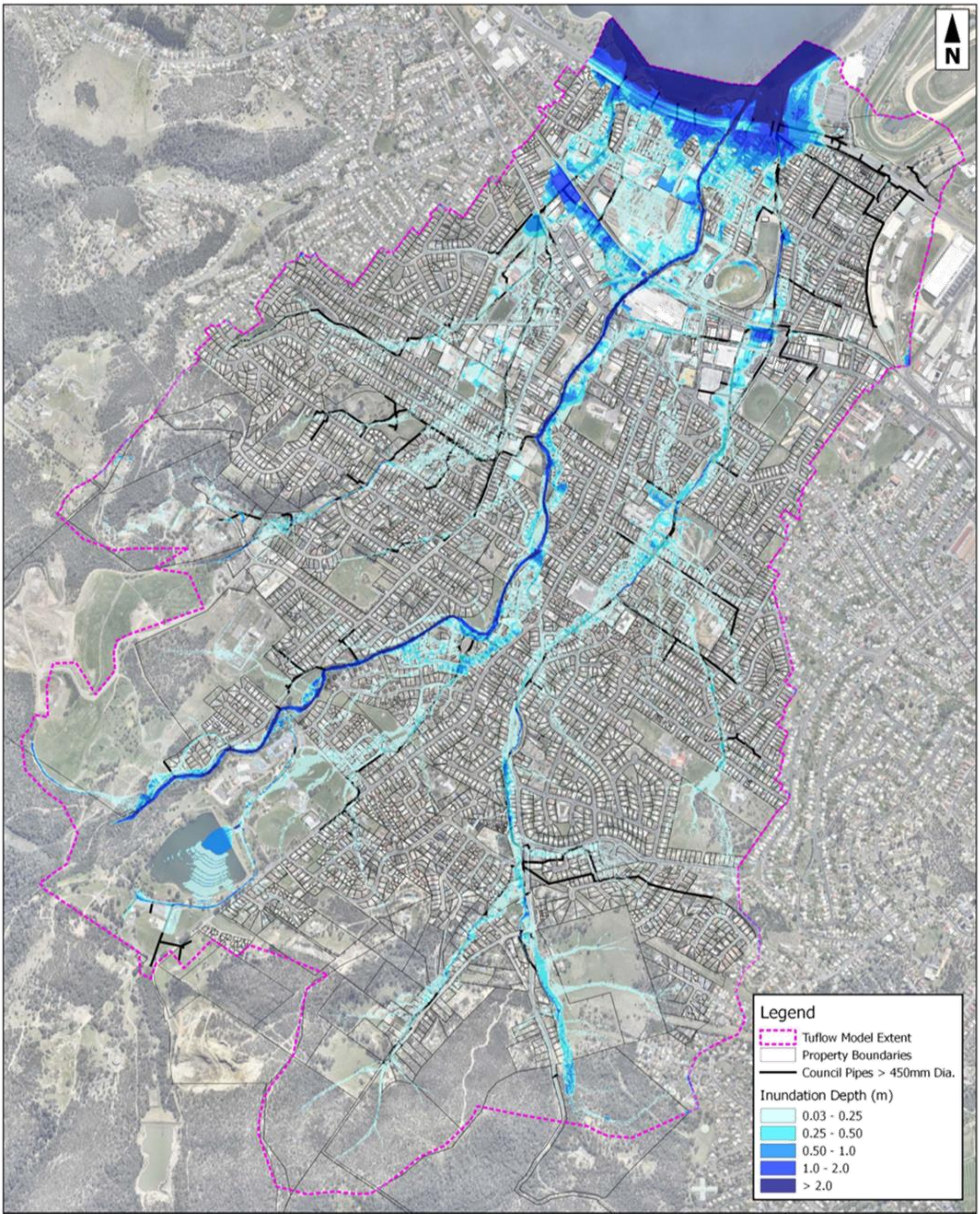

REVISION: A
AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-cc3
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 2 - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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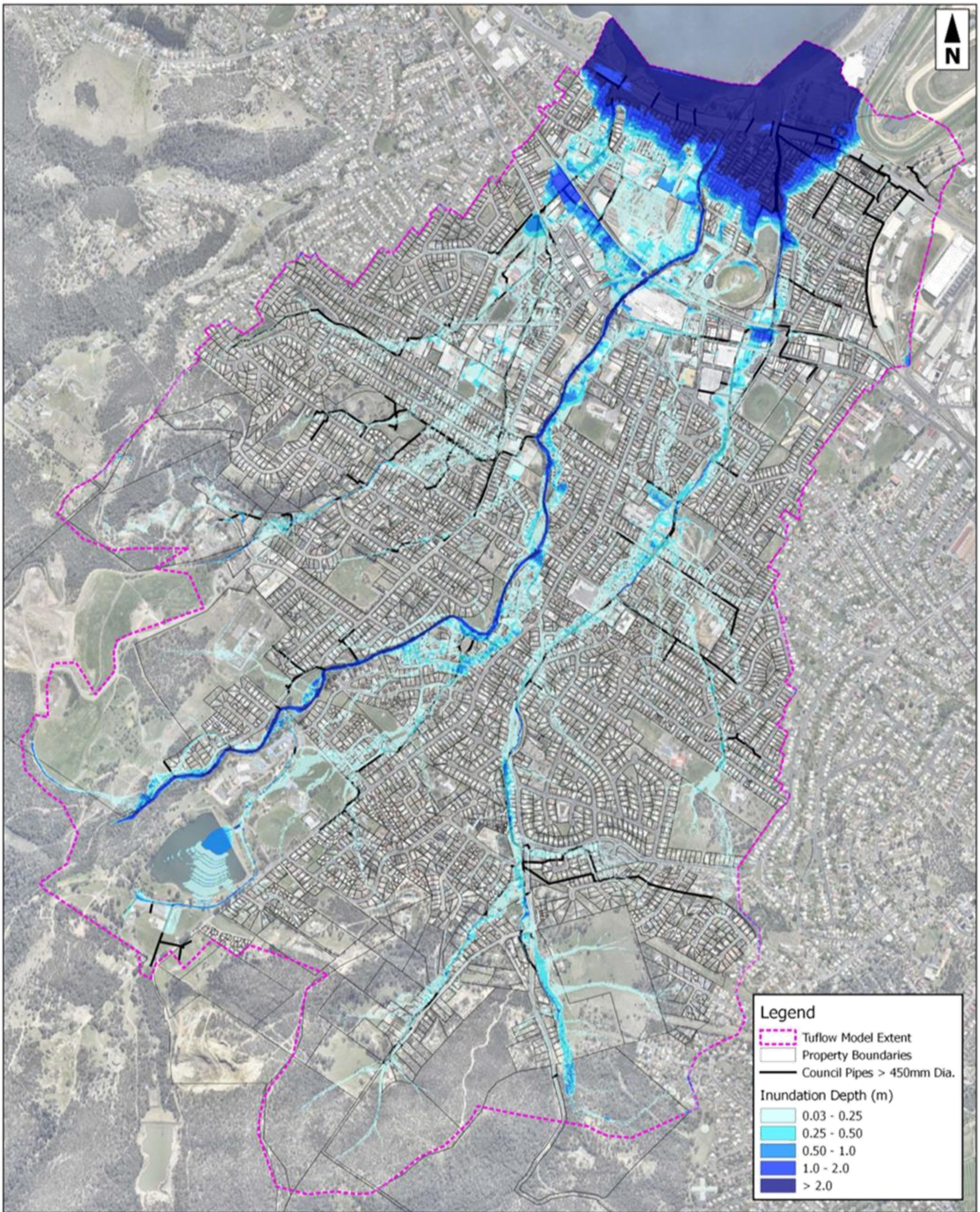

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STATUS: FINAL
SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen
DATE: 7/09/2018
FIGURE: 30041618-E-cc5
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 3 - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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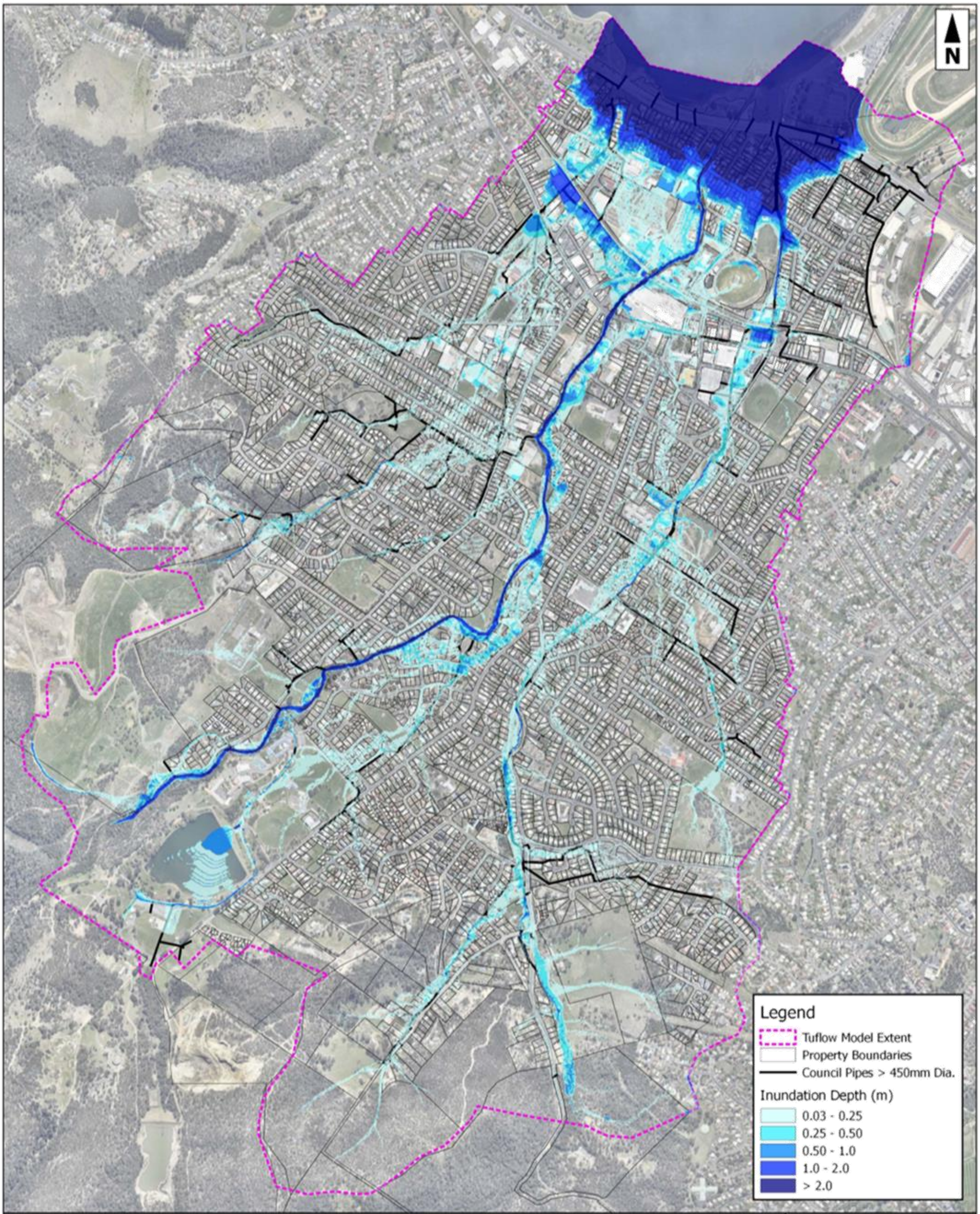

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SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen
DATE: 7/09/2018
FIGURE: 30041618-E-cc7

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 4 - Innundation Depth Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000

0 200 400 600 m

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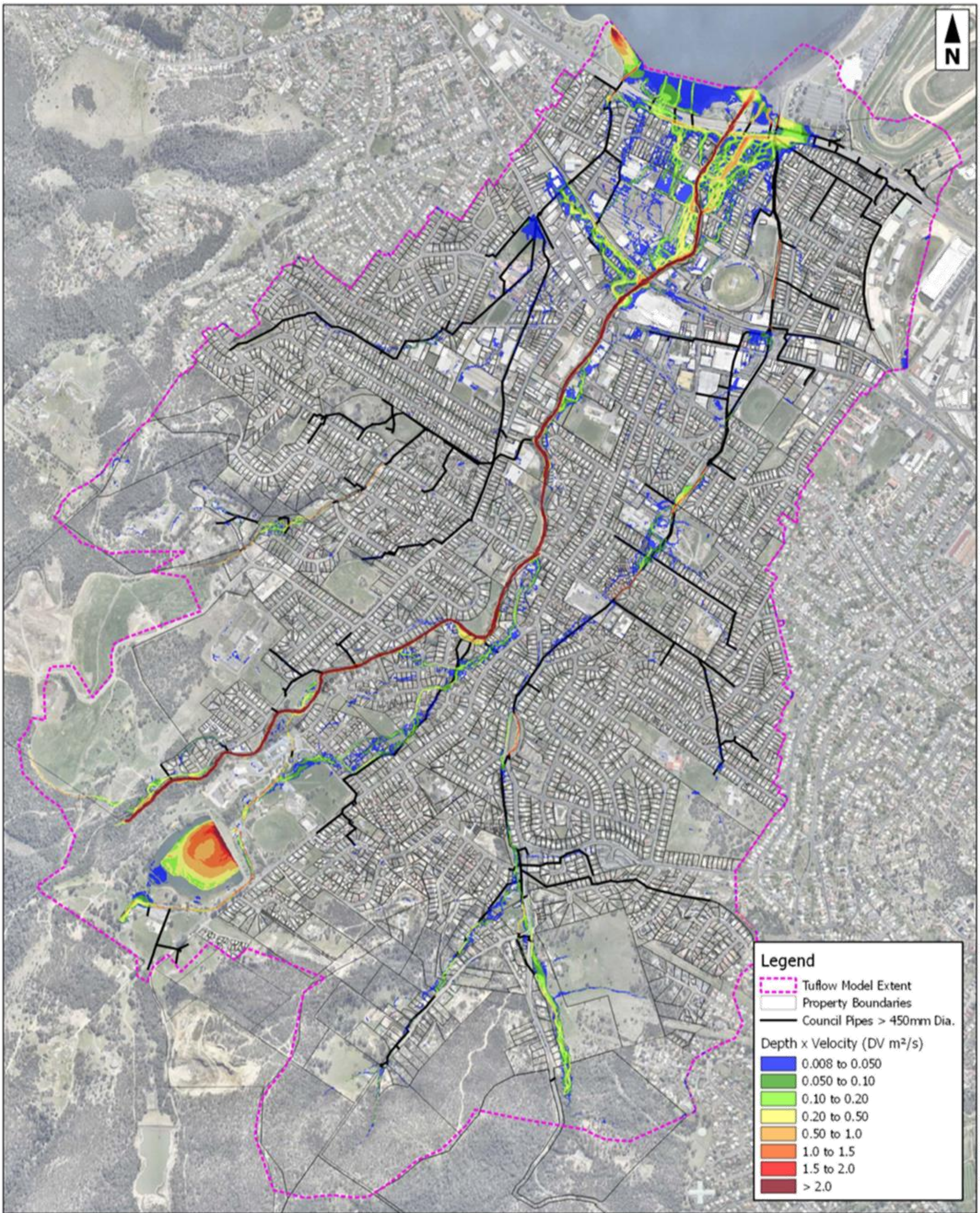

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-cal2

FIGURE TITLE: 1996 CALIBRATION EVENT - Innundation Hazard (DV) Map

CLIENT: GLENORCHY CITY COUNCIL

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

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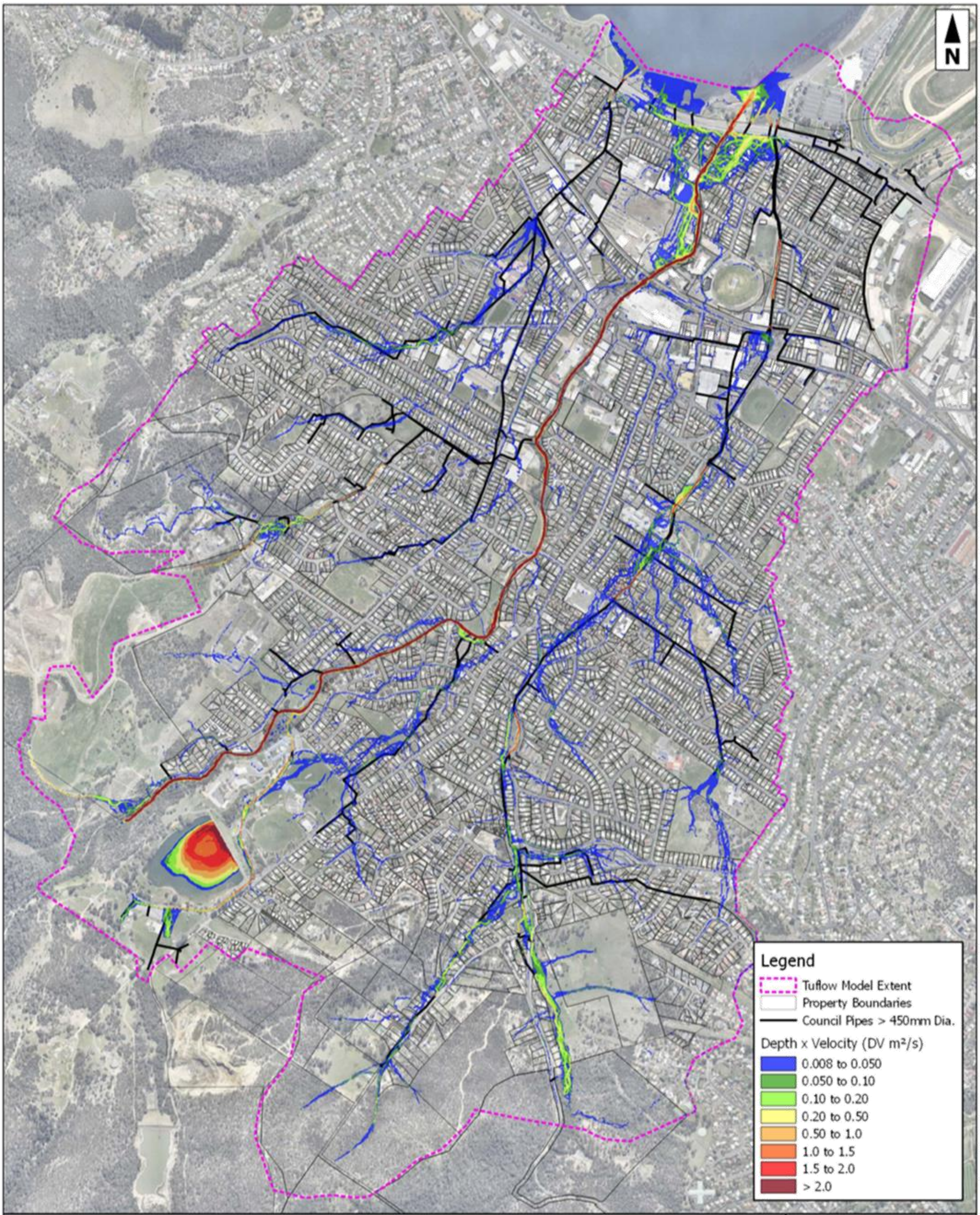

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AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-ex2

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 20 AEP EXISTING - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

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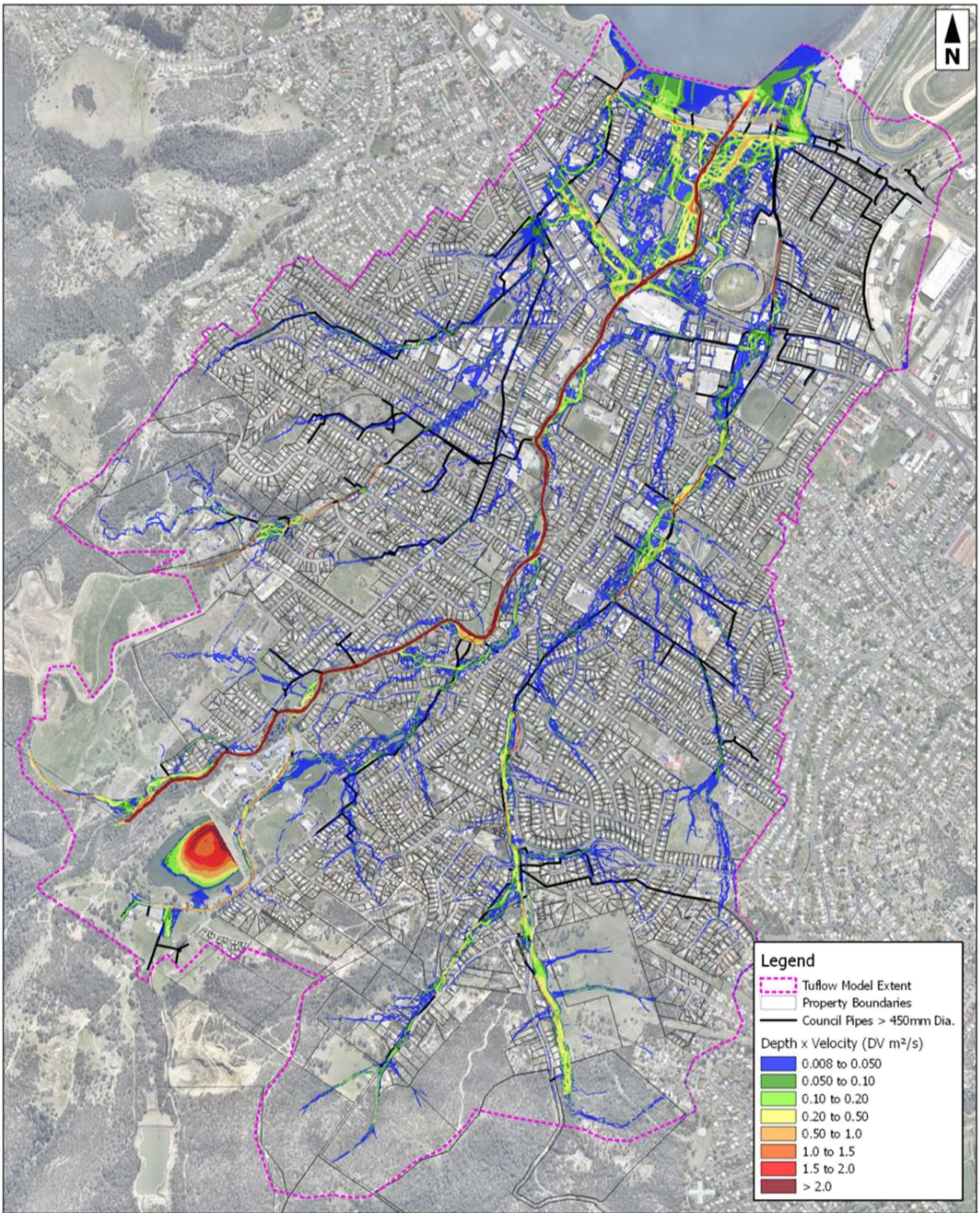

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AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-ex4

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP EXISTING - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000

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PROJECT NO: 30041618
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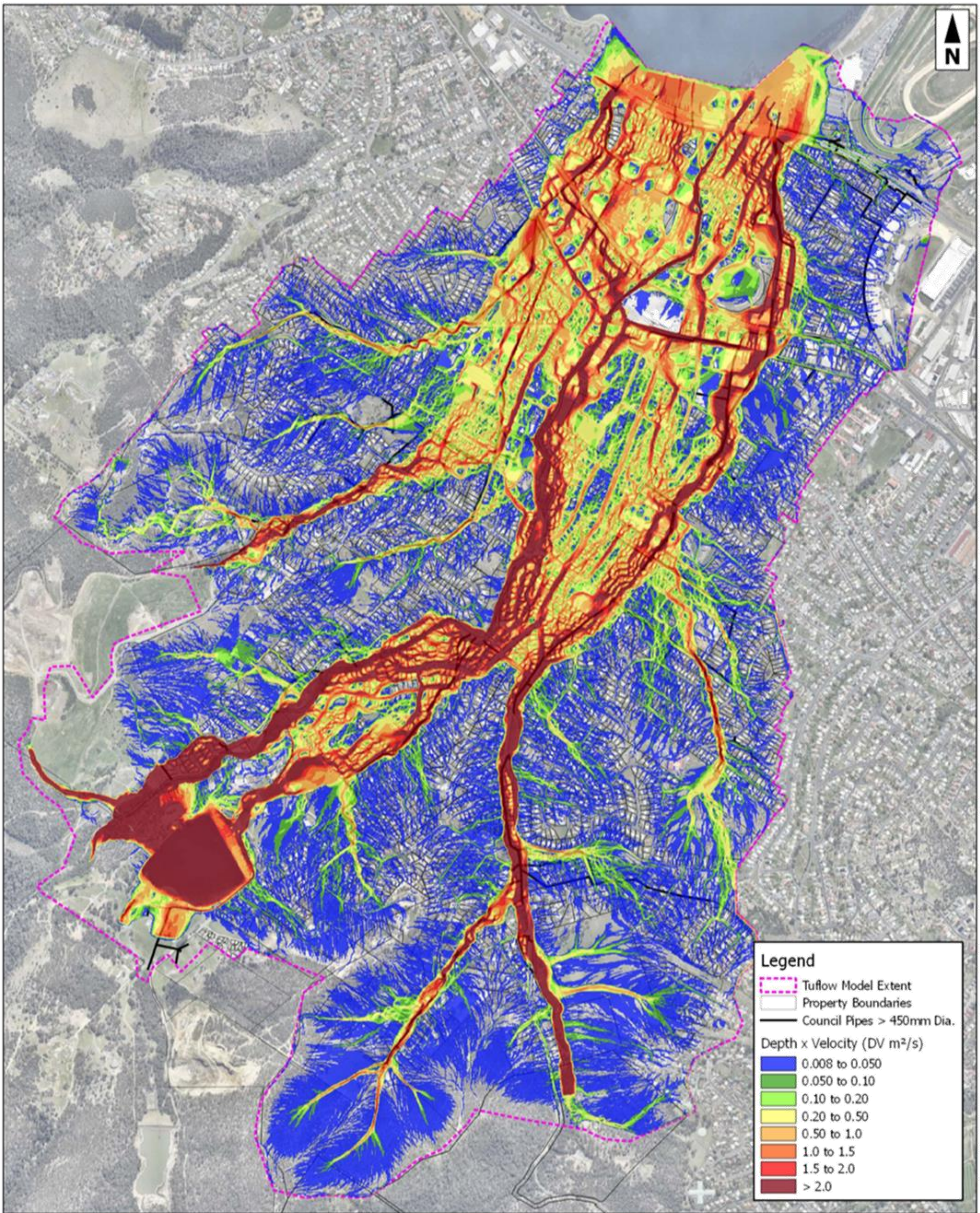

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AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-ex6

FIGURE TITLE: PMF EXISTING - Innundation Hazard (DV) Map

CLIENT: GLENORCHY CITY COUNCIL

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

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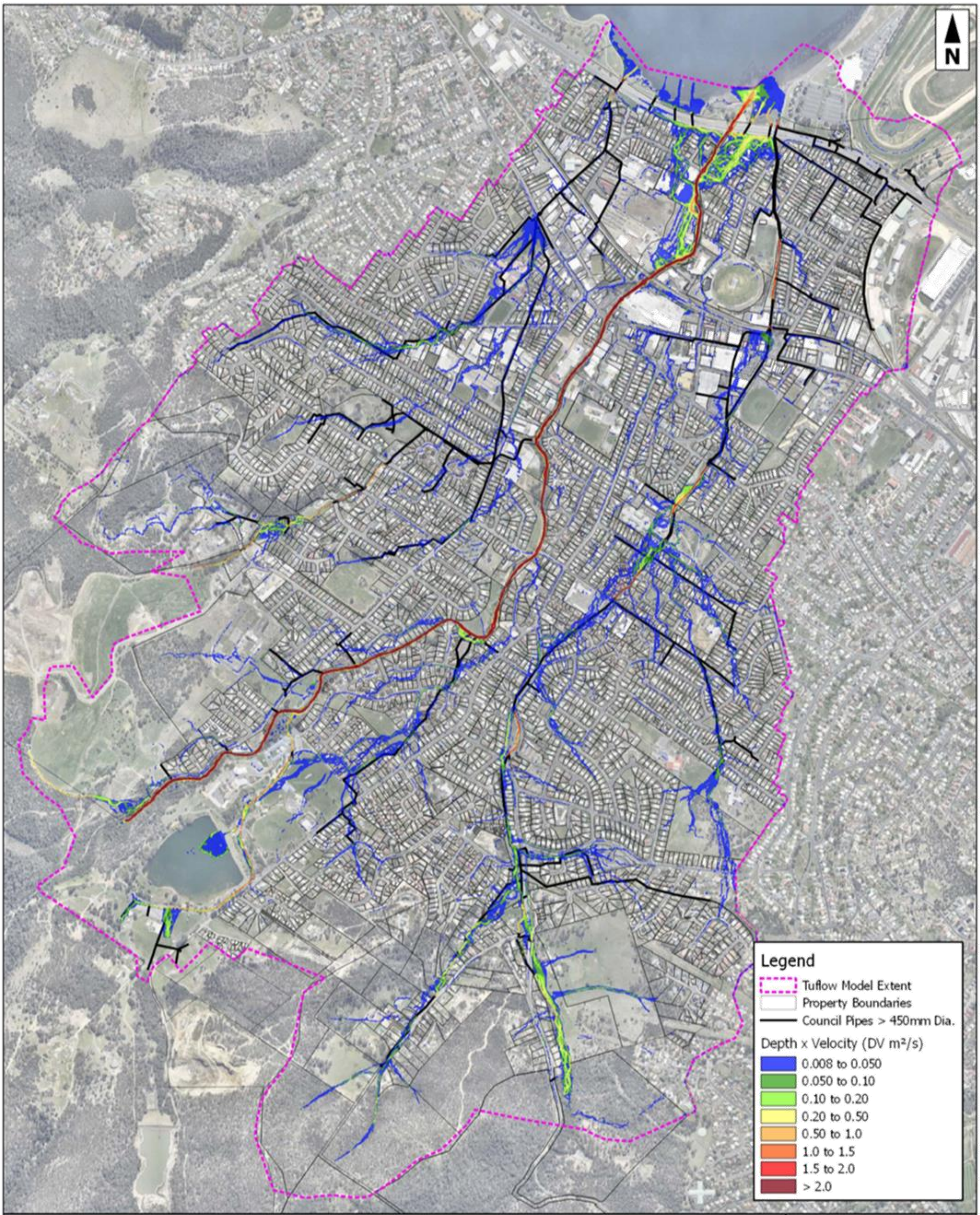

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AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-dr2
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 20 AEP DEVELOPED - EXIST DAMS LEVEL - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

PROJECT NO: 30041618
PROJECT TITLE: GLENORCHY CBD SSMP

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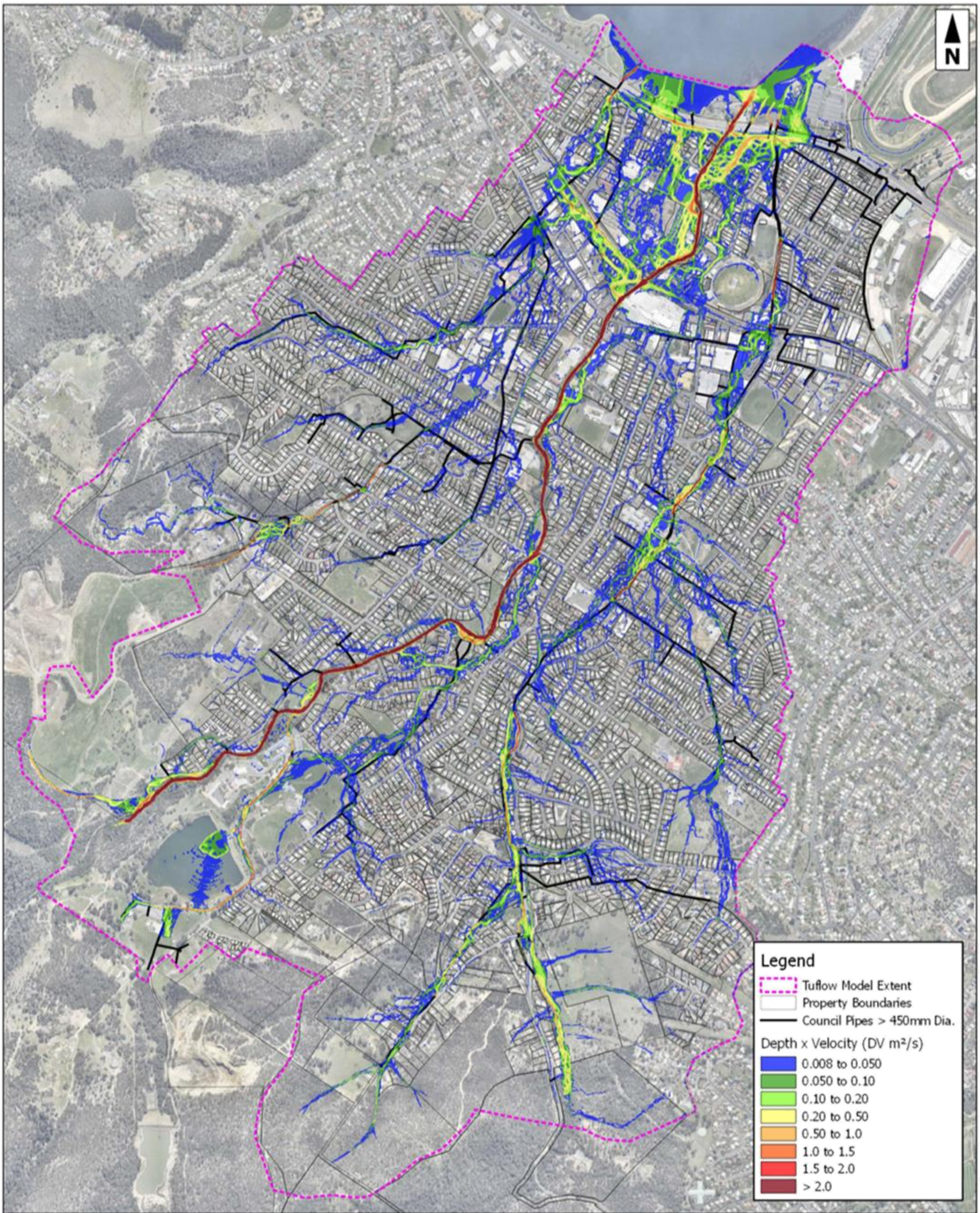

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018	CLIENT: GLENORCHY CITY COUNCIL
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-dr4	

FIGURE TITLE: 1 in 100 AEP DEVELOPED - EXIST DAMS LEVEL - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

PAGE SIZE: A3 SCALE: 1:13,000

0 200 400 600 m

PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

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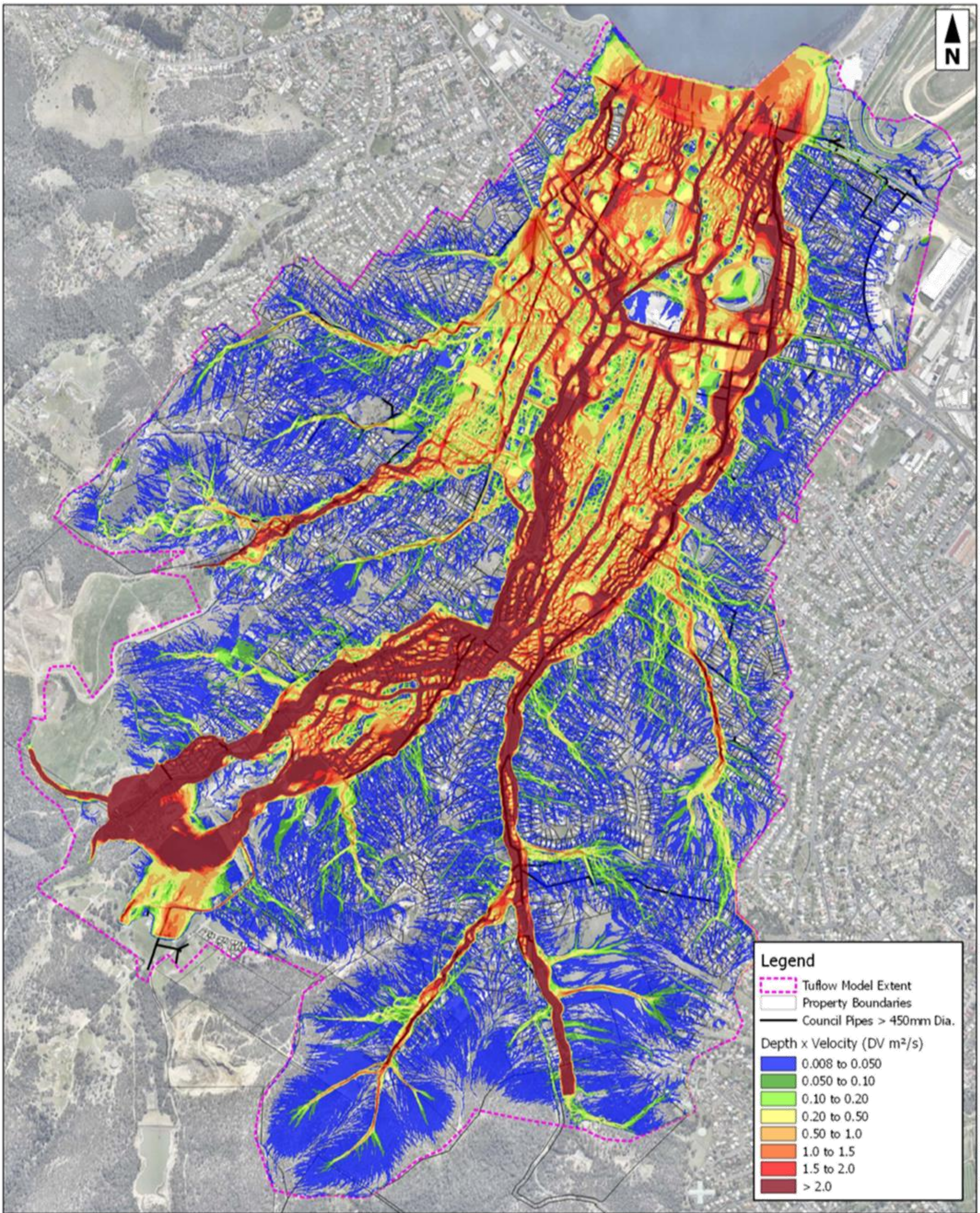

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STATUS: FINAL
SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen
DATE: 7/09/2018
FIGURE: 30041618-E-dr6
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: PMF DEVELOPED - EXIST DAMS LEVEL - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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PROJECT NO: 30041618
PROJECT TITLE: GLENORCHY CBD SSMP

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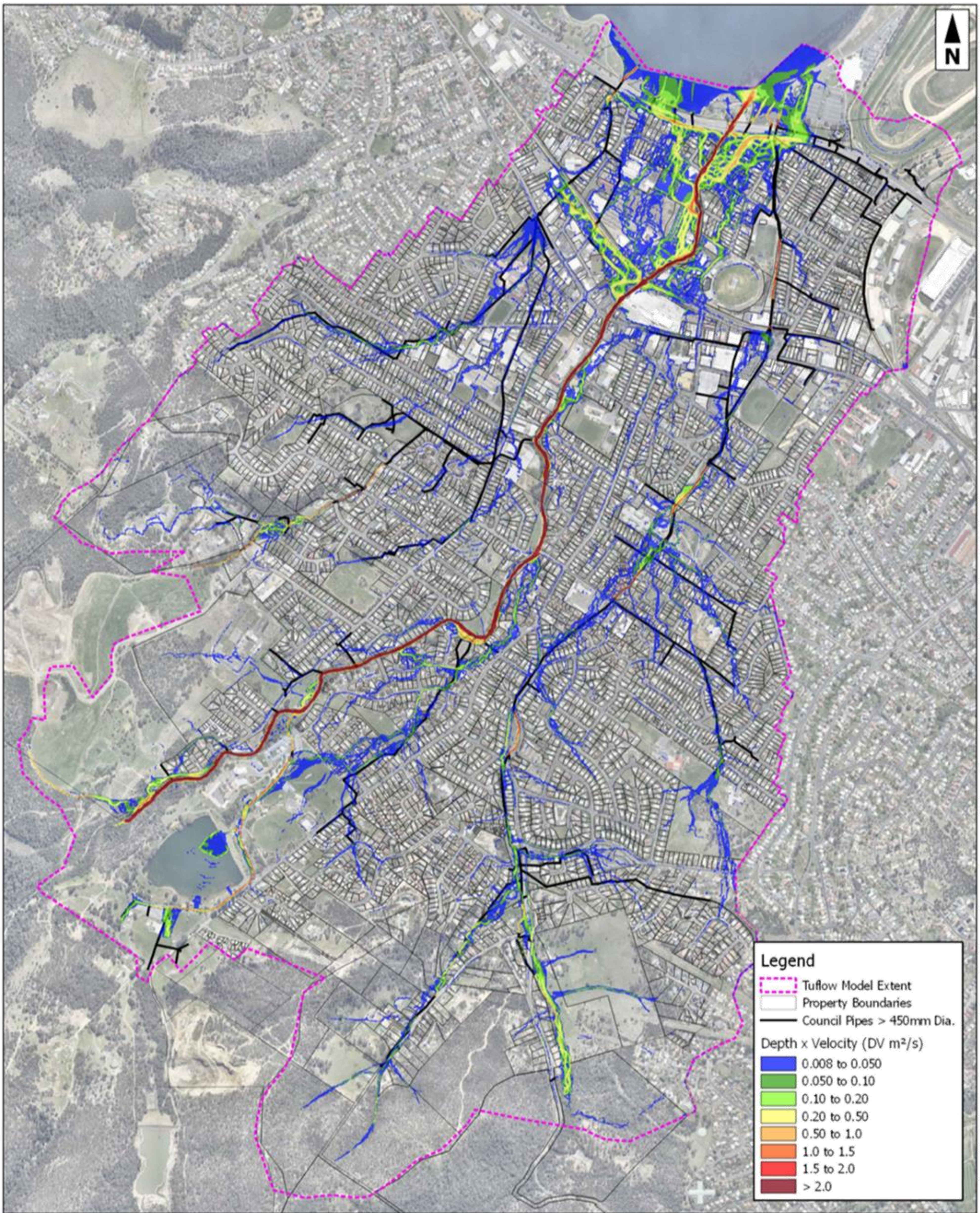

REVISION: A AUTHOR: H. Nguyen-Mallen	STATUS: FINAL DATE: 7/09/2018	SOURCES: © NEARMAP 2018 FIGURE: 30041618-E-de2
FIGURE TITLE: 1 in 20 AEP DEVELOPED - DAMS FULL - Innundation Hazard (DV) Map		
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55 PAGE SIZE: A3 SCALE: 1:13,000	0 200 400 600 m	
PROJECT NO: 30041618	PROJECT TITLE: GLENORCHY CBD SSMP	

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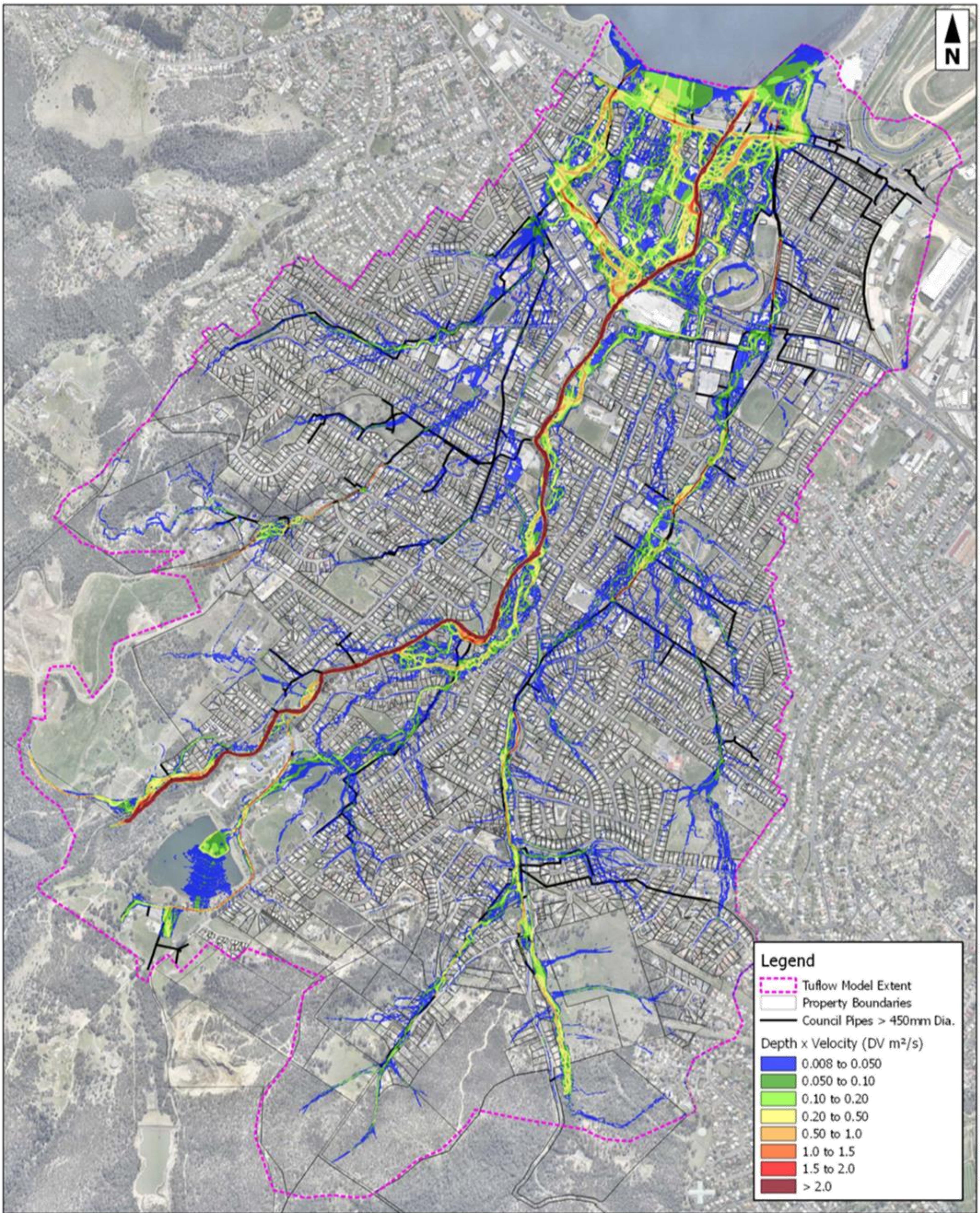

REVISION: A AUTHOR: H. Nguyen-Mallen	STATUS: FINAL DATE: 7/09/2018	SOURCES: © NEARMAP 2018 FIGURE: 30041618-E-de4	CLIENT: GLENORCHY CITY COUNCIL
FIGURE TITLE: 1 in 100 AEP DEVELOPED - DAMS FULL - Innundation Hazard (DV) Map			
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55 PAGE SIZE: A3 SCALE: 1:13,000	0 200 400 600 m		SMEC Member of the Surbana Jurong Group SMEC AUSTRALIA PTY LTD ABN 47 065 475 149
PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP			

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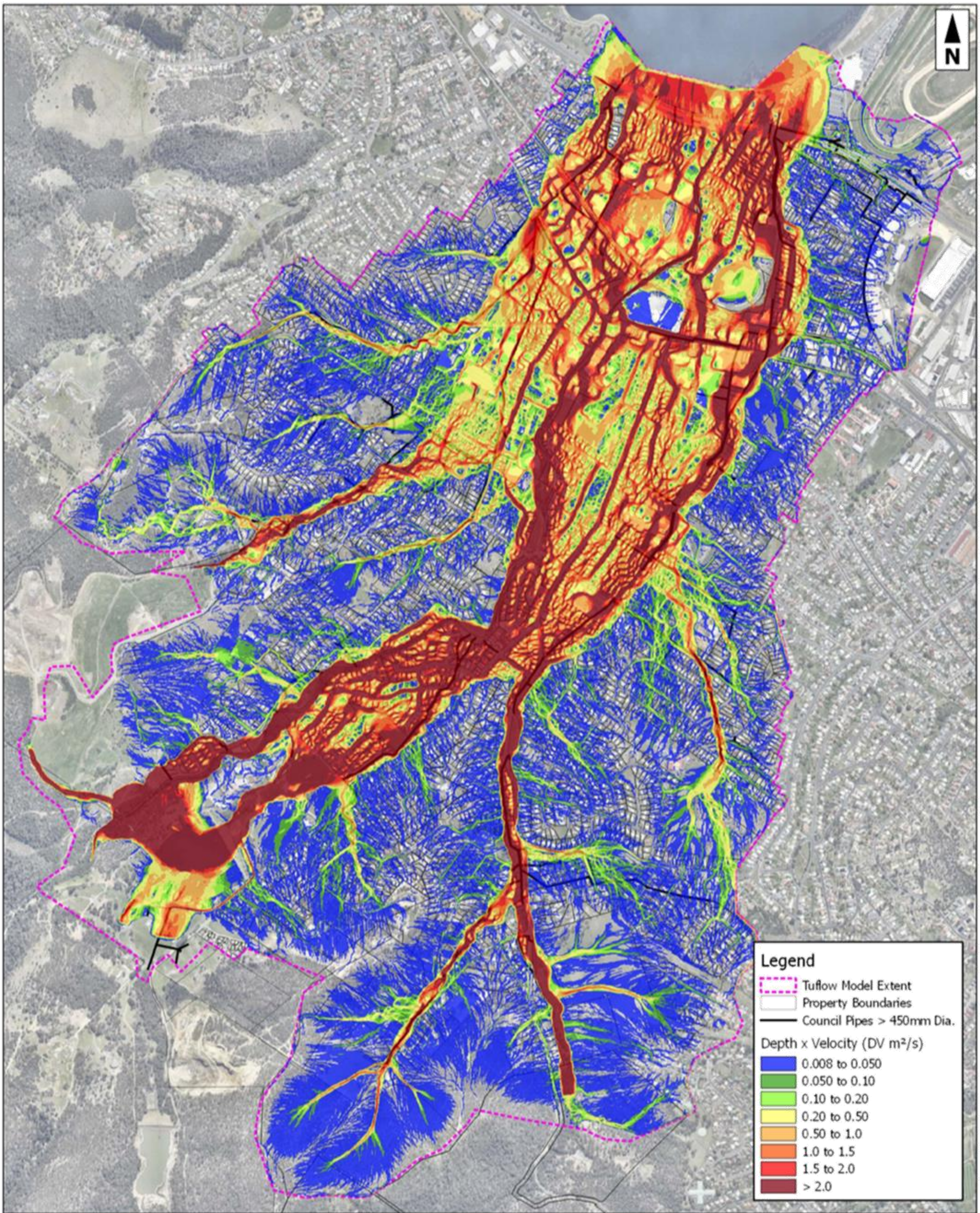

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AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-de6
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: PMF DEVELOPED - DAMS FULL - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000

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PROJECT NO: 30041618
PROJECT TITLE: GLENORCHY CBD SSMP

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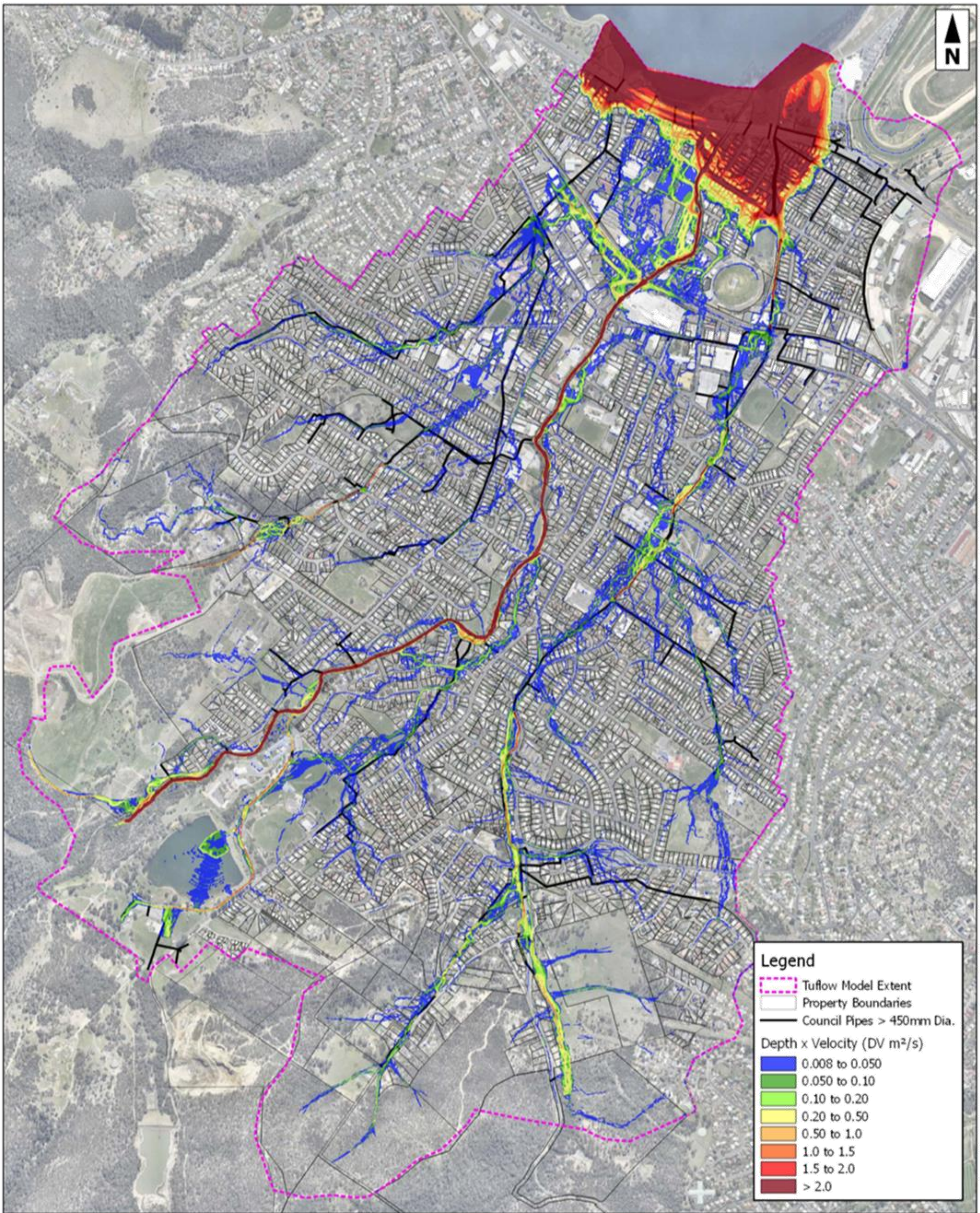

REVISION: A
STATUS: FINAL
SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen
DATE: 7/09/2018
FIGURE: 30041618-E-cc2
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 20 AEP DEVELOPED - CLIMATE CHANGE 1 - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

PROJECT NO: 30041618
PROJECT TITLE: GLENORCHY CBD SSMP

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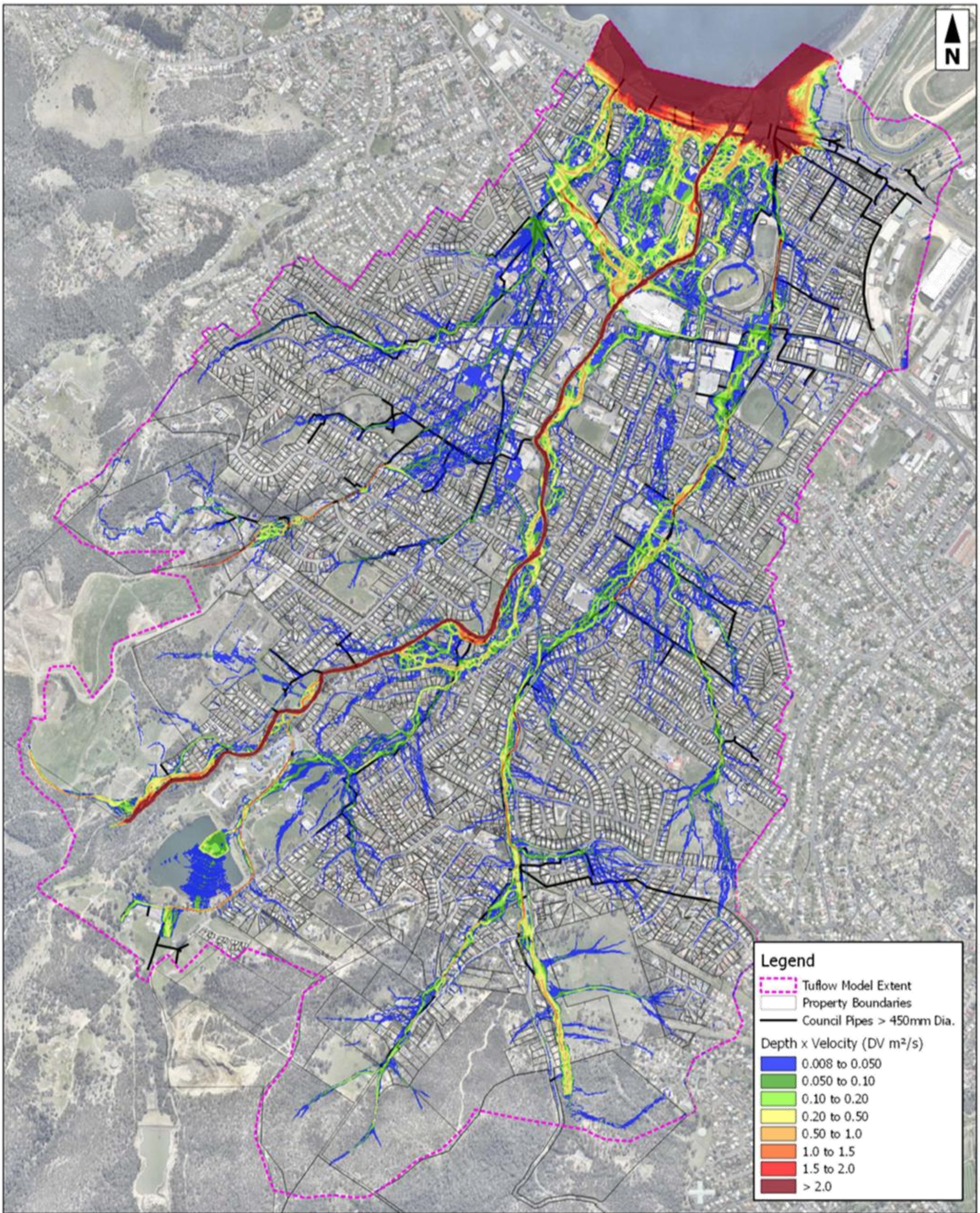

REVISION: A
AUTHOR: H. Nguyen-Mallen

STATUS: FINAL
DATE: 7/09/2018

SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-cc4

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 2 - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3 SCALE: 1:13,000

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PROJECT NO: 30041618 PROJECT TITLE: GLENORCHY CBD SSMP

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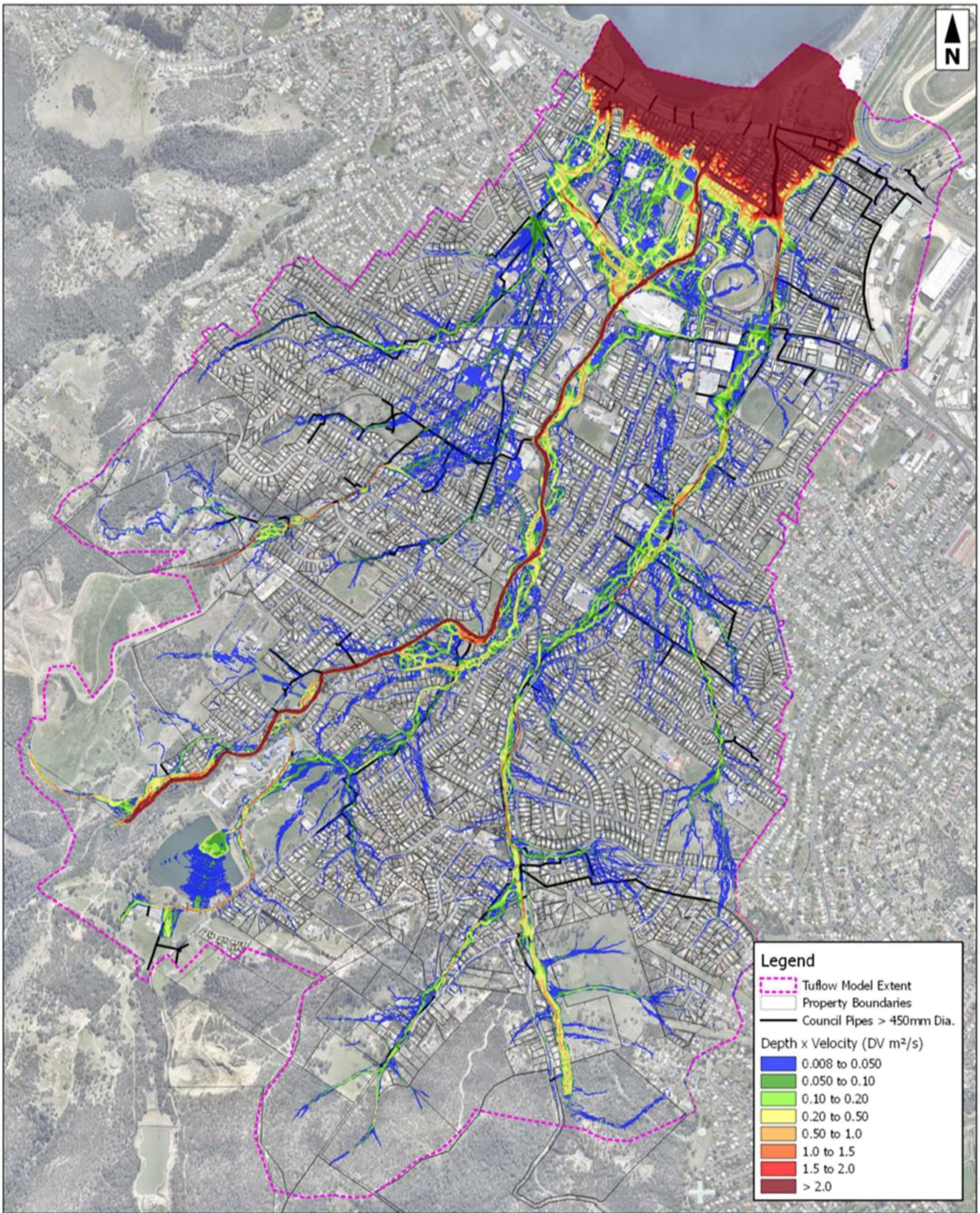

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018	CLIENT: GLENORCHY CITY COUNCIL
AUTHOR: H. Nguyen-Mallen	DATE: 7/09/2018	FIGURE: 30041618-E-cc6	
FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 3 - Innundation Hazard (DV) Map			
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55	SCALE: 0 200 400 600 m		SMEC
PAGE SIZE: A3	SCALE: 1:13,000		Member of the Surbana Jurong Group SMEC AUSTRALIA PTY LTD ABN 47 065 475 149
PROJECT NO: 30041618	PROJECT TITLE: GLENORCHY CBD SSMP		

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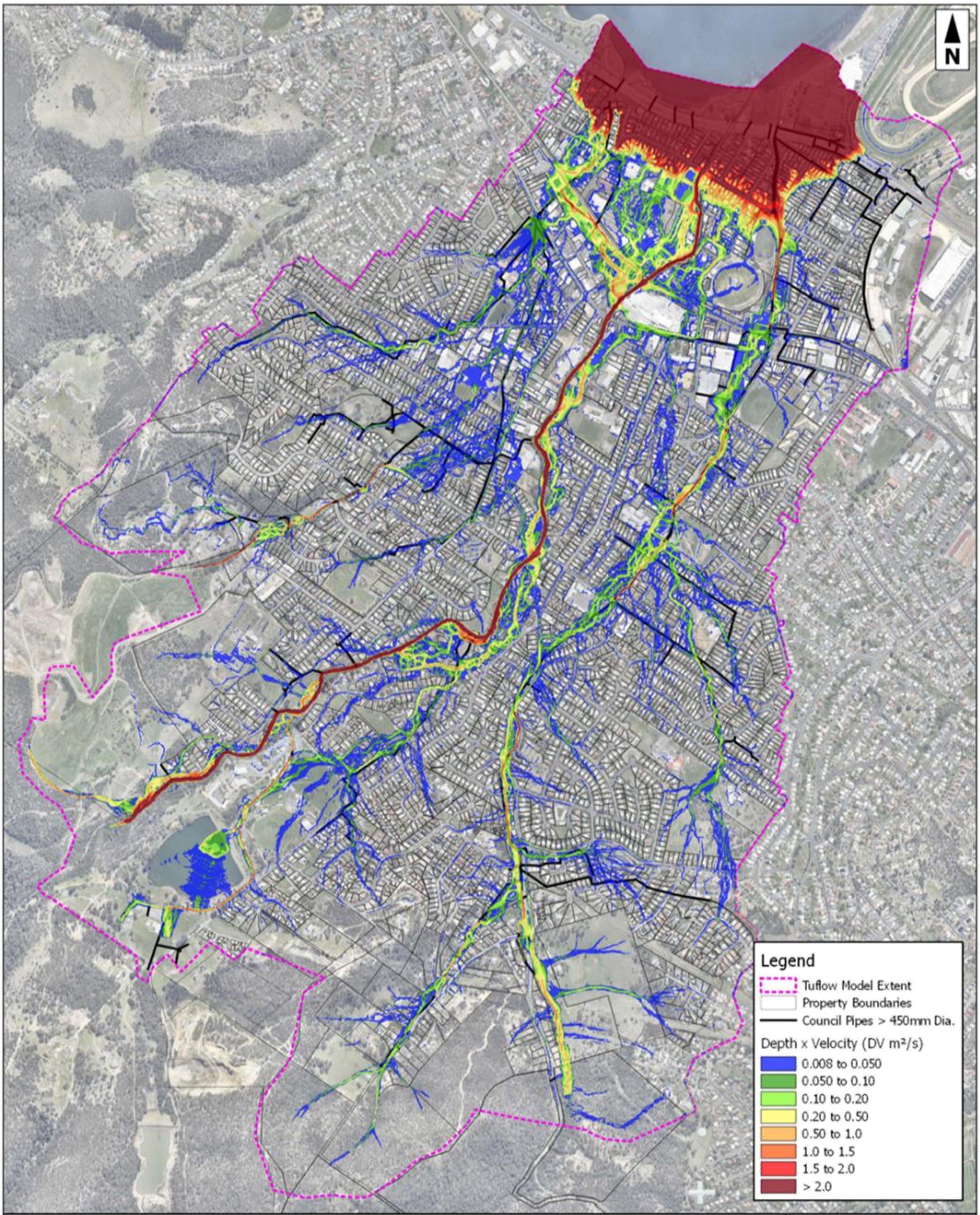

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AUTHOR: H. Nguyen-Mallen
STATUS: FINAL
DATE: 7/09/2018
SOURCES: © NEARMAP 2018
FIGURE: 30041618-E-cc8
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 4 - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55
PAGE SIZE: A3
SCALE: 1:13,000
0 200 400 600 m

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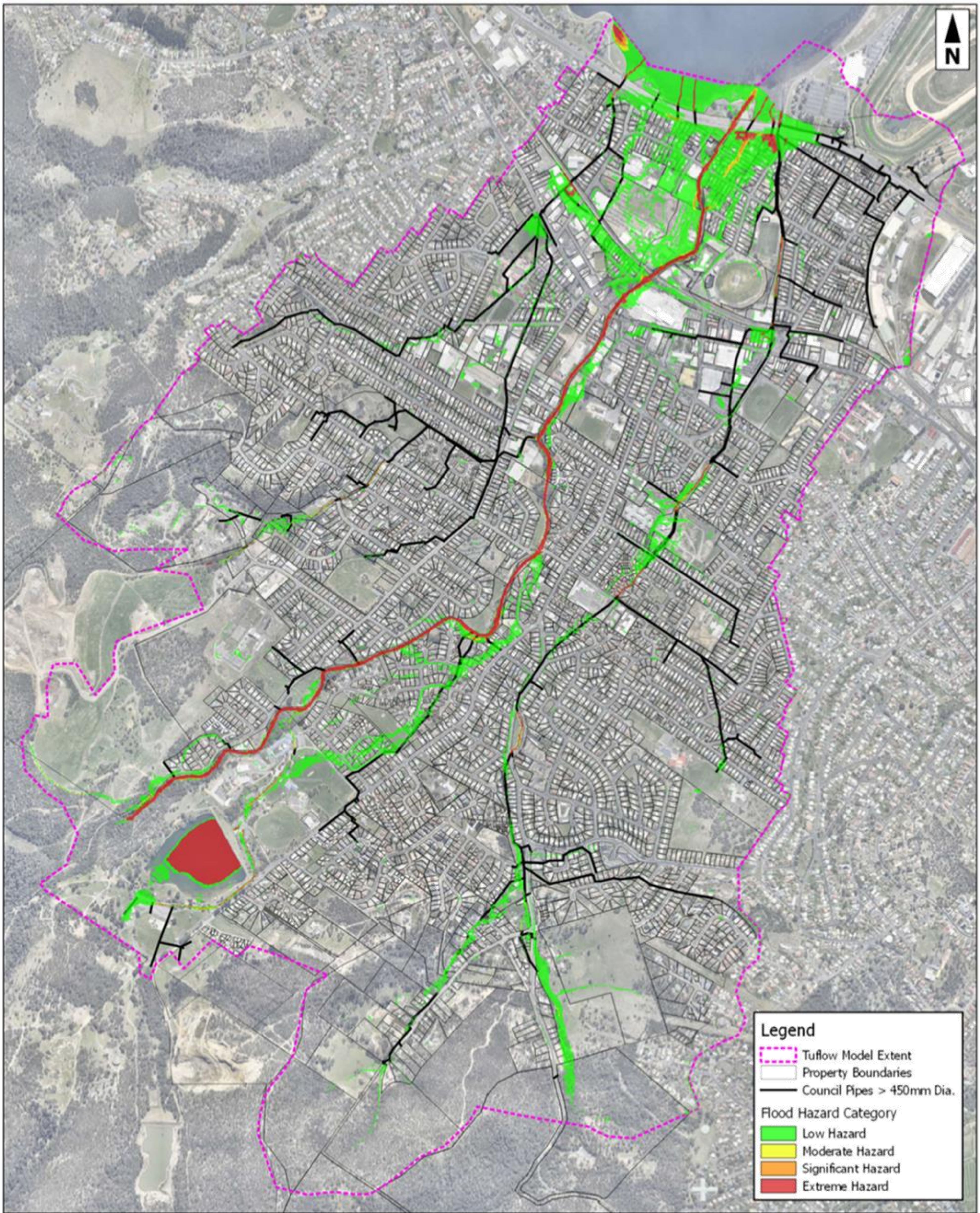
PROJECT NO: 30041618
PROJECT TITLE: GLENORCHY CBD SSMP



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AUTHOR: H. Nguyen-Mallen	DATE: 16/11/2018	FIGURE: 30041618-E-cal3	
FIGURE TITLE: 1996 CALIBRATION EVENT - Innundation Hazard (DV) Map			
COORDINATE SYSTEM: GDA 94 / MGA ZONE 55	PAGE SIZE: A3	SCALE: 1:13,000 (0 200 400 600 m)	SMEC Member of the Surbana Jurong Group SMEC AUSTRALIA PTY LTD ABN 47 065 475 149
PROJECT NO: 30041618	PROJECT TITLE: GLENORCHY CBD SSMP		

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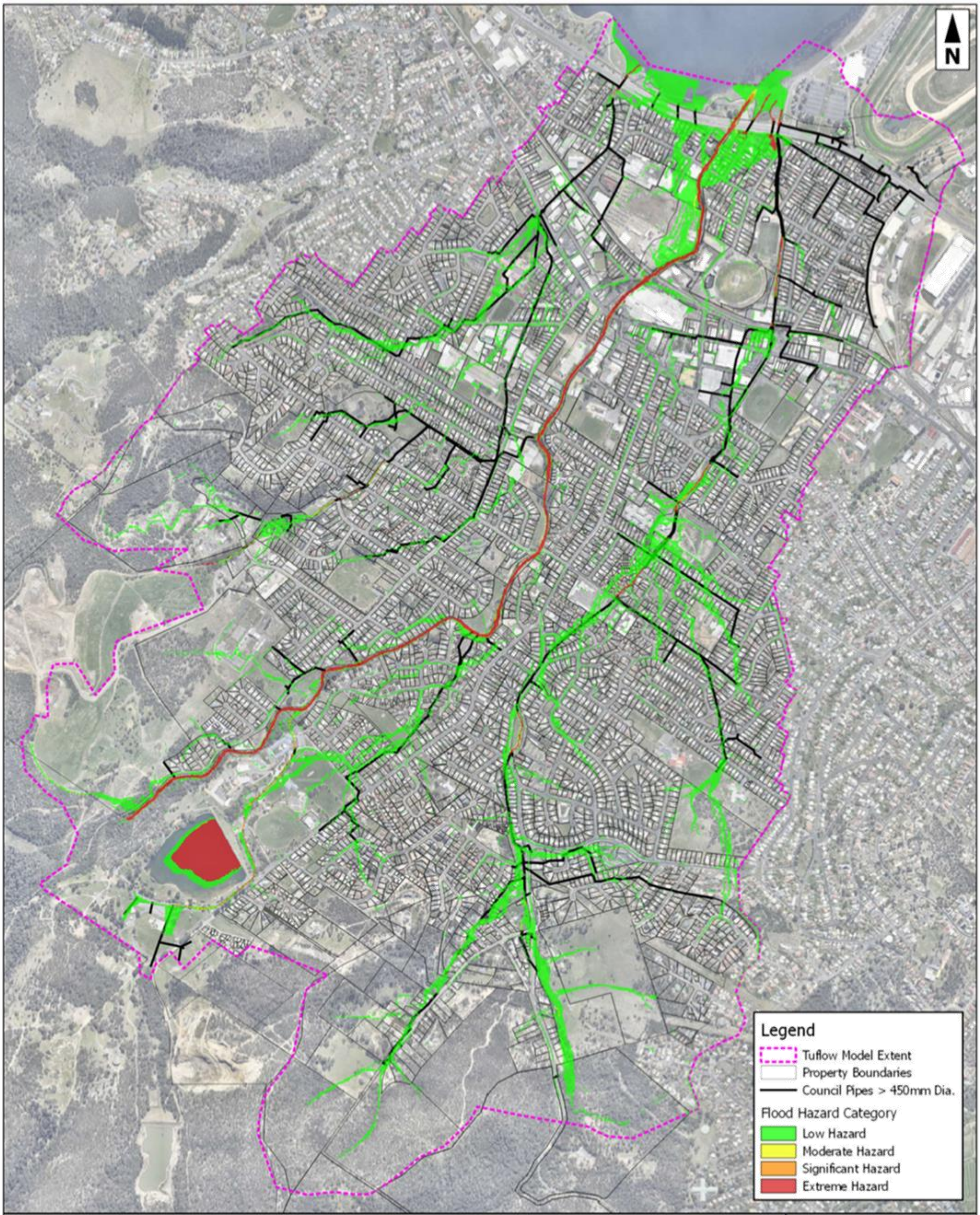

REVISION: A	STATUS: FINAL	SOURCES: © NEARMAP 2018
AUTHOR: H. Nguyen-Mallen	DATE: 16/11/2018	FIGURE: 30041618-E-ex7

CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 20 AEP EXISTING - Innundation Hazard (DV) Map

COORDINATE SYSTEM: GDA 94 / MGA ZONE 55

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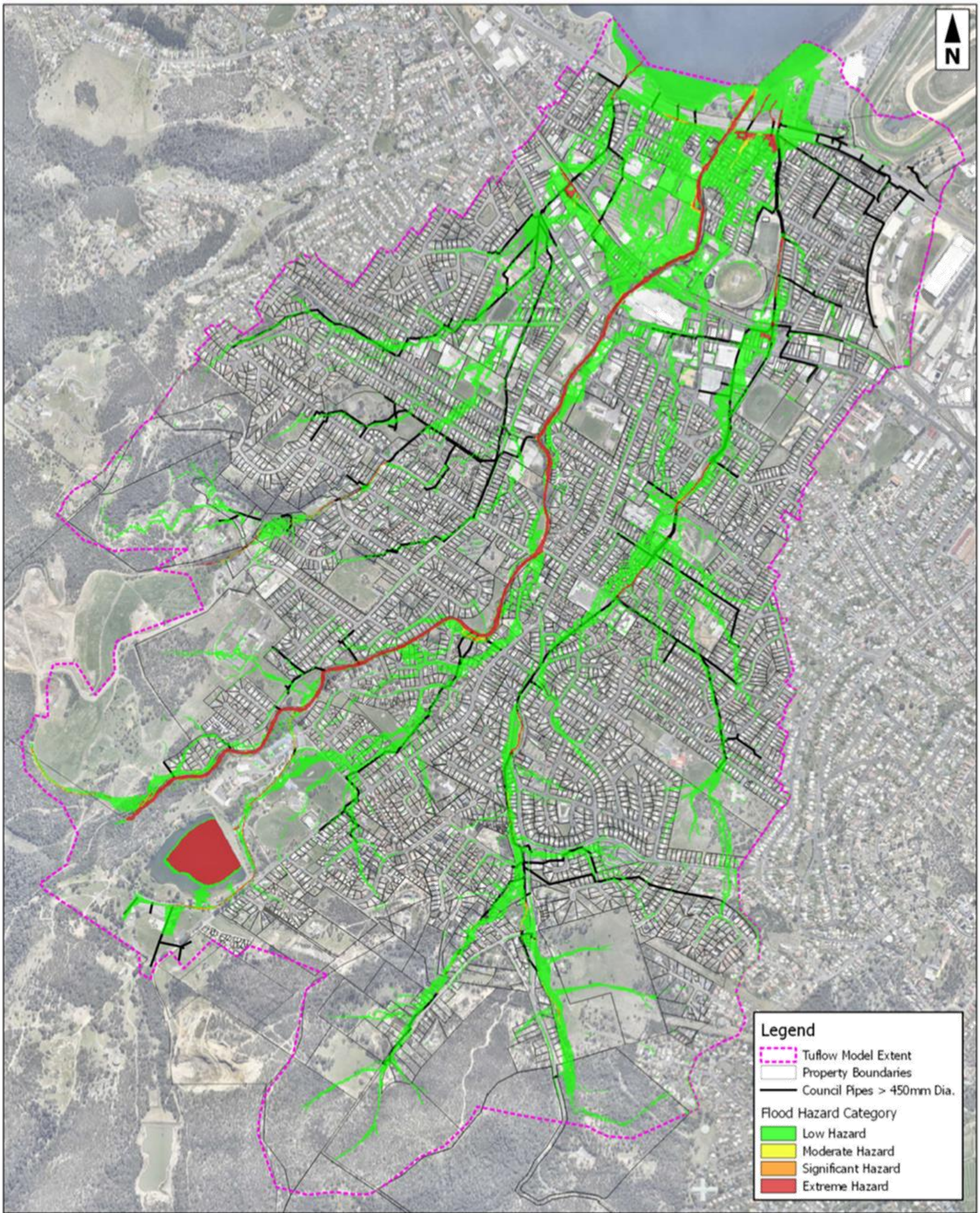

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DATE: 16/11/2018
FIGURE: 30041618-E-ex8
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: 1 in 100 AEP EXISTING - Innundation Hazard (DV) Map

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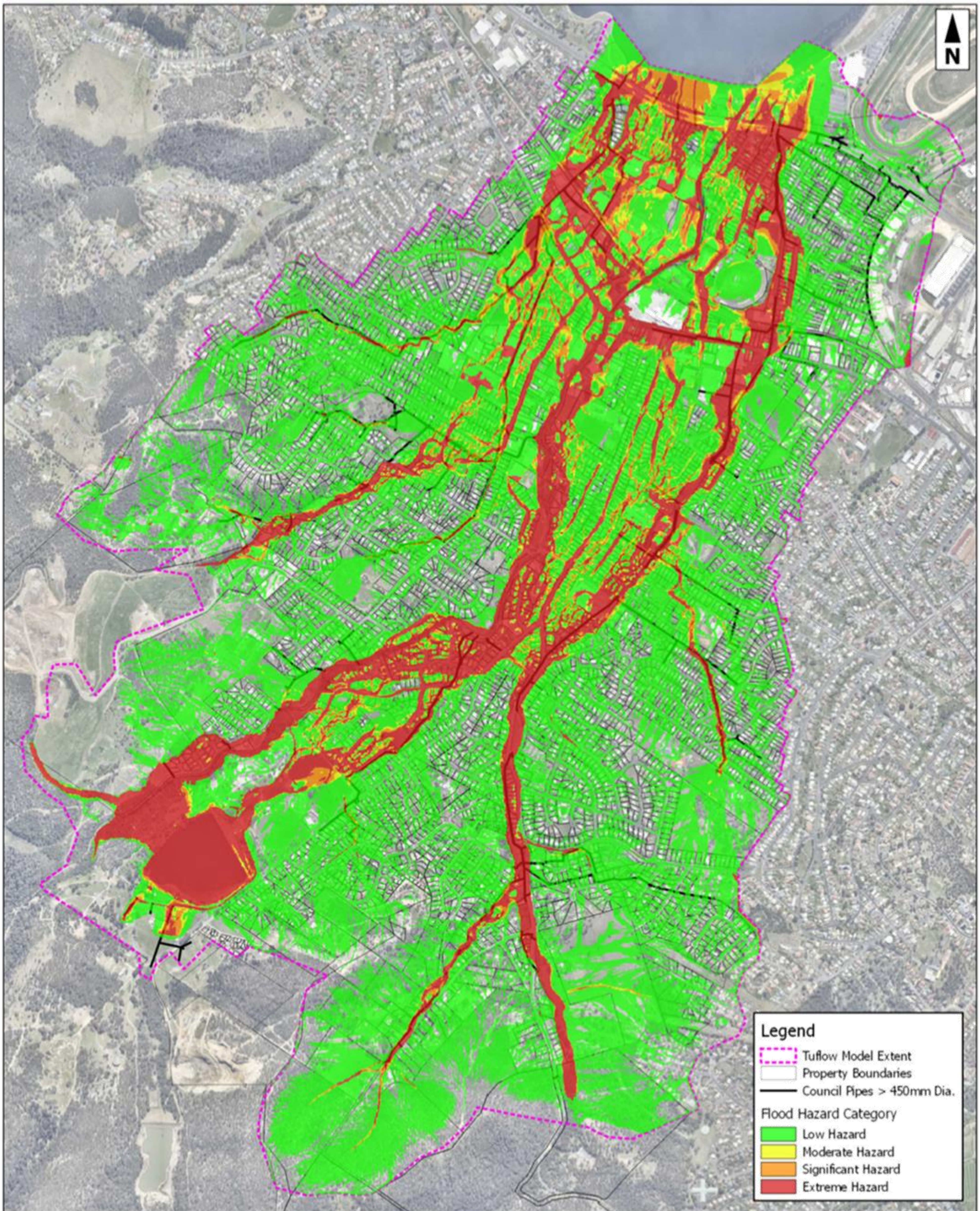

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DATE: 16/11/2018
FIGURE: 30041618-E-ex9
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: PMF EXISTING - Innundation Hazard (DV) Map

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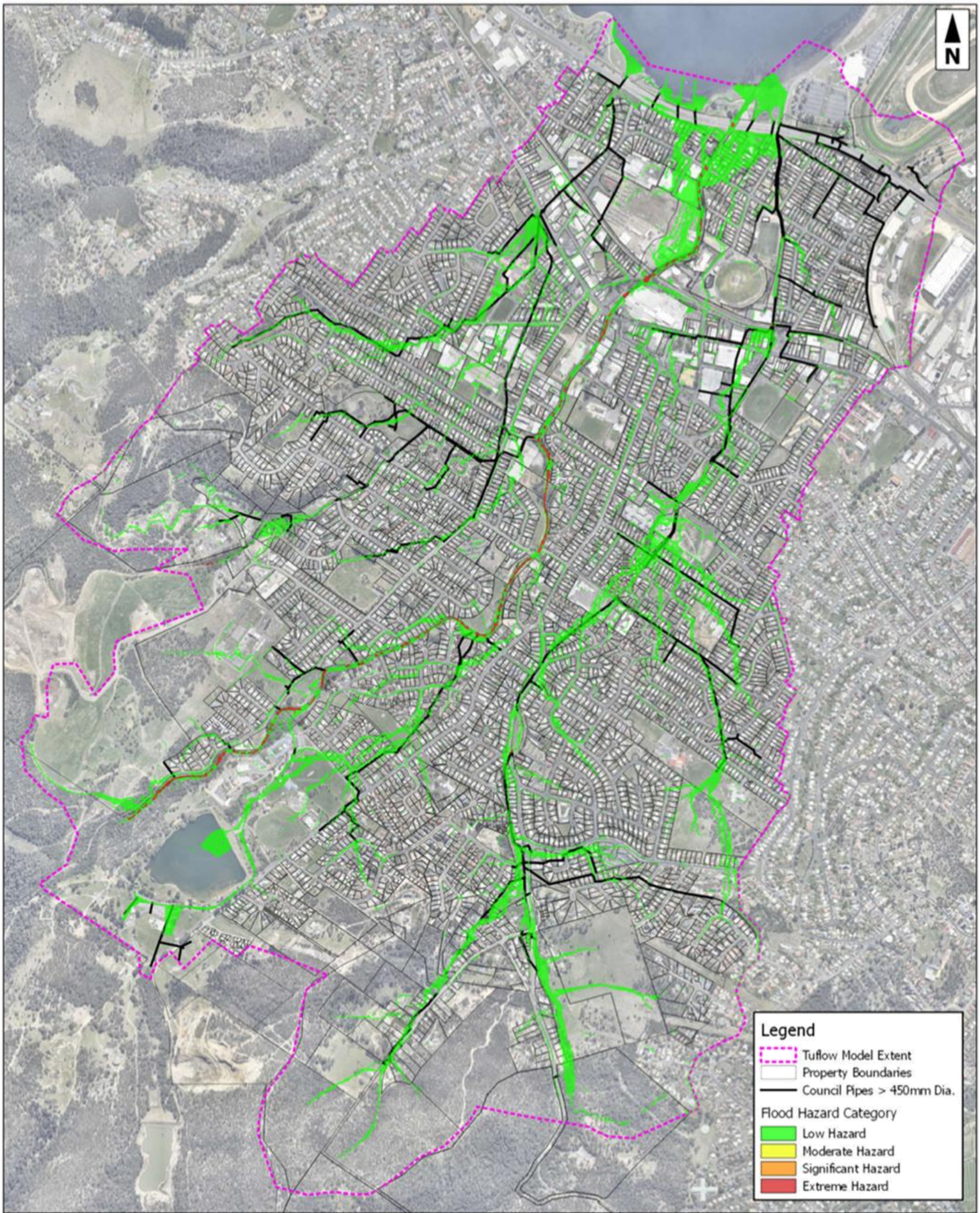

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AUTHOR: H. Nguyen-Mallen
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DATE: 16/11/2018
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FIGURE: 30041618-E-dr7
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FIGURE TITLE: 1 in 20 AEP DEVELOPED - EXIST DAMS LEVEL - Innundation Hazard (DV) Map

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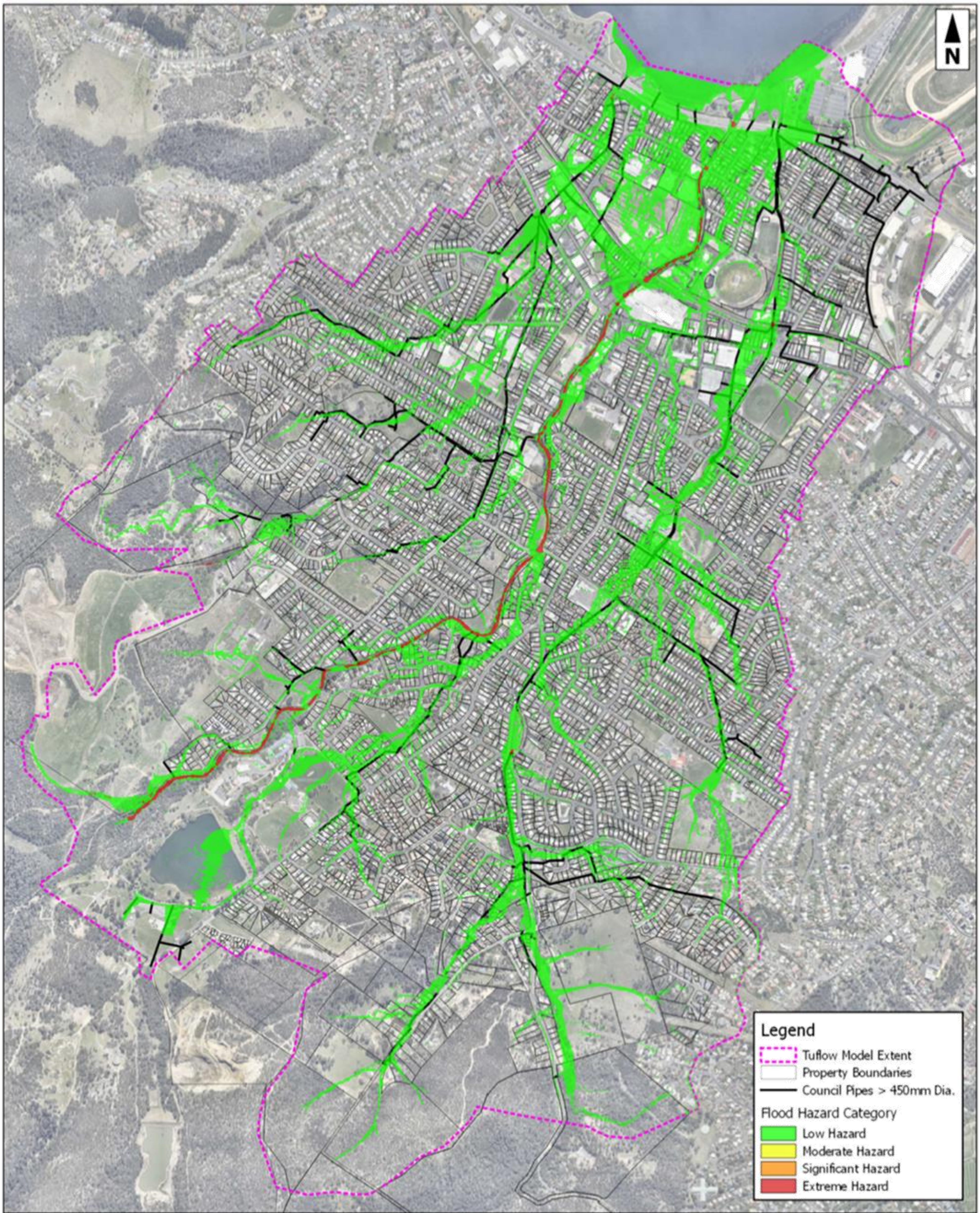

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AUTHOR: H. Nguyen-Mallen	DATE: 16/11/2018	FIGURE: 30041618-E-dr8	
FIGURE TITLE: 1 in 100 AEP DEVELOPED - EXIST DAMS LEVEL - Innundation Hazard (DV) Map			
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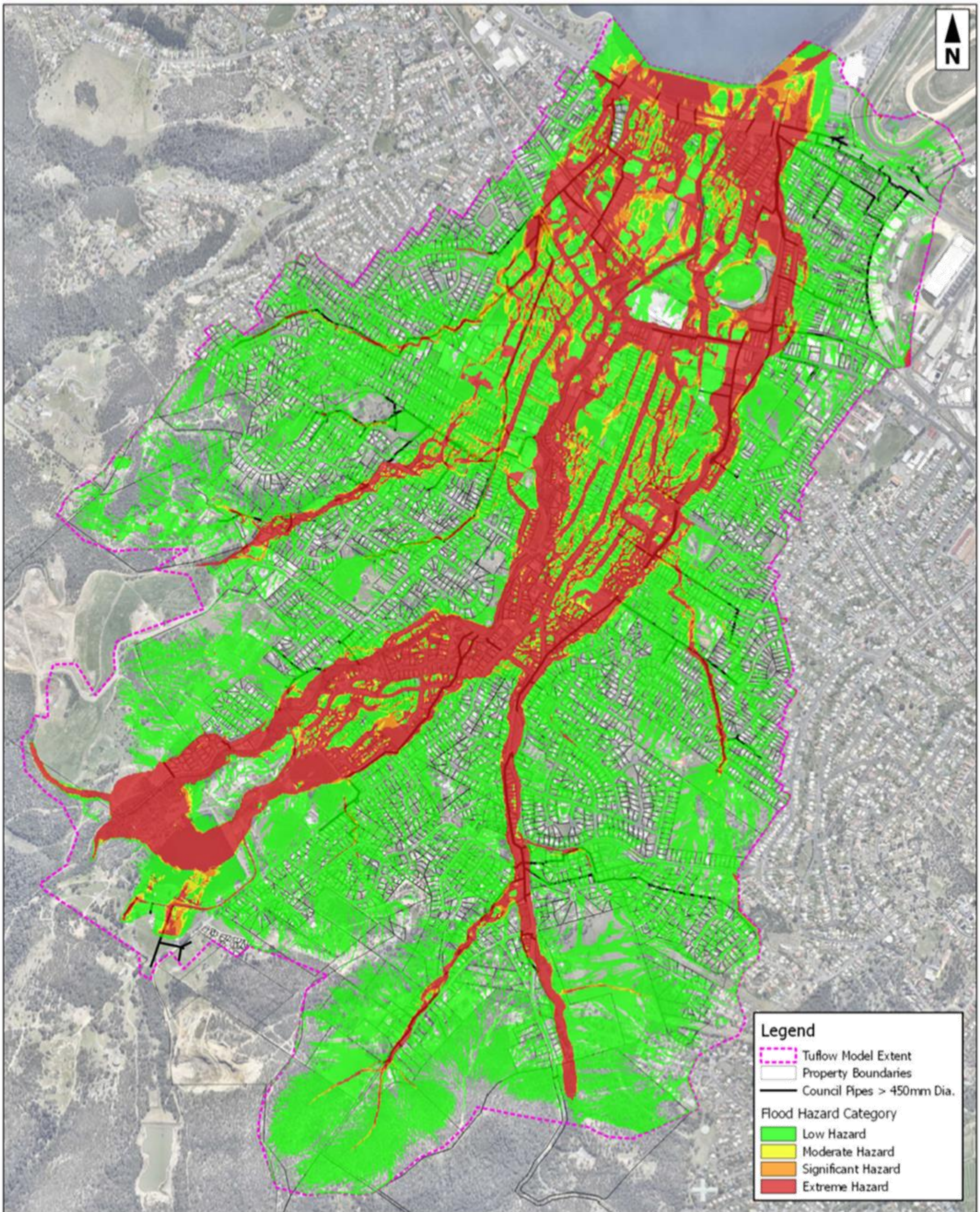

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AUTHOR: H. Nguyen-Mallen	DATE: 16/11/2018	FIGURE: 30041618-E-dr9	
FIGURE TITLE: PMF DEVELOPED - EXIST DAMS LEVEL - Innundation Hazard (DV) Map			
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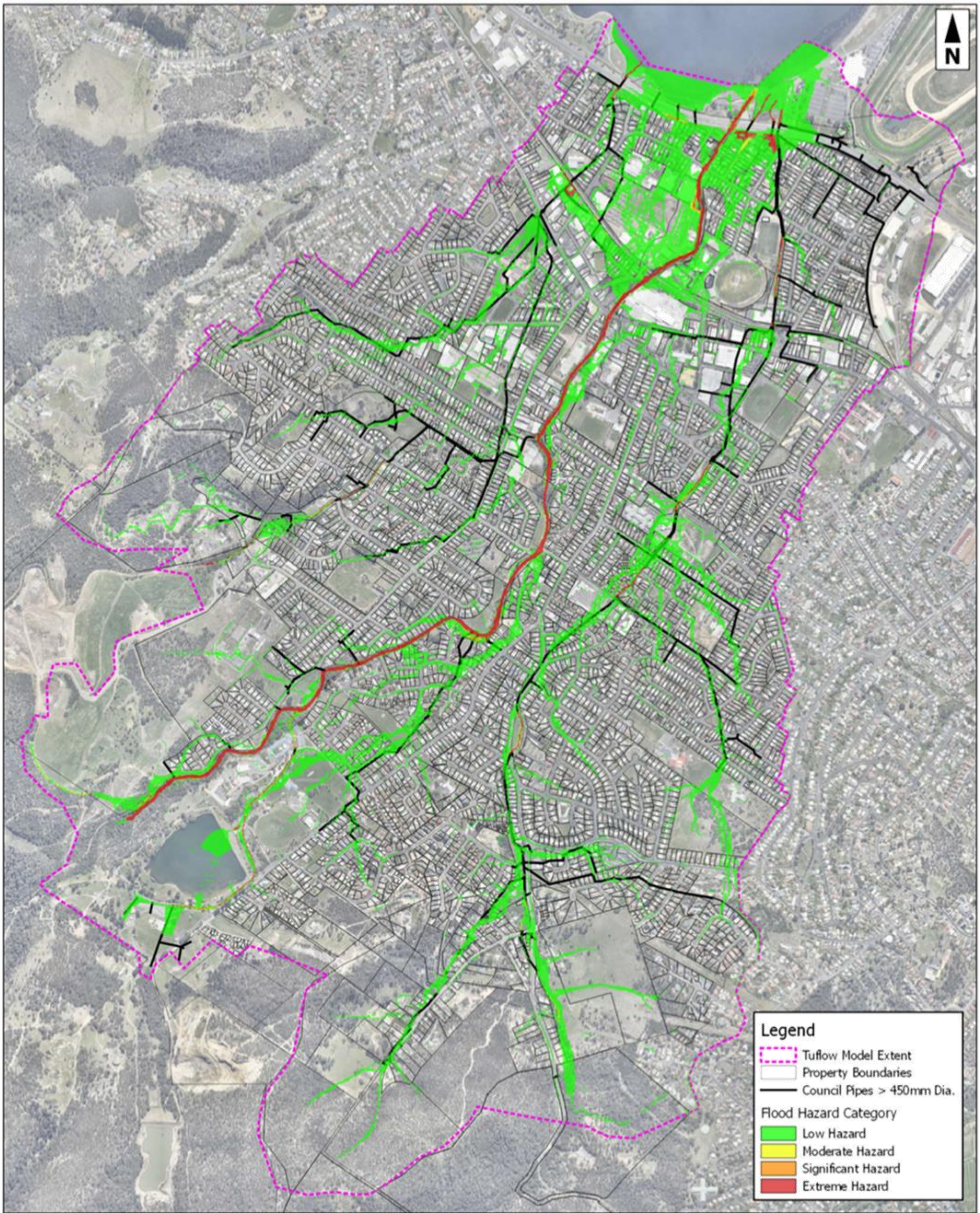

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AUTHOR: H. Nguyen-Mallen		DATE: 16/11/2018		FIGURE: 30041618-E-de7		
FIGURE TITLE: 1 in 20 AEP DEVELOPED - DAMS FULL - Innundation Hazard (DV) Map						
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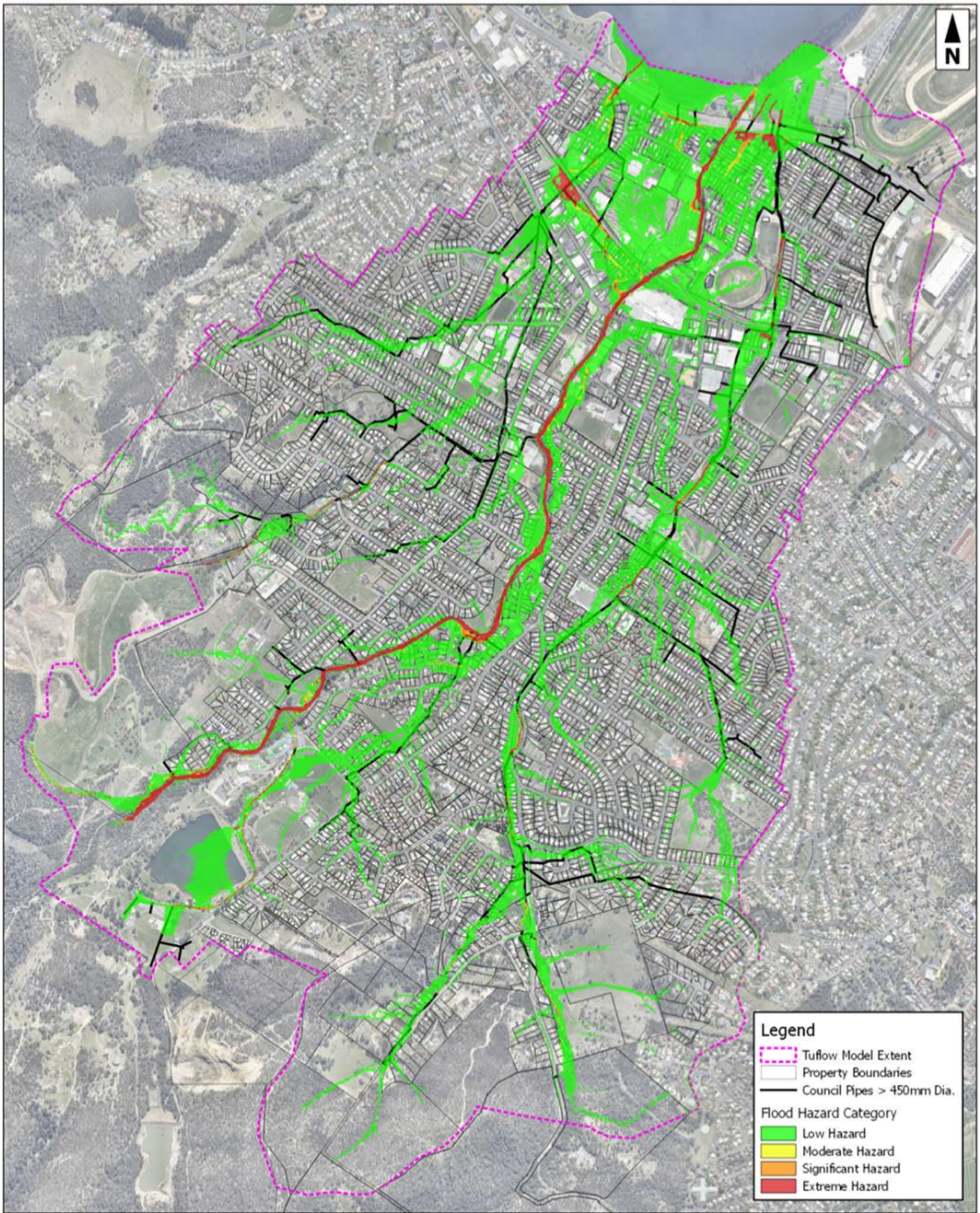

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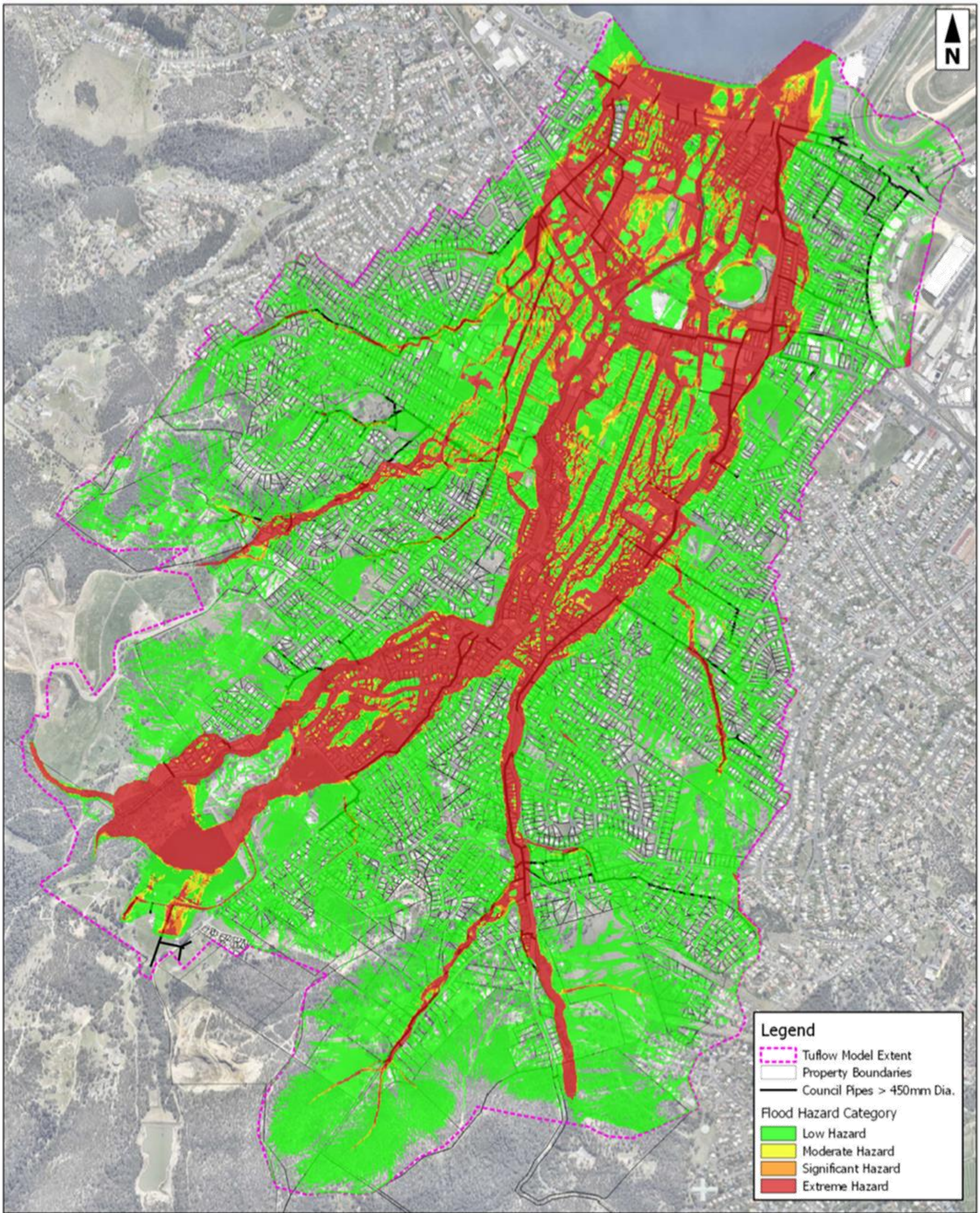

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STATUS: FINAL
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FIGURE: 30041618-E-de9
CLIENT: GLENORCHY CITY COUNCIL

FIGURE TITLE: PMF DEVELOPED - DAMS FULL - Innundation Hazard (DV) Map

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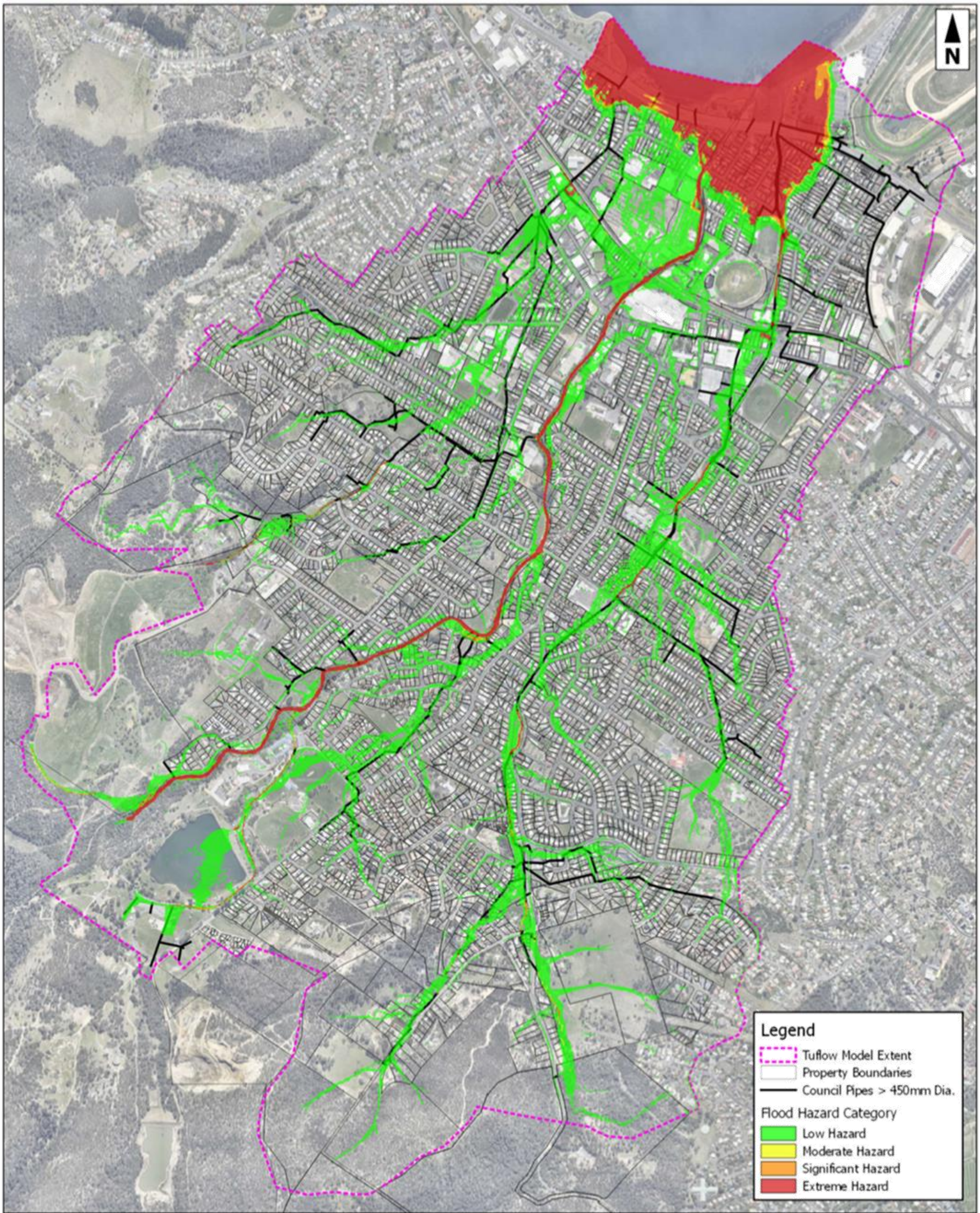

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FIGURE TITLE: 1 in 20 AEP DEVELOPED - CLIMATE CHANGE 1 - Innundation Hazard (DV) Map

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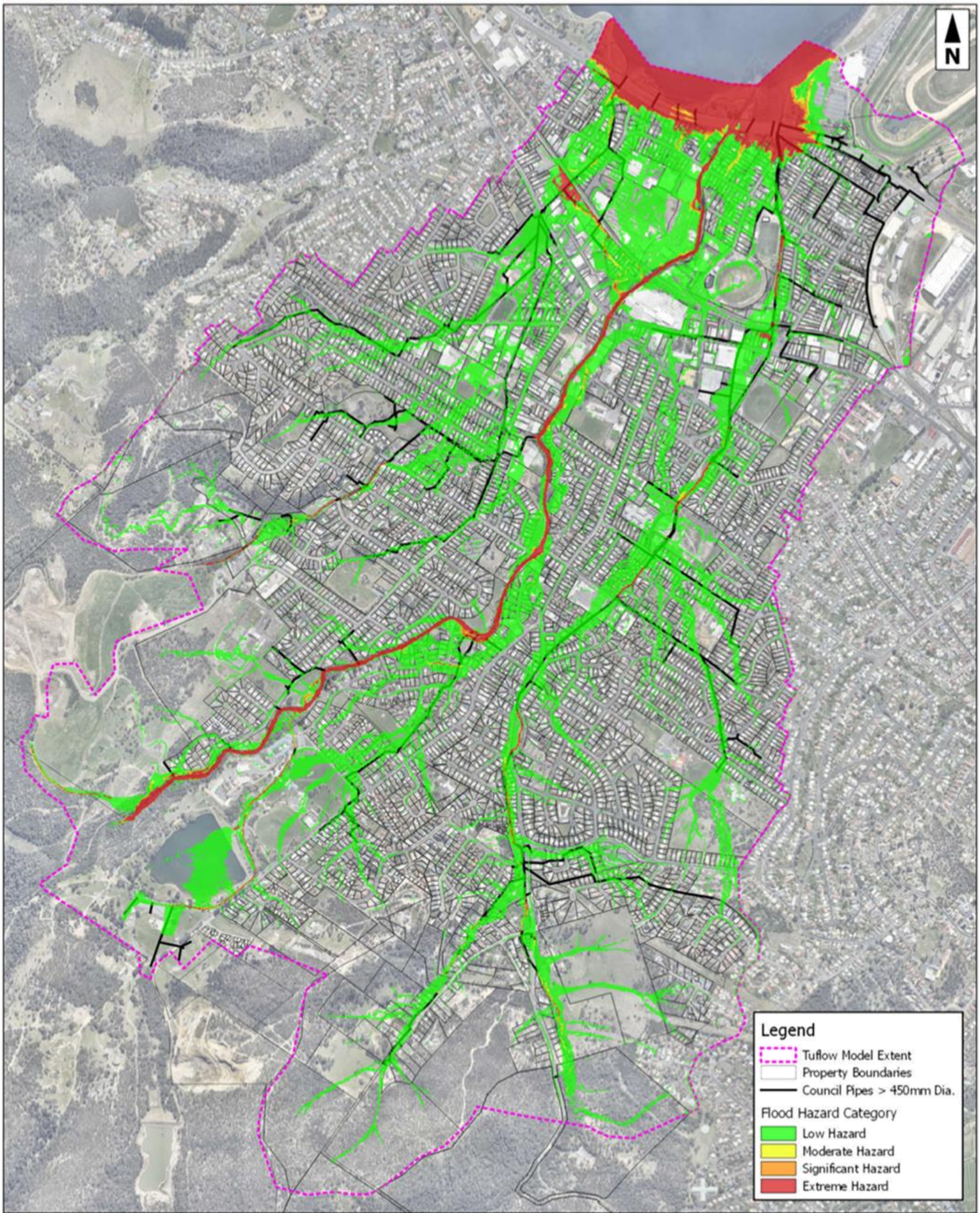

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FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 2 - Innundation Hazard (DV) Map

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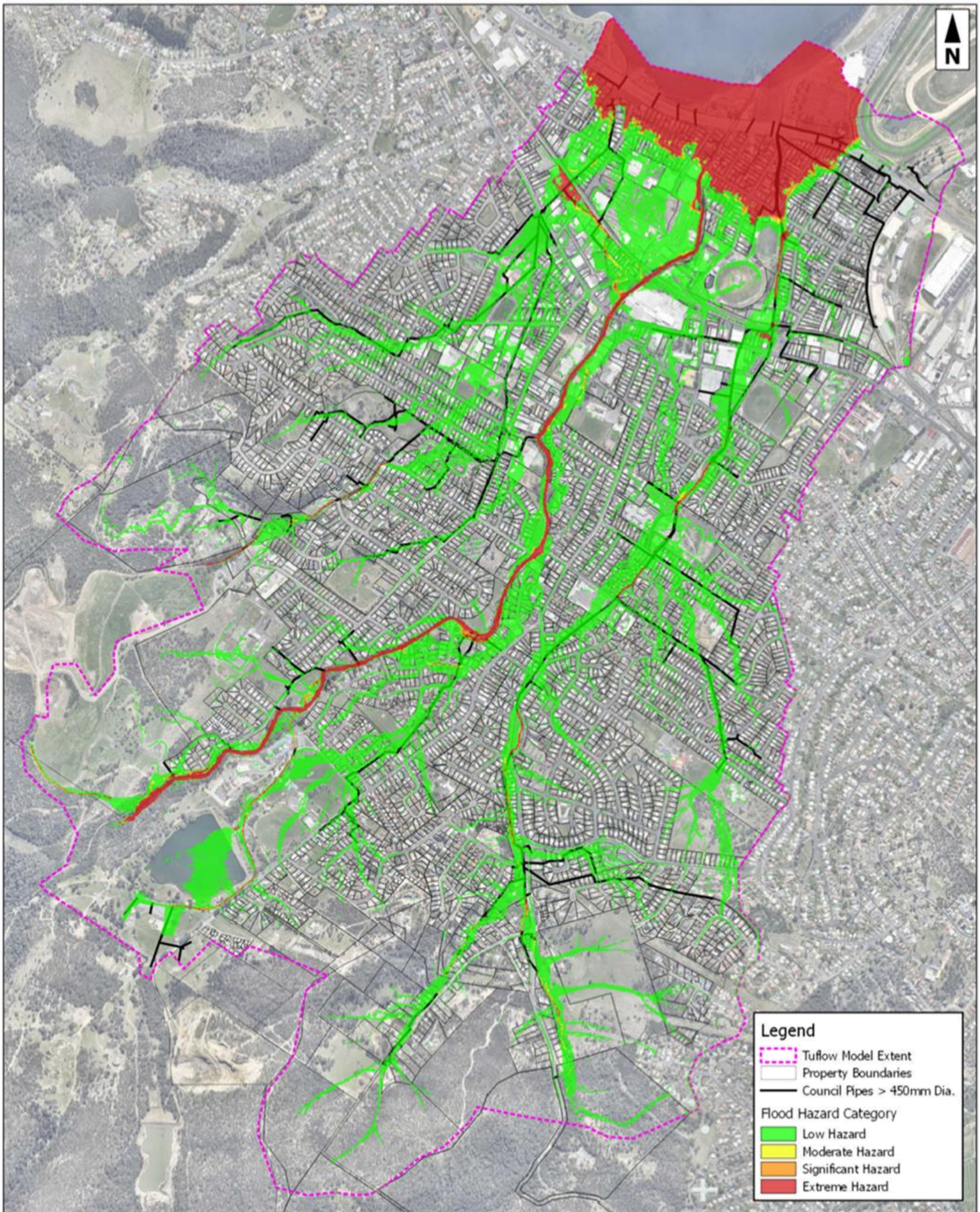

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AUTHOR: H. Nguyen-Mallen	DATE: 16/11/2018	FIGURE: 30041618-E-cc13	
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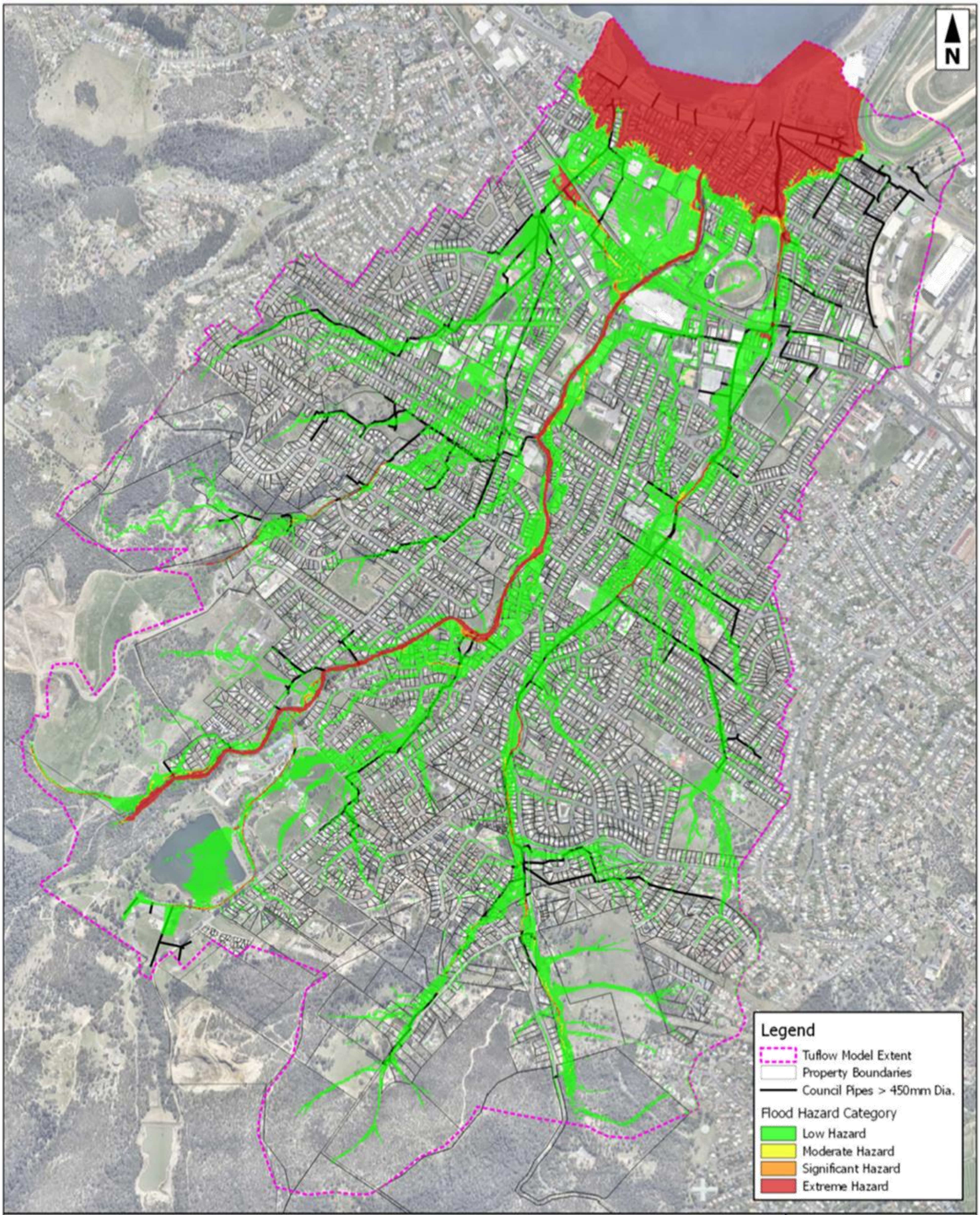

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FIGURE TITLE: 1 in 100 AEP DEVELOPED - CLIMATE CHANGE 4 - Innundation Hazard (DV) Map

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Project Name:	Glenorchy CBD Stormwater System Management Plan;
Project Number:	30041618p
Revision Number:	Final Rev. 1 Report

Revision History

Revision	Date	Prepared by	Reviewed by	Approved for Issue by
Final	31-10-2018	H. Nguyen-Mallen	T. Rhodes & S. van Hall	S. van Hall
Final Rev. 1	30-11-2018	H. Nguyen-Mallen	T. Rhodes	S. van Hall

Reviewer Register

Revision	Date	Approved for Issue by	Reviewed by
Final Rev. 1	30-11-2018	SMEC Australia S. van Hall	WMAwater Fiona Ling
Issuer Signature:	Sander van Hall		Date: 30-11-2018
Reviewer Signature:			Date:

Issue Register

Distribution List	Date Issued	Number of Copies
Glenorchy City Council	31-10-2018	1 Electronic
SMEC Project File	31-10-2018	1 Electronic

SMEC Company Details

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GLENORCHY CITY COUNCIL

Public Meeting: Repair and Reopen the Glenorchy War Memorial Pool

The subject matter of the meeting, as petitioned by Janeice Bryan to the Glenorchy City Council

We the undersigned, hereby request that Council:

- Urgently repair and re-open the Glenorchy War Memorial Pool
- Hold a public meeting to address the pool related concerns.

Summary of Submissions

Council has advertised twice in the Mercury newspaper, on our noticeboard, and website inviting submissions to the public meeting. 9 written submissions were received. The Act requires that submissions are summarised and the summary is provided at the meeting. This summary will also be uploaded to Council's website.

The pool should be repaired and reopened

There is an overwhelming desire from the community and Council to repair and reopen the pool. With the promise of $5 million in State Government funding, commencing repairs to the pool to enable it to reopen in the short-mid term is now possible.

Lack of swimming opportunities in the Greater Hobart region

There is a view that there is a lack of swimming opportunities, swim school availability, and swim carnival spaces, with the Glenorchy pool currently closed, as well as the closure of the Barossa Park Lodge pool and no access to beaches in the area.

History of the pool

The Glenorchy Pool is felt to hold historical importance in the Glenorchy area and to the community of Glenorchy. The community feels that the pool has historical significance.

Social Impacts

Community members expressed that they are hurting due to the loss of the pool facility. There is a view that the pool is essential for youth engagement, belonging, and inclusion, and a feeling that teenagers unable to access the pool may be contributing to escalating youth crime.

Health and Wellbeing

Community members highlighted the health and wellbeing benefits of the pool in various ways. This includes the physical benefits of swimming, as well as the mental health and social benefits of the pool.

Council understands the community health and wellbeing benefits of the pool and has been dedicated to finding ways to ensure its long-term future.

Maintenance

There is a perception that Council has failed to provide and maintain amenities that contribute to physical and mental wellbeing.

Due to maintenance issues, Council has been advocating for funding to redevelop the pool for several years. Council is currently working with engineering specialists to identify priority works required and start planning to safely repair and reopen the Glenorchy War Memorial Pool.

Financial Issues

There is a view that the money can be sourced to repair the pool or should have been sought years ago, and it may be difficult to secure government funding in the current economic climate.

The State Government provided $200 000 to fund a project to explore long-term options for the future of the site, including pool redevelopment and other options. There have been recent election commitments from both the Labor and Liberal Parties to provide $5 million funding to repair and reopen the pool.

The cost to the community to repair the pool without government funding would have been more than $230 per ratepayer.

There is a query as to how council resources are allocated, and what level of operation loss is tolerable.

Safety

The pool was closed by the council due to significant safety issues. Several risks to public safety were identified including:

- structural issues with the concrete grandstand
- urgent need to replace the electrical switchboard

GLENORCHY CITY COUNCIL

- major upgrade works required to the chemical dosing and filtration system
- structural issues with the water slide
- trip, slips, and fall hazards on the concourse requiring immediate repairs
- the toilets and changeroom areas do not meet current child safety requirements, privacy, and accessibility (DDA compliance) standards and therefore require a complete refurbishment.
- faults in the pool shell and associated pipework, causing the pool to leak.

Council's General Manager – as the PCBU (person conducting a business or undertaking) under the *Work Health and Safety Act 2012* – made the difficult decision that the pool would remain closed for the foreseeable future.

Those who made written submissions will be invited, but are not obliged, to speak to their submission.

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Frequently Asked Questions

Glenorchy War Memorial Pool 2023 Update

Why is the pool closed?

The Glenorchy City Council commissioned an independent report into the condition of the pool due to its age. The report highlighted a number of issues which posed safety risks for the public and facility staff. As a responsible authority, the council had no choice but to prioritise public safety and close the pool to the public.

When will the pool reopen?

The council is commissioning a study of long-term options for the pool site, which includes consideration of a redeveloped pool facility, and will include community consultation. It is estimated it would cost several million dollars to repair the pool's current faults and safety issues to an extent it would be safe for public use. Such work would likely see the pool closed this summer and possibly next summer as well, and only provide up to five more years of operational life before redevelopment would be required. The council does not believe this would be an effective use of ratepayer funds, which is why longer-term options are being sought.

So, is there a chance the pool may be closed permanently?

The current pool facility will not be re-opened due to the fact it has reached the end of its operational life and is unsafe. As the repairs it requires are extensive, and would only amount to a short-term solution, council will look at other options for the site, including a redeveloped pool facility.

Can't the problems just be fixed without a full redevelopment?

It is estimated it would cost several million dollars to repair the pool's current faults and safety issues to an extent it would be safe for public use. Such work would likely see the pool closed this summer and possibly next summer as well, and only provide up to five more years of operational life before redevelopment would be required. The council does not believe this would be an effective use of ratepayer funds, which is why longer-term options are being sought.

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Why was the pool allowed to deteriorate so badly?

The pool was built in the 1960s. Facilities of this type normally have an operational life of about 40 years, while this pool has 60 years. The fact that it has been able to achieve a longer-than-expected operational life is due to the council's management of the facility over the years. However, all public infrastructure has an operational lifespan, and when that is reached, require redevelopment or replacement. The pool has reached a point where normal maintenance cannot keep up with deterioration caused by the age of the facility and the plant that operates it. The pool has been costing ratepayers a significant amount of money ($400,000 last season) to keep open.

A lot of people use the pool – what will they do?

Last season, fewer than 100 people a day used the pool on average, and patronage has been dwindling in recent years. People will now need to access another aquatic facility instead.

What happens next?

The council is commissioning a study of long-term options for the pool site, which includes consideration of a redeveloped pool facility, and will include community consultation. The council will keep the community informed as to how they can be a part of this process, which will focus on ensuring the City of Glenorchy has a contemporary community asset that the public can utilise for the long term.

Is the pool leaking?

When it was operational, the pool needed to be continually filled around the clock to ensure it had sufficient water volume. Water metering showed that this amounted to 35,000 litres a day which is significantly more than could be attributed to water loss through evaporation or splashing.

Does the council plan to sell the pool site?

No. The council is commissioning a study into options for the site, including a redeveloped pool. This process will involve community consultation. There are no plans to sell the pool or the site.

Why was the pool drained?

The pool was drained due to the fact remnant water was becoming stagnant and attracting wildlife. In addition, due to the fact the facility is not staffed, there was a potential public safety risk.

Why wasn't the community consulted before the pool was drained?

The council published media statements and social media posts about the need to close the pool due to safety risks. The council's decision to seek long-term options for the site was also published. While the council accepts some people are upset that the pool was drained and will not be re-opened in its current form, the safety risks the facility posed meant there was no option but to close the facility and manage it

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accordingly, which included having it drained. There was no scenario where an end-of-life, leaking pool shell would be re-used as a public facility.

Didn't draining the pool potentially damage the pool shell?

Given the pool shell is 60 years old and leaking, a redeveloped facility would have a new pool shell installed. There are no plans to re-open the pool using the existing shell, as council does not consider short-term repairs a cost-effective use of ratepayer funds.

Is the pool heritage listed?

The pool is not listed on the Tasmanian heritage register.

To further inform future site options, the council has initiated a separate project to commission an independent site-specific heritage assessment.

Has council spoken to other levels of government about funding the pool?

Yes. The council unsuccessfully asked the Federal Government for funding prior to the last Federal Budget. It has subsequently again written to the Federal Government for funding consideration, and has met with the State Government, which provided financial assistance for the independent report into options for the site.

Based on an estimated cost of $30 million, council would not be able to solely fund the redevelopment of the pool, if that was the preferred option.

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Pool Public Meeting - Answers to Questions in Submissions

Question	Answer
Do you think council has a role in assisting learn to swim programs for our migrant :ommunity given the dire drowning stats in Australia? What is that role if yes?	There are other organisations for whom this is core business. For example, organisations supporting our multi-cultural community or water safety organisations. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool. Obviously Council would be happy to take bookings for such classes when the pool returns to operation.
Do you see council as having a role in running and maintaining public facilities like pools?	Council's Priority Projects Prospectus states: *The Council understands the importance of recreation spaces to the community.* *Whether it is a redeveloped swimming pool, or some other type of recreation facility, providing spaces that encourage healthy, connected and active lifestyles across the widest cross section of the community possible is a core responsibility of Council.* Councils provide a range of community open space and recreational facilities subject to community need, the availability of funding and the community's willingness to pay.
Vould you consider a community run pool model like Victoria's Bendigo Golden Square pool, once repairs are done to the pool given the absence of a leasing fee to companies like Belgravia?	Council is open to exploring a range of management models having regard to factors such as organisational capability, maintenance, risk management and cost.
Does Mayor Thomas intend to remain in her position and therefore remain keen to "steer :he ship" through this pool situation/pool consultation/and necessary funding processes?	The Mayor has announced her candidacy for the Legislative Council seat of Elwick, for which polling day is 4 May 2024. Nevertheless, Council remains well-placed to continue the work to resolve the pool issue. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool. We continue to work on the Pool Redevelopment and Alternative Options Project to explore a longer term solution.

As recently as the February 2024 Council Meeting, Aldermen spoke of the 'work' they'd done on the pool issue. Having spoken to politicians over the last 8 months they have all stated they have been waiting for Council to 'do the work'. Can you please provide detailed information as to what work has been undertaken over the last 10 years by Council towards funding, business plans, any representations with Politicians including the recent meeting between Mayor Thomas and Senator Brown where Thriving Suburbs Program funding was discussed. Please detail any correspondence that has been sent in an effort to retain our local pool.	The Council officers report on the pool dated 26 August 2023 detailed past advocacy efforts. In addition, Council's Priority Projects Prospectus, including pool redevelopment, were circulated to candidates in the recent State election. The work to prepare a business plan for the future of the pool site is part of the current Pool Redevelopment and Alternative Options Project being undertaken by MI Global to provide a stronger factual basis for future advocacy to governments on the long term future of the site.
Why does Council deem it okay for the MAC to run at a substantial loss around $500,000.00 but seems to hold our pool to a different standard, with it's loss around $400,000.00? Yet our pool caters to a wider cross section of Community	It was decided in July 2023 not to reopen the pool for the foreseeable future for safety reasons. The operational cost of the facility was not a consideration in this decision. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool.
There is enormous concern, suffering and anxiety being felt in this community due to the sudden loss of the Glenorchy War Memorial Pool. Why has the Council ignored the hard work and requests from the community to seriously submit applications for government funding?	Council has been advocating to government (Council officers report on the pool dated 26 August 2023 detailed past advocacy efforts). In addition, Council's priority projects, including pool redevelopment, were circulated to candidates in the recent State election. A business case will be developed by MI Global as part of the Pool Redevelopment and Alternative Options Project which is well underway to provide a stronger factual basis for future advocacy to governments on the long term future of the site.

Why did the Council empty the pool and put the seals and pool shell at increased risk? It makes sense to repair the pool immediately instead of leaving it to deteriorate further whilst Government funding applications are made. There will be a long wait for a response and a lengthy time is required to develop plans before any work is ready to start on upgrading this important public amenity. Why does the Council let elite sport get priority over community needs? Funding should have been applied for years ago. Why hasn't this council systematically applied for grant funding for facilities and amenities on behalf of this large, neglected community?	Council has had aquatic engineering specialists (Lacus) inspect the pool in recent weeks in preparation for the recent $5M State election funding commitments. This work will assist Council to prepare preliminary upgrade and repair plans in preparation of receiving the grant funding. Council also sought advice on the need to for the pool be filled with water to protect its structural integrity. The advice received is that the associated risk is ground water building up underneath the pool that can subsequently push the floor of the pool shell up (without the weight of the pool water to hold it down) and cause cracking. Rather than needing to fill the pool up however, the advice is to install a series of Hydrostatic Relief Valves on the floor of the pool. These valves open if there is an excessive build up of water pressure under the pool whilst the pool is empty. The technical specifications for the installation of the relief valves is currently being prepared, and the installation works will be undertaken ASAP (with Council funds). The relief valves will also provide ongoing benefits for the pool that needs to stay empty during the planned repair works, and is emptied each year for maintenance.

The Lacus expert advised Council to obtain a chemical analysis of the shell and concrete to determine the true-life expectancy of the pool to ensure Council and Aldermen are properly informed when making critical decisions about its future. Why did the Council fail to do this?	Council has had aquatic engineering specialists (Lacus) inspect the pool in recent weeks in preparation for the recent $5M State election funding commitments. This work will assist Council to prepare preliminary upgrade and repair plans in preparation of receiving the grant funding. Council also sought advice on the need to for the pool be filled with water to protect its structural integrity. The advice received is that the associated risk is ground water building up underneath the pool that can subsequently push the floor of the pool shell up (without the weight of the pool water to hold it down) and cause cracking. Rather than needing to fill the pool up however, the advice is to install a series of Hydrostatic Relief Valves on the floor of the pool. These valves open if there is an excessive build up of water pressure under the pool whilst the pool is empty. The technical specifications for the installation of the relief valves is currently being prepared, and the installation works will be undertaken ASAP (with Council funds). The relief valves will also provide ongoing benefits for the pool that needs to stay empty during the planned repair works, and is emptied each year for maintenance.
Our Memorial Pool needs to remain public with affordable fees. It must be supported by the Council and Government and remain a public facility. It must not be handed to Property Developers and privatised with unaffordable fees in this disadvantaged and low socio-economic municipality. It should not be co-located with the promotion of addictive online gambling and alcohol serving activities to groom our children and ruin their lives. Is this the return-on-investment entertainment of 18 hours per day in the KGV Precinct envisaged and outlined in the Greater Glenorchy Plan? The Council and Government's philosophies are ethically and seriously wrong. Neglect for community priorities must change. The philosophy of the rich getting richer and the poor getting poorer is unethical and unacceptable. This is also occurring because it appears evident and proven that this Council lacks the skill and capability to build infrastructure and facilities for their community. It is 5 years since the $12.8 million grant was announced to be spent at North Chigwell and just look at the YMCA building closed to residents after a $6 million redevelopment grant announced in 2019 (also before an election). Why have the Council and Aldermen remained silent about that?	Council reports the progress of its capital works program publicly on a quarterly basis. The YMCA is an organisation that is completely independent of Council and questions as to the status of its project are best addressed to the YMCA. However, we understand that a planning permit has been granted for the work and the organisation is undertaking building and engineering design work on a modified design following cost escalation.

₹atepayers clearly want their rates spent to benefit them and their families and supply ocally accessible infrastructure to support their well-being and the livability of their city. The provision of essential facilities such as a pool is an absolute equal right for our community ncluding our children and young people who deserve the same opportunities other governments and councils provide for their communities. Why are we being discriminated against? Opportunities such as accessing life-saving 'learn to swim' programs, acquiring social skills, challenging themselves and just plain having fun should not be denied to them by unjust and unjustified decisions of Council and Aldermen.	It was decided in July 2023 not to reopen the pool for the foreseeable future for safety reasons. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool.
Why is Council and the Government requiring $50 Million from Private Developers on your Priority Investment List for this site? This is far more than a basic pool facility. We reject any alternative that disposes of our public pool and privatises it with a co-located facility aimed at normalising gambling and alcohol serving to groom our young children at our supposed health promoting pool site.	The Council's Priority Projects Prospectus states that Glenorchy City Council is seeking investment partners to deliver important community projects that will provide significant economic and social benefits to the people of Glenorchy and Greater Hobart. While the Prospectus is aimed primarily at government funding sources, Council would be unwise to preclude other potential funding sources. The scope of the Pool Redevelopment and Alternative Options Project includes development of costings for future redevelopment - and the project's community engagement process provides the opportunity for the community to provide input, including about likely costs.
Why is Council and the Government requiring $50 Million from Private Developers on your Priority Investment List for this site? This is far more than a basic pool facility. We reject any alternative that disposes of our public pool and privatises it with a co-located facility aimed at normalising gambling and alcohol serving to groom our young children at our supposed health promoting pool site.	The Council's Priority Projects Prospectus states that Glenorchy City Council is seeking investment partners to deliver important community projects that will provide significant economic and social benefits to the people of Glenorchy and Greater Hobart. While the Prospectus is aimed primarily at government funding sources, Council would be unwise to preclude other funding sources. The scope of the Pool Redevelopment and Alternative Options Project includes development of costings for future redevelopment - and the project's community engagement process provides the opportunity for the community to provide input, including about likely costs.
Has MI Global been instructed to factor in the wide-ranging additional health costs incurred for the Government's Budget by not providing a preventative health facility such as a pool for a large proportion of the Tasmania's population of 54,000 plus in the 4th largest City?	MI Global will be undertaking cost benefit analysis of potential options for the site, including for a redeveloped aquatic facility. This work will include demand, financial and economic modelling as well as a wide range of potential benefits that can be reasonably ascertained for potential development options. Health and wellbeing benefits will be one of these considerations.

What price will you quantify for the loss of lives of children or adults who will not 'learn to swim' because of this unjust return on investment notion by this derelict government and council?	Alternative "Learn to Swim" facilities are available outside of Glenorchy. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool.
Are you aware of the widespread anxiety being felt about the injustice of this decision? The people of Glenorchy and indeed Southern Tasmania will not accept the loss of this outdoor pool from this site ever. Alternative options can be realised in another location. This is an easily accessible location for families with children and the social and family realised benefits of this facility cannot be underestimated. It takes a lot of effort and many visits to a pool for parents to teach their children to swim and be water safe. Often parents cannot afford expensive 'learn to swim' lessons and prefer to teach children themselves. This is important family bonding as well. Kids alive do the five.	Council is aware of the substantial community feedback it has received for not reopening the pool for the foreseeable future for safety reasons. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool.
Swimming and Water Safety Programs are mandatory for Year 3, 4 and 5 students and at-risk year 6 in our Government Schools. Is the closure of the Glenorchy Public Pool against the Government's own Swimming and Water Safety Policy?	Not to our knowledge. The Department for Education, Children and Young People provides a Swimming and Water Safety Program for all Year 3, 4 and 5 students in Tasmanian Government Schools (required attendance) and Year 6 students assessed as being at-risk at the end of the Year 5 program (optional attendance). This three-year program consists of ten consecutive lessons each year. It supports our students to become competent swimmers and be water safe. The State Government funds this program, with a minimal contribution from individual schools. While the Glenorchy Pool is closed, there are alternative facilities where the Program can be delivered.
If Council states that the pool is unsafe when it is fixable (refer Lacus Report). This policy is more unsafe when people resort to using backyard pools. With and without fencing the backyard pools are known to be more dangerous and result in so many silent drownings. Unsafe monitoring of water quality also creates additional high health risks. Will Council fund the additional cost of inspecting the safety of backyard pools in this municipality?	The pool was not reopened for safety reasons. Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool. In relation to backyard pools, the fencing of backyard pools is regulated by the National Construction Code. Private Building Surveyors are required to assess and certify pool fencing arrangements, where pools exceed 30 cm in depth. The permit authority has a compliance role.

he Belgravia Contract is stated to be applicable from 10 September 2020 to 9th September 022(2 seasons) for $1,200,000 and included Contract extension options. (Annual Report 020-21 Page 59) How much was actually paid to Belgravia for only 2 seasons of operation? n addition, did Belgravia also retain admission, hire fees and kiosk profits during this period?	The Belgravia contract was for a 2 year agreement with the option of a +3 year extension. The $1.2M figure quoted from the 2020-21 annual report details the total expected contact sum including any extension periods allowed for in the contract (i.e. a 5 year period in total). The contract payments are only made on a per annum basis for each year of service provided. Belgravia were formally notified of the closure in July 2023, which was prior to opening the pool for the 2023/24 season, and as such no payments were made for this season. Payments ceased after the end of the 2022/23 season.
Why is there no income from the pool shown on Annual Reports since 2011 and why did Council vote to cease setting fees and charges for the Glenorchy Memorial Pool and obtain the Title Deeds to the land in 2015?	This is because the level of pool revenue is insignificant compared to other more substantial revenue sources and is subsumed within the "other fees and charges" category under "User fees".
Why are Council's documented purpose, policies, reports, objectives, strategies, values and goals for the community so different to what is occurring with the actions of Council, Mayor and Aldermen?	This is a matter of opinion. It is considered that the decision not to reopen the pool for the foreseeable future for safety reasons is consistent with Council's strategic objective to work for a safe and clean City (Strategic Plan Objective 2.1). Now that election commitments have been made by both major parties, Council officers are planning for the repair and reopening of the pool. We continue to work on the Pool Redevelopment and Alternative Options Project to explore a longer term solution.

GLENORCHY CITY COUNCIL

Public Meeting: Repair and Reopen the Glenorchy War Memorial Pool

Subject matter of the meeting, as petitioned by Janeice Bryan to the Glenorchy City Council

We the undersigned, hereby request that Council:

- Urgently repair and re-open the Glenorchy War Memorial Pool
- Hold a public meeting to address the pool related concerns.

27 March 2024		18:00 – 20:00	
Meeting Chair:	Adrian Smith	**Minute taker:**	GCC Staff
Agenda			
Agenda Item:			
1	**Welcome (Chair)**		
2	**Acknowledgment of Country**		
3	**Safety/House Keeping**		
4	**Context Setting**		
5	**Ground Rules**		
6	**Acknowledgement of Submissions**		
7	**Public Statements and Questions**		
8	**Motions**		
9	**Next Steps and Closing Remarks**		
10	**Meeting Closed**		

Minutes of a public meeting held on Wednesday 27 March 2024 at 6.00pm at KGV, Glenorchy, in response to a petition submitted by Janiece Bryan.

The subject matter of the meeting, as petitioned by Janiece Bryan to the Glenorchy City Council

We the undersigned, hereby request that Council:

- Urgently repair and re-open the Glenorchy War Memorial Pool
- Hold a public meeting to address the pool related concerns.

The meeting was facilitated by Adrian Smith of CorComms.

Attendees

Community members: 87

Elected Members: Aldermen Dunsby, Alderman King, Mayor Thomas, Deputy Mayor Hickey, Alderman Cockshutt, Alderman Alderton, Alderman Yaxley and Alderman Slade, Councillor Kendall

Glenorchy City Council Staff: Tony McMullen (General manager), Tracey Ehrlich (Director Corporate & Community Services), Luke Chiu (Manager Property, Environment & Waste), Michael Jacques (Acting Manager People & Governance), Emma Watkins (Coordinator Executive & Strategy), Kirilly Crawford (Community Engagement Advisor), Andrea Marquardt (Coordinator Communications & Engagement), Mandy Henderson (Executive Assistant to the General Manager), Mel Burk (Executive Assistant to the Mayor).

1. Welcome

The Facilitator welcomed attendees including Elected Members, the Mayor, and political representatives and thanked Janiece Bryan.

2. Acknowledgement of Country

The Facilitator gave an acknowledgement of country.

3. Housekeeping

The Facilitator advised:

- that participants were in attendance to discuss pool related concerns
- the meeting would run for a duration of around 2 hours
- 3-minute takers would be minuting the meeting
- the meeting was being recorded (audio only)
- minutes from the meeting, including answers to any questions taken on notice, will be available on the Council website 4 days prior to next Council meeting will be up on the website (evening of Wed 24 April 2024)
- all minutes from the meeting will be fed into the MI Global engagement program

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The Facilitator advised that a number of questions were received in advance and have been answered by Council. Copies were printed and are included in handouts.

4. Acknowledgement of Submissions.

Council received 9 submissions in advance of this meeting. Those submissions were summarised and included in handouts. Thank you to those who sent in their submissions.

The Facilitator advised that Janiece Bryan would start proceedings and Dr Shane Gould would then speak about her thesis and would be available during the Q&A session.

5. Ground rules

The Facilitator set out ground rules:

- be respectful
- no abuse and shouting over speakers
- each person to have 3 minutes for a statement and question
- everyone to have a say
- be mindful that other people will want to speak

6. Facilitator Introduction

The Facilitator introduced himself as Adrian Smith of CorComms. His two business partners were in the room to manage roving microphones.

The facilitator highlighted that CorComms do not work for Council. They do own several Newspapers including the Glenorchy Gazette. The facilitator stated that he was a Glenorchy City Council ratepayer and resident and is very connected to the area.

7. Context Setting

The Facilitator provided an update on funding requests, MI Global engagement, bipartisan election commitments of $5m. Council is working with Lacus to commence repairs. Currently there is a second petition being circulated seeking an elector poll.

8. Public Statements and Questions

Submissions and Questions asked at the meeting have been summarised and may not include the participant's full preamble.

The following Submissions and Questions were provided. Any Questions taken on notice will be answered in the 29 April 2024 Council meeting agenda.

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Janiece Bryan – Petitioner

Special thanks to Dr Shane Gould and wisdom about swimming pools. Caring about children and caring about the public. The petition started when people started to question the Council. Hopefully, they will now listen and care about their community, what we desperately need. Seeking transparency and accountability, need for pool to reopen as soon as possible. No money yet cost shifting. In Nov 2021 stated on a podcast that there are no noes on this council, yet there have been many for this community. We want our money spent on our very neglected youth. Council must commit to public funding of the pool and recognising its wide-ranging benefits to this community. We believe an elector poll is the only way that we can give people a say. It must not be handed to property developers. Why are we being discriminated against?

In 1963 people worked hard to build this pool for people they did not meet. $840,000 spent on upgrades in the last 3 years to refurbish the water slide and water heat, reseal parking area, roof, kiosk, shade covers, etc.

Quote from Jaquie Lambie

"I'll be damned if I vote to tell those rural and regional areas of Tasmania that they deserve to have their opportunities suffocated in a way they'd never even know. I'm not doing it, I'll never do that.

"I don't care what you offer. You can offer me a billion bucks for Tasmania, but I won't sell out our kids.

"I refuse to be the vote that tells poor kids out there, those sitting on that fine line, that no matter how gifted, no matter how determined you are, you might as well dream a little cheaper. Because you can't afford it"

A resident from Glenorchy wrote to the Mercury. School children playing reminds her of the Glenorchy Pool. So sad people are no longer able to enjoy the pool.

Leeanne Rose, administrator of 'Save Glenorchy War Memorial Pool Facebook group'.

Shared of history of the pool. Thanks to Janiece Bryan.

Introduction of Dr Shane Gould, best known as an Australian Sporting Legend and Australian of the Year 1972, won 5 individual medals at the Munich Olympics. Please welcome her and thank her to support our community of Glenorchy and all those who use our pool.

Dr Shane Gould

The problem that Glenorchy has is worldwide. Pools are old and decayed and need to be funded. I have travelled the world with my husband Milton and seen how they have been revitalised. The facility here is a place, not just an asset or a service role. Potential to be revitalised as a special place in people's lives. 25 years ago a change to how local governments viewed community facilities (read from a research paper, Ian McShane in response to pools closing in Victoria). Cannot put a financial value on a swimming pool. What is the function of a public swimming pool? As a Dr of Philosophy studying the culture of swimming in Australia. Values of a swimming facility.

List: Social meeting place, place for older people to watch and feel included from memories in a safe social space, physical activity, water safety, all the sports and swimming clubs including learn to swim and paddle boarding. Becomes a learning place. In Mildura there is a shared facility with a library. No school – no pool. Remote program in WA, to stop truancy. Pool, not school at the pool. Cultural and having a sense of inclusiveness and social cohesion.

UTAS sustainable living. Engage the local people with the knowledge, PhD, on how and what to do with the pool. Experiential and research.

Thank the people for airing their concerns and utilising their democratic right to be heard.

6:44pm, 5-minute break, reconvene at 6:50pm.

Reconvened at 7.00pm

8. Public Statements and Questions Continued

Mala Crew

Tenders, in the past council invited tenders, contractors called to get a tender pack, informed that they were not entitled to a pack if they had not worked with council in the past.

Q. Will you be opening these tenders to all Tasmanian contractors?
A. (General Manager) Council runs an open procurement process, legal requirement to do so. Invited Mala to provide details and will investigate.
Q. Our Mayor goes on leave from 3 April to run for a seat for the upper house. Assurances that everything we decide upon this evening will work properly.
A. (Mayor) One of 10 people whilst she is on leave of absence, Alderman Sue Hickey will act as Mayor, full team of elected members to represent the community in the April Council meeting.
Q. Proposed housing projects. Infrastructure for that, are we going to sacrifice parking in Glenorchy. We need parks, pools, open green spaces. Prior to handing out these contractors to developers, make sure that this infrastructure is in place.
A. (General Manager) Yes, where we can we ensure that adequate infrastructure is in place, or that we are providing adequate infrastructure for the growth of the city. For example, there are 10 playgrounds being upgraded as we speak.

Nicole Vout

Thanks to Jan. Communication on this has been poor, Lacus report, March 2023, counted down the seconds until she got into the pool. Ratepayers were not informed.

Q. To the Mayor, realise that people are entitled to act on personal aspirations however should ride the wave, should be here to continue to work on funding.
A. (Mayor) I am committed to representing the people in whatever capacity and be a strong advocate on this issue.
Q. Re accessing a pool. I acted on a council directive to re access other pools. I have found that other pools are busy and not as easy to get to. **Question directed to Tony McMullen**, a conversation I have had with you and others, stated we thought we had 2 years. Clarification of what that means?
A. (General Manager) We had a 45 minute phone conversation about 6 months ago so I don't recall the precise discussion about the 2 years you refer to. Council in its current Annual Plan included two specific actions relating to the investigation of the future of the pool. When we commissioned the Lacus report, we were not expecting the condition report outcome to be as it was. The pool is a 60-year asset at the end of useful life. The dilemma for Council was how do we go forward from there. Knowledge Asset Management Services, to whom Lacus was a sub-contractor, provided a range of options going forward. As GM I am responsible for WHS (Work Health and Safety) with the statutory responsibility of keeping our workers and community safe and the condition report showed a range of safety issues with the pool I made

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the decision in July, to keep the pool closed for the foreseeable future for safety reasons. So the reference to 2 years may have referred to the fact we knew the pool was approaching end of life, and thought we had more time, to work out the solution going forward. MI Global process is trying to work through the business case to seek funding for long term replacement of the facility.

(Mayor) Over the last 2 years Council has been aware that a condition assessment was the first step towards a strategy to explore the future of aquatic centre. Hard to engage community. Room full of people now listening since the pool has closed. Ongoing significant funding commitment. We all need to be lobbying.

Renee Rime

Q. Why did GCC decide to empty the pool?

A. (Manager Property, Environment and Waste), we understand the concerns. Advice sought from engineer around the issue. The issue is not the water holding the pool walls up, rather water building up under the pool. Without the weight of the water, the bottom can push up and cause cracking.

Solution is to drill core holes and install hydro static relief valves. This will be happening imminently with Council's own funds. As soon as holes in the floor are created, pressure can't build up. the pool shell is not compromised. The seals will be replaced as part of the $5M refurbishment.

Regarding 35,000 litres a day. The pool was stagnant, water green and a safety risk. We cannot allow the water to escape into environment and creek.

John Pritchard

Q. Re the 35,000 litres a day, communication has been nil to ratepayers. If water is escaping, why do we need the valves?

A. (Manager Property, Environment and Waste) The valves protect the structure and are an ongoing benefit for future pool emptying. In the Lacus report, the main area of concrete impacted is the pool concourse. area of concrete that shows the main impact (concourse at the top). That area may need to be dug up and replaced in order to repair pipework (obtain usual response).

Richard Rowlands

Q. Regeneration of the Tattersalls Hobart Aquatic Pool and the new Southern Midlands pool and gym. Can we follow their successful outcomes and their course of action?

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A. (General Manager) I cannot comment on Tattersalls Aquatic Centre, but my recollection is the initial cost was $8M for the Southern Midland's development (pool and sporting facility). There was Government funding for the Southern Midlands project.

Lisa Rime

Do not have a question, I don't have faith in council answers; they are inconsistent, condescending, patronising – we care about this place. We feel like we have had the wool pulled over our eyes. You think we are stupid. Please engage with sincerity. You are representatives we vote you in. Know there is a feeling of mistrust within the community.

Alderman Stuart Slade

Q. Communications need to improve as of tonight. I seek a commitment around the valves that they are going in and a date on when they will be completed?

A. (Manager Property, Environment and Waste) The technical specifications were only received late yesterday and we will publicise when these works occur as soon as we can.

Richard Rowlands

Q. Where is the plan to have upgrades and refurbishments done? Was there anyone in the last 10 years who could foresee this?

A. (Manager Property, Environment and Waste) The General Manager outlined the background of what occurred over the last 2 years earlier. In addition, 12 months prior to that a budget bid was put forward that asked for $100,000 to undertake condition assessment and undertake community engagement on the longer term pool preferences, as we were aware the pool was 60 years old and hence near the end of its life. The condition report unfortunately indicated it was too unsafe to open the pool as it was too serious a health and safety risk.

Nicole Vout

Council had not maintained the pool therefore funding was rejected.

Ella Haddad, Labor Member for Clark

Q. Question around the $5M. Labor's commitment was not contingent on majority government, and the Liberal's was. I am worried that the money may not be delivered by the Liberals. Has GCC sought any assurance from the Liberal party that they will deliver the money?

A. (Mayor) Assurance from the fact that all have committed to supporting the repair and reopening of the pool. GCC will contact them when it is known who has been voted in. Continuing to advocate on what has been committed.

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Unknown Participant 1

Q. If 4000 signatures already obtained, why do we need another 1000? Urged every person in the room to take the petition and seek signature of 14 neighbours, therefore providing 1400 signatures potentially.

A. (General Manager) The legislation has two separate sections. The first required 1000 elector signatures to trigger a public meeting, and then a further 1000 elector signatures would be needed to require an elector poll.

Deputy Mayor Sue Hickey

Confirmed she will be acting Mayor for the four weeks from 3 April 2024.

Regarding the Tattersalls Pool, Doone Kennedy was a tenacious Mayor of HCC, they had $1M to put towards swimming pool. Cost of pool, needs funding, is a massive expense. On behalf of the EMs this is a massive level of engagement. Warning arising from Save UTAS campaign – this elector poll will cost $200,000 which could go into repair of the pool. It is non-binding (referencing UTAS moving). Reference the Xmas tree. In public battles, sometimes things are said that become fact.

Q. To the General Manager, where has this idea come from that Council wants to give the public land to big developers?

A. (General Manager) One of our strategic objectives at Council is to be "open for business" in Glenorchy> There would not be too many other councils that did not have a similar objective. We want to create jobs in Glenorchy. In terms of the questions of "selling off the farm", that is not the case. We have a land disposal program where surplus land is disposed of. However, we take these proceeds and reinvest them in improvements. For example, GCC is investing significantly in our open space and invested significantly in the past 6 months in Giblin's Reserve and Benjafield Park.

James Bryan

Sue is correct, the community is letting people know they are unhappy.

The Elector Poll will ensure Council knows the depth of community feeling about closure of the pool. Looking at the Greater Glenorchy Plan and what is suggested to happen over the next 10-20 years, parking spaces have development on them (Barry/Regina Street referred to as Mill Lane). GCC not being open and honest with the community. commentator compelled people to put their full address on the petition.

Unknown Participant 2

Please test things on a smaller scale, making any alterations to big pool, can it be put into a smaller pool? We want to keep the presence of the War Memorial, try it elsewhere before intervening with our pool. Talking about youth and enjoying the pool. Bring it forward, follow the heart of what people are saying.

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Angela Strk

Q. Sue Hickey, are you on the Board of OneCare and did you vote to get rid of the hydrotherapy pool that was part funded with taxpayers' money?

A. (Alderman Sue Hickey) Yes, I am on the Board of OneCare. The pool was never a warm water therapy pool, it ran 3 degrees below what it should. It was built against a business plan. Aged Care, core business to protect the elderly. Explained that it was always under repair. We received no funding from political people, no funding from anywhere. It is not the responsibility of Aged Care Centre to provide a community facility. Lots of issues. Myths. Residents had to pay to use the facility.

Unknown Participant 4

Q. Friends of Glenorchy Pool and other action groups have been calling for a public meeting for months. Thanks to Jan for the petition, and the community and the people who signed the petition, an outstanding effort. Why has it taken so long for the GCC to listen or agree to have a public meeting, so many miscommunications. The Community Yarn was a disgrace.

A: (Mayor) It has been a long process. Council has been transparent – answering 112 questions from the community – with or without notice – through the Council meetings since July. They are all on the Pool page on the Council website. The Yarn was not a comfortable space for anyone. MI Global took steps to engage and listen to community at a recent KGV meeting.

Simon Vout

Add to the last question, Jan has done a fantastic job. My understanding is that any stage after the Yarn that any Elected Member could have proposed the Public Meeting.

Q. Why didn't any of the Alderman propose a public meeting? Why did we have to go through the process of getting all those signatures and putting this meeting at risk of never occurring?

A. (General Manager) Council does have the power under the Act to hold a public meeting of its own volition. We believed a public meeting would unnecessarily duplicate the very through community engagement process that MI Global is undertaking. . This has included 3 community pop-ups, a public meeting, meeting with stakeholders, and a community survey. QoN 112 over last 9 months. Lot of listening to the community over this time. Nevertheless, we applaud Ms Bryan for the work she has done in bringing the public meeting forward.

Deanne Gillie/Shaw

Q. 35,000 litres of water. No visible damage, the water may even be watering the KGV oval. Maybe the water meter has been tampered with. Fresh concrete, what works were undertaken with the water meter?

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A. (Manager Property, Environment and Waste) The water sub-meter we are referring to was specifically installed to work out how much was leaking. It goes to the plant room only. Referenced what 35,000L/day looks like, and that it is equivalent to a garden hose with reasonable water pressure running 24 hours a day (i.e. 25L/min x 60 minutes x 24 hours = 36,000L)

Renee Rime

Q. Why are we (public) not presented with some basic plans and drawings with what we are doing with the land and where the cost is going?

A. (Facilitator) MI Global will delivery this in July

John Pritchard – question taken on notice

Q. You haven't answered the question regarding the pool and 35,000 of water loss.

A. A water submeter was installed on the water line that only feeds the pool plant room that is used to top the pool up. The submeter was installed before the start of the season and once the pool was already full, and then read immediately after the season closed. This submeter reading showed 6,330KL was used over the season to keep the pool full. When divided by 183 days (i.e. 6 months season) that equates to an average of 34,600L/day of water loss.

Regarding the question on why the 35,000L hasn't caused a landslip or isn't visible in the creek - 35,000L is a large volume of water at once. However, over a 24 hour period that is only equivalent to 25L/minute which is the flow rate of a garden hose with reasonable water pressure (i.e. 25L/min x 60 minutes x 24 hours = 36,000L)

Nicole Vout

Q. What was the cost for the engineer, Lacus, to the ratepayer for the recent assessment and recommendation.

A. (Manager Property, Environment and Waste) $5000-$6000.

9. Motions

Motion 1

Moved: Janiece Bryan

Seconded: Mala Crew

That Council:

1. Make the immediate repair of the pool site their major priority, and
2. Commit to immediately research and produce quality submissions for state and federal funding for an upgraded public aquatic facility at the current Anfield Street site, and
3. Immediately apply to the State government for the promised $5 million funding to urgently commence repairs to the pool, and
4. Commit to providing regular monthly reports on this project at Council meetings.

Motion Carried

Motion 2

Moved: Nicole Vout

Seconded: C/Kathy Williams

That Council:

1. Make all Council workshops open to the community and ratepayers for observation.

Motion Carried

Motion 3

Moved: Leeanne Rose

Seconded: Deanne Gillie

That Council:

1. Immediately after MI Global submit their recommendation, lobby the State Government for funding for a state-of-the-art facility to be run and managed by a management team with wisdom to make the pool more viable.

Motion Carried

Motion 4

Moved: Leanne Rose, on behalf of Bradley McDougall

Seconded: Nicole Vout

That Council:

1. Require Elected Members intending to nominate for positions outside of their council position to not prepare on council time, and
2. Require Elected Members nominating for political positions outside of their council position to resign from their current position in its entirety before nominating.

Motion Carried

Motion 5

Moved: Sally Hill

Seconded: Tracey Smith

That Council:

1. Be upfront and honest about the minimum amount of works required to open the pool, including the costs for the minimum viable repairs and the timeframe for the works.

Motion Carried

Motion 6

Moved: Mala Crew

Seconded: Leeanne Rose

That Council:

1. Maintain our facilities responsibly using local Tasmanian contractors, and
2. Investigate sustainable options for the future of the pool.

Motion Carried

Motion 7

Moved: Lisa Rime

Seconded: Sally Hill

That Council:

1. Does not hold any meetings about the pool in secret or any closed meetings or where certain Councillors or Aldermen are not included regarding the pool, and

GLENORCHY CITY COUNCIL

2. Does not hold any meetings about the pool where certain Councillors or Aldermen are not included.

Motion Carried

Motion 8

Moved: Nicole Vout

Seconded: Angela Strk

That the attendees at this public meeting::

1. Have no confidence in this Council.

Motion Carried

Motion 9

Moved: Janiece Bryan

Seconded: Leeanne Rose

That Council:

1. Complete concrete analysis as soon as possible to determine the life expectancy of the pool.

Motion Carried

Meeting closed at 8:18pm


Quarterly Report
Quarter 3 2024
GLENORCHY
CITY COUNCIL

Contents

STRATEGIC AND OPERATIONAL HIGHLIGHTS FOR THE QUARTER

I am pleased to bring you the strategic and operational highlights for the third quarter of the 2023/2024 financial year, ending 31 March 2024.

GLENORCHY WAR MEMORIAL POOL

At its 26 February meeting, following election campaign announcements from both the Labor and Liberal parties, Council directed the General Manager to immediately begin preparing a schedule of works to repair and eventually open the Glenorchy War Memorial Pool.

Council sought further advice from qualified engineers at Lacus to inform the schedule of works. This work includes determining whether the pool shell needed to be filled with water to protect its structural integrity. The engineers advised Council that there is a risk that ground water may build up underneath an empty pool shell. This could subsequently push the floor of the pool shell up (without the weight of the pool water to hold it down) and cause cracking. Lacus then advised Council to install a series of Hydrostatic Relief Valves on the floor of the pool, rather than refill the pool. These valves will open if there is an excessive build-up of water pressure underneath the pool shell whilst it is empty, to manage the risk of cracking.

This work is happening in parallel to the State Government funded Glenorchy Pool Site engagement process, being run by MI Global.

By the end of the quarter, MI Global were in the final stages of the first engagement phase, with community engagement strong and key stakeholders consulted. A stakeholder engagement report will be provided to Council, capturing all insights from the surveys and interviews. This report will be published online for community review and comment.

The next steps will include MI Global consolidating all information into an Options Assessment Presentation to assist with the second phase of engagement. This will include a Public Insights Session and in-person and 2 - 3 online workshops with key stakeholders.

As the project progresses, Council will keep the community informed about ways it can be involved in the project's extensive consultation process to help MI Global provide the best guidance to Council on the future of this important recreational site in our City.

PUBLIC MEETING – ADDRESSING POOL RELATED CONCERNS

At its 29 January meeting, Council received a petition. The petition stated:

Petition to Glenorchy City Council

We the undersigned, hereby request that Council

1. *Urgently repair and re-open the Glenorchy War Memorial Pool*
2. *Hold a public meeting to address the pool related concerns.*

At its 26 February meeting, Council considered the petition and was provided with background material, information about the petition's compliance with the *Local Government Act 1993*, and next steps in relation to the topics of the petition. The petition met the legal requirement of 1,000 elector signatures to require a public meeting to be held on the topic.

Council invited submissions to the meeting twice in the Mercury newspaper, on Council's notice board, and on its website. 9 submissions were received and summarised for the meeting.

The public meeting was held at 6pm, 27 March 2024 at KGV.

87 members of the public attended, as well at 9 Elected members, and 9 Glenorchy staff members.

The meeting was facilitation by Adrian Smith of CorComms and went for just over two hours. During this time submissions were made, questions asked and answered, and motions were moved and carried.

Former Olympian, Dr Shane Gould, also attended and addressed the meeting, providing her insights and experience in public swimming infrastructure, research, and people's sense of place.

Council will consider the motions from the public meeting at its April Council meeting.

STATEMENT OF LOCAL HERITAGE SIGNIFICANCE FOR GLENORCHY WAR MEMORIAL POOL

At its February meeting, Council was briefed on a Council-commissioned Statement of Local Cultural Heritage Significance of the Glenorchy War Memorial Pool prepared by Praxis Environment.

The purpose of the study was to assess the historic heritage significance of the pool complex against the criteria set out for local Heritage Places in the Tasmanian Planning Scheme using threshold guidelines established by Heritage Tasmania for use in Assessing Historic Heritage Significance.

The conclusion of the Statement, after considering the 7 criteria in the threshold guidelines established by Heritage Tasmania for use in Assessing Historic Heritage Significance, was that the place is of some local historic heritage significance on historical and community grounds.

ESTABLISHMENT OF THE ACCESS AND INCLUSION SPECIAL COMMITTEE

At its January meeting, Council established a new Access and Inclusion Special Committee with revised terms of reference.

The Committee will provide advice to Glenorchy City Council on a wide range of matters, including public spaces, road and footpaths, buildings, Council Action Plans, Statements of Commitment, Policies, and much more.

The Committee will be made up of 8-10 core members, including Elected Members Alderman Jan Dunsby and Alderman Shane Alderton, council officers, community subject matter experts, and representatives of key stakeholder groups.

This Committee will be in place for the duration of the Council term.

CAPITAL WORKS

At its February meeting, Council received its capital works status update report which outlined changes to the capital works program budget.

Delivery of a large capital work program requires adjustments during the financial year due to project-related variables and external market factors. Some variations are caused by variations to the scope of works and/or contractor delays. Several adjustments are also needed in the recurrent capital works program, due to inflation impacts, and contractor availability, as well as several additional projects, such as contaminated soil removal.

Council's Capital Works program for this year has an annual budget of $32.686 million with the major grant funded projects making up close to half of the program. The report provided Council with details on proposed variations to expenditure, as well as detail on Major and Grant funded projects, such as:

- Giblins Reserve Playspace
- Montrose Bay Foreshore Skatepark
- Council Chambers Solar Panel Installation and Roof Upgrades
- Football Packages
- Tolosa Park Dam Reintegration Project
- Playground Renewal Program

Council opened the new Benjafield Park playspace

The new district-level playspace at Benjafield Park was officially opened on 15 March following a $1.2 million renewal project. The new play space is space-themed in response to feedback from a community poll.

TOLOSA PARK DAM REINTEGRATION PROJECT

The Tolosa Park Sam Reintegration Project is at Stage 1 of an agreed master plan for the Tolosa Dam. The project involves reintegrating the dam into the remainder of the park. The project is jointly funded with TasWater who are responsible for delivery of stage 1 works. In the last quarter, final earthworks and irrigation works have progressed. The schedule of Stage 1 works is expected to be completed this financial year and will allow this area to become an open recreation area that will service not only the people of Glenorchy but the wider Hobart region.

PLANNING SCHEME AMENDMENTS

Earlier this year, The Tasmanian Planning Commission approved new planning controls for the Glenorchy CBD and an area of Main Road, between Moonah and Montrose. This paved the way for additional housing development in the area.

The new controls are the Principal Activity Centre Specific Area Plan (PAC SAP) and the Northern Apartments Corridor Specific Area Plan (NAC SAP), which will apply, respectively, to the Glenorchy CBD and Main Road between Moonah and Montrose. The amendments to the Glenorchy Local Provisions Schedule (LPS) take effect on Wednesday 13 March 2024.

The PAC SAP replaces an existing planning control for the Glenorchy CBD. It renews urban design standards and introduces new measures to protect key assets like sunlight and views of the mountain. The PAC SAP also ensures apartment developments provide good amenity for residents, without affecting nearby businesses.

The NAC SAP is focused on the Commercial Zone along Main Road, where residential use is currently not allowed. The new planning control allows well-designed apartments to be built above or behind ground floor shops and businesses. Apartments must be designed to 'fit-in' and reduce impacts from the non-residential uses such as noise, movement of commercial vehicles etc, to make sure commercial activity remains the primary focus for this area.

STATE ELECTIONS

At the recent State elections, a number of campaign announcements relevant to Glenorchy were made by the Liberal Party, which is, at the time of writing, working to form minority government.

These include:

Glenorchy specific:

- Glenorchy Pool Repair and Reopen Funding- $5m
- Rapid Transit Bus Network – Overall support
- Chocolate Experience at Cadbury – up to $12m
- New Ferry Terminal at Wilkinsons Point by 2028 – Overall support
- Moonah Multicultural Hub - $150K
- Multicultural Council of Tasmania – Increase in funding

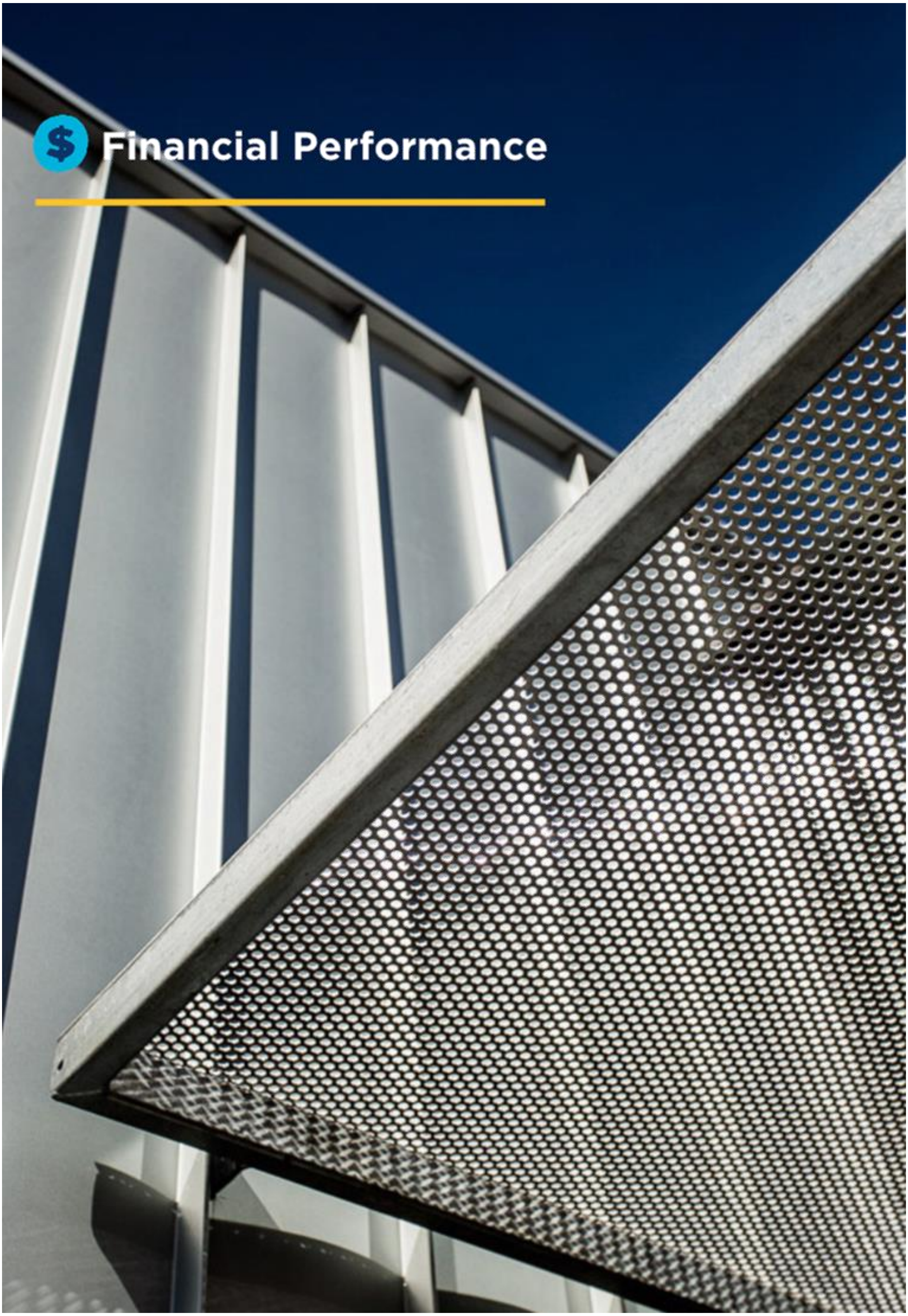
Council will be actively advocating to the new government to follow up on these announcements, in particular, the pool repair funding announcement.

FUTURE OF LOCAL GOVERNMENT REVIEW FINAL REPORT SUBMISSION

Council endorsed a submission to the Tasmanian Government on the recommendations of the Future of Local Government Review Final Report. Council welcomed the opportunity to provide further comment on the Future of Local Government Review Final Report and its 37 recommendations for local government reform and looks forward to working with the incoming Tasmanian Government to ensure that momentum for the reform continues.

Council reflected that the Review is important for the sector and for the State of Tasmania. Council supported most of the 37 recommendations for reform, with some notable exceptions and qualifications around the expanded scope for local government, amalgamation, shared services, and funding arrangements.

Tony McMullen
General Manager
April 2024


Financial Performance

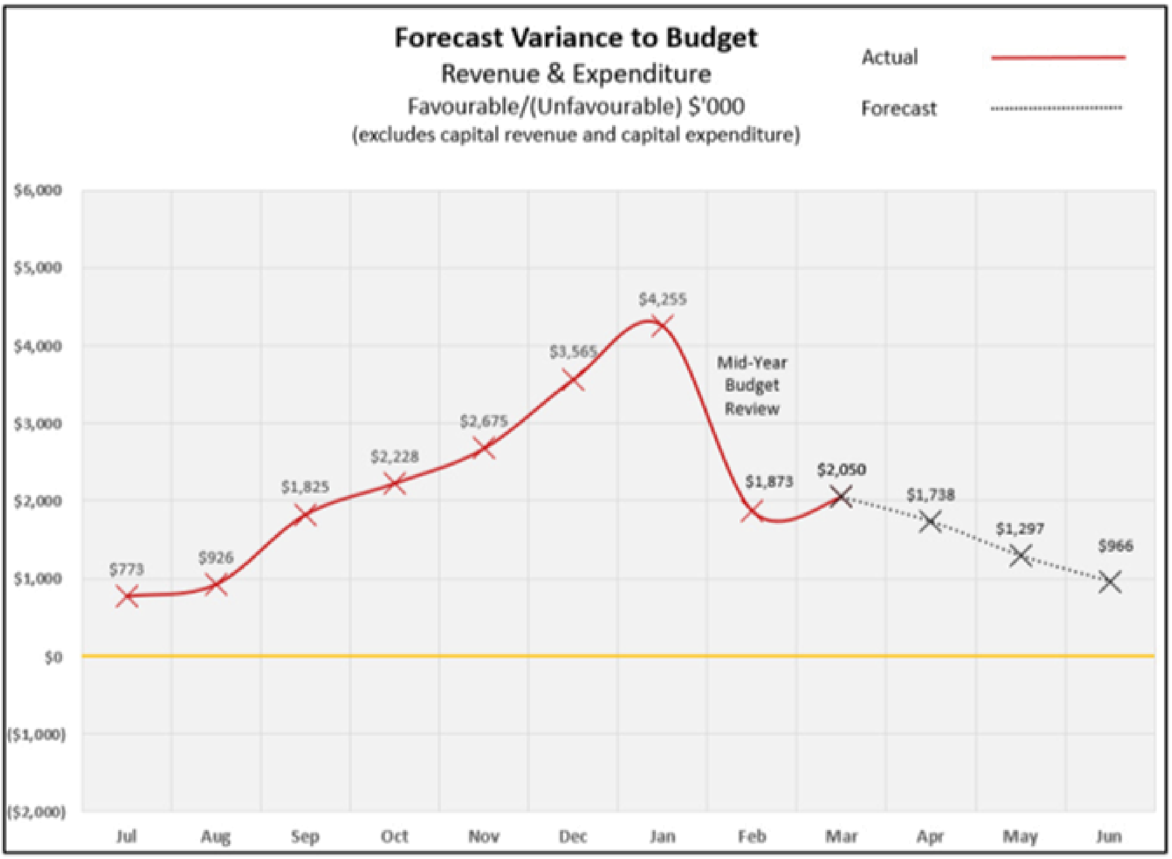
Quarterly Financial Performance

For the year-to-date ending 31 March 2024

OPERATING SUMMARY

Council's operating result as at the end of the March 2024 quarter is $2.050m better than the budgeted position. The favourable variance is the combined result of $0.408m more revenue than budgeted and $1.642m less expenditure than budgeted.

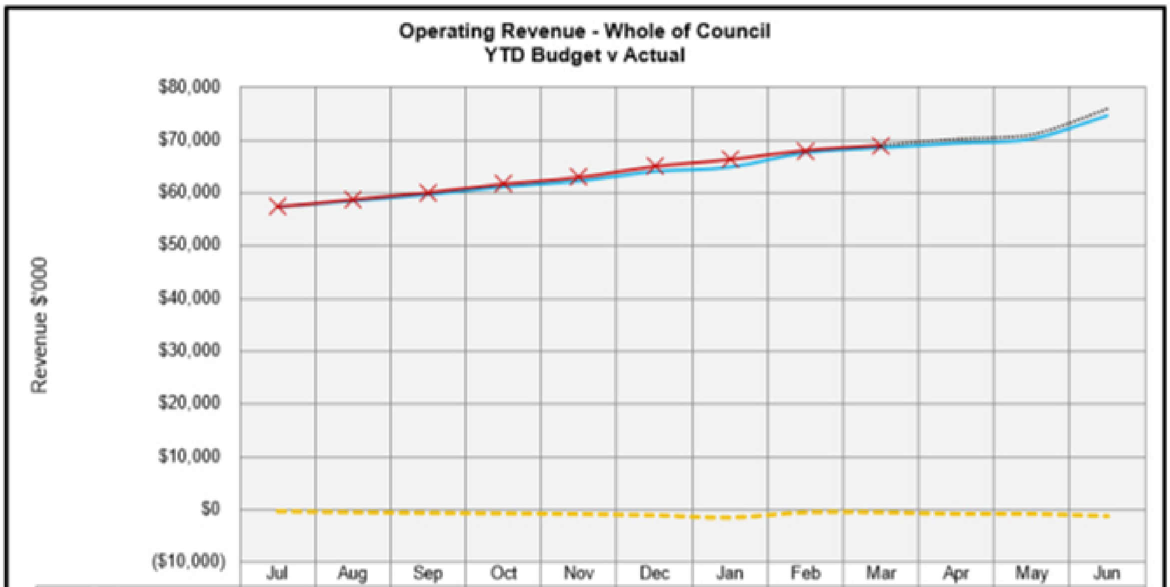
OPERATING FORECAST TO 30 JUNE 2024



Note 1: The data in this chart is a compilation of actual, budget and forecast revenue / expenditure. It is recalculated each month to ensure it represents the most up-to-date analysis of Councils financial position which may result in differences to previously reported charts.

OPERATING REVENUE

Year-to-date operational revenue is $68.995m compared to budgeted operational revenue of $68.586m. This represents a favourable result of $0.408m or 0.6% against budget.



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Budget ($'000)	$57,254	$58,415	$59,611	$61,096	$62,209	$64,014	$64,849	$67,623	$68,586	$69,481	$70,308	$74,712
Actual ($'000)	$57,466	$58,820	$60,145	$61,727	$62,975	$65,003	$66,306	$68,035	$68,995			
Running Variance - $'000 (Favourable) / Unfavourable	($213)	($405)	($534)	($630)	($766)	($989)	($1,456)	($412)	($408)	($736)	($731)	($1,161)
Forecast ($'000)										$70,218	$71,038	$75,873

Note: operational revenue does not include capital revenue or gain/loss on sale of assets but does include unspent grants received in the prior year.

NOTE 1 – RATES REVENUE

Favourable against the year-to-date $49.373m budget by $5k, noting supplementary valuation rate revenue is on target.

NOTE 2 – USER CHARGES AND LICENCES REVENUE

Favourable against the year-to-date $12.895m budget by $157k, noting landfill user fees of $99k, reimbursement of private land fire hazard reduction expenses $61k and planning fees of $52k.

NOTE 3 – INTEREST ON INVESTMENTS

Favourable against the year-to-date $884k budget by $422k, noting $1.456m in interest has been received to date less accruals back to last year of $126k.

NOTE 4 – OPERATING GRANTS

Unfavourable against the year-to-date $3.926m budget by $275k, noting that 100% of the 2023/24 Financial Assistance Grant was prepaid in 2022/23, resulting in a budget shortfall unless 100% of the 2024/25 grant is prepaid this year.

NOTE 5 – CONTRIBUTIONS - CASH

Unfavourable against the year-to-date $31k budget by $16k, noting no planning cash-in-lieu has been received to date.

NOTE 6 – TASWATER INCOME

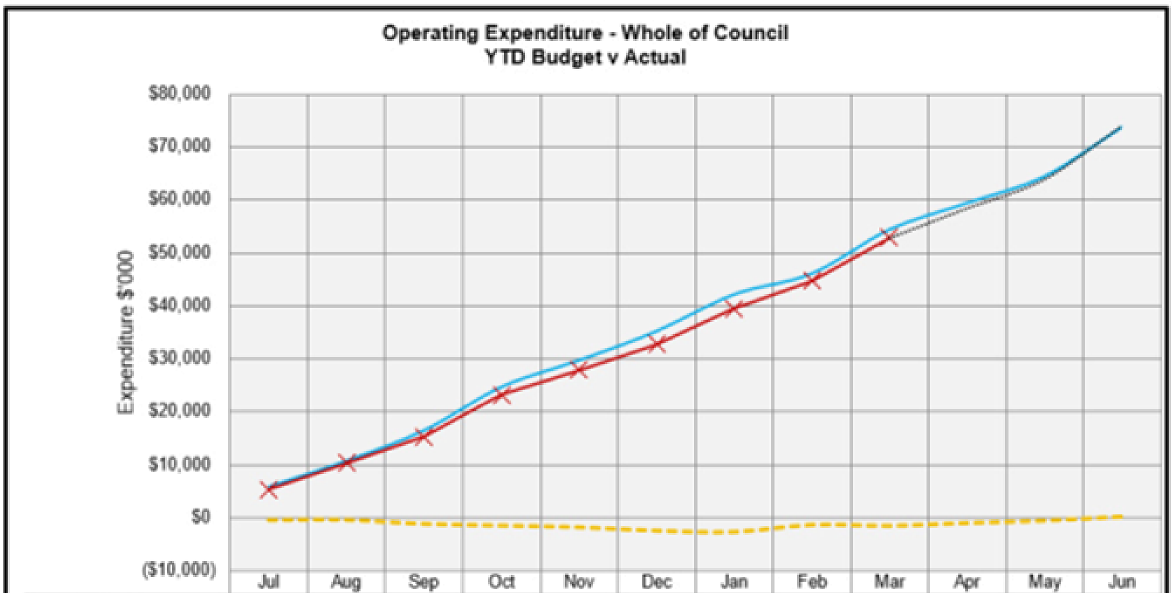
On track noting two dividend payments totalling $1.086m have been received against an annual budget of $2.172m.

NOTE 7 – OTHER INCOME

Favourable against the year-to-date $391k budget by $114k, noting $64k for the State Fire Levy commission for April was paid in March.

OPERATING EXPENDITURE

Year-to-date operational expenditure is $52.838m compared to budgeted expenditure of $54.479m. This represents a favourable result of $1.641m or 3.0% against budget.



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Budget ($'000)	$5,921	$10,789	$16,531	$24,779	$29,797	$35,302	$42,276	$46,205	$54,479	$59,542	$64,589	$73,852
Actual ($'000)	$5,361	$10,268	$15,240	$23,181	$27,888	$32,727	$39,477	$44,745	$52,838			
Running Variance - $'000 (Favourable) / Unfavourable	($561)	($521)	($1,291)	($1,598)	($1,909)	($2,575)	($2,799)	($1,460)	($1,641)	($1,104)	($669)	$92
Forecast ($'000)										$58,438	$63,921	$73,944

NOTE 8 – EMPLOYMENT COSTS

Favourable against the year-to-date $20.583m budget by $253k, representing positions remaining vacant for extended periods during the recruitment process.

NOTE 9 – MATERIALS AND SERVICES EXPENDITURE

Favourable against the year-to-date $13.521m budget by $650k, noting underspends in waste management $188k, regional contributions awaiting invoices $157k, public utility charges timing $101k and internal cross-program cost recovery $83k.

NOTE 10 – DEPRECIATION AND AMORTISATION

Favourable against the year-to-date $14.081m budget by $445k, noting these figures are on an accrual basis until asset reconciliations are undertaken in April 2024.

NOTE 11 – FINANCE COSTS

Favourable against the year-to-date $111k budget by $1k, with no notable variances to report.

NOTE 12 – BAD AND DOUBTFUL DEBTS

No bad or doubtful debts identified this year to date.

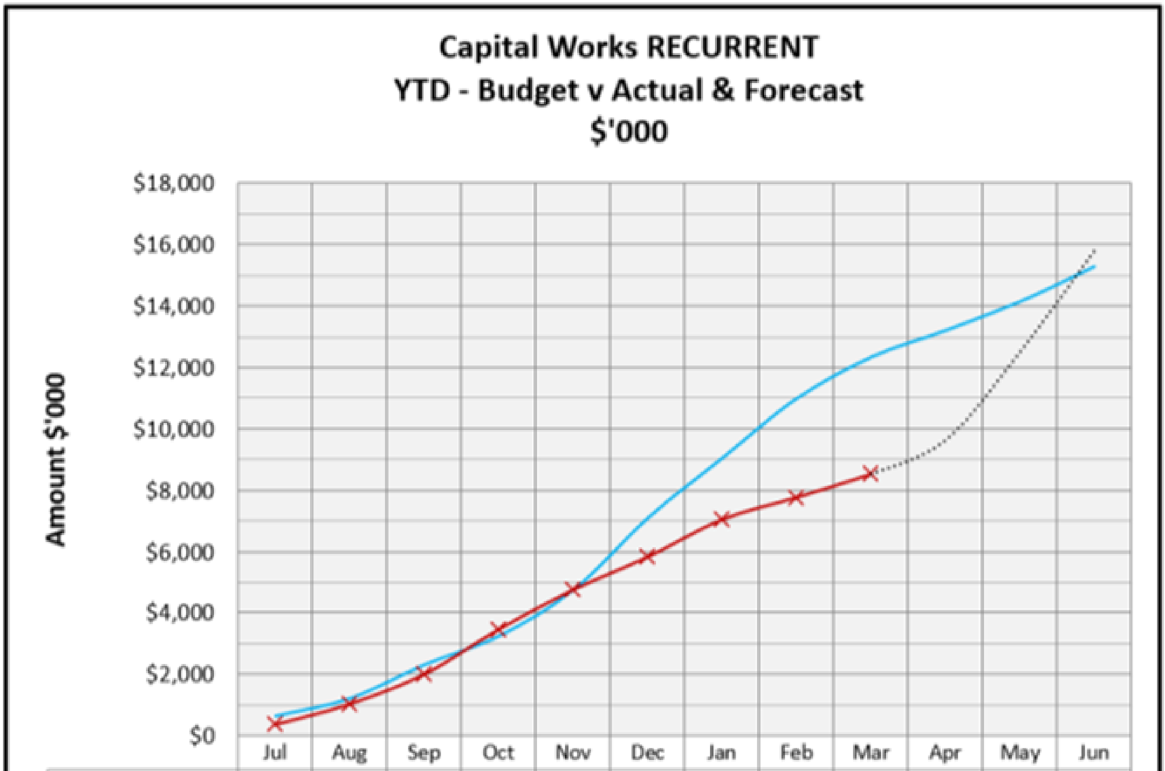
NOTE 13 – OTHER EXPENSES

Favourable against the year-to-date $6.182m budget by $292k, noting these figures are on an accrual basis until asset reconciliations are undertaken in April 2024.

CAPITAL WORKS

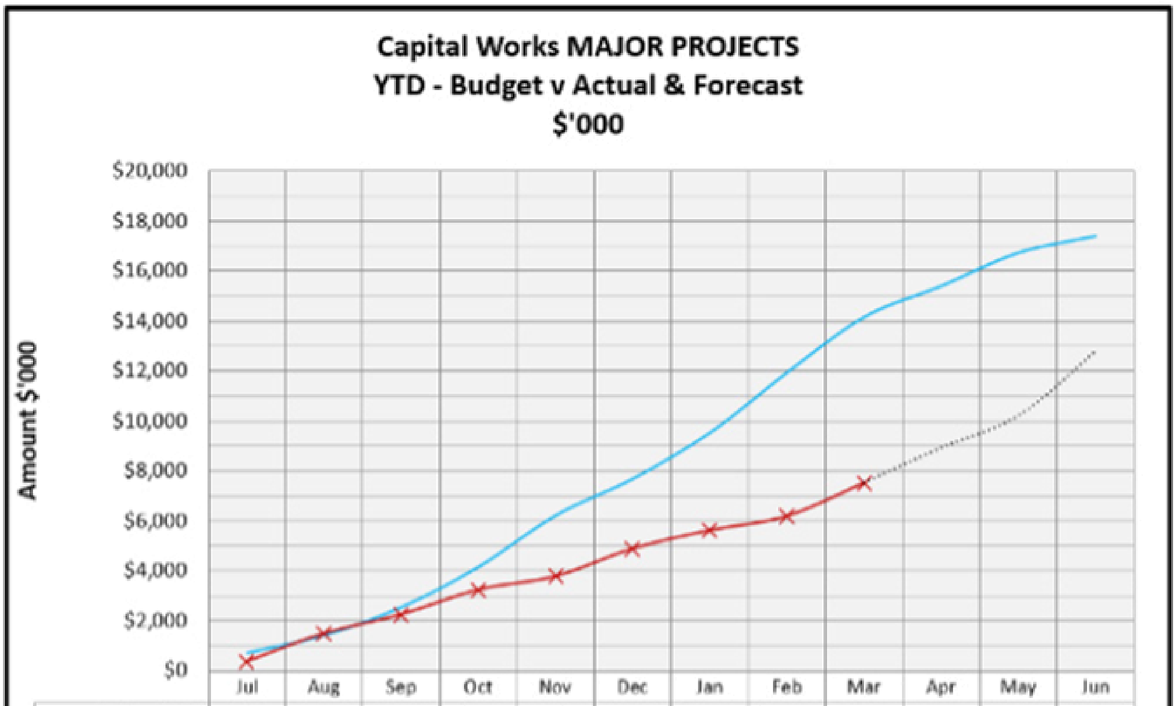
Year-to-date Capital Works expenditure is $16.042m against a combined annual budget of $32.686m and a combined annual forecast spend of $28.573m. At the end of March, $8.537m or 56% of the annual Recurrent projects budget has been expended and $7.505m or 43% of the Major projects budget has been expended.

CAPITAL PROGRAM – RECURRENT



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Budget YTD	625	1,198	2,306	3,237	4,740	7,087	9,044	10,985	12,337	13,206	14,149	15,293
Actual YTD	370	1,043	2,019	3,479	4,768	5,840	7,055	7,775	8,537			
Forecast										9,643	12,511	15,790

CAPITAL PROGRAM – MAJOR GRANT FUNDED PROJECTS*



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Budget YTD	710	1,415	2,544	4,149	6,215	7,680	9,522	11,930	14,155	15,395	16,724	17,394
Actual YTD	363	1,484	2,246	3,231	3,764	4,868	5,606	6,176	7,505			
Forecast										8,912	10,206	12,782

*The following projects form the Grant Funded / Major Projects capital works program:

Project	YTD Actual	ANNUAL Budget	ANNUAL Forecast
101059 - CSR - KGV Soccer - Design & Construction	$1,210,430	$2,500,000	$2,160,430
101246 - Grant - Giblins Reserve Play Space	$1,830,002	$2,500,000	$1,920,002
101250 - Grant - North Chigwell Football and Community Facility	$132,800	$4,000,000	$1,032,800
101282 - Grant - Montrose Foreshore Park Skatepark	$290,596	$0	$370,596
101517 - Upgrade Interchange Facilities at KGV Oval for GDFC	$185,905	$145,000	$185,905
101518 - Upgrade to the Claremont Junior Football Clubrooms	$0	$0	$0
101536 - Tolosa Park Dam Rehabilitation	$1,342,454	$3,195,000	$3,117,454
101767 - Relocation of Terry Street to Chambers	$490,730	$200,000	$490,730
101914 - MP - Benjafield Playground Renewal	$1,271,456	$1,234,138	$1,271,456
101915 - Grant - Playground Renewal - Federal	$69,313	$1,680,748	$645,575
101916 - Benjafield Childcare Centre Stage 1 - Sleep Area	$30,954	$700,000	$505,954
101917 - Benjafield Childcare Centre Stage 2 - Amenities	$0	$580,000	$0
101930 - Eady St Sportsfield Lighting	$127,020	$0	$127,020
101931 - Mountain Bike Renewal	$245,639	$0	$245,639
101953 - Municipal Revaluation 2024	$59,250	$395,000	$395,000
101954 - Multicultural Kitchen	$23,777	$164,000	$118,777
101956 - Cadbury Changerooms	$195,131	$100,000	$195,131
TOTALS	**$7,505,456**	**$17,393,886**	**$12,782,468**

NON-OPERATING REVENUE

NOTE 14 – CONTRIBUTIONS – NON MONETARY ASSETS

No non-monetary asset contributions have been received to date against an annual budget of $3.500m.

NOTE 15 – GAIN OR LOSS ON DISPOSAL OF FIXED ASSETS

Favourable against the year-to-date $208k budget loss by a $9k gain, noting upfront expenditure has been incurred on properties identified as being eligible for disposal $101k, less minor assets sales of $110k.

NOTE 16 – CAPITAL GRANTS

Unfavourable against the year-to-date $7.290m budget by $259k, noting federal major projects grant yet to receive $896k, less R2R grant received in advance $387k and new State Govt grants $250k.

NOTE 17 – CONTRIBUTIONS – MONETARY

Favourable against the year-to-date $128k budget by $22k, noting two new contributions of $19k and $3k have been received.

NON-OPERATING EXPENDITURE

NOTE 18 – ASSETS WRITTEN OFF

No assets have been written off to date against an annual budget of $1.920m.

CASH AND INVESTMENTS

At 31 March 2024, actual funds available in cash and investments totalled $41.833m compared to $44.448m for the same period last year. Cash flow from rates is delayed due to changes to rate instalment dates. In particular, the fourth and final instalment is now due on 1 May compared to the previous 17 March due date.

RATES COLLECTIONS

At 31 March 2024, Rates collected totalled 82.94% compared to 95.98% in the prior year. The rate payment changes Council approved in this year's budget distorts prior year comparisons, including:

- payment due dates have been extended
- penalty and interest rules have been relaxed
- recovery of overdue rate timeframes have been modified

In particular the fourth and final instalment is not due until 1 May, six weeks later than last years date of 17 March. It is expected a meaningful year-on-year comparison of rate collections will not be available until June.

STATEMENT OF COMPREHENSIVE INCOME

Glenorchy City Council

Financial Report

Statement of Comprehensive Income to 31 March 2024

Year-to-Date (YTD)	Note	2024 Budget $'000	2024 Actual $'000	2023 Actual $'000	2024 Variance Actual to Budget
Operating Revenue					
Rates	1	49,373	49,379	45,778	▲
User charges and licences	2	12,895	13,052	12,115	▲
Interest	3	884	1,306	675	▲
Grants	4	3,926	3,651	3,025	▼
Contributions - cash	5	31	15	34	
Investment income from TasWater	6	1,086	1,086	1,086	↔
Other income	7	391	506	289	▲
Total Operating Revenue		**68,586**	**68,995**	**63,001**	▲
Operating Expenditure					
Employment costs	8	20,583	20,330	18,110	▼
Materials and services	9	13,521	12,871	12,226	▼
Depreciation and amortisation	10	14,081	13,636	10,975	▼
Finance costs	11	111	110	14	▼
Bad and doubtful debts	12	-	-	-	↔
Other expenses	13	6,182	5,890	5,096	▼
Total Operating Expenditure		**54,479**	**52,838**	**46,421**	▼
Total Operating Surplus/(Deficit)		**14,108**	**16,157**	**16,580**	▲
Non-Operating Revenue					
Contributions – non-monetary assets	14	-	-	2,513	↔
Net gain/(loss) on disposal of property, infrastructure, plant, and equipment	15	(208)	9	(138)	▲
Capital grants received specifically for new or upgraded assets	16	7,290	7,030	6,362	▼
Contributions - Monetary	17	128	150	-	▲
Total Non-Operating Revenue		**7,210**	**7,189**	**8,737**	▼
Non-Operating Expense					
Assets written off	18	-	-	373	↔
Total Non-Operating Expense				**338**	
Total Surplus/(Deficit)		**21,317**	**23,346**	**25,316**	▲

STATEMENT OF FINANCIAL POSITION

Glenorchy City Council Financial Report Statement of Financial Position to 31 March 2024	2024 YTD $'000	2023 YTD $'000
Asset		
Current assets		
Cash and Cash Equivalents	3,016	8,926
Trade and Other Receivables	10,351	5,160
Inventories	154	125
Assets Classified as Held for Sale	1,197	1,625
Contract Assets	-	-
Current Investments	37,479	34,184
Other Current Assets	45	70
Total Current Assets	**52,242**	**50,090**
Non-Current Assets		
Property, Infrastructure, Plant and Equipment	858,586	813,334
Investment in Water Corporation	168,374	163,198
Intangible Assets	(32)	4
Right of Use Assets	1,529	2,078
Other Non-Current Assets	28,110	14,199
Total Non-Current Assets	**1,056,567**	**992,813**
Total Assets	**1,108,809**	**1,042,903**
Liabilities		
Current Liabilities		
Trade & Other Payables	12,678	920
Provisions	5,031	5,068
Borrowings	319	315
Trust Funds and Deposits	840	613
Lease Liabilities	559	702
Contract Liabilities	-	-
Other Liabilities	169	89
Total Current Liabilities	**19,596**	**7,707**
Non-Current Liabilities		
Provisions	7,536	3,864
Borrowings	984	1,621
Lease Liabilities	1,037	1,442
Total Non-Current Liabilities	**9,557**	**6,927**
Total Liabilities	**29,153**	**14,634**
Net Position	**1,079,656**	**1,028,269**

ADJUSTMENTS TO AMOUNTS PREVIOUSLY REPORTED

There are instances where ledger adjustments are required in respect of amounts reported in prior periods. These adjustments will be visible when comparing this report against previously presented Financial Performance Reports.


Measures

GCC Annual Plan Measures

MAKING LIVES BETTER

Percentage of direct Council operational expenditure on priority community services (parks, playgrounds, urban services, asset maintenance and community development and welfare programs).

PERCENTAGE OF DIRECT EXPENDITURE ON PRIORITY COMMUNITY SERVICES

1 July to 31 March 2024

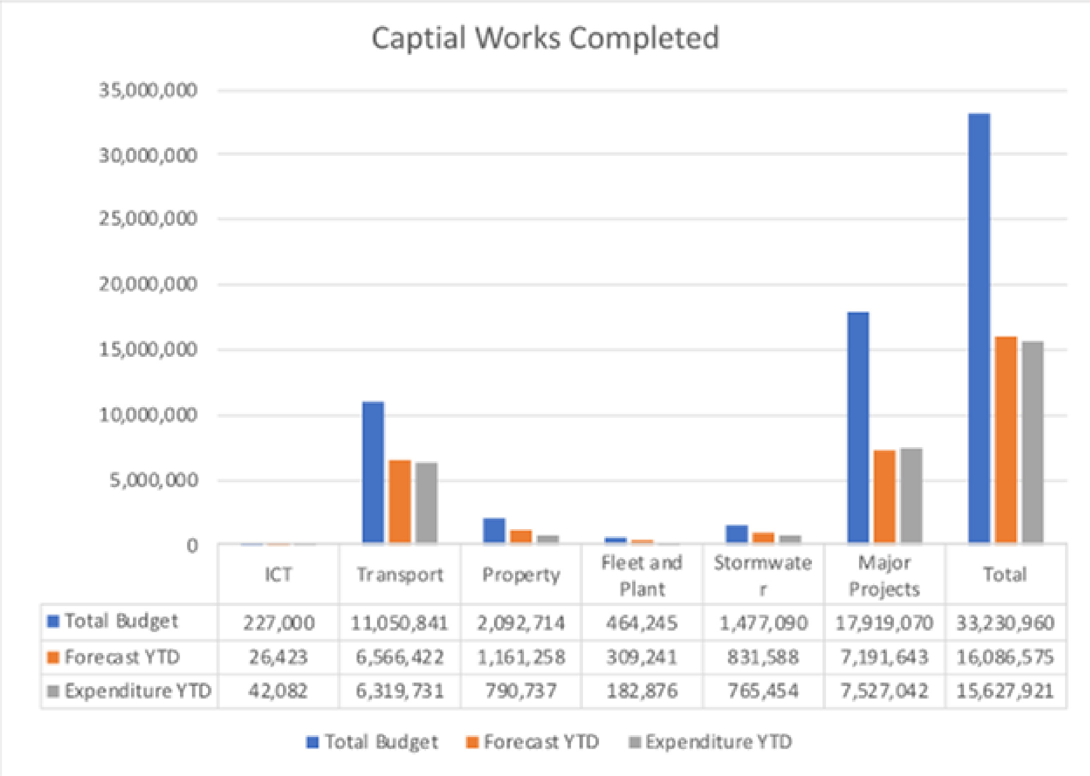
Program	Targeted Expenditure	Employee Effort	Total Direct Expenditure	Percentage of Total Direct Expenditure	Annual Budget	Percentage of Program Annual Budget Spent
Bushfire Mitigation	$99,315	$167,604	$266,919	2.68%	$549,390	48.58%
Childcare	$96,306	$1,734,515	$1,830,821	18.41%	$2,898,920	63.16%
Community Development	$315,240	$473,991	$789,231	7.94%	$1,415,614	55.75%
Community Engagement	$93,400	$224,221	$317,621	3.19%	$532,023	59.70%
Environment	$17,304	$246,905	$264,209	2.66%	$773,370	34.16%
Glenorchy Jobs Hub	$130,088	$265,269	$395,357	3.98%	$650,000	60.82%
Moonah Arts Centre	$109,013	$367,491	$476,504	4.79%	$724,997	65.72%
Parks & Recreation	$496,893	$940,606	$1,437,499	14.46%	$2,130,173	67.48%
Roads & Stormwater	$946,516	$949,458	$1,895,974	19.07%	$2,820,521	67.22%
Urban Services	$527,577	$752,184	$1,279,761	12.87%	$1,861,942	68.73%
Vegetation Control	$493,654	$495,394	$989,048	9.95%	$1,301,451	76.00%
Total Direct Expenditure - Priority Community Services	**$3,325,306**	**$6,617,638**	**$9,942,944**	**100%**	**$15,658,401**	

Percentage of capital works expenditure actual to budget.

Council's Capital Works program has an annual budget for this year of $33.2 million. Council's expenditure on its normal body of capital works is on track with forecast (97% vs forecast). It is anticipated that Council will complete the majority of all road, footpath, bridge, stormwater and property renewal and upgrade works that have been planned for this financial year.

Council is undertaking a large program of grant funded major projects, which involves some major sporting facility redevelopments. The scope and size of these projects is a resource intensive process.

Council is continuing to experience delays in the supply of materials and contract services due to market constraints, increases in construction costs and the availability of contractors, due to a buoyant and heated construction market. 91% of expenditure has been spent against original forecasts. It is expected that $5M will not be spent under Major Projects this financial year and the expenditure has been included in the 2024/25 capital program. This includes funding for the North Chigwell Football and Community Facility and KGV Soccer Projects.



	ICT	Transport	Property	Fleet and Plant	Stormwater	Major Projects	Total
Total Budget	227,000	11,050,841	2,092,714	464,245	1,477,090	17,919,070	33,230,960
Forecast YTD	26,423	6,566,422	1,161,258	309,241	831,588	7,191,643	16,086,575
Expenditure YTD	42,082	6,319,731	790,737	182,876	765,454	7,527,042	15,627,921

Number of customers receiving services through Council partners

During the quarter Council has developed and maintained a number of key partnerships to deliver services to the community.

These partnerships include:

- Police Citizens Youth Club (PCYC) – the PCYC report that services are provided to a core group of 177 individuals with occasional support provided to a number of others.
- 26TEN Foundation - "Building a 26TEN Community" 179 people have participated in 23 programs/workshops/events during the January – March 2024 period.
- MCoT at the Multicultural Hub – 4,783 individuals have used the Multicultural Hub during the quarter.
- Mission Australia Youth Beat program - The Youth Beat program has had 10 sessions engaging with young people aged between 8 and 18 years during the last quarter.
- Full Gear Motorbike Safety program, including marketing campaign for young people delivered in Huonville (1 x 8 week program delivered)

Amount of advocacy undertaken on community priorities

- *Number of mayoral advocacy letters and deputations*

Advocacy letters outlining Council's five priority projects were sent to all relevant Tasmanian Government Ministers and the Leader of the Opposition as part of the 2024-2025 Budget Community Consultation process.

The five priority projects are:

- Tolosa Park Masterplan - $12 million to implement the masterplan.
- Glenorchy War Memorial Pool - $50 million to deliver the best long-term facility for Glenorchy.
- Multicultural Hub - $300 000 over our years to create stability of service provision and continuity of service for the multicultural community.
- Northern Suburbs Transit Corridor – sufficient investment to deliver an appropriate transport mode and support an increased supply of housing along the corridor.
- Youth Engagement - $400 000 over four years to implement a program of initiatives that support and engage young people to reduce anti-social behaviour.

Letters were sent to:

- Premier Jeremy Rockliff
- Felix Ellis
- Guy Barnett
- Jo Palmer
- Madeleine Ogilvie
- Nic Street
- Nick Duigan
- Roger Jaensch
- Bec White

Ahead of the Federal budget process, advocacy letters for the five priority projects were also sent to:

- Federal Treasurer, Jim Chalmers
- Senators Jacqui Lambie, Nick McKim, Jonathon Duniam
- Independent Member Andrew Wilkie

In the lead up to the Tasmanian State election, the Mayor sent advocacy letters reiterating and outlining Council's five priority projects to Tasmanian Government Ministers, Leader of the Opposition and sitting members and candidates in the seat of Clark.

Letters were sent to:

- Madeleine Ogilvie
- Simon Behrakis
- Felix Ellis
- Guy Barnett
- Jo Palmer
- Nic Street
- Nick Duigan
- Roger Jaensch
- Jeremy Rockliff
- Michael Ferguson
- Ella Haddad
- Josh Willie
- Bec White
- Vica Bayley
- Kristie Johnston
- Ben Lohberger
- Casey Davies
- Catherine Searle
- Emma Atterbury
- Helen Burnet
- James Zalotockyj
- Janet Shelley
- John Kamara
- Jon Gourlay
- Lorraine Bennet
- Louise Elliot
- Marcus Vermey
- Mohammad Aldergham
- Nathan Volf
- Peter Jones
- Rebecca Prince
- Simon Davis
- Stefan Vogel
- Stuart Benson
- Sue Hickey
- Susan Wallace
- Trenton Hoare

During the quarter, the Mayor also sent letters advocating for the establishment of a permanent Breast Screen facility in Glenorchy to the Premier and Minster for Health, and a letter to the Minister for Infrastructure and Transport advocating for the installation of traffic signals at the intersection of Foreshore Road, Duncan Street and Brooker Highway.

Number of Council submissions on policy and legislation reviews

Council endorsed one submission this quarter to the Tasmanian Government. It was regarding the recommendations of the Future of Local Government Review Final Report. Council welcomed the opportunity to provide further comment on the Future of Local Government Review Final Report and its 37 recommendations for local government reform.

Council reflected that the review is important for the sector and for the State of Tasmania. Council supported most of the 37 recommendations for reform, with some notable exceptions and qualifications around the expanded scope for local government, amalgamation, shared services, and funding arrangements.

Council land released for housing development and social housing projects.

Large residential zoned property at 23A Norman Circle, Glenorchy is now ready for sale listing, now that title boundary errors have been resolved.

Two residential zoned properties at 11 and 11a Nielson Drive, Montrose ready for sale listing.

Number of rezoning amendments prepared to increase capacity for housing.

Both the Principal Activity Centre (PAC) and Northern Apartments Corridor (NAC) specific area plans were approved by the Tasmanian Planning Commission and became effective on Wed 13 Mar 2024.

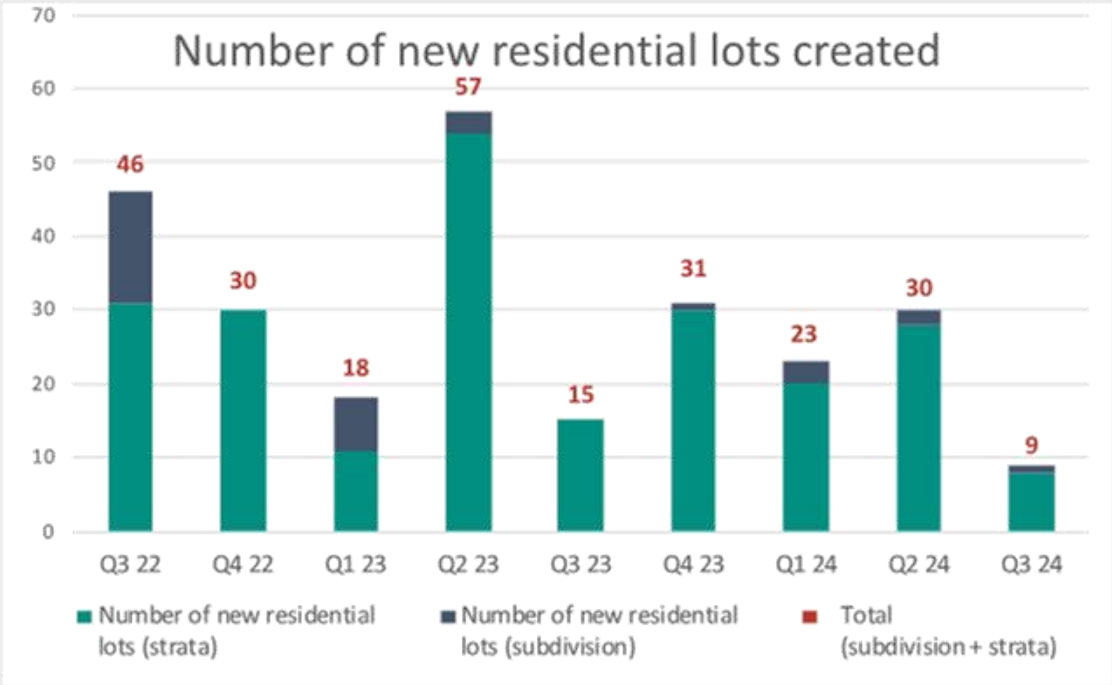
The Mill Lane Precinct specific area plan has undergone informal consultation and is scheduled to go before the Glenorchy Planning Authority on Monday 15th April 2024. The amendment proposes to rezone the land within the Mill Lane Precinct to an Urban-Mixed Use Zone so existing business can stay while providing opportunities for well-designed apartments close to the Glenorchy CBD.

A planning scheme amendment has been lodged for the Royal Agricultural Society of Tasmania showgrounds to facilitate redevelopment of the site to accommodate residential development. The application is not yet valid however informal internal referrals are underway.

On behalf of the State Government, consultants are undertaking State-wide residential land supply analysis under the Greater Hobart Plan/Regional Land Use Strategy review. Council officers reviewed a ‘first cut’ of the analysis and provided feedback on the results for Glenorchy, and the underlying methodology. More work is to be undertaken to modify the approach to account for the Hobart (and Glenorchy) metropolitan context.

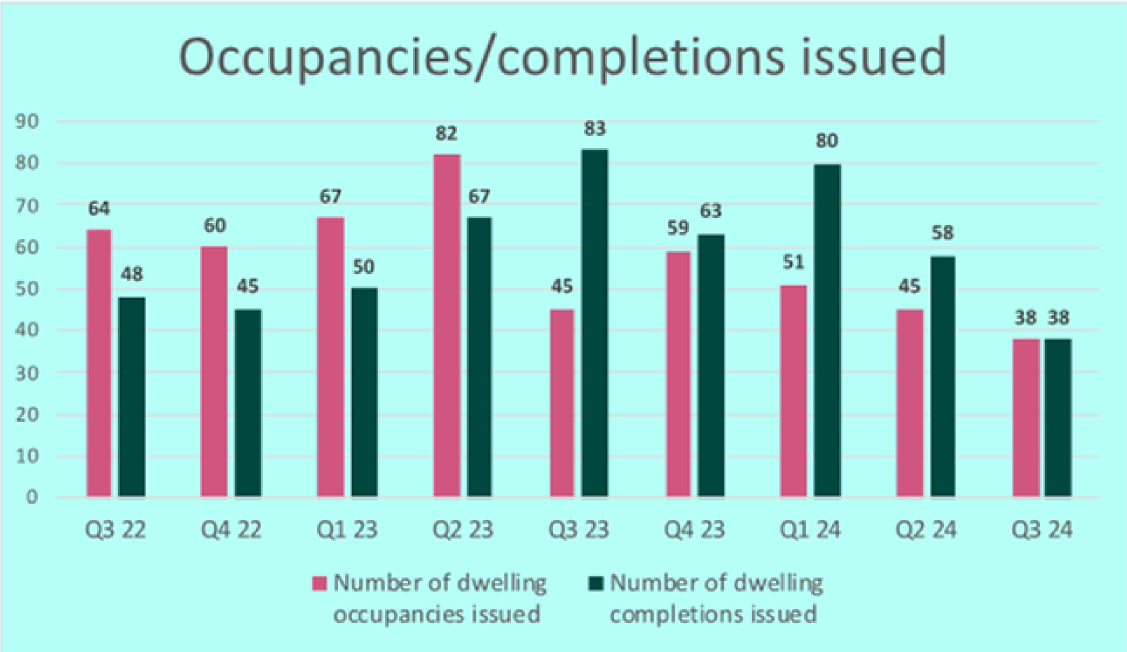
Number of new residential lots created.

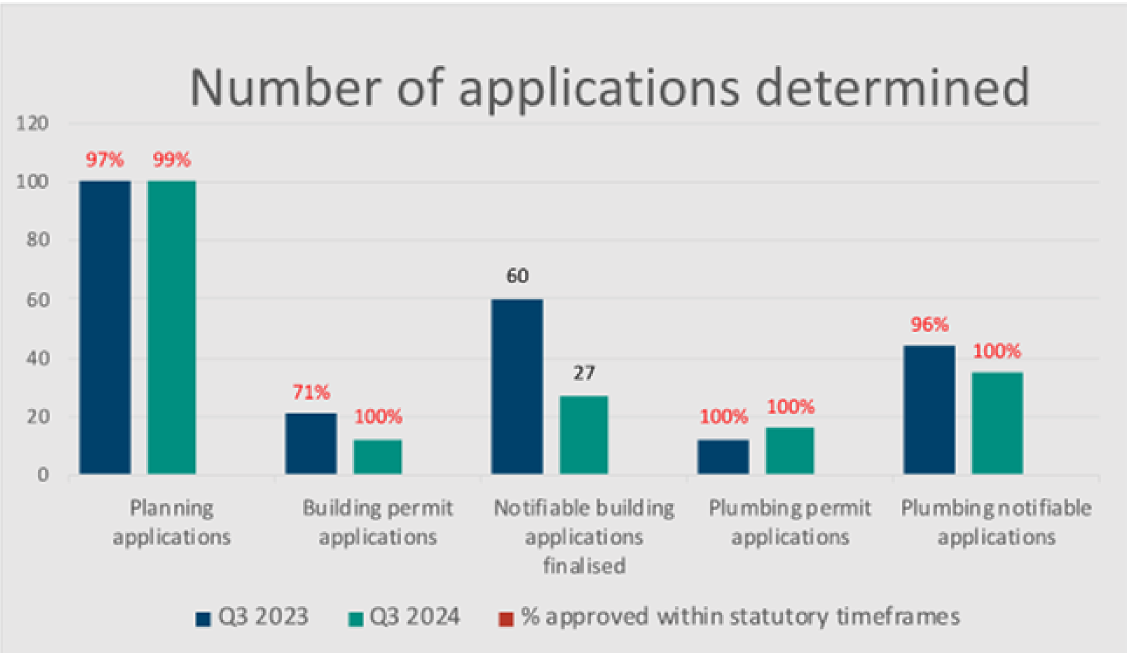
The number of new lots created in this quarter was nine, which is well below the average for the past quarters which is 31. The year-to-date figure is 62, which means it is likely that the final figure for FY24 will be substantially less than the two previous financial years, which were 131 and 121.



Number of dwelling completions.

The number of both dwelling occupancies and completions have fallen to their lowest numbers in two years. This reflects a general downturn in activity across the building sector and may be influenced by increasing build costs and statewide labour shortages.





Status of the Northern Suburbs Transit Corridor project

Council officers and the General Manager, continue to work with the City of Hobart and State Government through the Northern Suburbs Transit Corridor Masterplan Steering Committee to advance the planning for the corridor, including consideration of a Growth Strategy for the Corridor and development of a brief for an Employment Lands Study

BUILDING IMAGE AND PRIDE

Person hours of security patrolling as engaged by Council.

600 hours of security patrolling Glenorchy CBD were recorded during the quarter.

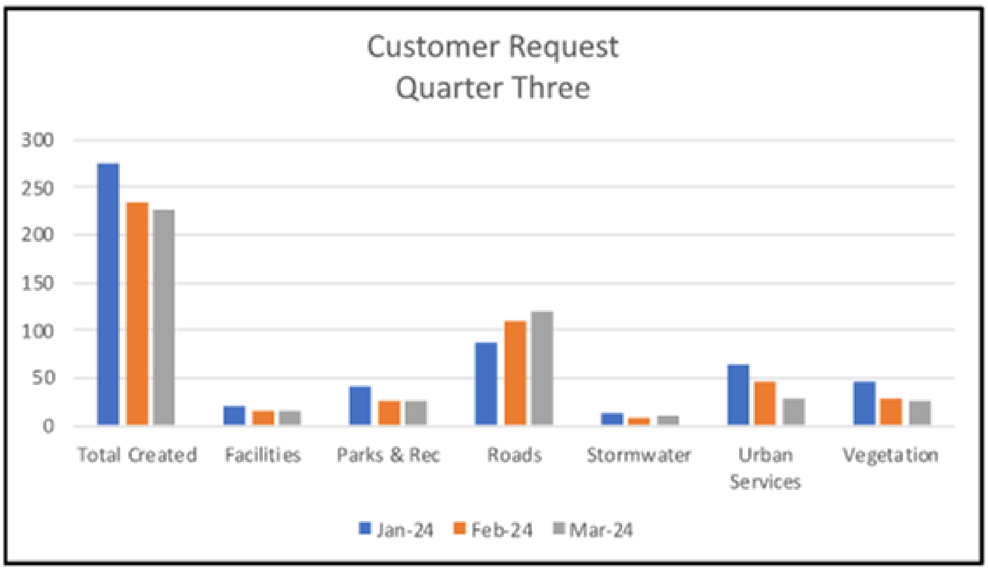
Number and type of Police and Community Youth Club (PCYC) contacts

From January 2024, PCYC has been required to complete daily timesheets and log all contacts (by type) electronically to ensure robust data is collected going forward. 177 engagements were recorded during this quarter.

Number of meetings with Glenorchy Police Inspector with Mayor / GM

During the quarter, one meeting was held on 6 March between the Glenorchy Police Inspector, Mayor and General Manager.

In addition, the Glenorchy Police Inspector attended a Moonah traders meeting on 14 February to discuss safety issues, the Collinsvale Community Yarn on 13 March, and the Public Meeting on the Glenorchy War Memorial Pool on 27 March.



Number of completed maintenance activities (service requests) for different asset classes:

- *Roads*
- *Parks and Recreation*
- *Footpaths*
- *Stormwater*
- *Facilities*

Frequency of principal activity centre cleaning activities and municipal street sweeping.

The CBD areas are subject to daily litter collections and Council's vacuum sweeper truck has been active with both the street sweeping program and other reactive work such as oil spill clean ups and debris on roads.

Visitation at the Moonah Arts Centre and attendance at other Council-run Arts events.

Over the January to March quarter, 17,354 people attended Moonah Arts Centre

January – 1,319

February – 3,870

March – 12, 165 (includes 8,599 who attended Moonah Arts Centre to complete early voting, at the State Election)

Facebook:

Facebook users who saw MAC content (including posts, stories, tags, shares): 70 304 users in total (6% decrease since last quarter of 74 775).

MAC Facebook followers: 8351 (264 new followers since last quarter vs 333 since last quarter). In this quarter, 20 people unfollowed the page, which is a 20% increase since last quarter.

Engagement with Facebook content (post reactions, comments and shares): 1800 (an increase of 3.2% engagement since last quarter, but a decrease when compared to the 86.1% increase achieved in the previous quarter).

Clicks on links within Facebook posts: 2310 (26.9% increase since last quarter – however, much of this activity is due to ad campaigns, and is a decrease in growth when compared to the 77.7% increase from last quarter).

Instagram:

MAC Instagram followers 4380 (328 new followers this quarter and 70 unfollows).

Instagram users who saw MAC content: 10 717 (39% increase from last quarter vs 65% increase last quarter).

Engagement with Instagram content (post reactions, comments and shares): 1300 (12.8% decrease from last quarter).

Links published as part of MAC content on Instagram was clicked 245 times (155.2% increase from last quarter).

Social Media Advertising:

Advertising during this period via social media:

- Video ad for The Shruti Sessions
- Total reach of target audience was 27 225 people
- Total clicks on the link: 668

Feedback from Meta to increase CPC (Cost per Click) was increase budget and duration

- The Shruti Sessions Facebook Event boosted x 4
- Total reach of target audience: An average across all 4 ads of 5961.5 people
- Total clicks on the link: An average across all 4 ads of 136.75 clicks

Ajak Kwai and Jarabi Band Facebook Event boosted

- Total reach of target audience: 9040 people
- Total clicks on the link: 432

Video ad for Ajak Kwai and Jarabi Band

- Total reach of target audience: 29 803 people
- Total clicks on the link: 1508

There was an increase in budget on social media advertising of 66% since last quarter. Paid campaigns boost brand awareness among new and existing followers, and therefore organic social following and engagement should be expected to have grown during this quarter, due to the amount of paid advertising campaigns that was conducted between December and February.

Moonah Arts Centre Website:

During this quarter, the MAC website has 4333 unique people visit the site (an increase of 429 unique visitors from last quarter which is a 10% increase from last quarter) and 27 283 page views (an increase of 6711 visits since last quarter, which is a 24% increase in visitation).

MAC E-newsletter:

General e-newsletter audience is at 2990 Subscribers. During this quarter we received 71 new members, 22 unsubscribes and 18 hard bounces. This is a 2% audience increase, but a 7% decrease in signup rate since last quarter.

The source location of sign-ups for this quarter are: 64% Wordpress Sign Up form (through the website), 18% direct copy paste (hard copy sign up form at MAC), 18% hosted sign-up form (social media, QR code on program and DL).

Open rate of each email campaign for this quarter is 40% of our email list which is an average 1177 people per email (7.5% increase in since last quarter).

Visitation at the Multicultural Hub.

There was a total of 126 bookings with an estimated 4,783 people who attended the Multicultural Hub January to March 2024

Overall estimated attendance at civic events (Citizenship Ceremonies, ANZAC Day Memorial, Community and Volunteer Awards).

Council hosted its first Citizenship Ceremony for 2024 on 23 January where 57 conferees from 20 countries became Australian Citizens.

During the quarter, the Community and Volunteer Awards Program was launched with 17 nominations received over the six award categories. Judging and award presentations will take place in quarter 4.

Overall estimated attendance at, International Day for People with Disability.

Council hosted an event on the Council lawns on 1 December 2023 for International Day for People with Disability. 15 service providers had pop-up stalls and approximately 150 people participated on the day to access a diverse range of services and activities.

Number of Reflect Reconciliation Action Plan actions implemented.

Property

- *Action 5.5 - Explore the inclusion of local and Aboriginal cultural story telling and cultural awareness information and naming of public spaces.*
  - In the previous quarter (Q2) Approval was sought and granted from the TAC to utilise Aboriginal language on Council's playground signage – "riyawina lumi (have fun here) In palawa kani, the language of Tasmanian Aborigines". These words have been included in an additional new playground at Benjafield Park, Moonah (also at Giblins Reserve last Q)

- *Action 5.8 – Acknowledge the importance of Land handback and explore Land custodian and stewardship opportunities in consultation with the Aboriginal and Torres Strait Islander community.*
  - The donation of Council-owned land at 12 Rothesay Circle Goodwood to the Karadi Aboriginal Corporation was finalised during Q3.
- *Action 8.3 – Engage with local Aboriginal organisations before commencing works on Council-owned land when Aboriginal values are likely to be present.*
  - Engagement with Karadi regarding a proposed trail upgrade on the Berriedale foreshore near known Aboriginal heritage sites was undertaken and supported by Karadi. A permit has now been granted from AHT for the works with a proposed no-dig methodology to ensure no disturbance of any potential artefacts. Works will be undertaken during Q4.

OPEN FOR BUSINESS

Number and types of engagement with Glenorchy businesses.

Council Customer Service Satisfaction Rating (> 75%) – Contact and Guidance.

Council's Customer Satisfaction (CSAT) Score for the third quarter of 2023/24 is **89.6%**. This score was calculated from 744 responses received from customers via after-call, e-mail signature and tablet surveys.

Number of Breaches or formal complaints received.

For quarter 3, the Customer Service Centre has answered 81% of the 7,933 calls received within 1 minute and completed 95% of the 3,396 enquiries under 5 minutes on front counter. Council has responded to 4 (66%) of the 6 complaints received this quarter, within 10 days. Unfortunately, according to our data, only 48% of the 901 call back requests were returned by the end of the next business day. This is an area we can improve upon, however we are somewhat restricted by our core system in both completing the requests and reporting on them, so accuracy of this statistic can vary.

Number of job placements through the Glenorchy Jobs Hub by type (casual, permanent etc.).

As at 31 March 2024 the Jobs Hub ha placed 1257 persons since August 2021 and 93 jobs filled for the January to 31 March 2024 quarter.

Status of structure plans for northern suburbs growth areas.

Council is awaiting further information/activity from the applicant for the Granton greenfield development (rezoning). No further work can be done until this is received.

Number of actions delivered from the Glenorchy Parking Strategy

During the quarter, progress on the Glenorchy Parking Strategy is as follows:

- Develop Parking Plan – 50% complete
- Develop Cash -in-lieu Policy – 50% complete

LEADING OUR COMMUNITY

Number of community engagements completed by type.

There are 1,636 people registered on the Let's Talk site (59 new registrations during Q3). Let's Talk, Glenorchy received 2,925 visits during Q3:

- 2,186 aware participants visited at least one page
- 667 informed participants viewed a video or photo, downloaded a document, visited multiple project pages, contributed to a tool
- 69 engaged participants participated in surveys or quick polls, contributed to ideas

There were two external engagement projects during Q3:

- GCC Climate Change Mitigation Plan
- Claremont Skatepark/Pumptrack Project
- The Glenorchy War Memorial Pool engagement project was also promoted on Let's Talk, Glenorchy during Q3.

Both the GCC Climate Change Mitigation Plan and the Claremont Skatepark/Pumptrack Project engagements are considered as crossing the "Inform" and "Consult" levels on the Spectrum of Public Participation.

Both engagements sit at a Level 3 on the Level of Impact Scale (Lower Impact LGA).

There were two internal engagement projects during Q3:

- Mind Body Spirit Committee
- Project Hudson Game Plan

Non-GCC engagements shared via Council's online engagement platform included:

- Tasmania Police Survey
- Access and Inclusion Special Committee
- What's On at the Glenorchy Library
- Local Government Review
- Community Protection Flood Guides
- CCYP Program

Ongoing projects include Council Land Disposals and Community Yarns and Pop-Ups. During Q3 a Community Yarn was held on 13 March and a Public Meeting on the Glenorchy War Memorial Pool was held on 27 March.

Claremont Community Library visitors

- January – 59
- February – 83
- March – 78

Number of Council initiatives being undertaken on community safety, access, housing and electronic gaming machines.

- PCYC delivers youth engagement activities every weekday in the CBD.
- Mission Australia (Youth Beat) delivered youth engagement activities on Council Lawn every Monday during school term and had 233 youth engagements from January-March in Glenorchy.
- 1 x 8-week Full Gear Motorbike Safety program, including marketing campaign for young people delivered in Huonville.
- Access and Inclusion Committee established.
- Meetings held with Wesley LifeForce and Be-Kinder Foundation

Number of resolutions made by Council / Proportion of Council decisions made in open meetings

The Council made 65 decision this quarter, of which 42 were made in open meetings.

Number of engagements with strategic partners and peak bodies

During the quarter, the following engagements with Strategic Partners were held:

January

- Local Government Emergency Management and Recovery
- Sparking Conversations, Igniting Action (SCIA) Steering Committee

February

- 26TEN Communities Roundtable engagement
- Migrant Resource Centre
- 26TEN Steering Committee
- Moonah Business Community
- Bridgewater PCYC
- Full Gear Program
- Safe City Working Group
- SCIA Steering Committee

March

- Multicultural Hub (MCOT)
- St Francis Flexible School
- Rob Fairs Foundation
- Greater Hobart Homelessness Alliance
- Glenorchy Digital Ready for Daily Life 26TEN Partnership Steering Committee
- DPAC - Child Safety in Evacuation Centres

- Wesley LifeForce
- B-Kinder Foundation
- SCIA
- Specialist Homelessness and Housing Services (ShelterTAS)

Completed fuel reduction burns (hectares).

During the quarter, no fuel reduction burns were completed. Typically, the summer quarter's weather is not suitable for controlled burning. Work has been progressing with the TFS to conduct one FRB during Q4 2023-4.

Metres of fire tracks maintained.

Approximately 40km of GCC managed fire trails have been maintained to specifications. This represents the entirety of the GCC fire trail network.

Number of storm water pits installed.

During the period there were 5 stormwater pits installed and modified.

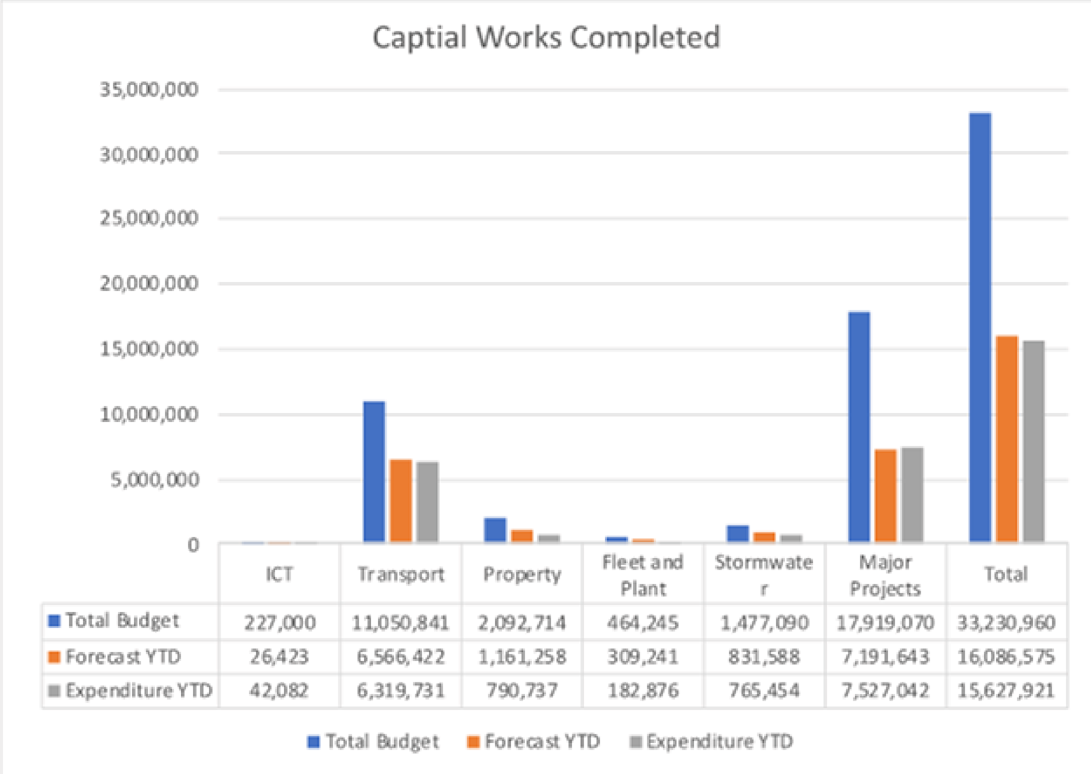
Metres of pipe and drains installed.

During the period there were 61 meters of stormwater pipes installed.

EMERGENCY MANAGEMENT ORGANISATION PREPAREDNESS.

The Glenorchy Emergency Management Committee met on 23 February 2024. Updates on Council's flood mapping and preparedness and bushfire preparedness were well received. New procedures from the SES regarding activation of evacuation centres have been received and actioned.

Percentage of recurrent capital works program delivered against asset management plans.



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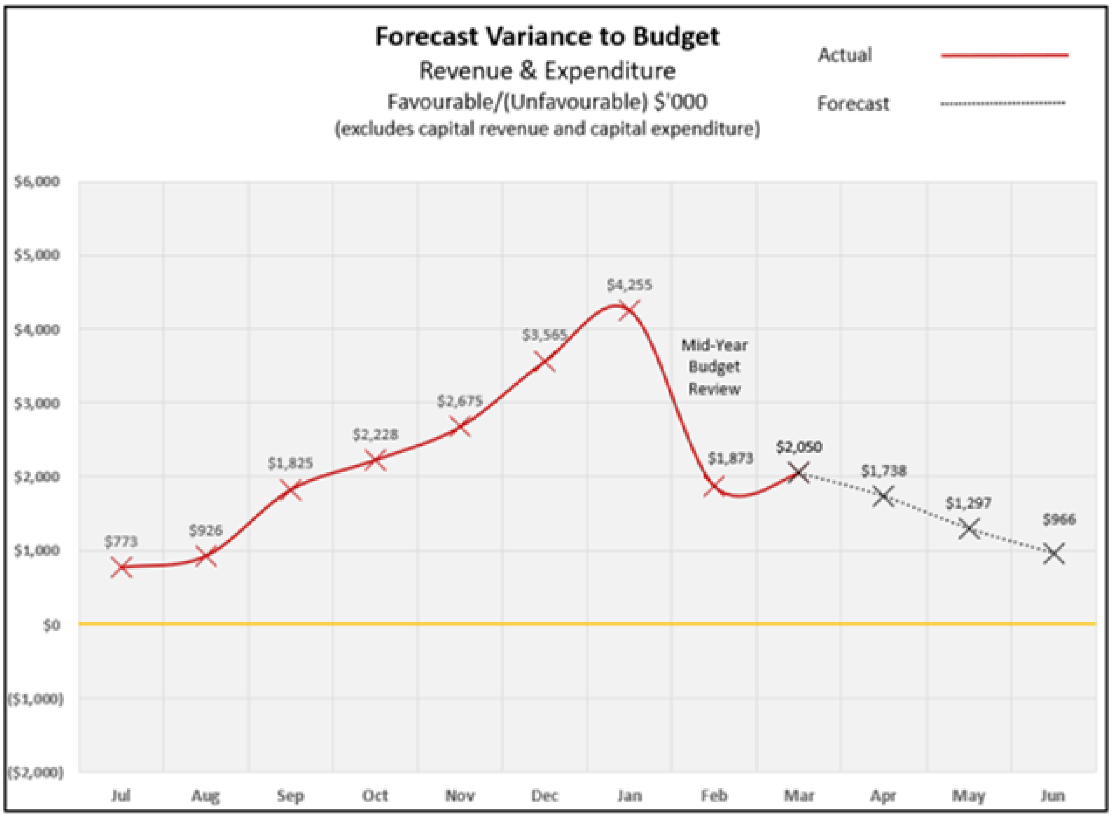
Number of Improvement Plan actions delivered from Council's Strategic Asset Management Plan.

Actions due this FY:

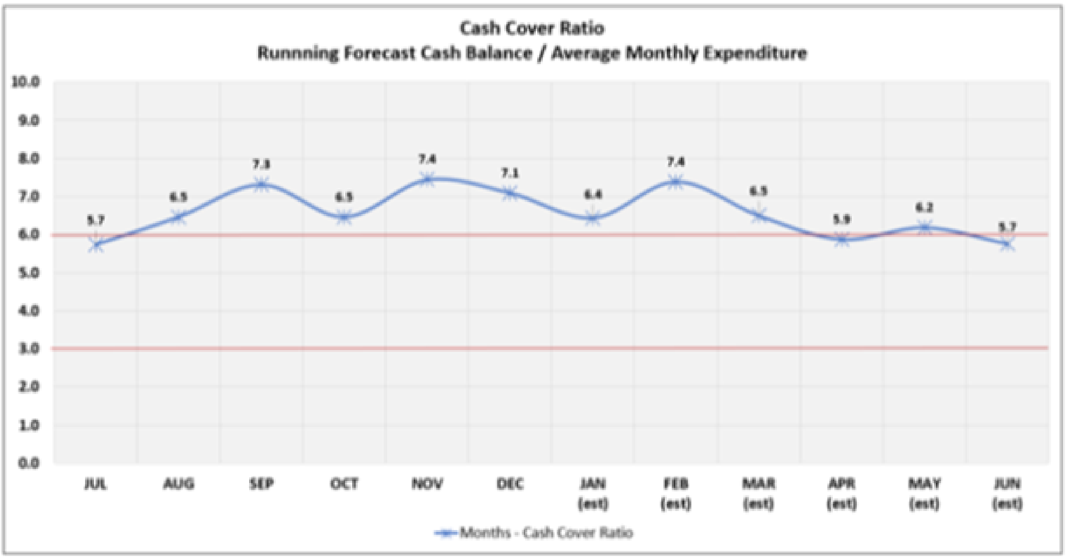
1. Develop Condition/revaluation specifications for four major asset classes, ensuring alignment to Council policies and relevant IPWEA practice notes. Condition assessment and asset revaluation will follow 4-year cycle. – 70% complete.
2. Promote the awareness of asset management principals across the organisation, including Elected Members, and highlight the importance of funding asset renewals – 100% - capital works workshop held in March including education on asset management and the importance of funding asset renewals.

Financial performance against budget reported monthly, quarterly and annually.



Note 1: The data in this chart is a compilation of actual, budget and forecast revenue / expenditure. It is recalculated each month to ensure it represents the most up-to-date analysis of Councils financial position which may result in differences to previously reported charts.

Cash cover ratio in months.



Peak Financial Months		
Rate Instalment Due	Fire Levy Instalment Due	Three Pay Periods
August	October	October
November	January	March
February	April	
May	June	

Percentage of strategic risks within agreed risk appetite.

Risk Area	Total risks	No. within Council risk appetite	Percentage risks with open treatments within agreed risk appetite
Stakeholder Engagement & Relationships	4 (4 treatments closed)	4	100%
Governance Risks	24 (13 treatments closed)	24	100%
Efficient & Effective Service Delivery	23 (8 treatments closed)	23	100%
Financial Sustainability & Budget Control	11 (1 treatment closed)	11	100%
Workforce	10 (7 treatments closed)	10	100%
Environmental Management	1 (treatment closed)	1	100%
IT Security & Data	8 (5 treatments closed)	8	100%
Management of Councils Assets	6 (5 treatments closed)	6	100%
TOTALS	**87**	**87**	**100%**

Percentage of internal audit recommendations completed.

Audit	% Completed	% Change Since Previous Report
Long Term Asset Management	New addition completed in February 2024	
Business Continuity Planning	58.3% (7 of 12 actions completed)	50%
Customer Service - Complaints Management	100% (6 of 6 actions completed)	16%
Asset Management	83.33% (5 of 6 actions completed)	33.34%
ICT Operating Controls	83% (10 of 12 actions completed *1 on hold for Project Hudson)	10%
Information Management Maturity	0% (0 of 3 actions completed)	0%
Infringements & Lease / Licence	N/A	On hold for Project Hudson
Payroll Process	N/A	On hold for Project Hudson

Number of staff participating in training.

Over 20 staff have attended training in the last quarter. This is down due to staff vacancy (the Learning and Development role is now filled with the staff member commencing in March 2024) and staff holidays in January.

VALUING OUR ENVIRONMENT

Number of natural environment engagement events.

9 Care group activities (e.g. Landcare) supported by Council in the quarter, equating to 286 volunteer hours.

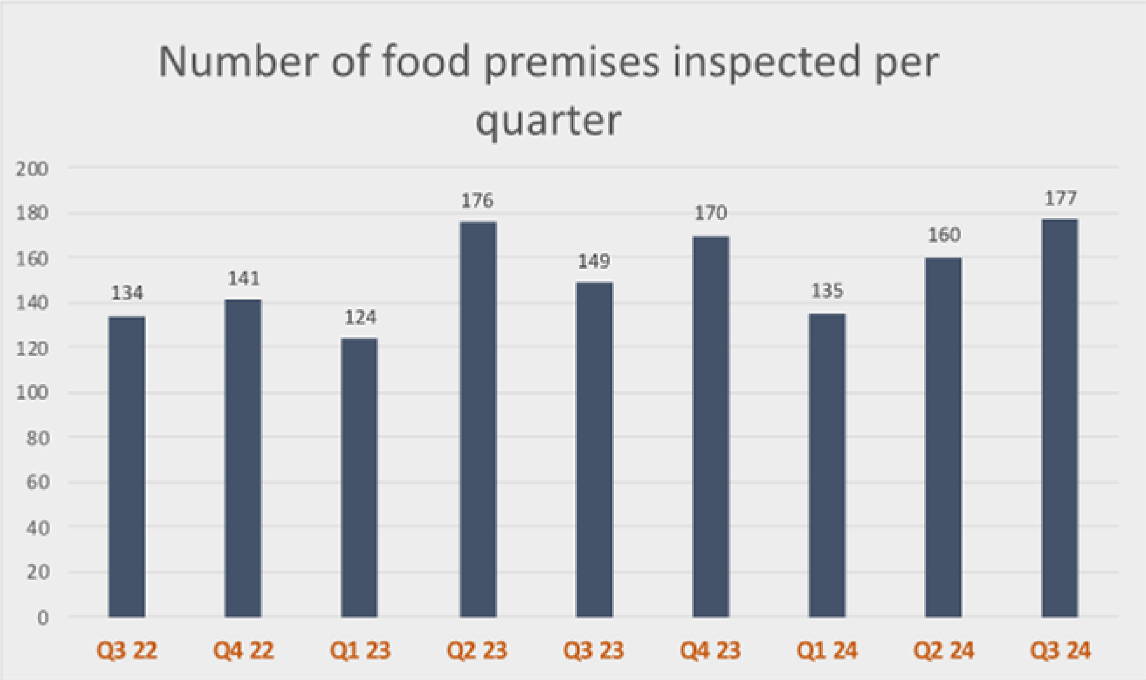
Number of water samples provided to the Derwent Estuary Program.

The Derwent Estuary Program has concluded for the 2023-24 season. All samples were satisfactory.

177 food premise inspections were conducted in the quarter which is consistent with previous quarters. Environmental Health also responded to at least 127 customer requests for the period.

During March, Environmental Health's resource sharing agreement with Southern Midlands Council (SMC) increased from 8.5 weekly hours to 12.5 weekly hours.

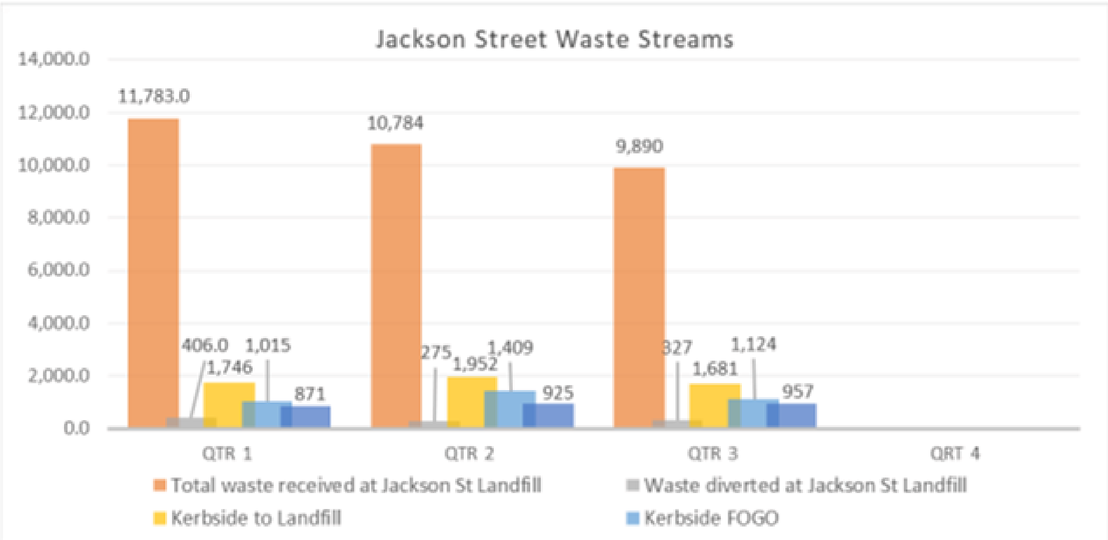
Three public immunisation clinics were held in this quarter. Additionally, the environmental health team worked with the Migrant Resource Centre to develop processes and guidance materials to help remove immunisation barriers for new migrants.



Percentage of waste diverted from landfill.

327 tonnes of waste diverted from the Jackson Street Landfill in Q3 through recovery of materials such as metals and recovery shop salvaging.

1,124 tonnes of kerbside waste diverted through FOGO kerbside collection, and 957 tonnes though recycling kerbside collections in Q3.



Council's Climate Change Mitigation Action Plan developed.

A draft of Council's Climate Change Mitigation Action Plan has been released for community consultation.

Windermere Reserve Public Toilet delivered as an action under the Public Toilet Strategy.

Project has been put out to tender and will be constructed during Q4.

Percentage of major recreation projects at KGV, North Chigwell & Giblins Reserve delivered.

KGV - Pitch upgrade and lighting upgrade completed last FY and fencing completed in Q1. Contract awarded for Changerooms and Toilets with works underway. New Changerooms and toilets expected completion in Q4. Refurbishment of old changerooms and grandstand next FY.

North Chigwell - Pitch upgrades and lighting upgrade completed last FY. Changerooms/ clubhouse contract awarded. Construction commencing in Q4, with completion next FY.

Giblins Reserve playspace completed and opened in previous quarter.

Percentage of Tolosa Park Redevelopment Project Stage A completed.

TasWater has awarded the construction contract to Gradco and works are progressing. The current program has the majority of works expected to be completed by the end of current financial year.

Number of Playspaces upgraded.

Giblins Reserve regional playspace project completed and opened in previous quarter.

Benjafield district playspace project completed and opened this quarter.

10 local playspaces upgrades supported by $1.5M federal grant have all been awarded for construction. Several will be completed during Q3 and Q4 and some in Q1 and Q2 of next FY. The 10 local playspaces are:

- Alroy Court, Rosetta (under construction)
- Cooinda Park, West Moonah
- Roseneath Reserve, Austins Ferry
- Chandos Drive Reserve, Berriedale (under construction)
- Pitcairn Street Reserve, Montrose
- Battersby Drive, Claremont
- Collinsvale Reserve, Collinsvale (completed)
- Lutana Woodlands, Lutana
- Barossa Road, Glenorchy (under construction)
- International Peace Park, Berriedale

Percentage of Federal Government Funded Black Spot program delivered.

Each year Council applies for funding under the Federally Funded Blackspot program which is used for road improvements where there is a potential road incident at risk of occurring. Council was successful in funding the two projects below.

PR22-30 Butler / Central Ave Intersection – 0% (not yet started)

PR22-40 Collins Cap Road Guardrail Extension - 0% (not yet started)

Percentage of Vulnerable Road Users program delivered.

The Vulnerable Road User Program is a grant program that aims to improve road safety outcomes in Tasmanian urban areas. Council was successful in funding the projects below.

PR20-02 Main Road Austins Ferry Crossing – 0% (not yet started)

PR22-02 Main Road Granton Shared Path – 0% (not yet started)

PR22-03 Intercity Cycleway Sunderland Street Crossing – 50%

PR20-03 Main Road 706 Berriedale Footpath Improvement – 100%

GLENORCHY
CITY COUNCIL

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GLENORCHY CITY COUNCIL

ANNUAL PLAN PROGRESS REPORT [PRIORITY]: 31 MARCH, 2024

15/04/2024

Draft · Not started · Behind · On Track · Overdue · Complete · → Direct Alignment · ⇢ Indirect Alignment

023/2024 ANNUAL PLAN

Goal	Owner	Update	Start Date	Due Date	Current Completion
2.2.1 Actively contribute to housing supply in the City through e actions in Council's Statement of Commitment on Housing	Manager Community	NEW Comments: Residential land releases - 23A Norman Circle, Glenorchy ready for sale listing, now that title boundary errors have been resolved. - 11 and 11a Nielson Drive, Montrose ready for sale listing. - 84 Sunshine Road and Baltonsborough Road, Austins Ferry properties awaiting outcome from Land Titles Office regarding removal of covenants. - 261 Main Road, Austins Ferry ongoing work to prepare property. - 14a Colston Street, Claremont ongoing work to prepare property. • The Social Planning and Policy Officer reviewed the Tasmanian Government's Tasmanian Housing Strategy Action Plan and collated media relating to affordable housing and the housing market. • The Housing Working Group met on 28/2/24 - Chaired by the Manager Community and attended by the Soicial Planning and Policy Officer. Next meeting 24/4/24. 05/04/2024	01/07/2023	30/06/2024	49% 49 / 100
1.1.1 Work in collaboration with government agencies and mmunity organisations to deliver diversional programs that n to improve youth and community safety, resilience, and gagement	Manager Community	NEW Comments: • Monthly safety reports provided to Elected members • Healthy Tasmania for $1 250 received to run a Neighbourhood Watch recruitment event on 4/4/24 at GCC Lawns. • Youth Beat is engaging with young people through their program on Council Lawns. •The team met with TCF on 23/1/24 to follow up on an unsuccessful funding application in 2023 for a youth project in the city. TCF invited GCC to submit a proposal by May 2024 to fund the development of a project aimed at removing barriers to learning for 8-19 year olds in Glenorchy. Staff have already held several meetings and made progress in the planning process. • The Community Development Officer has completed training two new mentors for the Happy Mentors program, starting 25/03/24 at Montrose Bay High School & Cosgrove in April 2024 • The Health, Wellbeing, and Resilience Officer will work one day per week on the Full Gear program until the end of this current deed. Program was delivered in Huonville with 8 participants. • The Social Planning and Policy Officer published the Child & Youth Safety Community Survey Report and produced three fact sheets to accompany the report. • The Social Planning and Policy Officer role has been modified and now includes supporting the implementation of the Child And Youth Safety Framework. • The Draft Statment of Commitment on Child And Youth Safety has been submitted to Manager Communities to share with the Working Group • Options paper was developed for with the director and manager in preparation for the Elected Member workshop in April. • The Safe City Lead implemented youth engagement practices with PCYC. However, PCYC staff failed to refer young people as required. To address this issue, the Community Development Officer will work 10 hours per week (until June 30) to provide active outreach and refer young people to social services, education, employment, and diversional programs. CB radios have been purchased to improve communication during the outreach. • Safe City Lead, Acting Coordinator, Manager Community and Acting Director of Community & Corporate Services met with an auditor from Tasmanian PCYC regarding Bridgewater PCYC • Extension received on PCYC activity grant ($25,000) to June 30, 2024. • Developed proposal for the Community Development team to activate the Pensioner's Building • Hosted Thrive to 25 and Linkages Multi Agency meetings at GCC • Established the Safe City Working group, met and approved a TOR 05/04/2024	01/07/2023	30/06/2024	75% 75 / 100

1.2.1 Improve the cleanliness of our CBDs by increasing the equency of cleaning activities including graffiti removal, litter ck up, street sweeping and footpath cleaning	Manager Works	NEW Comments: A focus on CBD cleanliness has been progressed with extra litter collections taking place and numerous graffiti removals being undertaken. A new resin pebble finish will be applied to garden beds outside Northgate so cigarette butts can be cleaned off easier. *16/10/2023*	01/07/2023	01/07/2024	25% 25 / 100
2.2.2 Implement the Reflect Reconciliation Action Plan to rengthen relationships with respect for and opportunities for original and Torres Strait Islander peoples	Manager Community	NEW Comments: •The Reconciliation Action Working Group (RAWG) established and are scheduled to meet every two months. The terms of reference has been drafted. •New reporting spreadsheet developed and implemented • Officers are to provide monthly updates against the actions in the RAP. • Cultural Awareness training options are being explored. *05/04/2024*	01/07/2023	30/06/2024	40% 40 / 100
1.1.1 Progress Glenorchy's economic development through frastructure support, job creation, city marketing, and a oactive regulatory approach	Manager Stakeholder Engagement	NEW Comments: During Q3 economic development within the Municipality continued through the four defined pillars of infrastructure development, job creation through the Glenorchy Jobs Hub, operation of which transferred to GCC in September 2023; city marketing; and a proactive regulatory approach. In addition, GCC continues to engage with local businesses to gauge the support and advice they need. *10/04/2024*	01/07/2023	01/07/2024	75% 75 / 100
2.1.1 Facilitate the operation of the Glenorchy Jobs Hub to nnect local people with local jobs and assist local industry d business to meet current and future workforce needs	Manager People and Governance	NEW Comments: 31/03/2024 - The Jobs Hub successfully held the annual Jobs Fair on 19 March 2024 with 35 employers and over 750 job seekers attending the 4 hour expo. Feedback was overwhelmingly positive with some employers actively interviewing on the day. The jobs hub will follow up employers after 4 weeks to ascertain jobs filled on the day. To date the Jobs Hub has assisted employers fill 1257 positions since opening in August 2021. It has a total of 1683 registered applicants. *08/04/2024*	01/07/2023	01/07/2024	55% 55 / 100
2.2.1 Identify and progress amendments required to enorchy's planning scheme to facilitate growth including ructure plans of future residential land	Manager Development	NEW Comments: Q3 Both the Principal Activity Centre (PAC) and Northern Apartments Corridor (NAC) specific area plans were approved by the Tasmanian Planning Commission and became effective on Wed 13 Mar 2024. The Mill Lane Precinct specific area plan has undergone informal consultation and is scheduled to go before the Glenorchy Planning Authority on Monday 15th April 2024. The amendment proposes to rezone the land within the Mill Lane Precinct to an Urban Mixed Use Zone so existing business can stay while providing opportunities for well-designed apartments close to the Glenorchy CBD. A planning scheme amendment has been lodged for the Royal Agricultural Society of Tasmania showgrounds to facilitate redevelopment of the site to accommodate residential development. The application is not yet valid however informal internal referrals are underway. On behalf of the State Government, consultants are undertaking State-wide residential land supply analysis under the Greater Hobart Plan/Regional Land Use Strategy review. Council officers reviewed a 'first cut' of the analysis and provided feedback on the results for Glenorchy, and the underlying methodology. More work is to be undertaken to modify the approach to account for the Hobart (and Glenorchy) metropolitan context. *08/04/2024*	01/07/2023	01/07/2024	75% 75 / 100
1.2.1 Keep the community up to date with regular and propriate communication about Council projects, decisions d operations through social media, website and conventional edia	Manager Stakeholder Engagement	NEW Comments: During Q3 communicating council activity continued through social media channels, Facebook and Instagram; via the GCC website; and a number of stories broadcast through conventional media including print, radio and television. *10/04/2024*	01/07/2023	01/07/2024	75% 75 / 100
2.1.1 Maintain and upgrade stormwater infrastructure with a iority on reducing flood risk	Manager Infrastructure, Engineering & Design	NEW Comments: Humphreys Rivulet project to commence this month. Abbotsfield Park stormwater project to commence before the end of the financial year. *03/04/2024*	01/07/2023	01/07/2024	60% 60 / 100

2.4.3 Upgrade Council's core software technology through the fective delivery of Project Hudson to enhance customer and er experience and productivity	Manager ICT Services	NEW Comments: Project Hudson is on Track and is scheduled for 3 key phases. The first Phase involves the transition to the new modules for Property and Rating, Finance, Payroll and HR, with a proposed go live date in April 2024. Phase 2 will commence prior to Phase 1 going live in April 2024 and be running concurrently. Over 90 workshops have been schedules with staff subject matter experts and the vendors subject matter specialists. The first workshops commenced in October 2023 with Finance specific workshop, which included a new draft Chart of Accounts. Extensive work has been undertaken to ensure the workshop sessions with the vendors are adequately resources to allow Council to maximise the value of the workshops in configuring the system and in preparing Council for business changes. *15/10/2023*	01/07/2023	01/07/2024	25% 25 / 100
1.3.2 Reduce waste to landfill to extend the life of our landfill ile meeting environmental standards	Manager Property, Environment & Waste	NEW Comments: 327 tonnes of waste diverted from the Jackson Street Landfill in Q3 through recovery of materials such as metals and recovery shop salvaging. 1,124 tonnes of kerbside waste diverted through FOGO kerbside collection, and 957 tonnes though recycling kerbside collections in Q3. *05/04/2024*	01/07/2023	01/07/2024	75% 75 / 100
1.3.3 Explore options for waste management beyond the ndfill life	Manager Property, Environment & Waste	NEW Comments: Work underway on resurveying and planning the final extension of the landfill to extend its life. *02/10/2023*	01/07/2023	01/07/2024	75% 75 / 100
2.3.1 Complete a new regional Playspace at Giblins Reserve, a w district Playspace at Benjafield Park and progress the grade of 10 local Playspaces under the Glenorchy Playspace rategy	Manager Property, Environment & Waste	NEW Comments: Completed December *23/01/2024*	01/07/2023	01/07/2024	100% 100 / 100
2.3.2 Work with TasWater as the lead partner to implement the losa Park Redevelopment Project Stage A and seek funding r Stage B to develop it into a major regional recreational stination	Manager Property, Environment & Waste	NEW Comments: TasWater has awarded the construction contract to Gradco and works are underway. Current program has works expected to be completed at the end of FY. *02/10/2023*	01/07/2023	01/07/2024	75% 75 / 100
2.3.5 Deliver the federally funded sport and recreation ojects at KGV Football Park and North Chigwell Junior Soccer ib	Manager Property, Environment & Waste	NEW Comments: KGV - Pitch upgrade and lighting upgrade completed last FY. Fencing completed Q1. Contract awarded for Changerooms and Toilets with works underway. New Changerooms and toilets expected completion in Q4. Refurbishment of old changerooms and grandstand next FY. North Chigwell - Pitch upgrades and lighting upgrade completed last FY. Changerooms/clubhouse contract awarded. Construction commencing in Q4, with completion next FY. *03/04/2024*	01/07/2023	01/07/2024	75% 75 / 100
2.4.1 Manage and maintain a road network that meets the nsport needs of the community	Manager Works	NEW Comments: Road Maintenance programs have been commenced. Council's capital works program for roads was competed last year improving the overall standard of road pavements in Glenorchy. *09/10/2023*	01/07/2023	01/07/2024	25% 25 / 100

GLENORCHY CITY COUNCIL

ANNUAL PLAN PROGRESS REPORT [ALL]: 31 MARCH, 2024

15/04/2024

65 GOALS

63% GOAL COMPLETION

Draft · Not started · Behind · On Track · Overdue · Complete · → Direct Alignment · ⇢ Indirect Alignment

023/2024 ANNUAL PLAN

Goal	Owner	Start Date	Due Date	Current Completion
.1.1.1 Review the Moonah Arts Centre Business Plan	Manager Community	01/07/2023	30/06/2024	30%
.1.1.2 Provide quality, sustainable, compliant childcare ervices : 100 to 100	Manager Community	01/07/2023	30/06/2024	On Track 100%
.1.2.1 Coordinate literacy activities including digital cills, employment services, family literacy and olunteering	Manager Community	01/07/2023	30/06/2024	70%
.2.1.1 Secure future funding for the Multicultural Hub and eliver the first stage of the commercial kitchen evelopment	Manager Community	01/07/2023	30/06/2024	70%
.2.1.2 Deliver grant funded projects that support mental ealth courses and "Glenorchy on the Go" projects	Manager Community	01/07/2023	30/06/2024	75%
.2.2.1 Actively contribute to housing supply in the City rough the actions in Council's Statement of Commitment n Housing	Manager Community	01/07/2023	30/06/2024	49%
.1.1.1 Work in collaboration with government agencies nd community organisations to deliver diversional rograms that aim to improve youth and community safety, esilience, and engagement	Manager Community	01/07/2023	30/06/2024	75%
.1.2.1 Improve the cleanliness of our CBDs by increasing e frequency of cleaning activities including graffiti emoval, litter pick up, street sweeping and footpath eaning	Manager Works	01/07/2023	01/07/2024	25%
.1.2.2 Maintain the City's infrastructure within defined ervice levels so that it is in good condition for our ommunity	Manager Works	01/07/2023	01/07/2024	25%
.2.1.1 Plan, promote and present an annual program of ts and cultural exhibitions, workshops, concerts, and	Manager Community	01/07/2023	30/06/2024	75%

Goal	Owner	Start Date	Due Date	Current Completion
.2.2.1 Deliver events such as International Day for People ith a Disability, Disability Awareness workshops, 3BTQI+ safety and easy English training	Manager Community	01/07/2023	30/06/2024	75%
.2.2.2 Implement the Reflect Reconciliation Action Plan strengthen relationships with respect for and pportunities for Aboriginal and Torres Strait Islander eoples	Manager Community	01/07/2023	30/06/2024	40%
.2.3.1 Plan and support the delivery of Civic events and wards programs	Manager Stakeholder Engagement	01/07/2023	01/07/2024	75%
.2.3.2 Deliver, partner and support community and ultural development through programs and events	Manager Community	01/07/2023	30/06/2024	75%
.1.1.1 Progress Glenorchy's economic development rough infrastructure support, job creation, city arketing, and a proactive regulatory approach	Manager Stakeholder Engagement	01/07/2023	01/07/2024	75%
.1.2.1 Assess planning permit applications against the lanning Scheme as required, working constructively with arties through the process	Manager Development	01/07/2023	01/07/2024	75%
.1.2.2 Assess building and plumbing applications against e National Construction Code, working constructively ith parties through the process	Manager Development	01/07/2023	01/07/2024	75%
.1.3.1 Review the Customer Service Charter to ensure ustomer service levels are appropriate and able to meet xpectations	Manager Customer Services	01/07/2023	01/07/2024	100%
.1.3.2 Update Council's forms and develop a Council wide alendar of activities under the Customer Service Strategy	Manager Customer Services	01/07/2023	01/07/2024	60%
.1.3.3 Provide a high standard of customer service by eeting or exceeding other service levels in our Customer ervice Charter	Manager Customer Services	01/07/2023	01/07/2024	75%
.2.1.1 Facilitate the operation of the Glenorchy Jobs Hub connect local people with local jobs and assist local dustry and business to meet current and future orkforce needs	Manager People and Governance	01/07/2023	01/07/2024	55%
.2.2.1 Identify and progress amendments required to lenorchy's planning scheme to facilitate growth including ructure plans of future residential land	Manager Development	01/07/2023	01/07/2024	75%
.2.2.2 Review the Glenorchy Parking Strategy 2017-2027 include the development of parking plans and a cash-in-eu of car parking policy	Manager Infrastructure, Engineering & Design	01/07/2023	01/07/2024	60%
.1.1.1 Seek community feedback to guide our decision-aking, using the Community Engagement Framework	Manager Stakeholder Engagement	01/07/2023	01/07/2024	75%
.1.1.2 Maintain up to date Council policies and easy to ccess financial hardship assistance	Manager Finance	01/07/2023	01/07/2024	75%
.1.2.1 Keep the community up to date with regular and ppropriate communication about Council projects, ecisions and operations through social media, website nd conventional media	Manager Stakeholder Engagement	01/07/2023	01/07/2024	75%
.1.3.1 Facilitate and engage with partners to advocate for e reduction of harm caused to individuals, families, and e broader community by gaming machines in our city	Manager Community	01/07/2023	30/06/2024	50%

Goal	Owner	Start Date	Due Date	Current Completion
.1.3.2 Implement Council's Statement of Commitment on ousing and contribute to State Government policy and gislation	Manager Community	01/07/2023	30/06/2024	60%
.1.4.1 Prepare high quality officer reports for Elected lember decision-making and publish open agenda, and inute documents on Council's website within the tatutory timeframe	Manager Stakeholder Engagement	01/07/2023	01/07/2024	75%
.1.5.1 Participate in the Hobart City Deal, Greater Hobart ommittee, Greater Hobart Strategic Partnership, Local overnment Association of Tasmania, TasWater Owners epresentatives' Group and Southern Tasmanian Regional 'aste Authority Owners Forum	General Manager	01/07/2023	01/07/2024	26%
.1.5.2 Actively participate in the Future of Local overnment Review	General Manager	01/07/2023	01/07/2024	26%
.1.6.1 Implement the Bushfire Mitigation Program to ianage the risk of bushfire to the City and protect natural ılues	Manager Works	01/07/2023	01/07/2024	9%
.1.6.2 Ensure we are prepared for disaster and maintain mergency Management Strategies	Manager People and Governance	01/07/2023	01/07/2024	50%
.2.1.1 Maintain and upgrade stormwater infrastructure ith a priority on reducing flood risk	Manager Infrastructure, Engineering & Design	01/07/2023	01/07/2024	60%
.2.1.2 Manage Council's property, parks and recreation frastructure and facilities sustainability for the benefit of ie community by implementing asset management plans iat maintain or replace facilities as they reach the end of ieir useful lives	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.2.1 Produce and monitor the Annual budget in line with ie long-term financial management plan	Manager Finance	01/07/2023	01/07/2024	75%
.2.2.2 Prepare Council's Annual Plan and monitor the rogress of actions	Manager Stakeholder Engagement	01/07/2023	01/07/2024	75%
.2.2.3 Investigate options and advocate for pool pgrades, redevelopment or alternative options that romote the community's health and wellbeing	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.2.4 Develop a governance framework to guide ctioning of and status reporting on Council's informing rategies	Manager People and Governance	01/07/2023	01/07/2024	27%
.2.3.1 Actively manage Council's strategic risks within ieir agreed risk appetites and provide regular status ports	Manager People and Governance	01/07/2023	01/07/2024	26%
.2.3.2 Manage Council's information assets within atutory requirements	Manager Customer Services	01/07/2023	01/07/2024	75%
.2.3.3 Undertake property inspections to ensure sidents keep their properties free of fire risks	Manager Customer Services	01/07/2023	01/07/2024	75%
.2.3.4 Assist businesses to comply with public health quirements	Manager Development	01/07/2023	01/07/2024	75%
.2.3.5 Assist drivers to ensure compliance with parking gulations	Manager Customer Services	01/07/2023	01/07/2024	75%
.2.3.6 Assist residents to ensure compliance with animal ianagement regulations	Manager Customer Services	01/07/2023	01/07/2024	75%

Goal	Owner	Start Date	Due Date	Current Completion
.2.4.1 Implement the WHS Development Framework to ıpport staff in delivering services in a safe workplace ıat complies with workplace health and safety obligations	Manager People and Governance	01/07/2023	01/07/2024	40%
.2.4.2 Implement the Workforce Development Framework 023-2026 to support staff in delivering services and ısure a culture of continuous improvement	Manager People and Governance	01/07/2023	01/07/2024	40%
.2.4.3 Upgrade Council's core software technology ırough the effective delivery of Project Hudson to ıhance customer and user experience and productivity	Manager ICT Services	01/07/2023	01/07/2024	25%
.1.1.1 Participate in the Derwent Estuary Program by ndertaking water quality monitoring and reporting	Manager Development	01/12/2023	30/06/2024	100%
.1.2.1 Support stewardship of our natural environment ırough education programs and volunteer events in ıtural reserve areas	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.1.3.1 Implement and update the Waste Management trategy	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.1.3.2 Reduce waste to landfill to extend the life of our ndfill while meeting environmental standards	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.1.3.3 Explore options for waste management beyond the ndfill life	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.1.4.1 To develop a climate change mitigation action plan ır reducing Council's greenhouse gas emissions	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.1.1 Develop a new public toilet at Windemere Reserve 023/24, under the Public Toilet Strategy 2020-2030	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.2.1 Deliver the capital works program to renew and ɔgrade Council Infrastructure	Manager Infrastructure, Engineering & Design	01/07/2023	01/07/2024	52%
.2.3.1 Complete a new regional Playspace at Giblins eserve, a new district Playspace at Benjafield Park and rogress the upgrade of 10 local Playspaces under the lenorchy Playspace Strategy	Manager Property, Environment & Waste	01/07/2023	01/07/2024	100%
.2.3.2 Work with TasWater as the lead partner to nplement the Tolosa Park Redevelopment Project Stage and seek funding for Stage B to develop it into a major gional recreational destination	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.3.3 Establish a Public Art Oversight Group to advise on nd oversee the development and maintenance of public rt in the City's public spaces	Manager Community	01/07/2023	30/06/2024	50%
.2.3.4 Seek funding or interested investors to implement ıe Mountain Bike Masterplan	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.3.5 Deliver the federally funded sport and recreation rojects at KGV Football Park and North Chigwell Junior occer Hub	Manager Property, Environment & Waste	01/07/2023	01/07/2024	75%
.2.3.6 Investigate the future of the Glenorchy War lemorial Pool, including redevelopment or alternative ptions that promote the community's health and ellbeing	Director Infrastructure & Works	01/07/2023	01/07/2024	15%
.2.4.1 Manage and maintain a road network that meets ıe transport needs of the community	Manager Works	01/07/2023	01/07/2024	25%
.2.4.2 Review Urban Road network to prioritise blackspot ınding addressing capacity issues - June 2025	Manager Infrastructure, Engineering & Design	01/07/2023	01/07/2025	75%

.2.4.3 Provide a network of shared paths, footpaths and ails that is safe and provides access to all abilities - cluding a hierarchy review to improve the network	Manager Infrastructure, Engineering & Design	01/07/2023	01/07/2024	75%

COUNCIL POLICY

Private Works Policy

GLENORCHY CITY COUNCIL

PURPOSE

The purpose of this Policy is to:

- Provide transparent and consistent guidelines for any circumstance where Council performs private works.
- Ensure that if private works are undertaken by Council this at market prices. This ensures an acceptable profit margin and full cost recovery to Glenorchy City Council that is consistent with the no advantage requirements of the Local Government Act 1993 and anti-competitive requirements.

SCOPE

This policy applies to:

- Private works undertaken by Council on behalf of individuals, private organisations and businesses. Works may include the supply of labour, materials, plant, services, and other resources.
- Works undertaken by Council on behalf of State Government Departments and other service authorities.

STRATEGIC PLAN ALIGNMENT

Valuing Our Environment

Strategy 3.1.3	Manage the City's transport network and the associated infrastructure to promote sustainability, accessibility, choice, safety and amenity for all modes of transport.

Leading Our Community

Objective 4.1	Govern in the best interests of our community
Strategy 4.1.1	Manage Council for maximum efficiency, accountability and transparency

RELATED DOCUMENTS

- Glenorchy City Council Code for Tenders and Contracts
- Glenorchy Risk Management Policy
- Glenorchy Code of Conduct for Employees
- Glenorchy Safety Commitment
- Glenorchy Receipt of Gifts and Benefits Policy

STATUTORY REQUIREMENTS

Acts	*Local Government Act 1993*

GLENORCHY CITY COUNCIL

April 2024

	Competition and Consumer Act 2010
Regulations	*N/A*
Australian/International Standards	*N/A*

DEFINITIONS

Applicant means the person or entity named in the Works Agreement

Council means Glenorchy City Council

Private works means the supply of Council's labour, materials, plant, services, and any other resources where the provision of those services are beyond the role and responsibility of Council.

Major private works means any private works valued above $50,000 (excl GST).

Minor private works means any private works valued at or below $50,000 (excl GST).

BACKGROUND

The organisation has considerable in-house skills and resources which at times can be made available for supply to parties outside the organisation.

On occasions that such private works are provided, all associated costs, at a minimum, need to be recouped.

POLICY STATEMENT

1. Council does not generally undertake private works except under special circumstances as approved by the relevant Manager, Director or General Manager.
2. Priority for use of Council's plant, equipment, labour and other resources is to be given to Council's own work program at all times, before entering into any private works arrangement.
3. It is Council's preference that all private works be undertaken by private contractors in the first instance.
4. Requests for private works must be made in writing to the General Manager.
5. Council reserves the right to refuse a request for private works, specifically if it is deemed to be outside of Council's capabilities or resource availability and with consideration to clause 11.

State Government and service authorities

6. Council occasionally undertakes works on behalf of State Government Departments or service authorities. Requests for these works will be evaluated on merit with

consideration to community benefit and Council's capability and resource availability to undertake the works requested.

7. Works undertaken on behalf of State Government Departments and service authorities must include full cost recovery to Council.

8. Works undertaken on behalf of State Government and service authorities will require the consent of the General Manager.

Other private works

9. Other minor private works (valued at or below $50,000) will require the consent of the General Manager, Director or relevant Department Manager.

10. Other major private works (valued above $50,000) will require the consent of the General Manager.

11. Major private works will only be considered in the following circumstances:

    a. There is no private contractor available to undertake the work;

    b. The project would be of strategic economic, social, safety or environmental benefit to the community;

    c. The Staff and Council have the capacity to undertake the project; and

    d. It may provide a valuable training opportunity for the Staff.

Plant hire

12. Council will not hire out plant without an approved Council operator and in accordance with this Policy.

13. Council is responsible for the payment of Council operators engaged on private works. No other payment arrangements are permissible.

Works agreement

14. Council will only undertake private works following the execution of a works agreement for either a fixed price or a schedule of rates, with detailed scope of works, bill of quantities and terms of trade included.

15. For Major Private Works detailed design drawings, specifications and all required permits are to be provided to Council prior to commencement of works.

16. All private works will be authorised and costed according to Council's standard procedures and in strict alignment with this policy.

17. All private works are to be undertaken in accordance with Council's standard operating procedures and employee agreements and in compliance with Council's risk management and work health and safety procedures.

18. Where unforeseen circumstances require a change to the scope of works or will incur additional costs, the works agreement may be renegotiated or terminated.

Invoicing and Payment

19. For each private works, a separate job/project account will be created in the Councils finance system to capture all costs relating to that particular private works.

20. Upon completion of the private works, an invoice will be issued which will include all costs captured in the separate job/project account plus oncosts and any other costs permitted by the Works Agreement

Deposit, Progress Payment or Other Security

21. The applicant may be required to provide a deposit, progress payment or other form of security prior to the commencement or during the undertaking of the private works

Conflict of interest

22. Council employees, elected members, volunteers, consultants and contractors must not gain any advantage if any private works are undertaken by Council and all provisions contained in this policy and Council's Code of Conduct for Employees apply.

DOCUMENT CONTROL

Version:	1.0	**Adopted**		**Commencement Date**	
Minutes Reference				**Review Period**	4 Years from adoption
Previous Versions:	N/A				
Responsible Directorate	Infrastructure & Development		**Controller:**	Manager Assets Engineering and Design	
ECM Document No.:					