APPENDIX 4: FLOOD REPORT

ALLAN & DENNIS

CITISWICH STAGE 7

REGIONAL FLOOD IMPACT ASSESSMENT

AUGUST 2023

J17015/R10V1

PREPARED FOR
WALKER
CORPORATION

DOCUMENT INFORMATION

Prepared for:
Walker Corporation

Job reference:
J17015

Report reference:
R10v1

ALLAN & DENNIS PTY LTD

ABN 20 621 755 440

2/505 Lytton Road
Morningside Q 4170

07 3899 8379

allandennis.com.au
admin@allandennis.com.au

PREPARED

RPEQ 17118
2023.08.24 15:35:50 +10'00'

Laurence Allan
Principal Engineer

APPROVED

RPEQ 16758
2023.08.24 15:37:23 +10'00'

Rick Dennis
Principal Engineer

REVISION HISTORY

Version	Date	Revision	Prepared	Approved
R10v1	24 August 2023	For Council Submission	L. Allan	R. Dennis

EXECUTIVE SUMMARY

This regional flood impact assessment has been prepared by Allan & Dennis to support the development application of Citiswich Stage 7. Citiswich Stage 7 is approximately 115 hectares and is bounded by the Bremer River to the west and north, the Warrego Highway to the south and existing lots to the east, as shown on Figure 1.

The overall site development was assessed in the Citiswich Master Plan Flood Study (CLT, 2012, August) and approved by Ipswich City Council 8 October 2012. As noted in Ipswich City Council's approval letter, the Citiswich Master Plan Flood Study considered fill beyond the preliminary approval (in terms of plan area) to override the planning scheme and land use zoning.

Since this approval, subsequent regional flood studies have been prepared:

- Brisbane River Catchment Flood Study (BMT WBM, 2017) and update (BMT, 2020); and
- Ipswich Rivers Flood Study Update, (BMT, 2019).

This report considers both regional flood studies to determine the most appropriate model to adopt for future flood impact assessments of the Citiswich site. Although the Citiswich site is located within the lower Bremer River, peak flooding is generally driven by Brisbane River backwater inundation. For this reason, the Brisbane River Catchment Flood Study hydraulic model was adopted for this flood impact assessment.

To ensure site specific suitability, the Brisbane River Catchment Flood Study hydraulic model was updated and considered the following scenarios:

- Base – As per the Citiswich site in its current condition and the approved Citiswich Stage 7 fill;
- Proposed – as per the Base scenario, with the proposed Citiswich Stage 7 fill; and
- Riparian Revegetation – as per the Base scenario, with increase in hydraulic roughness (representing an increase in vegetation density) along a 25 m corridor of the Bremer River bank.

The following model features were **not** changed from the Brisbane River Catchment Flood Study:

- Hydrologic inputs;
- Computational engine (Tuflow Classic); or
- Topographic or hydraulic roughness outside of the Citiswich site boundary.

The Base scenario produces a reasonable match to the Brisbane River Catchment Flood Study 1% and 2% Annual Exceedance Probability flood levels.

The Proposed scenario results indicate negligible difference in predicted flood levels or discharge. Furthermore, the Proposed fill provides a higher flood immunity than the current operational works approval (ref: 3668/2013/MAEXT/D). In addition, access will be via the proposed Westphalen Road extension, providing 1% Annual Exceedance Probability access east to the Cunningham and Warrego Highways, further reducing flood risk.

Riparian rehabilitation within Citiswich Stage 7 is not being considered as results indicate adverse flood impacts external to the site, irrespective of the fill being placed.

NOMENCLATURE

A&D	Allan & Dennis Pty Ltd
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AFRL	Adopted Flood Regulation Line
ALS	Aerial Laser Survey
ARI	Average Recurrence Interval
ARR	Australia Runoff and Rainfall
BRCFS	Brisbane River Catchment Flood Study (BMT WBM, 2017), (BMT, 2020)
CLT	Cardno Lawson Treloar
Council	Ipswich City Council
DA	Development Application
DFL	Defined Flood Level
DNRM	Department of Natural Resources and Mines
FIA	Flood Impact Assessment
IEAust	The Institution of Engineers Australia
IPWEAQ	Institute of Public Works Engineering Australasia
IRFSU	Ipswich Rivers Flood Study Update (BMT, 2019)
LGA	Local Government Area
MCU	Material Change of Use
MPFS	Master Plan Flood Study (CLT, 2012, August)
OpW	Operational Works
PMF	Probable Maximum Flood
QUDM	Queensland Urban Drainage Manual
ROL	Reconfiguration of Lot
RZHIA	Riparian Zone Hydraulic Impact Assessment (CLT, 2012, June)
WCL	Walker Corporation Limited (Current owner of the overall Citiswich site)

In-line with the recent implementation of ARR (Ball, et al., 2019) design storm events are described in terms of AEP, the probability of a storm event magnitude exceeded in any given year as a percentage. This terminology was implemented to replace the ARI, of which is commonly misinterpreted, for example, that a 1 in 10 year ARI will occur exactly once in every ten years. The reference equivalency of standard design storm events are presented below:

AEP (%)	ARI (year)	Shorthand	BRCFS Notation	IRFSU Notation
50	1 in 2	Q2	D0002	Q00002
20	1 in 5	Q5	D0005	Q00005
10	1 in 9.49	Q10	D0010	Q00010
5	1 in 20	Q20	D0020	Q00020
2	1 in 50	Q50	D0050	Q00050
1	1 in 100	Q100	D0100	Q00100

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

This regional Flood Impact Assessment (FIA) has been prepared by Allan & Dennis Pty Ltd (A&D) to support the Walker Corporation (WCL) Development Application (DA) for Citiswich Stage 7. Citiswich Stage 7 is approximately 115 hectares and is bounded by the Bremer River to the west and north, the Warrego Highway to the south with existing lots to the east. The site location and Citiswich Stage 7 extents are shown on Figure 1.

The development of the Citiswich site was assessed in the Citiswich Master Plan Flood Study (MPFS) (CLT, 2012, August) and approved by Ipswich City Council (Council) on 8 October 2012. As noted in Council's approval letter, the MPFS considered fill beyond that (in terms of plan area) of the preliminary approval to override the planning scheme and now current land use zoning, specifically the site north of the Warrego Highway (Citiswich Stage 7).

Citiswich Stage 7 fill has Operational Works approval (ref: 3668/2013/MAEXT/D) and has substantially commenced.

However, since the approval, subsequent regional studies have been prepared, including:

- Brisbane River Catchment Flood Study (BRCFS) (BMT WBM, 2017) and update (BMT, 2020); and
- Ipswich Rivers Flood Study Update (IRFSU), (BMT, 2019).

As per discussions with Council, this updated assessment has been issued to consider the subsequent regional studies, in order to demonstrate no adverse flood impacts external to the site relative to the current approval.

Citiswich Stage 7 is zoned as industrial use and situated between the 1 in 20 development line and the Adopted Flood Regulation Line (AFRL) (the 1974 historical flood level). In accordance with Council's Planning Scheme (ICC, 2006) industrial land use is supported within the 1 in 20 development line and the AFRL. The proposed Citiswich Stage 7 fill pad and access (via the future Westphalen Road extension) to the site are proposed to be situated above the 1% AEP in accordance with Council's Implementation Guideline No. 24 (ICC, 2016).

1.2 OBJECTIVES

With the introduction of the BRCFS and the IRFSU, the previously approved MPFS hydraulic model has been potentially superseded. However, both the BRCFS and IRFSU models differ in their purpose and how they represent flood behaviour in the lower Bremer River.

The overall objective of this report is to assess the hydraulic impacts of the proposed Citiswich Stage 7 fill against the approved fill under Operational Works 3668/2013/MAEXT/D. This will be achieved by reviewing the flood behaviour within the vicinity of the Citiswich Site of both the BRCFS and IRFSU and selecting a single model to conduct a FIA of the proposed Citiswich Stage 7 development.

1.3 APPROACH

This assessment will be undertaken by:

- Obtaining, reviewing and simulating the BRCFS and IRFSU flood models;
- Determine the most appropriate model to use for this FIA;
- Update the preferred model to represent the current Citiswich site;
- Compare results to the unaltered model and verify the models are still suitably calibrated within the vicinity of the Citiswich site; and

- Conduct a FIA considering design events up to the 1% AEP to assess and (if needed) modify the approved Citiswich Stage 7 fill pad to obtain acceptable results.

1.4 REPORT STRUCTURE

The report is structured as follows:

- Section 2 compares flood results from the BRCFS and IRFSU and identifies the adopted model for this FIA;
- Section 3 details the methodology and results of the Citiswich Stage 7 FIA;
- Section 4 summarises the conclusion and recommendations of this FIA;
- Section 5 qualifies the data and reports relied upon in this assessment;
- Section 6 provides acknowledgement to others whom assisted in the preparation of this assessment; and
- Section 7 provides a list of referenced reports and documents relevant to this assessment.

Appendices are structured as follows:

- Appendix A provides a comparison of the BRCFS and IRFSU results in the lower Bremer River;
- Appendix B illustrates the base scenario design event flood depth results;
- Appendix C illustrates the proposed scenario relative flood level difference; and
- Appendix D illustrates the riparian revegetation scenario relative flood level difference.

2 REGIONAL FLOOD MODEL COMPARISON

2.1 OVERVIEW

2.1.1 MASTERPLAN FLOOD STUDY

The MPFS adopted design flood events from the regional one-dimensional (1D) hydraulic model (SKM, July 2000) to create a calibrated two-dimensional (2D) SOBEK hydraulic sub-model of the site and surrounds. It assessed design event flooding from both Bremer and Brisbane River sources, resulting in critical storm durations of 18 and 30 hours respectively. The Brisbane River event produced peak site flood levels.

MPFS MODEL PARAMETERS

- SOBEK hydraulic model;
- 10 m grid;
- Model extends from Tivoli to the confluence of the Brisbane River;
- Australian Rainfall & Runoff (ARR) 1987 (Pilgrim, 1987) hydrology; and
- Calibrated to regional 1D hydraulic model (SKM, July 2000).

2.1.2 BRISBANE RIVER CATCHMENT FLOOD STUDY

The BRCFS adopted best-practice methodology and updated hydrologic data, resulting in modified design floods. It assessed design events from the 50% Annual Exceedance Probability (AEP) to 1% AEP (including climate change) along with rare and extreme events up to the 0.001% AEP (a proxy for the PMF). Both the hydrologic and hydraulic models that underwent rigorous calibration to historical events.

BRCFS MODEL PARAMETERS

- Tuflow Classic hydraulic model;
- 30 m grid;
- Model extends from Willowbank to the Port of Brisbane;
- Monte Carlo (Total Probability Theorem) hydrology (Ball, et al., 2019); and
- Extensive calibration to historic events.

2.1.3 IPSWICH RIVERS FLOOD STUDY UPDATE

Council commissioned a Local Government Area (LGA) specific flood study, based on the BRCFS. The hydrologic methodology was simplified to temporal pattern ensembles of ARR 2019 (Ball, et al., 2019), including climate change scenarios. The hydraulic model adopts an updated computational scheme (Heavily Parallelised Compute (HPC)). The IRFSU model forms a sound basis for benchmarking future flood level management investigations and flood planning (i.e. setting flood levels for development).

IRFSU MODEL PARAMETERS

- Tuflow HPC hydraulic model;
- 10 m grid;
- Model extends from Mount Edwards to the confluence of the Brisbane River;
- Temporal pattern ensemble hydrology (Ball, et al., 2019);
- Calibration focused at the Ipswich Central Business District (CBD)

2.2 RESULTS

Both the BRCFS and IRFSU were simulated for all design events and durations, peak discharge and flood levels were extracted and compared in the following sections. Table 2-1 presents key reporting points (flood level) and lines (discharge) as illustrated in Appendix A.

Appendix A also contains tabulated results of additional intermediate locations along with flood surface level long sections for both design events and the historical 1974 and 2011 events. The flood surface level long-sections start at the confluence of Warrill Creek and the Bremer River (Chainage 0 km) and extend past the Bremer / Brisbane River confluence (Chainage 29 km).

TABLE 2-1 DISCHARGE REPORTING LINE & FLOOD LEVEL REPORTING POINT LOCATIONS

Line ID (Discharge)	Point ID (Flood Level)	Location Description
Q_BRE_024km	RP343	Bremer River at Old Toowoomba Road, West Ipswich
17_2	RP351	Bremer River at East Street Bridge, Ipswich CBD
BREM08	BREM21	Bremer River, 1 km upstream of Brisbane River Confluence

2.2.1 DESIGN EVENTS

Table 2-2 and Table 2-3 present a comparison of the discharge and flood levels for the Design Events, produced by the BRCFS and IRFSU.

TABLE 2-2 BRCFS VS IRFSU PEAK DISCHARGE COMPARISON – DESIGN EVENTS

AEP	**Q_BRE_024km** Discharge (m^3/s)				**17_2** Discharge (m^3/s)				**BREM08** Discharge (m^3/s)			
(%)	BRCFS	IRFSU	Diff.	Diff %	BRCFS	IRFSU	Diff.	Diff %	BRCFS	IRFSU	Diff.	Diff %
1	3984	4010	26	0.6	3813	3967	154	4.0	3349	4049	700	20.9
2	3248	3302	54	1.7	3234	3268	35	1.1	3136	3345	209	6.7
5	2339	2509	170	7.3	2280	2491	211	9.2	2200	2551	351	15.9
10	1928	1732	-196	-10.2	1890	1726	-165	-8.7	2036	1772	-264	-12.9
20	1311	1167	-144	-11.0	1276	1163	-113	-8.8	1243	1209	-34	-2.7
50	43	664	621	1435	46	662	616	1331	153	690	537	351

Diff in the above table is short for difference.

Table 2-2 generally shows peak discharges are consistent in both the BRCFS and IRFSU outputs upstream of the Ipswich CBD, however the variance in peak discharge increases closer to the Brisbane River confluence with the IRFSU typically yielding peak discharges greater than those from the BRCFS.

TABLE 2-3 BRCFS VS IRFSU PEAK FLOOD LEVEL COMPARISON – DESIGN EVENTS

AEP	**RP343** Flood Level (mAHD)			**RP351** Flood Level (mAHD)			**BREM21** Flood Level (mAHD)		
(%)	BRCFS	IRFSU	Diff (m)	BRCFS	IRFSU	Diff (m)	BRCFS	IRFSU	Diff (m)
1	24.44	24.85	0.42	19.59	20.16	0.57	18.53	15.88	-2.65
2	23.27	23.29	0.03	18.59	18.75	0.16	14.94	14.57	-0.37
5	20.48	20.86	0.38	15.99	16.13	0.14	10.36	10.86	0.50
10	19.10	18.52	-0.57	14.65	14.80	0.15	7.09	12.13	5.04
20	16.39	15.74	-0.66	11.63	11.81	0.18	4.93	9.12	4.19
50	6.81	12.63	5.83	5.14	7.44	2.30	1.74	1.81	0.07

Diff in the above table is short for difference.

Table 2-3 generally shows similar peak flood levels in both the BRCFS and IRFSU outputs upstream of the Ipswich CBD. However, downstream of the Ipswich CBD the IRFSU produces flood levels lower than the BRCFS despite the IRFSU having a higher discharge within the lower Bremer River.

Appendix A.1 contains a chart further of the predicted peak flood levels from both the BRCFS and IRFSU in the lower Bremer River. This chart illustrates:

- Peak flood levels produced by the BRCFS are significantly lower than those from the IRFSU for the 50%, 20% and 10% AEP;
- Peak flood levels produced by the BRCFS are similar to those from the IRFSU for the 5% and 2% AEP; and
- Peak flood levels produced by the BRCFS are higher than those from the IRFSU for the 1% AEP.

With the exception of the 50% AEP, peak discharges in the Bremer River upstream of the Ipswich CBD are comparable in both the BRCFS and IRFSU with the 1% AEP discharge varying between 0.6% and 4% (East Street, 17_2).

- The IRFSU 50% AEP discharges and flood levels being greater than the BRCFS 50% AEP is more likely associated with the differences in adopted hydrology methodology rather than just being an influence of the assumed tailwater boundary.

Downstream of the Ipswich CBD, the discharge variance increases substantially in the IRFSU compared to BRCFS with a 21.3% increase in discharge at the Brisbane River Confluence (the IRFSU downstream model boundary). Whilst the discharge increases downstream of the Ipswich CBD the flood levels generally decrease compared to the BRCFS. This discrepancy is most likely attributed to the use of a fixed tailwater boundary in the IRFSU that is unable to resolve the complex hydrodynamic interactions between the Brisbane and Bremer River.

The IRFSU design events adopt different fixed tailwater boundary for design scenarios:

- For the 50% and 20% AEP the IRFSU flood models adopted the Mean High Water Spring (MHWS) tide level as a fixed tailwater condition;
- For the 10% - 1% AEP, all durations excluding the 48 hours duration the IRFSU flood models adopted a fixed tailwater condition based on the 10% AEP Brisbane River level determined from the BRCFS at the boundary location; and
- The IRFSU 48 hour durations adopt a fixed tailwater, greater than the 10% AEP BRCFS level, in order raise predicted flood levels in the lower Bremer River to calibrate at the Ipswich CBD. This generally provides a good representation of predicted flood levels upstream of the Ipswich CBD, but to the detriment of the correlation downstream.

In contrast, the BRCFS downstream tailwater boundary is located at the Port of Brisbane and as such does not influence predicted peak flood levels within the lower Bremer River. There is a strong correlation between peak flood levels within the lower Bremer River and the tailwater level in the Brisbane River. The BRCFS provides a good correlation of peak flood levels within the lower Bremer River and the joint probability of flooding from both the Brisbane and Bremer Rivers.

2.2.2 HISTORICAL EVENTS

Table 2-4 and Table 2-5 present a comparison of the discharge and flood levels for the 2011 and 1974 historical event, produced by the BRCFS and IRFSU.

TABLE 2-4 BRCFS VS IRFSU PEAK DISCHARGE COMPARISON – HISTORICAL EVENTS

Event	**Q_BRE_024km** Discharge (m^3/s)				**17_2** Discharge (m^3/s)				**BREM08** Discharge (m^3/s)			
	BRCFS	IRFSU	Diff.	Diff %	BRCFS	IRFSU	Diff.	Diff %	BRCFS	IRFSU	Diff.	Diff %
2011	2435	2459	23	1.0	2307	2315	8	0.3	1767	1874	198	11.8
1974	4537	3942	-596	-13.1	4451	3805	-646	-14.5	3852	3226	-625	-16.2

Diff in the above table is short for difference.

TABLE 2-5 BRCFS VS IRFSU PEAK FLOOD LEVEL COMPARISON – HISTORICAL EVENTS

Event	**RP343** Flood Level (mAHD)			**RP351** Flood Level (mAHD)			**BREM21** Flood Level (mAHD)		
	BRCFS	IRFSU	Diff (m)	BRCFS	IRFSU	Diff (m)	BRCFS	IRFSU	Diff (m)
2011	21.53	21.32	-0.21	19.14	19.14	0.0	18.75	18.58	-0.16
1974	25.82	24.77	-1.06	21.38	20.85	-0.53	20.84	20.33	-0.50

Diff in the above table is short for difference.

Unlike the design event models, for the purposes of calibration the IRFSU adopted a time varying tailwater level at the downstream boundary that was extracted from the BRCFS at that location. Of note, time-varying tailwater levels could not be extracted from the BRCFS design events for use in the IRFSU as the two studies used different hydrologic methods and the peak timing does not correlate, whereas the historical event hydrology is based on recorded rainfall in both studies.

The use of a time-varying tailwater level for calibration of the IRFSU provides a better agreement between the historical flood levels produced by the BRCFS and the IRFSU. Notably the 2011 flood event shows a very good correlation of flood levels between the two models, however the variance in discharge in the IRFSU increases in the lower Bremer River analogous to the design events.

2.3 DISCUSSION

The BRCFS and IRFSU and were developed for different regional scales and focused on different catchment extents, adopted different hydrologic methods and different computational engines.

- The BRCFS focused on the overall flood characteristics of the Brisbane River catchment, including the lower Bremer River.
- The IRFSU focused on the Bremer River catchment and the rivers and creek systems within the Ipswich LGA.

It is noted that:

- The reporting points used for the comparison of flood levels in this report are identical between both the BRCFS and IRFSU, along with the reporting lines downstream of the Ipswich CBD. The reporting lines upstream of the Ipswich CBD are not identical and have a slightly different location and orientation, however, the lines are generally in the same location and are representative of one another;
- The IRFSU, with a 10 m grid, provides a better resolution of conveyance through the river and creeks within the model and as such, it is expected that the peak discharge might vary slightly between the BRCFS and the IRFSU;
- The methodology of the hydrology differs considerably between the BRCFS and the IRFSU.

- The IRFSU hydraulic model uses a more modern and advanced computational engine, that does not produce identical results to the 'classic' Tuflow computational engine; and
- Both the BRCFS and IRFSU models underwent calibration to historical events.

As such, whilst these studies included hydrologic and hydraulic models that underwent rigorous calibration to historical events, results vary between the two flood studies. Furthermore, as noted by (BMT, 2019):

- The IRFSU *'replaces modelled flood output from previous flood studies undertaken for Ipswich City Council in the early 2000's.'*;
- The BRCFS *'represents the best estimates of AEP flood levels on the lower Bremer, including Ipswich, as the BRCFS modelling includes both the Brisbane and Bremer Rivers.'*; and
- *'Downstream of Ipswich, the IRFSU results will deviate from the BRCFS peak water levels and so the BRCFS peak levels should be used.'*

The IRFSU model terminates upstream of the confluence of the Brisbane River with a fixed tailwater boundary. A fixed flood level at this location does not adequately account for interaction of flood waters between the Brisbane and Bremer Rivers within the lower Bremer River nor the joint probability of flooding from the combination of simultaneous flooding from both the Brisbane and Bremer River.

The BRCFS downstream tailwater boundary, located at the Port of Brisbane, does not influence predicted peak flood levels within the lower Bremer River. There is a strong correlation between peak flood levels within the lower Bremer River and the tailwater level in the Brisbane River.

2.4 ADOPTED MODEL

The Citiswich site is located within the lower Bremer River where peak flooding is dominated by Brisbane River backwater flooding. As such, it is considered to be essential that the adopted model must be able to represent this type of flood behaviour within the lower Bremer River.

The BRCFS provides a good correlation of peak flood levels within the lower Bremer River and the joint probability of flooding from both the Brisbane and Bremer Rivers. Whereas, the IRFSU does not simulate this flood behaviour in the lower Bremer River, as such it has been concluded that the BRCFS hydraulic model should be used for assessment of the Citiswich Stage 7 development.

It is also noted, that both models predict similar peak flood levels for the 2011 event and that those flood levels are consistent with the BRCFS 1% AEP, of which the 2011 event had a similar exceedance probability. It is viewed that this observation gives further support for adopting the BRCFS for FIA purposes within the lower Bremer River.

Whilst the BRCFS was produced for flood planning purposes, it can be utilised to determine the relative difference in flood levels for this FIA, as detailed in Section 3.

3 REGIONAL FLOOD IMPACT ASSESSMENT

3.1 METHODOLOGY

The overall regional flood impact assessment methodology included:

- Simulate all BRCFS design events and durations and determine those critical to the Citiswich site;
- Modify the BRCFS to represent the current Citiswich site;
- Update the BRCFS model to include the currently approved and as-constructed (or under construction) development within the overall Citiswich site;
- Create the base scenario, using the approved Citiswich Stage 7 fill; and
- Update the base scenario to assess the proposed Citiswich Stage 7 fill and riparian vegetation.

3.2 SETUP

The regional hydraulic assessment was conducted using the BRCFS v803 TUFLOW Classic hydraulic model (Version 2016-03-AC).

3.2.1 TOPOGRAPHY

The BRCFS flood model topography does not represent the current Citiswich site, as such, the model was updated to include:

- Western Tributary per the ultimate developed scenario detailed in (A&D, 2021, February);
- Stage 1 (along Ashburn Road and Hawkins Crescent) as fully developed industrial lots;
- Stage 2 (along Hoepner Road) as fully developed industrial lots;
- Stage 3 (along Hume Drive) as fully developed industrial lots;
- Stage 4 (along Hume Drive) as fully developed industrial lots;
- Stage 5 (east of Bognuda Street) as fully developed residential lots;
- Stage 6 (west of Bognuda Street) as fully developed residential lots; and
- Stage 7 as per the preliminary approval.

These modifications were incorporated from digital elevation models of the design earthworks related to each of the respective stages DA's with the Citiswich Stage boundaries shown on Figure 1.

3.2.2 HYDRAULIC ROUGHNESS

The BRCFS flood model uses Manning's 'n' values to represent the hydraulic roughness, those relevant to the Citiswich site are presented in Table 3-1.

TABLE 3-1 HYDRAULIC ROUGHNESS AND LAND USE

Land Use	**Hydraulic Roughness (Manning's 'n' Value, s/m$^{1/3}$)**
Roads and road reserve	0.025
Grassed open space	0.040
Light vegetation	0.060
Medium vegetation	0.080
Residential, commercial and industrial lots	0.100
Dense vegetation / unmaintained vegetation	0.160
Buildings	0.200

These hydraulic roughness values represent industry standard values, and were defined within both the BRCFS and IRFSU models.

The unaltered BRCFS flood model represents the hydraulic roughness of Citiswich Stage 7 as two distinct land uses:

- The currently zoned industrial land use, with a hydraulic roughness (Manning's n) of 0.100; and
- The balance of the Citiswich Stage 7 area as open space / grassed with a hydraulic roughness (Manning's n) of 0.040.

These land uses were likely based on land use zones within each LGA, and are reasonable when considering the overall Brisbane and Bremer River catchment flooding. However, not completely representative of site-specific land use.

As such, it was decided to revise the hydraulic roughness within the Citiswich Stage 7 site to reflect the current site condition, based on available aerial imagery (2021-2023). Figure 5 illustrates the adopted base scenario hydraulic roughness.

Figure 6 illustrates the proposed hydraulic roughness, with the proposed Citiswich Stage 7 fill pad adopting a hydraulic roughness (Manning's n) of 0.100 with the hydraulic roughness of the balance of the Citiswich Stage 7 site per the base scenario.

The current RoL lot breakdown is subject to change, as such individual buildings were not modelled with a higher hydraulic roughness value rather, the overall proposed industrial fill pad adopted a hydraulic roughness (Manning's n) of 0.100. This is suitable as it accounts for minor blockages within the land use such as fences and walls but also hydraulically smoother areas such as roads and car parking areas but also buildings will only occupy a portion of each individual lot, with the balance being hardstand and carpark area.

Notwithstanding this, the proposed fill is set at 19.0 mAHD, above the 1% AEP flood level of 18.7 mAHD, the hydraulic roughness only influences rare flood events exceeding the 1% AEP, that are not assessed within this study.

Figures 5, 6 and 7 illustrate the hydraulic roughness for the base, proposed and riparian vegetation scenarios.

3.2.3 MODEL FEATURES THAT REMAIN UNCHANGED

The following features have not been updated, changed or otherwise amended from those of the BRCFS:

- Hydrologic inputs;
    - The hydrologic inputs were not changed as the peak of the local runoff from the proposed Citiswich Stage 7 is anticipated to occur within less than an hour of the onset of a local storm event. Whereas the regional peak discharge from the Bremer / Brisbane River occurs more than 24 hours after the onset of a regional storm event. As such the peak discharge from the local event would have passed well before the regional peak.
- The hydraulic model's computational engine, being Tuflow Classic, and specific software version.
    - Any change to the computational engine, or the software version will affect the predicted flood levels within the entire model domain.
- Computational grid cell size and orientation;
    - Changing the computational grid cell size would affect the conveyance and storage and thus predicted peak flood levels within the entire model domain. It is anticipated that reducing the grid cell size would result in more effective conveyance within the model domain, potentially rendering the original calibration obsolete.

    - The 30 m computational grid size is valid for this FIA due to the scale of the site being assessed.
    - Similarly rotating the grid from its current north-south orientation to better align with the site or Bremer River in the vicinity of the site would result in a slightly different elevation value being assigned to each grid cell. Minor changes to the topographic elevations within the model would also affect the predicted peak flood levels and likely render the calibration ineffective.
- Topographic features outside of the Citiswich site boundary; and
- Hydraulic roughness features outside of the Citiswich site boundary.

3.3 CONDITION SCENARIOS

The following scenarios, were assessed:

3.3.1 BASE SCENARIO (EX05G)

Considers the Citiswich existing site (i.e. Stage 1, 2, 3, 4, 5 and 6 fully developed) and updated to include the currently approved Citiswich Stage 7 fill. Hydraulic roughness was updated to reflect the existing and approved Citiswich Development (i.e. Stage 1, 2, 3, 4, 5 and 6) along with the existing Citiswich Stage 7 vegetation. The base scenario topography and hydraulic roughness are illustrated on Figure 2 and 5 respectively.

3.3.2 PROPOSED SCENARIO (DE11)

Updates the base scenario to include the proposed Citiswich Stage 7 development and includes:

- A south fill pad, that is predominately filled to 19.0 mAHD;
- A northern fill that is predominately cut from the existing ridgeline to 19.0 mAHD;
- An elevated road crossing the eastern tributary connecting the south and north fill pads with 7 / 2.4 x 2.4 m Reinforced Concrete Box Culvert (RCBC); and
- A high flow bypass channel with a base width of 30 m will traverse the southern fill pad. The high flow bypass channel will have a longitudinal grade of 0.5% from an invert of 16.25 mAHD at the south-western end. An internal road will cross the north-eastern end of the high flow bypass with 12 / 2.4 m x 2.4 m RCBC.

The proposed topography and hydraulic roughness are illustrated on Figure 3 and 6 respectively, with topographic difference base scenario shown on Figure 4.

3.3.3 RIPARIAN VEGETATION (EX05G_F3)

Updates the base scenario to include an increased hydraulic roughness (0.16) within a 25 m wide strip along the southern bank of the Bremer River within Citiswich Stage 7 to represent additional riparian revegetation. This scenario does not modify the model topography. The riparian vegetation hydraulic roughness is illustrated on Figure 7.

3.4 CRITICAL DURATION ASSESSMENT

3.4.1 PEAK FLOOD LEVEL

The hydraulic model was assessed for all design AEP and durations to determine the models that produced the highest peak flood level, as detailed in Table 3-2. The critical durations were determined from a maximum envelope of the flood level output grids for all durations for each AEP.

TABLE 3-2 PEAK FLOOD LEVEL CRITICAL DURATION AT CITISWICH

AEP (%)	Duration (hours)	Pattern ID
1	48	0770
2	48	0663
5	24	0670
10	36	0400
20	12	0693
50	120	0010

These durations were used to assess the relative impact of the proposed development. Appendix B contains peak flood depth maps including peak water surface levels for the base scenario, with Appendix C and D containing relative flood level difference maps for the proposed and riparian vegetation scenarios respectively.

3.4.2 PEAK DISCHARGE

It is noted that due to the complex hydrodynamic interactions between the Brisbane and Bremer Rivers, the storm events that produce the highest peak flood levels may not necessarily be derived from a duration with the highest peak discharge.

For this reason, a critical discharge assessment was also conducted, as shown in Table 3-3. The peak discharge critical durations were determined from a maximum envelope of the flow reporting lines for all durations for each AEP.

TABLE 3-3 PEAK DISCHARGE CRITICAL DURATION AT CITISWICH

AEP (%)	Duration (hours)	Pattern ID
1	12	0902
2	48	0620
5*	24	0670
10*	36	0400
20	24	0534
50*	120	0010

*It is noted that for the 50%, 10% and 5% AEP, the critical duration for both peak discharge and peak flood level were the same.

The critical peak discharge 1%, 2% and 20% AEP were also assessed as whilst they do not produce the peak flood level, they have a higher conveyance through the lower Bremer River. Appendix C and D include the peak discharge results for the base and proposed scenarios respectively.

3.5 RESULTS

Table 3-4 presents key reporting points (flood level) and lines (discharge) as illustrated in Figure 8.

TABLE 3-4 DISCHARGE REPORTING LINE & FLOOD LEVEL REPORTING POINT LOCATIONS

Line ID (Discharge)	Point ID (Flood Level)	Location Description
BREM03	B	Bremer River, Upstream of Citiswich
BREM05	A	Bremer River, Citiswich Stage 7
BREM07	C	Bremer River, Downstream of Citiswich

3.5.1 BASE SCENARIO VS BRCFS

Table 3-5 and Table 3-6 present a comparison of the discharge and flood levels for the design events, produced by the BRCFS and the base scenario.

TABLE 3-5 PEAK DISCHARGE (EX05G VS BRCFS)

AEP	**BREM03** Discharge (m^3/s)				**BREM05** Discharge (m^3/s)				**BREM07** Discharge (m^3/s)			
(%)	BRCFS	EX05g	Diff.	Diff %	BRCFS	EX05g	Diff.	Diff %	BRCFS	EX05g	Diff.	Diff %
1	3463	3245	-218	-5.8	3395	3111	-284	-8.4	3368	3037	-332	-9.8
2	3190	2732	-458	-14.4	3179	2704	-475	-15.0	3161	2680	-481	-15.2
5	2214	2212	-1	-0.1	2207	2217	10	0.4	2202	2212	9	0.4
10	2025	2029	4	0.2	2036	2044	8	0.3	2046	2051	5	0.3
20	1256	1230	-26	-2.1	1246	1212	-33	-2.7	1249	1210	-39	-3.1
50	113	112	-1	-0.3	130	129	-1	-0.4	142	143	1	0.7

Diff in the above table is short for difference.

Table 3-5 indicates that the peak discharge in the 1% AEP and 2% AEP base scenario are lower than those produced by the BRCFS.

TABLE 3-6 PEAK FLOOD LEVELS (EX05G VS BRCFS)

AEP	B Flood Level (mAHD)			A Flood Level (mAHD)			C Flood Level (mAHD)		
(%)	BRCFS	EX05g	Diff (m)	BRCFS	EX05g	Diff (m)	BRCFS	EX05g	Diff (m)
1	18.732	18.743	0.011	18.704	18.707	0.003	18.566	18.570	0.004
2	15.923	15.906	-0.017	15.681	15.653	-0.028	15.185	15.189	0.004
5	12.384	12.324	-0.060	11.850	11.782	-0.068	10.853	10.859	0.006
10	10.563	10.480	-0.083	9.903	9.788	-0.115	8.410	8.424	0.014
20	7.285	7.258	-0.027	6.803	6.756	-0.047	5.776	5.781	0.005
50	1.766	1.765	-0.001	1.758	1.757	-0.001	1.743	1.742	-0.001

Diff in the above table is short for difference.

Table 3-6 indicates that whilst the 1% AEP and 2% AEP peak discharge is lower in the base scenario compared to the BRCFS, the peak flood levels are comparative. Indicating that whilst changed, the models predict similar peak flood levels and that the BRCFS calibration is still valid.

3.5.2 PROPOSED SCENARIO VS BASE SCENARIO

Table 3-7 and Table 3-8 present a comparison of the discharge and flood levels for the design events, produced by the base scenario and the proposed scenario. Peak flood depth maps for the base scenario are contained in Appendix B for the 50% to 1% AEP design events with the resultant base scenario peak flood level grid was mathematically subtracted from the resultant proposed scenario peak flood level grid to produce a relative flood level difference map, as illustrated in Appendix C.

TABLE 3-7 PEAK DISCHARGE (DE11 VS EX05G)

AEP	BREM03 Discharge (m^3/s)				BREM05 Discharge (m^3/s)				BREM07 Discharge (m^3/s)			
(%)	EX05g	DE11	Diff.	Diff %	EX05g	DE11	Diff.	Diff %	EX05g	DE11	Diff.	Diff %
1	3245	3249	4	0.1	3111	3128	17	0.6	3037	3059	22	0.7
2	2732	2733	1	0.0	2704	2706	2	0.1	2680	2681	1	0.0
5	2212	2216	3	0.1	2217	2217	-	-	2212	2212	-	-
10	2029	2029	-	-	2044	2044	-	-	2051	2051	-	-
20	1230	1231	1	0.0	1212	1214	2	0.1	1210	1210	-	-
50	112	112	-	-	129	129	-	-	143	143	-	-

Diff in the above table is short for difference.

Table 3-7 indicates negligible change in peak discharge between the base and proposed scenarios for all design events.

TABLE 3-8 PEAK FLOOD LEVELS (DE11 VS EX05G)

AEP	B Flood Level (mAHD)			A Flood Level (mAHD)			C Flood Level (mAHD)		
(%)	EX05g	DE11	Diff (m)	EX05g	DE11	Diff (m)	EX05g	DE11	Diff (m)
1	18.743	18.744	0.001	18.707	18.702	-0.005	18.570	18.575	0.005
2	15.906	15.906	-	15.653	16.654	0.001	15.189	15.190	0.001
5	12.324	12.326	0.002	11.782	11.782	-	10.859	10.859	-
10	10.480	10.480	-	9.788	9.788	-	8.424	8.424	-
20	7.258	7.259	0.001	6.756	6.756	-	5.781	5.771	-0.010
50	1.765	1.765	-	1.757	1.757	-	1.742	1.742	-

Diff in the above table is short for difference.

Table 3-8 indicates negligible change in peak flood level between the base and proposed scenarios for all design events.

The results detailed in Table 3-8 and Table 3-7 and illustrated in Appendix B and C indicate that the proposed Citiswich Stage 7 development would result in negligible difference in peak flood levels or discharge.

3.5.3 RIPARIAN VEGETATION SCENARIO VS BASE SCENARIO

Peak flood depth maps for the base scenario are contained in Appendix B for the 50% to 1% AEP design events with the resultant base scenario peak flood level grid was mathematically subtracted from the resultant riparian vegetation scenario peak flood level grid to produce a relative flood level difference map, as illustrated in Appendix D.

The results contained in Appendix D indicate that the lower Bremer River is sensitive to changes to the hydraulic roughness along the bank of the Bremer River. This is expected, as the bank of the Bremer River adjacent to the Citiswich Stage 7 boundary is the main conveyance path for flood waters in the lower Bremer River.

The results indicate that any increase in hydraulic roughness (or intensification in vegetation density) along the 25 m riparian corridor on the bank of the Bremer River is predicted to increase flood levels upstream. For this reason, whilst the approved MFPS, the 25m linear riparian revegetation area along the bank of the Bremer River fronting the Citiswich Site, it is not considered suitable or practicable.

3.6 KEY ASSUMPTIONS

The following is a list of key assumptions used in this FIA:

- The base scenario assumes the currently approved Citiswich Stage 7 is in place. Whilst this fill has not completely been placed to form a complete fill pad, the option to fill this under the preliminary approval (3356/2002) has been manifestly taken up by the works conducted to date within Citiswich Stage 7. As such, this fill and the yet to be placed remainder can be placed in its currently approved state.
- The base scenario assumes existing hydraulic roughness over the fill pad, rather than industrial land use, as whilst the preliminary approval allowed fill, per above, it does not infer a material change of use. Figure 7 illustrates the hydraulic roughness for the riparian vegetation scenario.
- The proposed scenario fill:
    - Uses a simple elevation polygon, thus generally assumes vertical walls and any batters are contained within less than half a computational grid (i.e. 15 m) of the assumed fill polygon.
    - The simple elevation polygon assumes a flat fill pad at 19.0mAHD. It is noted for free drainage of local stormwater runoff and servicing of the proposed pad, the top of the pad will include a minimum grade of approximately 0.5% to 1%.
    - Includes a 30 m wide high flow bypass that is engaged in events exceeding the 2% AEP. This bypass is utilised to minimise the relative difference in predicted peak flood levels by allowing discharge over/through the proposed fill pad in a manner similar to the base scenario; and
    - The southern pad is predominately in fill whilst the northern pad is predominately in cut.
    - Figure 3 and 4 illustrate the proposed scenario topography and the difference between the base case respectively.

3.7 DISCUSSION AND RECOMMENDATIONS

The proposed Citiswich Stage 7 fill pad provides a higher flood immunity for the proposed Citiswich Stage 7 development that what is currently approved. This minimises the flood risk of the end users of the Citiswich Stage 7 development.

The southern fill pad is the most critical in terms of minimising hydraulic differences between the proposed scenario and the base scenario. As such, the shape and size of the proposed southern fill pad is similar to that of the base scenario. The southern fill pad incorporated a high flow bypass channel with a base width of 30 m grading at 0.5 % from an invert of 16.25 mAHD at the south-western end. An internal road will cross the north-eastern end of the high flow bypass with 12 / 2.4 x 2.4 m RCBC.

The northern fill pad, however, is located on an existing ridgeline that is mostly above 20.0 mAHD. As such the shape and size of it is less critical to the outcomes of the FIA.

Access to the Citiswich Stage 7 development would be provided via the future Westphalen Road extension, provide 1% AEP immune access east to the Cunningham Highway / Warrego Highway in accordance with the Section 7.2 (b) of Council's Implementation Guideline No. 24 (ICC, 2016).

Riparian rehabilitation within the Citiswich Stage 7 site is not being considered. Additional on-site revegetation could be considered within areas of the site less critical to conveyance, such as within the areas between the north and south fill pads, downstream of the Warrego Highway. The proposed northern fill pad will likely include batters that partially extend into the existing gully in this area and require minor earthworks to realign the gully, this area is not critical to regional Bremer River flood conveyance and could be utilised to enhance the existing vegetation.

4 CONCLUSION

This regional FIA has been prepared by A&D to support the WCL DA for Citiswich Stage 7 and specifically to revise the currently approved Citiswich Stage 7 fill extent to provide a development pad with a 1% AEP immunity.

This assessment considered both the BRCFS and the IRFSU in determining the most appropriate model to utilise for future FIA of the Citiswich site.

The Citiswich site is located within the lower Bremer River where peak flooding is dominated by Brisbane River backwater flooding. The adopted model is able to represent this type of flood behaviour within the lower Bremer River, and it is for this reason the BRCFS hydraulic model was adopted for this regional FIA.

The BRCFS model was updated to represent the Citiswich site and considered three scenarios:

- Base – with the Citiswich site in its current condition, including the approved Citiswich Stage 7 fill extent.
- Proposed – per the base, with the revised Citiswich Stage 7 proposed fill; and
- Riparian Revegetation – per the base, with riparian rehabilitation.

The proposed Citiswich Stage 7 fill pad and access road are to be filled to a minimum of 19.0 mAHD, above the 1% AEP in order to provide 1% AEP flood immune access and industrial use lots.

This hydraulic assessment found that the proposed Citiswich Stage 7 development would result in negligible difference in peak flood levels or discharge.

The results of the riparian vegetation investigation showed that any increase in hydraulic roughness (or intensification in vegetation density) along the 25 m riparian corridor on the bank of the lower Bremer River would result in increased upstream flood levels. For this reason, whilst the approved under the MFPS, the 25m linear riparian revegetation area along the bank of the Bremer River fronting the Citiswich Site is unsuited to the proposed revegetation and not recommended.

5 QUALIFICATIONS

The analysis and overall approach was specifically catered for the particular project requirements, and may not be applicable beyond this scope. For this reason, any other third parties are not authorised to utilise this report without further input and advice from A&D.

The report is based on the following information provided by others:

- BRCFS hydraulic model and flood study (BMT WBM, 2017), (BMT, 2020)
- IRFSU hydraulic model and flood study (BMT, 2019)
- Detailed site survey data provided by WCL;
- ALS data provided by DRNM;
- Proposed fill pad and detention basin design on Lot 21 SP288463 prepared by Premise (formerly ETS Engineering);
- Hume Western Drain design prepared by Premise;
- Stage 3 ROL design prepared by HCE Engineers; and
- Stage 4 earthworks design prepared by HCE Engineers;

Previous reports that A&D have utilised as background information in this report include:

- Citiswich Masterplan – Flooding Investigation (Including Local Flooding Assessment) Incorporating Amendment No.1 (CLT, 2012, August);
- Riparian Zone Hydraulic Impact Assessment (CLT, 2012, June);
- Citiswich Stage 6C & D – Stage-Based Stormwater Management Strategy (Response to Information Request) (CLT, 2013, September);
- Citiswich Stage 4 – Stage-Based Stormwater Management Strategy to Support a Reconfiguration of Lot Application (In Compliance with the Masterplan Flood Study) (CLT, 2015, March);
- Citiswich Stage 5 – Ultimate Development Stage-Based Stormwater Management Strategy (In Compliance with the Masterplan Flood Study) (CLT, 2015, September);
- Citiswich Stage 5 – 140 Lot Residential Stage-Based Stormwater Management Strategy (In Compliance with the Masterplan Flood Study) (CLT, 2015, November); and
- Citiswich Stage 3 – Revised Local Flood Assessment to Support ROL (CLT, 2016, July).

The accuracy of the report is dependent upon the accuracy of this information.

Whilst this report accurately assesses catchment hydraulic performance, using industry standard theoretical modelling techniques and engineering practices, actual future observed catchment flows, levels and extent of inundation may vary from those predicted herein. It is for this reason that flood freeboards are adopted.

6 ACKNOWLEDGEMENTS

This report has been prepared as part of the Citiswich Development, Bundamba which was funded by Walker Corporation Limited. The on-going involvement and review of this assessment and report by the following organisations, are appreciated:

- Mr Gary Ellis of Arcadis Pty Ltd; and
- Dr John Macintosh of Water Solutions Pty Ltd.

7 REFERENCES

A&D. (2019, April). *Citiswich Bundamba – Western Tributary Flood Assessment (ref J17015/R4/v3).* Allan & Dennis.

A&D. (2020, April). *Citiswich Stage 3 ROL – Flood Impact Assessment (ref J17015/R5/v3).* Allan & Dennis.

A&D. (2020, July). *Citiswich Stage 3 ROL – Flood Impact Assessment (ref J17015/R5/v4).* Allan & Dennis.

A&D. (2021, December). *Citiswich Stage 7 – Western Diversion Local Flood Assessment (ref J17015/R9/v1).* Allan & Dennis.

A&D. (2021, February). *Citiswich Stage 4 – Flood Impact Assessment (ref J17015/R8/v1).* Allan & Dennis.

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

BMT. (2018). *Ipswich Rivers Flood Study Update - Data Collection and Review (MR1).*

BMT. (2018). *Ipswich Rivers Flood Study Update - Model Development and Calibration (MR2).*

BMT. (2019). *Ipswich Rivers Flood Study Update.*

BMT. (2019). *Ipswich Rivers Flood Study Update - Design Flood Modelling and Mapping (MR3).*

BMT. (2019). *Ipswich Rivers Flood Study Update - Summary Report (MR4).*

BMT. (2020). *BRCFS Model Amendment Pack (803.tcf) Technical Memorandum.*

BMT WBM. (2014). *Brisbane River Catchment Flood Study - Comprehensive Hydraulic Assessment - Milestone Report 1: Data Review and Modelling Methodology.*

BMT WBM. (2015). *Brisbane River Catchment Flood Study - Comprehensive Hydraulic Assessment - Milestone Report 2: Fast Model Development and Calibration.*

BMT WBM. (2015). *Brisbane River Catchment Flood Study - Comprehensive Hydraulic Assessment - Milestone Report 3: Detailed Model Development and Calibration.*

BMT WBM. (2016). *Brisbane River Catchment Flood Study - Comprehensive Hydraulic Assessment - Milestone Report 4: Fast Model Results and Design Events Selection.*

BMT WBM. (2016). *Brisbane River Catchment Flood Study - Comprehensive Hydraulic Assessment - Milestone Report 5: Detailed Model Results.*

BMT WBM. (2016). *Brisbane River Catchment Flood Study - Comprehensive Hydraulic Assessment - Milestone Report 6: Hydraulics Report.*

BMT WBM. (2016). *Brisbane River Catchment Study Comprehensive Hydraulic Assessment Milestone Report 5: Detailed Model Results.*

BMT WBM. (2017). *Brisbane River Catchment Flood Study - Technical Summary Report - Comprehensive Hydrologic and Hydraulic Assessments.*

CLT. (2012, August). *Citiswich Masterplan – Flooding Investigation (Including Local Flooding Assessment) Incorporating Amendment No. 1 (ref: LJ8714/R5/v3/A1).* Cardno Lawson Treloar.

CLT. (2012, June). *Riparian Zone Hydraulic Impact Assessment (ref: LJ8714/Lt65).* Cardno Lawson Treloar.

CLT. (2013, September). *Citiswich Stage 6C & D – Stage-Based Stormwater Management Strategy (Response to Information Request) (ref LJ8714/R19/v2).* Cardno Lawson Treloar.

CLT. (2015, March). *Citiswich Stage 4 – Stage-Based Stormwater Management Strategy to Support a Reconfiguration of Lot Application (In Compliance with the Masterplan Flood Study) (ref LJ8714/R20/v4).* Cardno Lawson Treloar.

CLT. (2015, November). *Citiswich Stage 5 – 140 Lot Residential Stage-Based Stormwater Management Strategy (In Compliance with the Masterplan Flood Study) (ref LJ8714/R21/v2).* Cardno Lawson Treloar.

CLT. (2015, September). *Citiswich Stage 5 – Ultimate Development Stage-Based Stormwater Management Strategy (In Compliance with the Masterplan Flood Study) (ref LJ8714/R22).* Cardno Lawson Treloar.

CLT. (2016, July). *Citiswich Stage 3 – Revised Local Flood Assessment to Support ROL (ref LJ8714/R23).* Cardno Lawson Treloar.

CLT. (August 2012). *Citiswich Masterplan – Flooding Investigation (Including Local Flooding Assessment) Incorporating Amendment No. 1 (ref: LJ8714/R5/v3/A1).* Cardno Lawson Treloar.

Cox, R. J., Shand, T. D., & Blacka, M. J. (April 2010). *Australian Rainfall and Runoff Revision Project 10: Appropriate Safety Criteria for People.* Barton, ACT: Engineers Austraila.

ICC. (2006). *Ipswich Planning Scheme.* Ipswich City Council.

ICC. (2016). *Implementation Guideline No. 24 Stormwater Management.* Ipswich City Council.

IPWEAQ. (2016). *Queensland Urban Drainage Manual – Forth Edition.* Institute of Public Works Engineering Australasia, Queensland.

Pilgrim, D. H. (Ed.). (1987). *Australian Rainfall & Runoff – A Guide to Flood Estimation – Volume 1.* The Institution of Engineers, Australia.

SKM. (July 2000). *Ipswich Rivers Flood Studies Phase One and Phase Two.* Sinclair Knight Merz.

ALLAN & DENNIS

REFERENCE DRAWINGS

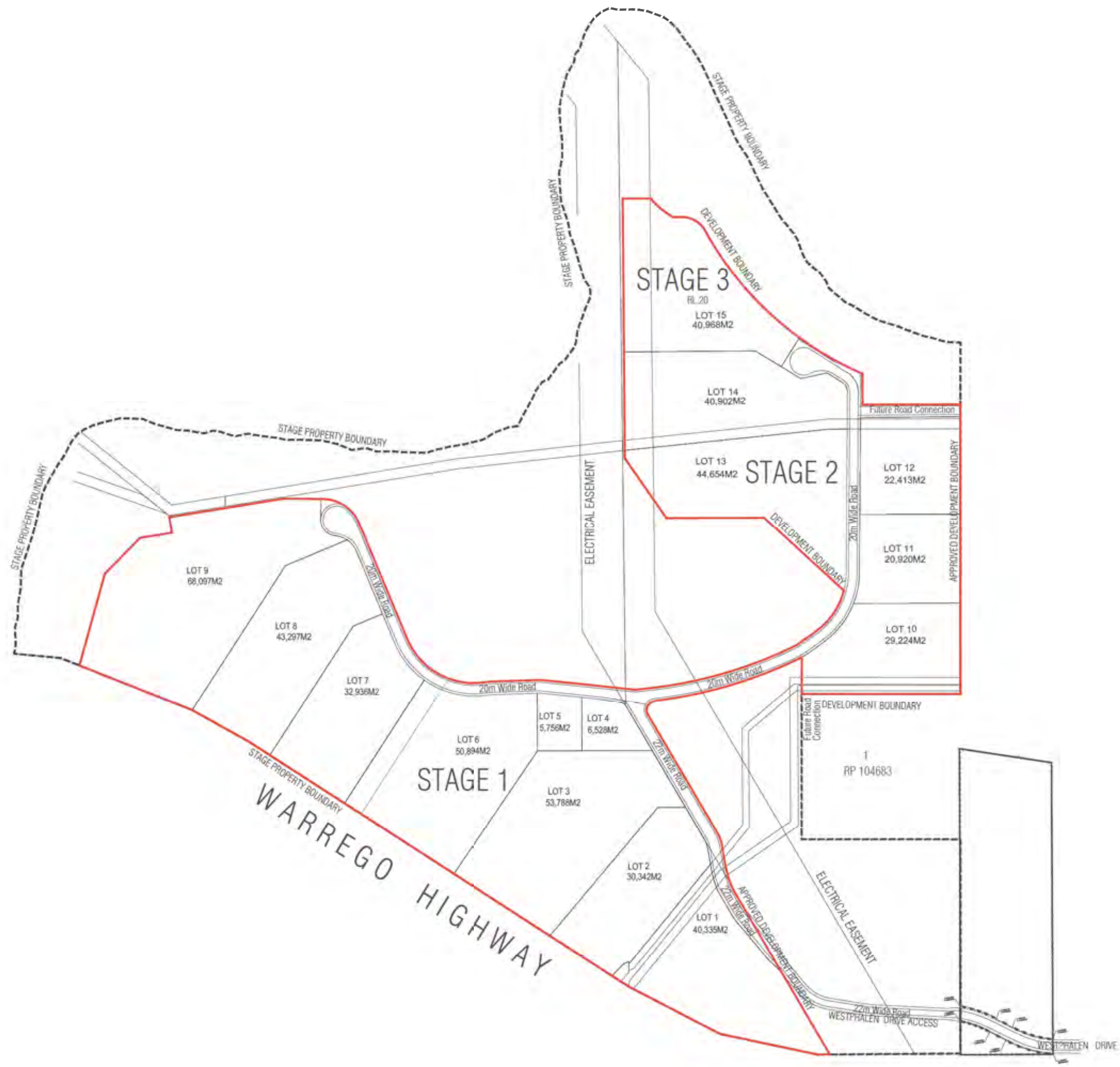
PROPOSED LOT LAYOUT

CITISWICH STAGE 7

Warrego Highway, Bundamba QLD

	574 478 m^2	DA APPROVED DEVELOPMENT AREA

Lots 1-9	331 973 m^2	STAGE 1
Lots 10-13	122 384 m^2	STAGE 2
Lots 14-15	76 697 m^2	STAGE 3
	531 054 m^2	TOTAL NLA APPROVED DEVELOPMENT BOUNDARY



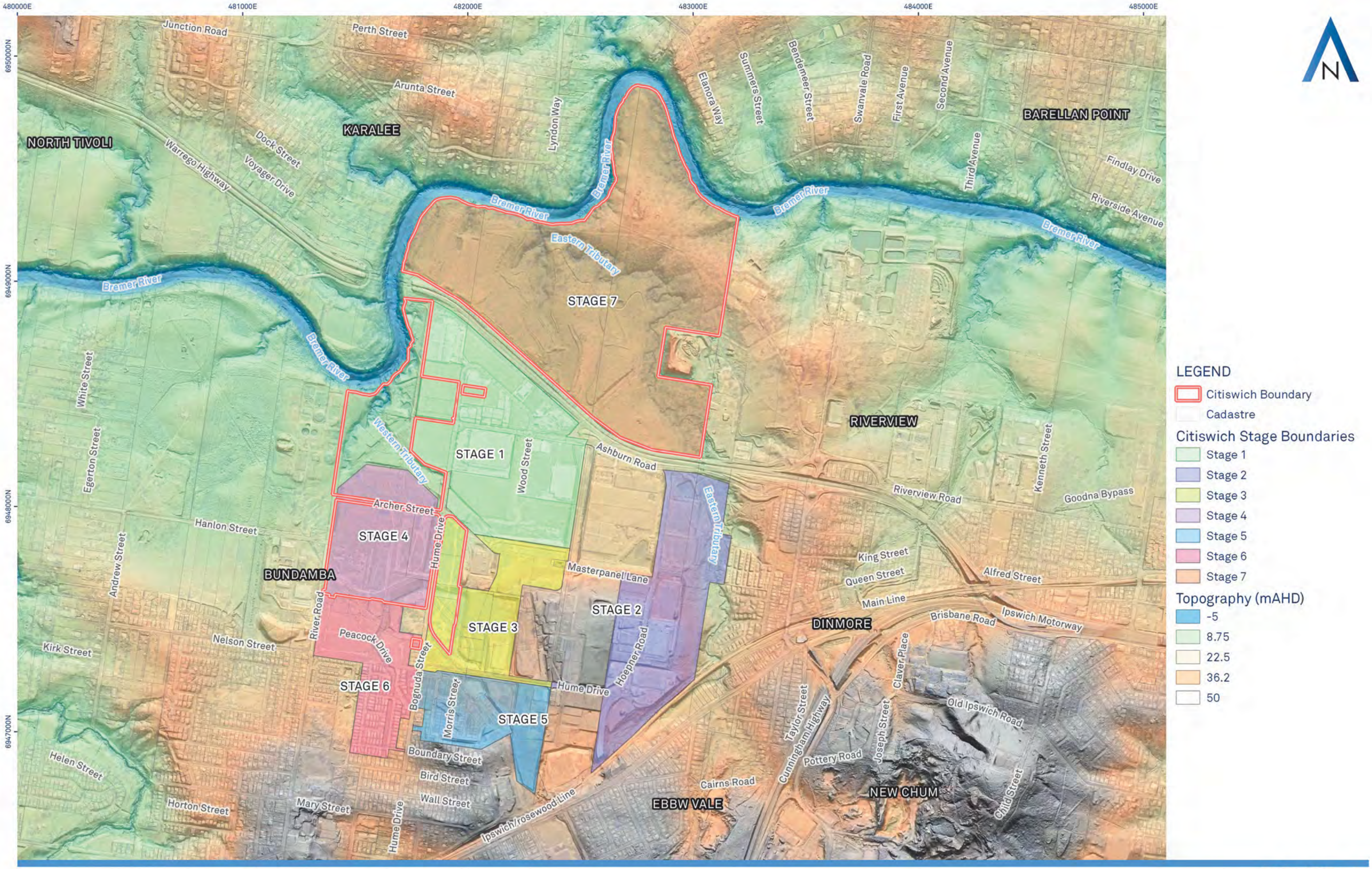
CITISWICH BUSINESS PARK - STAGE 7 - Approved Development Boundary

Date
22-Aug-23

Drawing number
WC-CS7-MP-074
Clean

walker

FIGURES



ALLAN & DENNIS

DATE
13 July 2023

SIZE
A3

REFERENCE
J17015

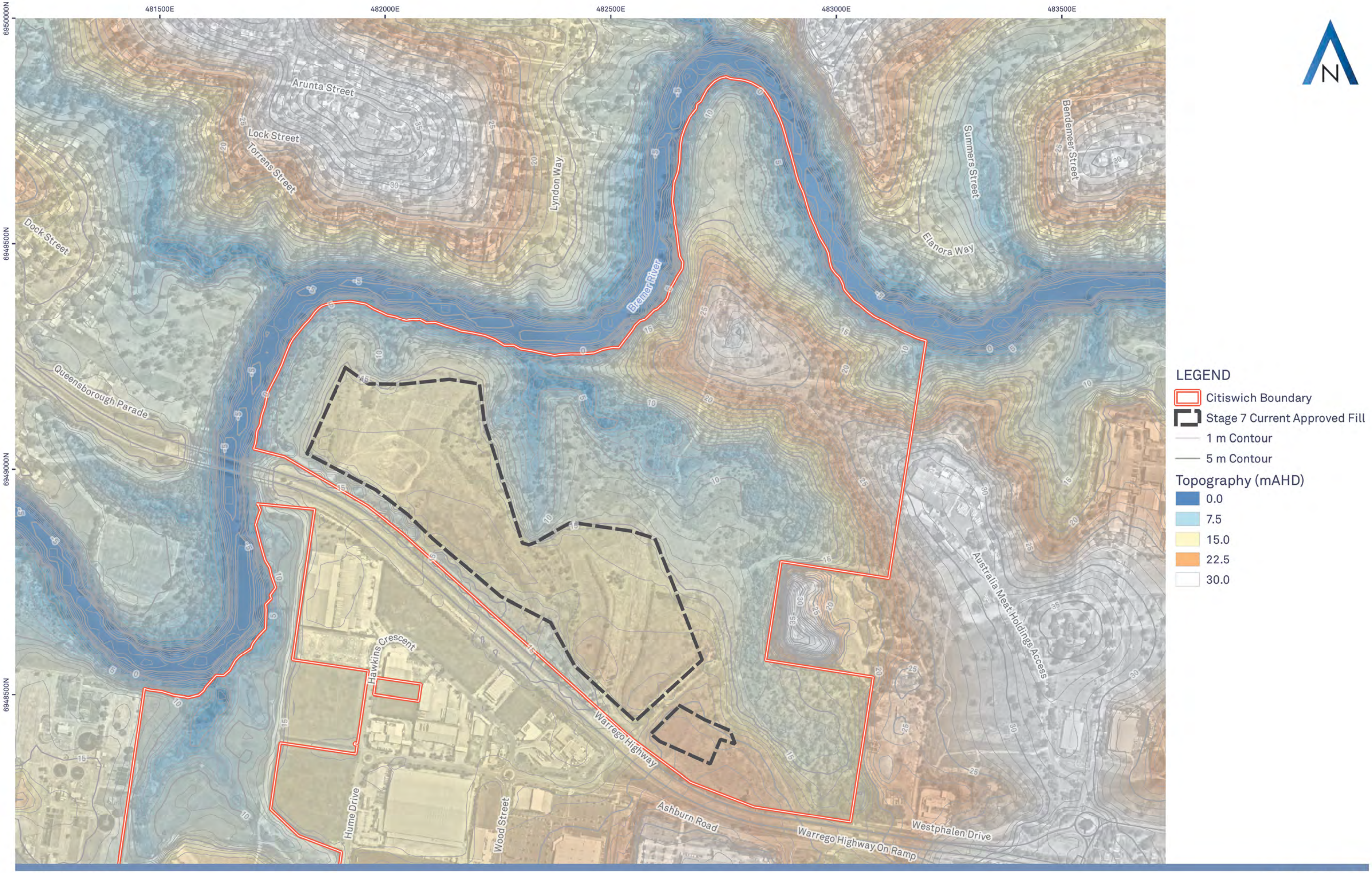
SCALE
1:15,000

0 300 600 900 1,200 1,500 m

FIGURE 1

SITE LOCATION

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
13 July 2023

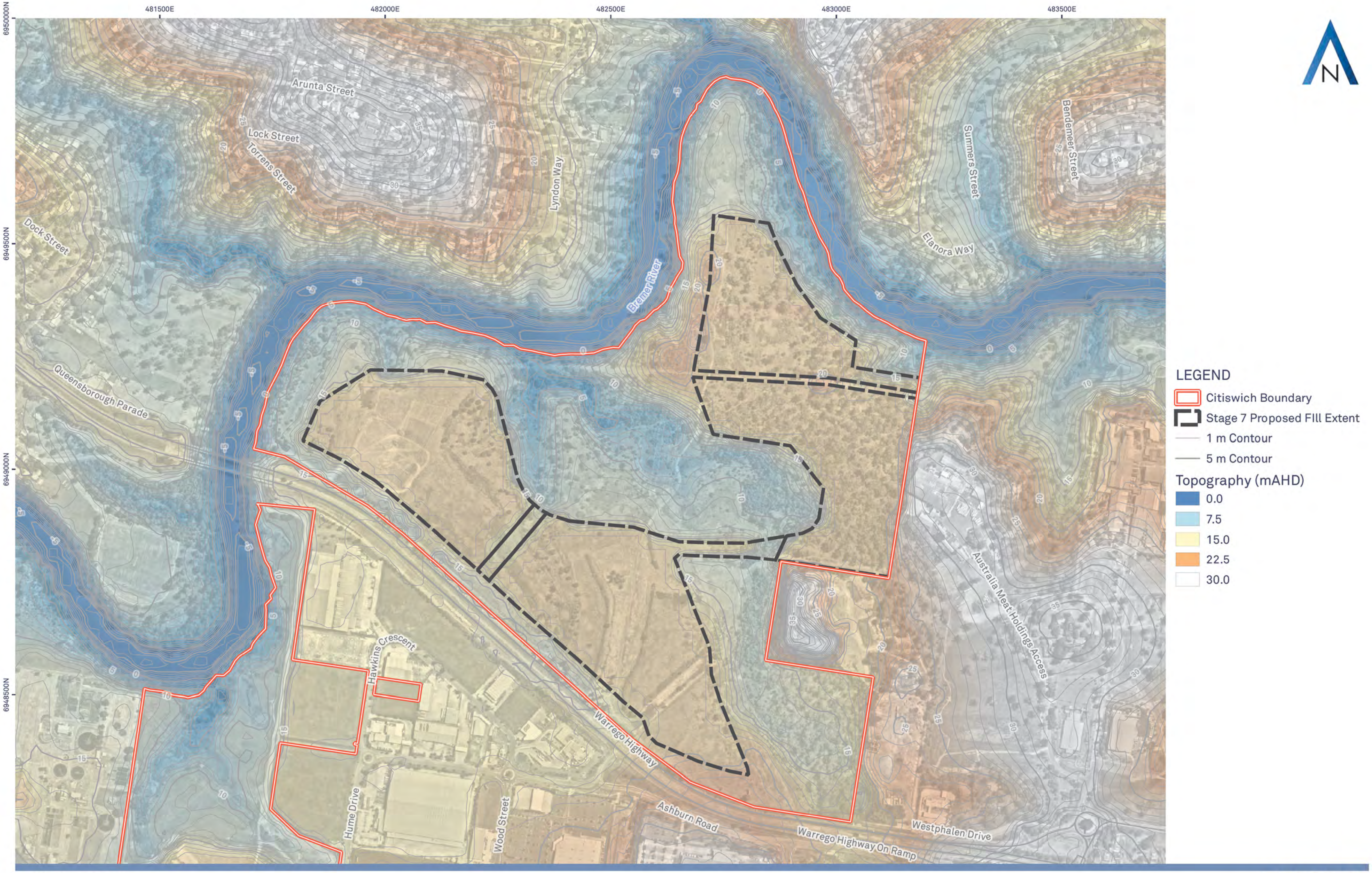
SIZE
A3

REFERENCE
J17015

SCALE
1:7,500

0 0.1 0.2 0.3 0.4 0.5 km

FIGURE 2
BASE SCENARIO TOPOGRAPHY (EX05g)
Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

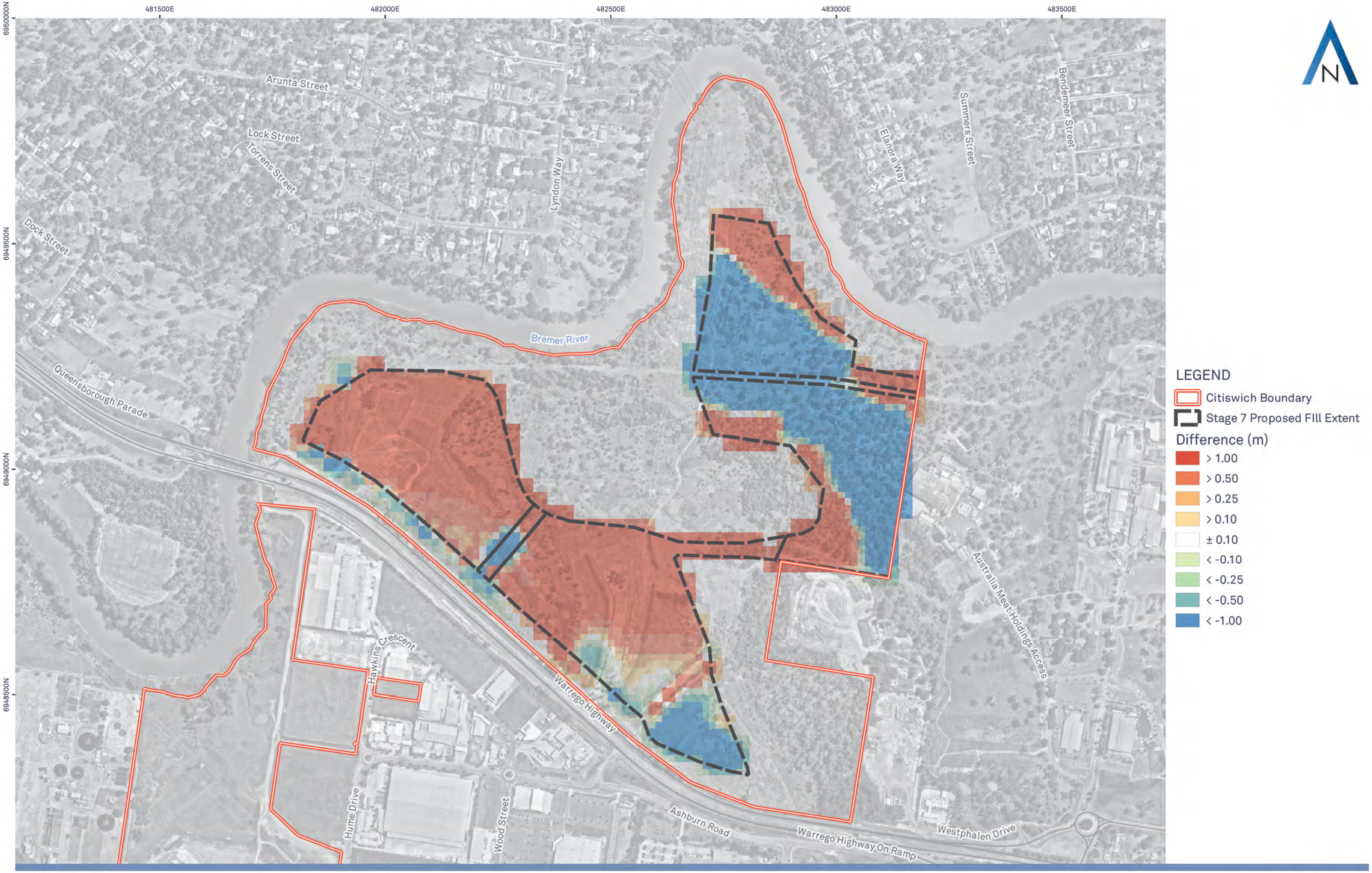
DATE	SIZE
13 July 2023	A3
REFERENCE	SCALE
J17015	1:7,500

0 0.1 0.2 0.3 0.4 0.5 km

FIGURE 3

PROPOSED SCENARIO TOPOGRAPHY (DE11)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56

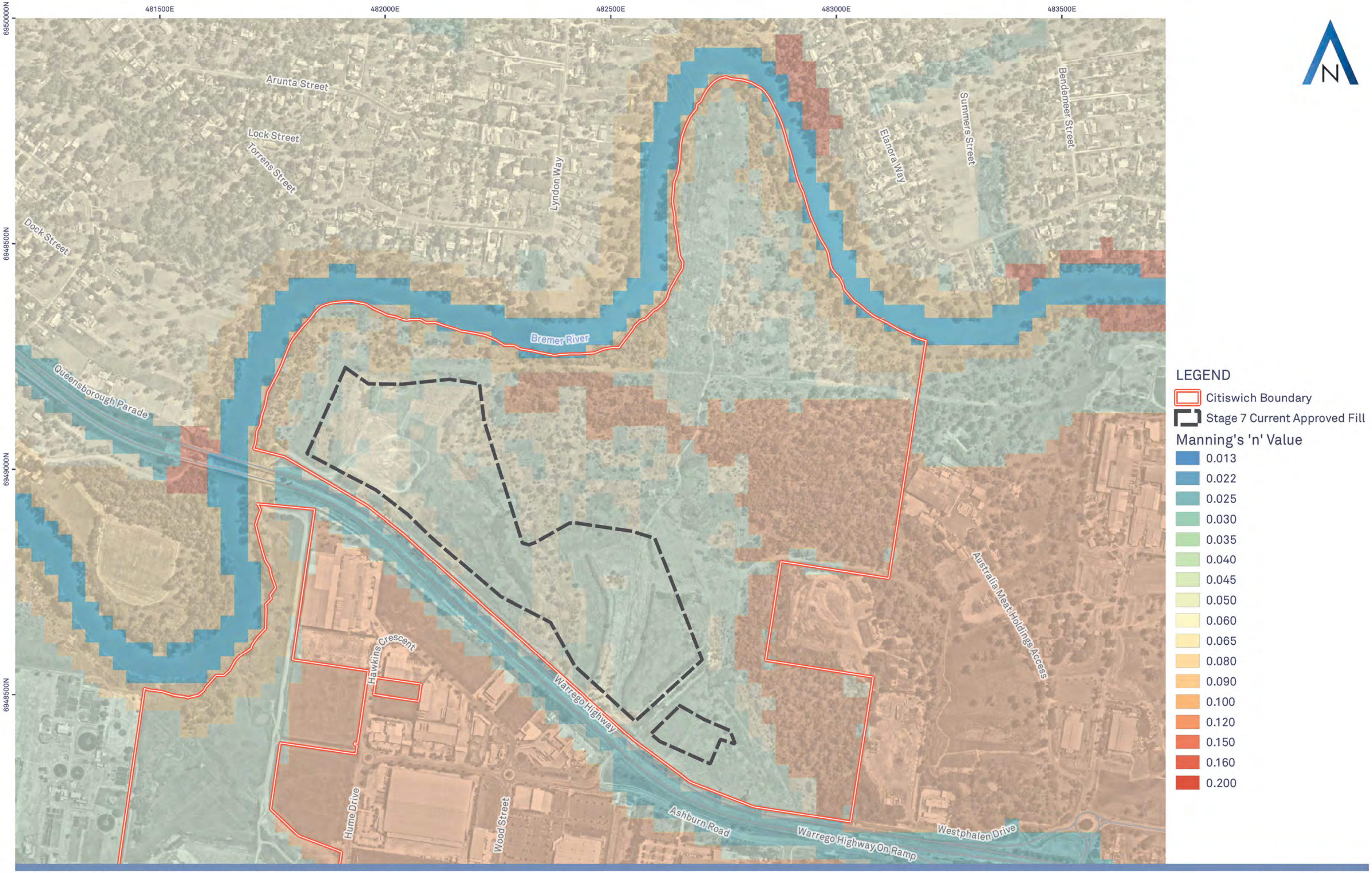
DATE	SIZE
13 July 2023	A3
REFERENCE	SCALE
J17015	1:7,500

0 0.1 0.2 0.3 0.4 0.5 km

FIGURE 4

PROPOSED SCENARIO TOPOGRAPHY DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
13 July 2023

SIZE
A3

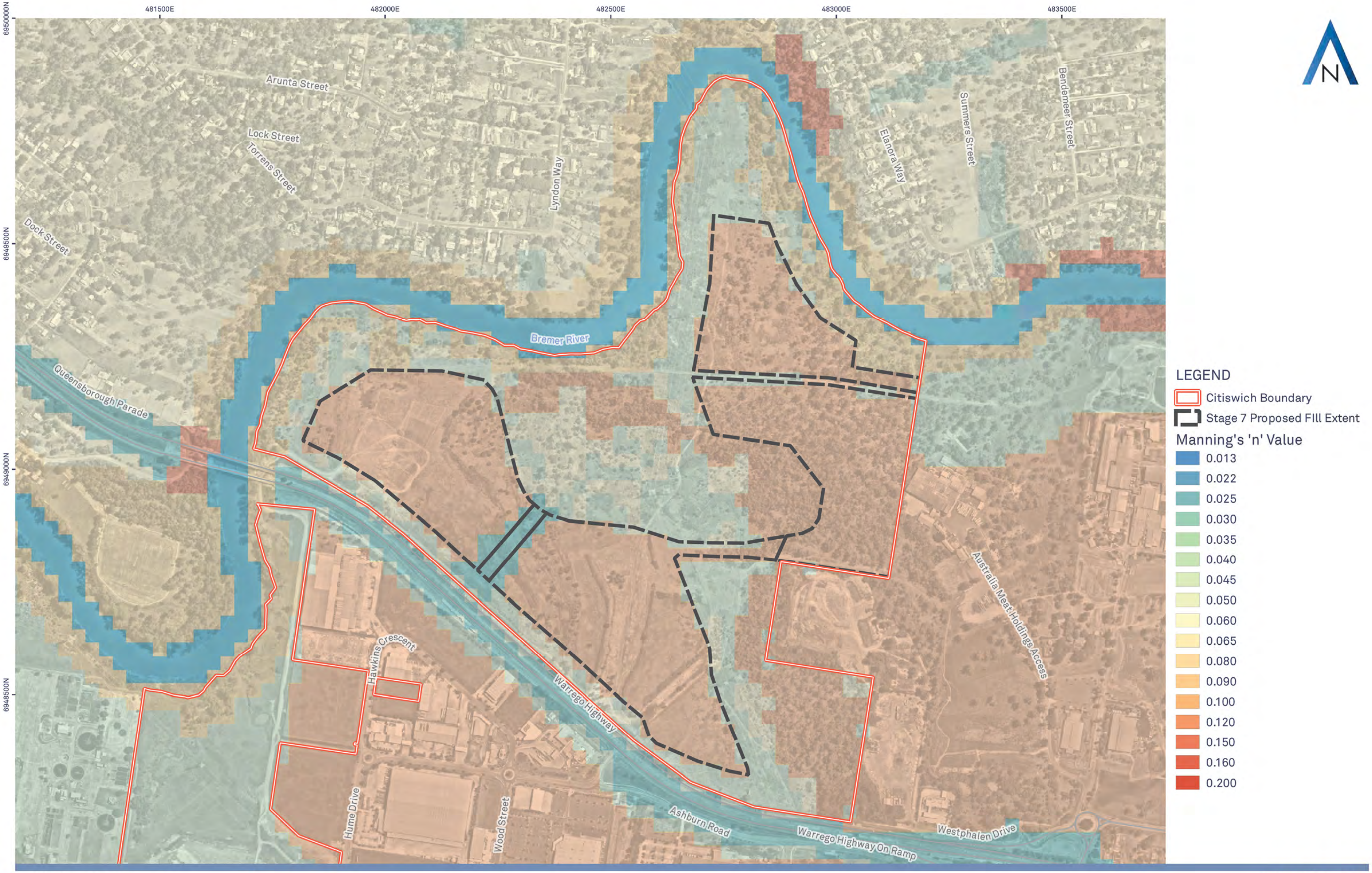
REFERENCE
J17015

SCALE
1:7,500

FIGURE 5

BASE SCENARIO HYDRAULIC ROUGHNESS (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56

ALLAN & DENNIS

DATE
13 July 2023

SIZE
A3

REFERENCE
J17015

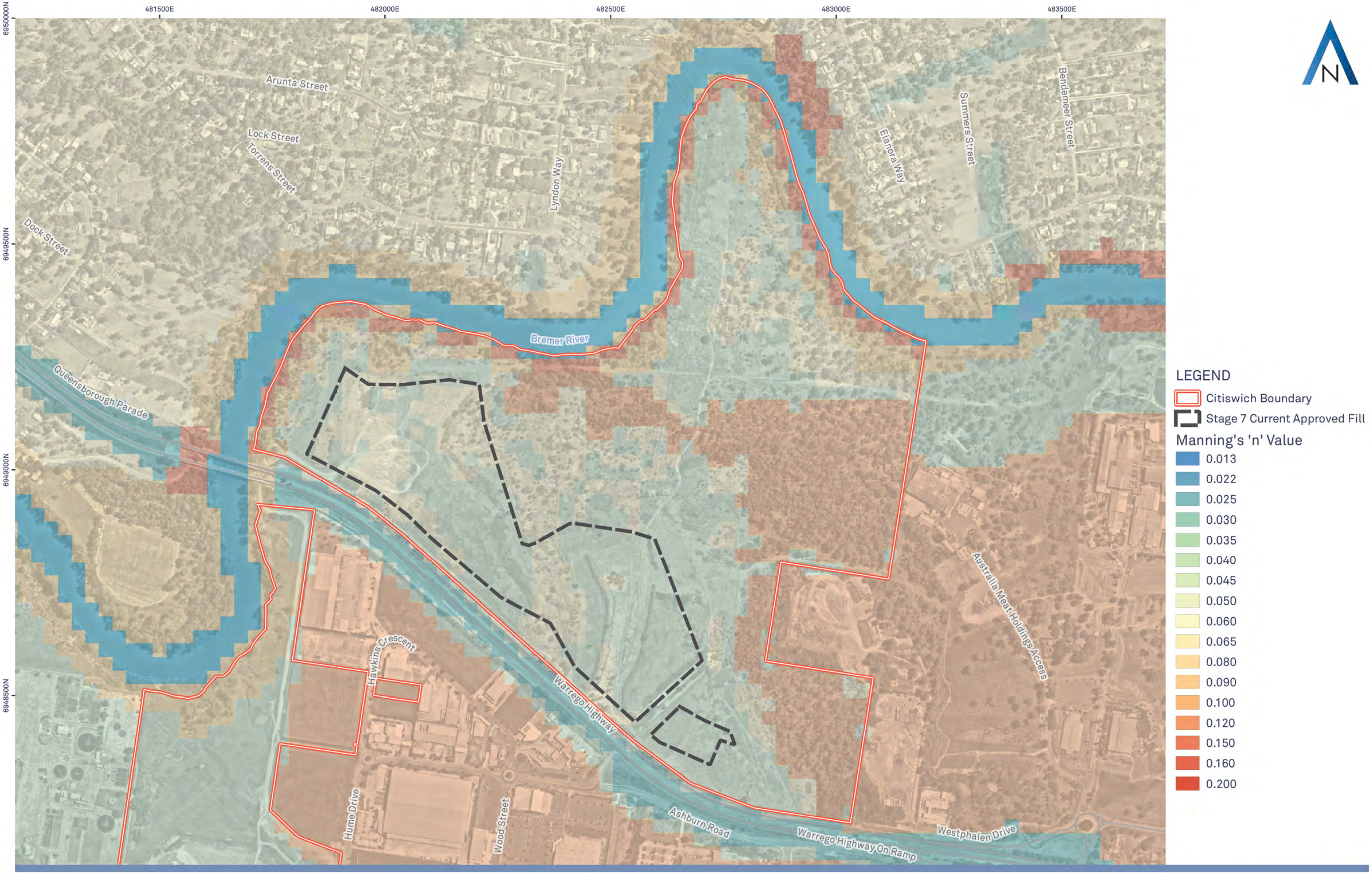
SCALE
1:7,500

0 0.1 0.2 0.3 0.4 0.5 km

FIGURE 6

PROPOSED SCENARIO HYDRAULIC ROUGHNESS (DE11)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
13 July 2023

SIZE
A3

REFERENCE
J17015

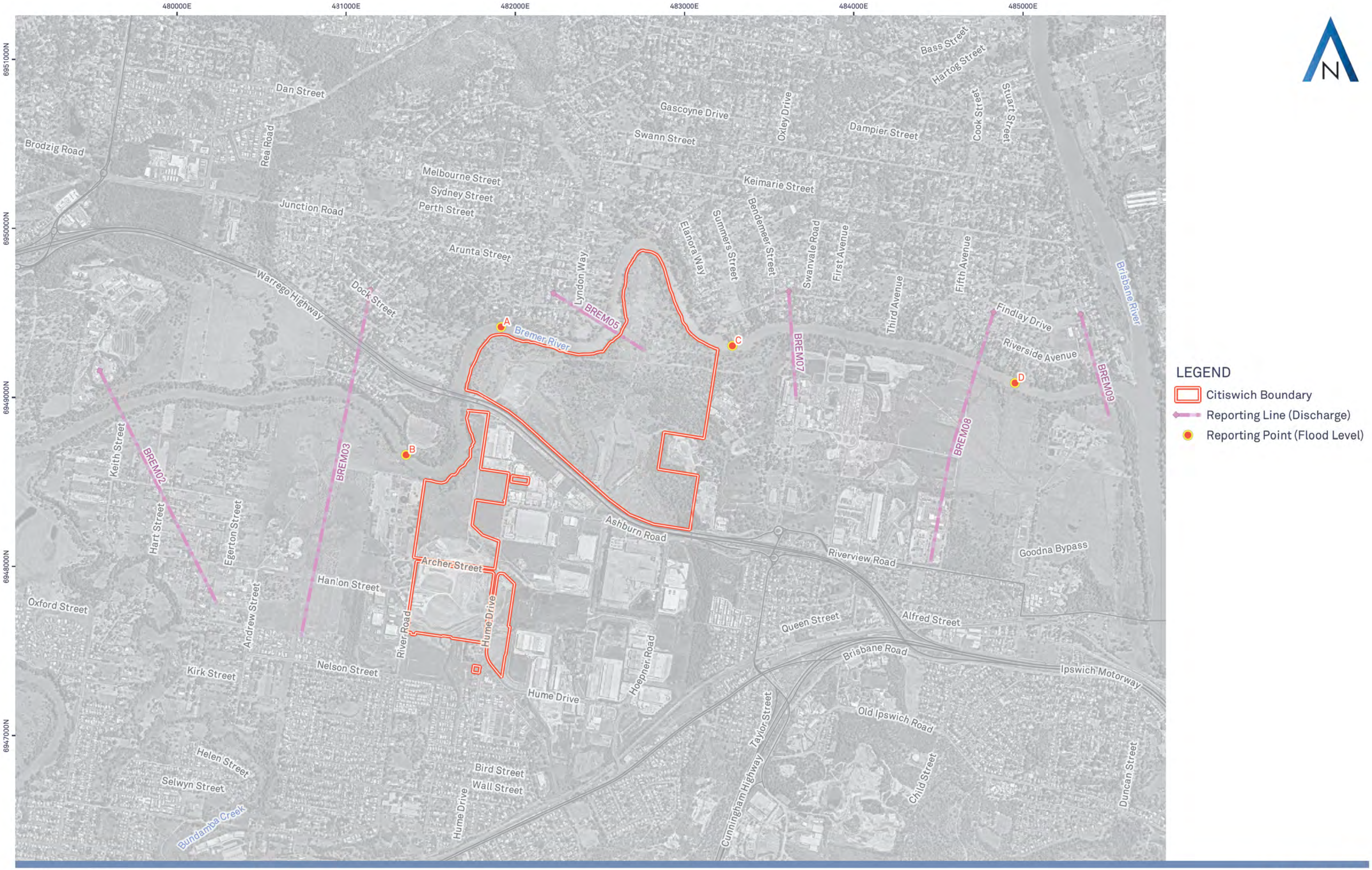
SCALE
1:7,500

0 0.1 0.2 0.3 0.4 0.5 km

FIGURE 5

RIPARIAN VEGETATION SCENARIO HYDRAULIC ROUGHNESS (EX05g_F3)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
13 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:20,000

0 0.4 0.8 1.2 1.6 2 km

FIGURE 8

DISCHARGE REPORTING LINES & FLOOD LEVEL REPORTING POINTS

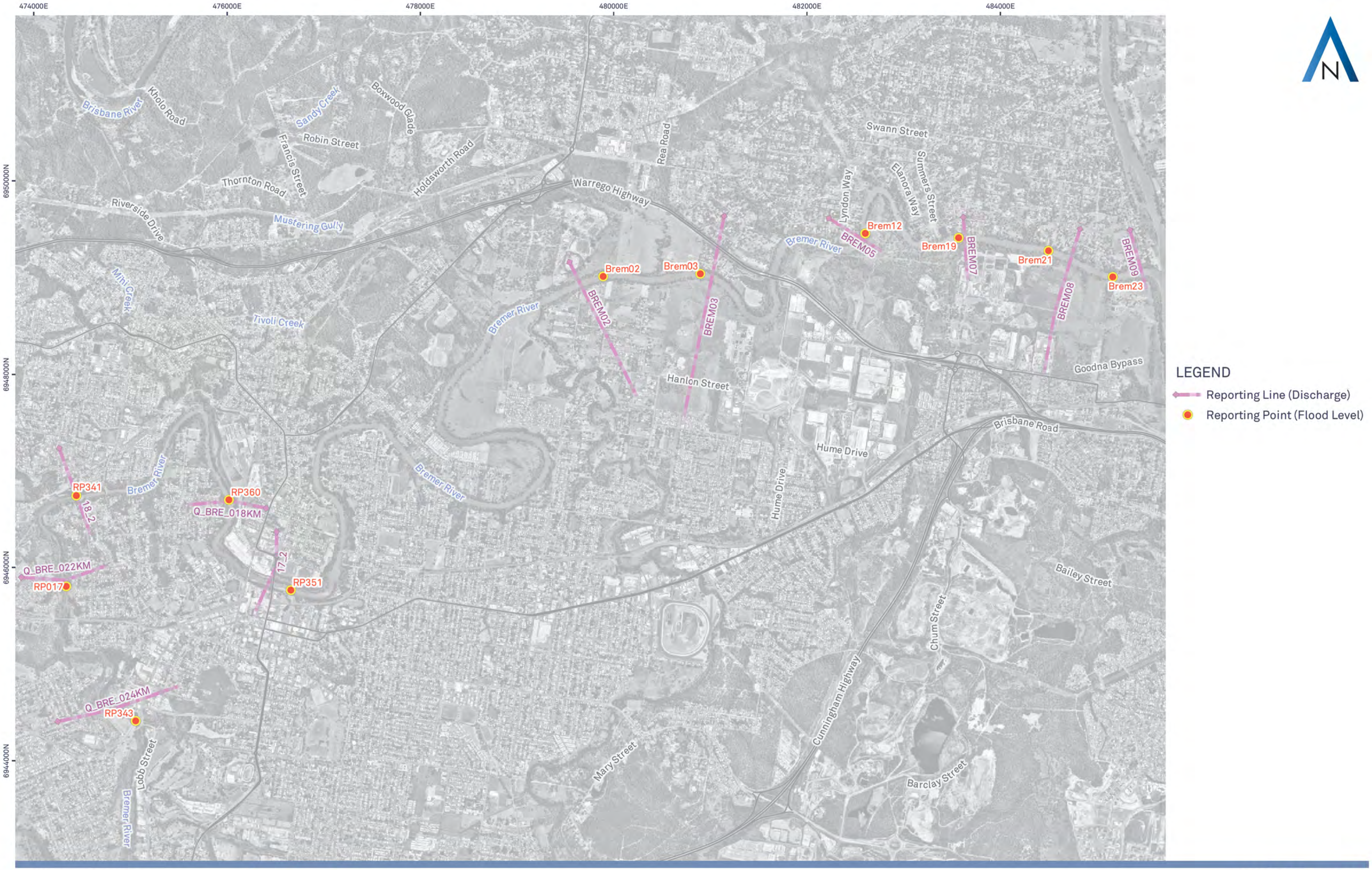
Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd

APPENDICES

APPENDIX A

BRCFS IRFSU COMPARISON

FIGURE A.0 BELOW ILLUSTRATES THE COMPARISON LOCATIONS FOR THE TABLES CONTAINED IN APPENDIX A.1 AND A.2



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:35,000

0 0.8 1.6 2.4 3.2 4 km

FIGURE A.0

BRCFS / IRFSU - DISCHARGE REPORTING LINES & FLOOD LEVEL REPORTING POINTS

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd

APPENDIX A.1

TABULATED RESULTS:
FLOOD SURFACE LEVEL & DISCHARGE

THESE TABLES INDICATE THAT WITHOUT THE POST-PROCESSING RECONCILIATION OF RESULTS, THE IRFSU DESIGN EVENTS DO NOT PROVIDE A GOOD REPRESENTATION OF THE LOWER BREMER RIVER FLOOD BEHAVIOUR

REPORTING POINT AND LINE RESULTS (BRCFS vs IRFSU)

Point ID	Peak Flood Level (mAHD)																	
	1% AEP			2% AEP			5% AEP			10% AEP			20% AEP			50% AEP		
	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.
RP343	24.44	24.85	0.42	23.27	23.29	0.03	20.48	20.86	0.38	19.10	18.52	-0.57	16.39	15.74	-0.66	6.81	12.63	5.83
RP017	23.01	23.21	0.20	21.92	21.62	-0.29	19.12	19.12	0.00	17.72	17.01	-0.71	14.94	14.11	-0.83	2.03	10.51	8.48
RP341	22.04	22.35	0.31	21.03	20.77	-0.26	18.21	18.19	-0.02	16.82	16.26	-0.57	13.96	13.26	-0.70	1.97	9.31	7.34
RP360	20.27	20.69	0.41	19.37	19.21	-0.16	16.65	16.58	-0.06	15.25	15.10	-0.15	12.30	12.10	-0.20	1.92	7.81	5.90
RP351	19.59	20.16	0.57	18.59	18.75	0.16	15.99	16.13	0.14	14.65	14.80	0.15	11.63	11.81	0.18	5.14	7.44	2.30
BREM02	18.60	17.62	-0.98	16.08	16.30	0.22	12.86	13.15	0.28	11.27	13.09	1.82	7.95	10.03	2.08	1.78	4.39	2.61
BREM03	18.60	17.57	-1.03	15.97	16.23	0.26	12.51	12.97	0.46	10.79	13.00	2.21	7.48	9.94	2.45	1.77	4.10	2.33
BREM12	18.57	16.98	-1.59	15.51	15.58	0.06	11.49	12.16	0.67	9.53	12.64	3.11	6.55	9.58	3.03	1.75	3.20	1.45
BREM19	18.54	16.10	-2.44	15.10	14.76	-0.34	10.62	11.19	0.57	8.18	12.24	4.06	5.61	9.23	3.62	1.74	2.32	0.58
BREM21	18.53	15.88	-2.65	14.94	14.57	-0.37	10.36	10.86	0.50	7.09	12.13	5.04	4.93	9.12	4.19	1.74	1.81	0.07
BREM23	18.52	15.61	-2.91	14.74	14.34	-0.40	10.22	10.62	0.40	6.33	12.04	5.71	4.34	9.04	4.70	1.73	1.59	-0.15

Line ID	Peak Discharge (m³/s)																	
	1% AEP			2% AEP			5% AEP			10% AEP			20% AEP			50% AEP		
	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.
Q_BRE_024km	3984	4010	26	3248	3302	54	2339	2509	170	1928	1732	-196	1311	1167	-144	43	664	621
Q_BRE_022km	3932	3998	66	3247	3293	45	2328	2504	176	1922	1729	-193	1303	1165	-138	43	663	620
18_2	3876	3988	112	3243	3284	41	2309	2501	192	1910	1729	-180	1302	1165	-136	43	664	621
Q_BRE_018km	3826	3971	145	3232	3273	41	2284	2493	210	1894	1727	-167	1283	1163	-120	42	663	620
17_2	3813	3967	154	3234	3268	35	2280	2491	211	1890	1726	-165	1276	1163	-113	46	662	616
BREM02	3558	4050	491	3210	3342	132	2237	2549	312	2021	1768	-252	1256	1204	-51	101	688	586
BREM03	3463	4046	583	3190	3340	150	2214	2548	334	2025	1769	-256	1256	1206	-50	113	689	576
BREM05	3395	4046	651	3179	3342	163	2207	2549	342	2036	1771	-266	1246	1208	-38	130	690	560
BREM07	3368	4048	680	3161	3344	183	2202	2550	348	2046	1772	-274	1249	1209	-40	142	690	549
BREM08	3349	4049	700	3136	3345	209	2200	2551	351	2036	1772	-264	1243	1209	-34	153	690	537
BREM09	3339	4049	710	3141	3345	204	2202	2551	350	2053	1772	-281	1248	1209	-38	157	691	533

Line ID	Peak Discharge (m³/s), Difference as Percent																	
	1% AEP			2% AEP			5% AEP			10% AEP			20% AEP			50% AEP		
	BRCFS	IRFSU	Diff (%)	BRCFS	IRFSU	Diff (%)	BRCFS	IRFSU	Diff (%)	BRCFS	IRFSU	Diff (%)	BRCFS	IRFSU	Diff (%)	BRCFS	IRFSU	Diff (%)
Q_BRE_024km	3984	4010	0.6	3248	3302	1.7	2339	2509	7.3	1928	1732	-10.2	1311	1167	-11.0	43	664	1435
Q_BRE_022km	3932	3998	1.7	3247	3293	1.4	2328	2504	7.6	1922	1729	-10.1	1303	1165	-10.6	43	663	1436
18_2	3876	3988	2.9	3243	3284	1.3	2309	2501	8.3	1910	1729	-9.4	1302	1165	-10.5	43	664	1438
Q_BRE_018km	3826	3971	3.8	3232	3273	1.3	2284	2493	9.2	1894	1727	-8.8	1283	1163	-9.3	42	663	1469
17_2	3813	3967	4.0	3234	3268	1.1	2280	2491	9.2	1890	1726	-8.7	1276	1163	-8.8	46	662	1331
BREM02	3558	4050	13.8	3210	3342	4.1	2237	2549	13.9	2021	1768	-12.5	1256	1204	-4.1	101	688	578
BREM03	3463	4046	16.8	3190	3340	4.7	2214	2548	15.1	2025	1769	-12.6	1256	1206	-4.0	113	689	511
BREM05	3395	4046	19.2	3179	3342	5.1	2207	2549	15.5	2036	1771	-13.0	1246	1208	-3.0	130	690	432
BREM07	3368	4048	20.2	3161	3344	5.8	2202	2550	15.8	2046	1772	-13.4	1249	1209	-3.2	142	690	388
BREM08	3349	4049	20.9	3136	3345	6.7	2200	2551	15.9	2036	1772	-12.9	1243	1209	-2.7	153	690	351
BREM09	3339	4049	21.3	3141	3345	6.5	2202	2551	15.9	2053	1772	-13.7	1248	1209	-3.1	157	691	339

REPORTING POINT AND LINE RESULTS (BRCFS vs IRFSU)

Point ID	Peak Flood Level (mAHD)					
	2011			1974		
	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.
RP343	21.53	21.32	-0.21	25.82	24.77	-1.06
RP017	20.45	20.17	-0.28	24.55	23.21	-1.34
RP341	19.88	19.75	-0.13	23.64	22.45	-1.19
RP360	19.30	19.25	-0.05	22.08	21.18	-0.91
RP351	19.14	19.14	-0.01	21.38	20.85	-0.53
BREM02	18.84	18.73	-0.11	20.95	20.45	-0.50
BREM03	18.84	18.73	-0.11	20.94	20.45	-0.50
BREM12	18.81	18.68	-0.13	20.91	20.41	-0.50
BREM19	18.76	18.60	-0.16	20.85	20.35	-0.50
BREM21	18.75	18.58	-0.16	20.84	20.33	-0.50
BREM23	18.73	18.57	-0.16	20.82	20.33	-0.50

Line ID	Peak Discharge (m^3/s)					
	2011			1974		
	BRCFS	IRFSU	Diff.	BRCFS	IRFSU	Diff.
Q_BRE_024km	2435	2459	23	4537	3942	-596
Q_BRE_022km	2415	2437	23	4521	3922	-599
18_2	2379	2401	23	4499	3893	-606
Q_BRE_018km	2318	2342	24	4458	3834	-624
17_2	2307	2315	8	4451	3805	-646
BREM02	1810	1838	28	4275	3586	-689
BREM03	1643	1744	102	4166	3490	-676
BREM05	1571	1763	193	4000	3342	-658
BREM07	1628	1837	210	3918	3278	-640
BREM08	1676	1874	198	3852	3226	-625
BREM09	1714	1943	229	3809	3189	-620

Line ID	Peak Discharge (m^3/s), Difference as Percent					
	2011			1974		
	BRCFS	IRFSU	Diff (%)	BRCFS	IRFSU	Diff (%)
Q_BRE_024km	2435	2459	1.0	4537	3942	-13.1
Q_BRE_022km	2415	2437	0.9	4521	3922	-13.2
18_2	2379	2401	1.0	4499	3893	-13.5
Q_BRE_018km	2318	2342	1.0	4458	3834	-14.0
17_2	2307	2315	0.3	4451	3805	-14.5
BREM02	1810	1838	1.5	4275	3586	-16.1
BREM03	1643	1744	6.2	4166	3490	-16.2
BREM05	1571	1763	12.3	4000	3342	-16.4
BREM07	1628	1837	12.9	3918	3278	-16.3
BREM08	1676	1874	11.8	3852	3226	-16.2
BREM09	1714	1943	13.3	3809	3189	-16.3

APPENDIX A.2

BREMER RIVER FLOOD SURFACE LEVEL LONG SECTION: DESIGN EVENTS

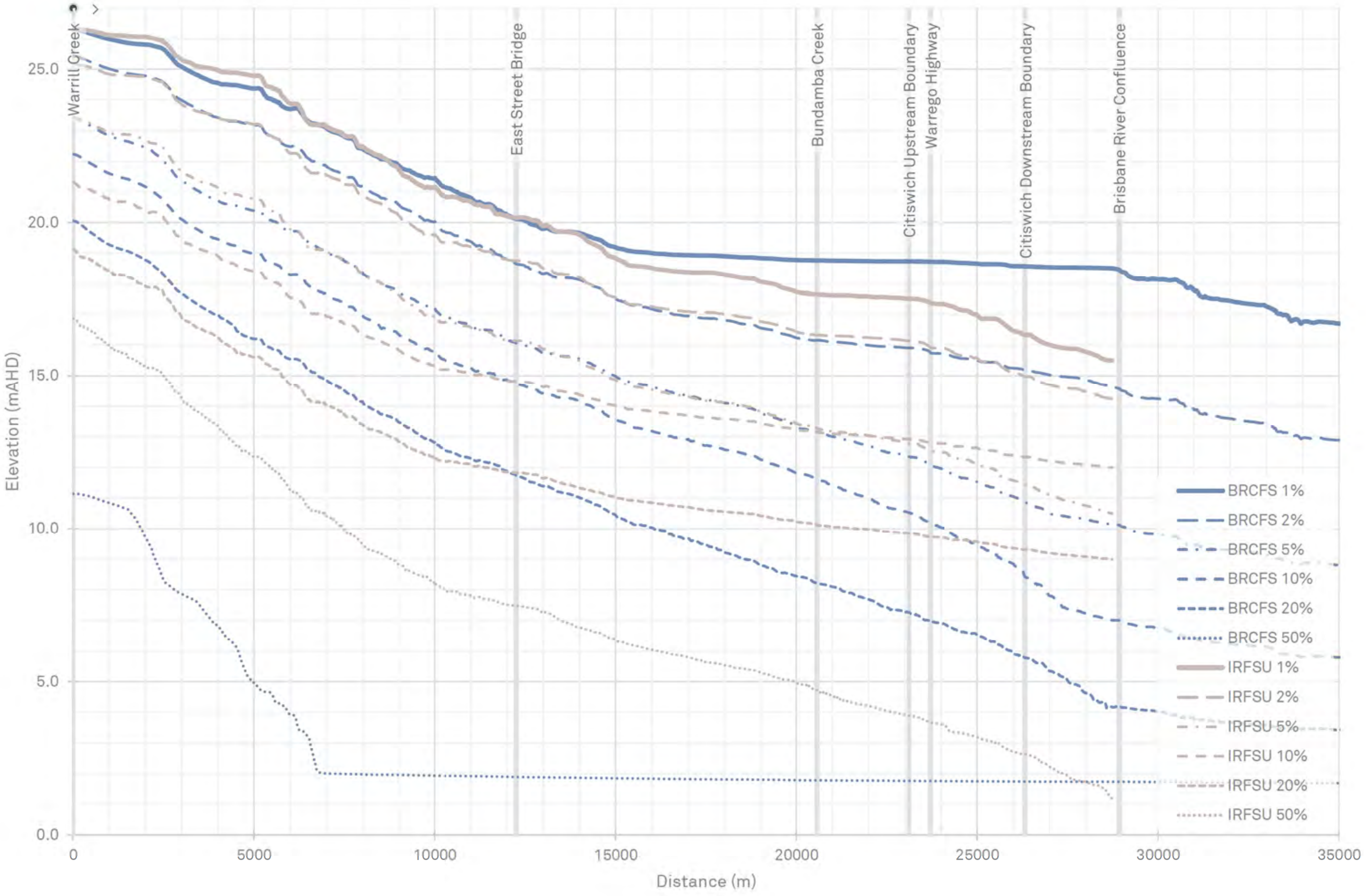
THIS CHART ILLUSTRATES THE DIFFERENCE IN DESIGN EVENT RESULTS FROM THE BRCFS AND IRFSU

BLUE LINES REPRESENT THE BRCFS MODEL

BROWN LINES REPRESENT THE IRFSU MODEL

IT IS NOTED THAT GENERALLY RESULTS UPSTREAM OF THE IPSWICH CBD (EAST STREET BRIDGE) ARE MORE CLOSELY ALIGNED BETWEEN BOTH STUDIES THAN THOSE DOWNSTREAM OF THAT LOCATION

BREMER RIVER - Peak Flood Levels - Long Section



APPENDIX A.3

BREMER RIVER FLOOD SURFACE LEVEL LONG SECTION: HISTORICAL EVENTS

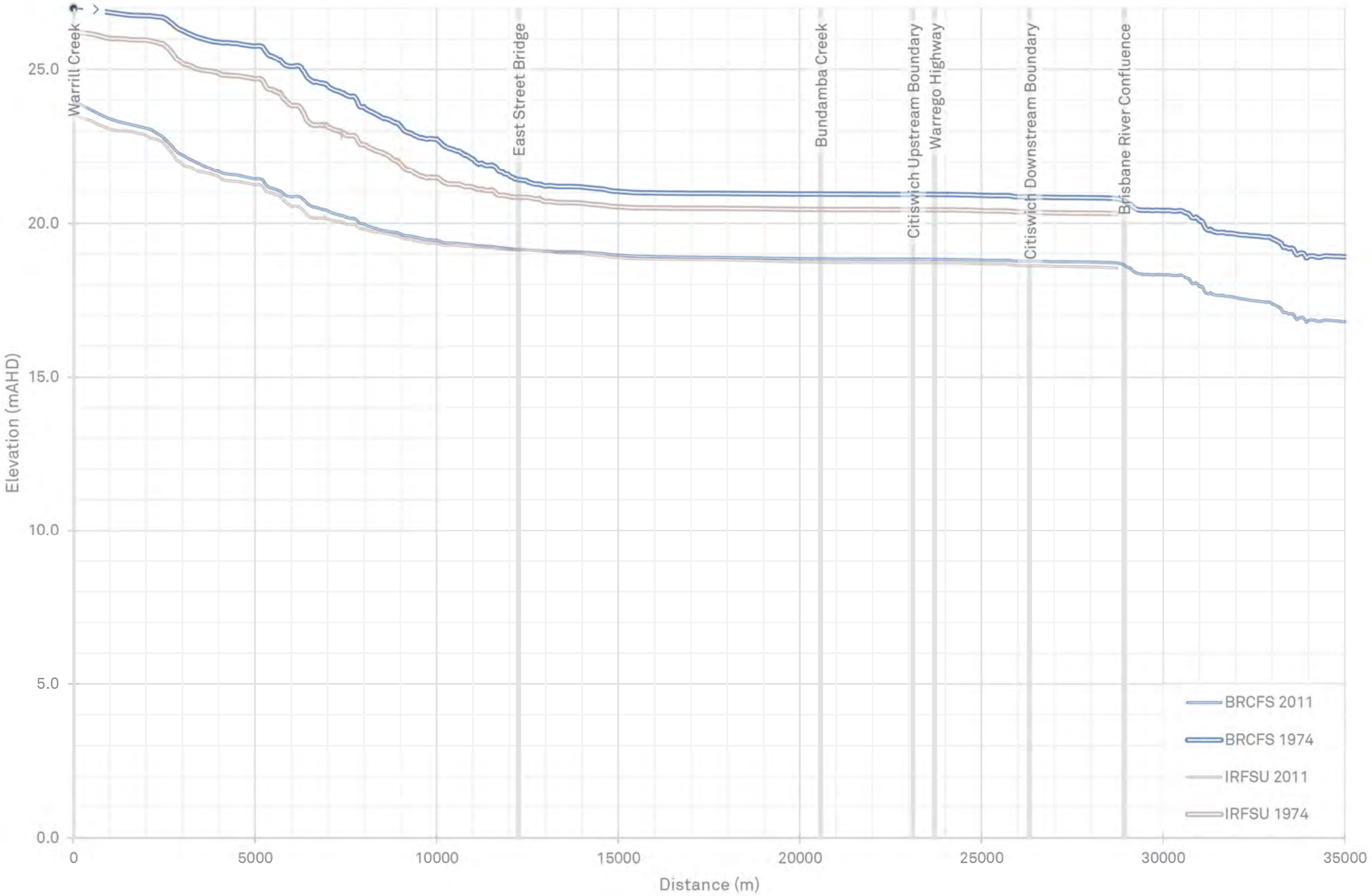
THIS CHART ILLUSTRATES THE DIFFERENCE IN DESIGN EVENT RESULTS FROM THE BRCFS AND IRFSU

BLUE LINES REPRESENT THE BRCFS MODEL

BROWN LINES REPRESENT THE IRFSU MODEL

IT IS NOTED THAT THE IRFSU 1974 EVENT TENDS TO BE PREDICT PEAK FLOOD LEVELS LOWER THAN THE BRCFS

BREMER RIVER - Peak Flood Levels - Long Section



APPENDIX B

BASE SCENARIO FLOOD RESULTS

THE BASE CASE MODEL INCLUDES THE CURRENTLY APPROVED STAGE 7 FILL.

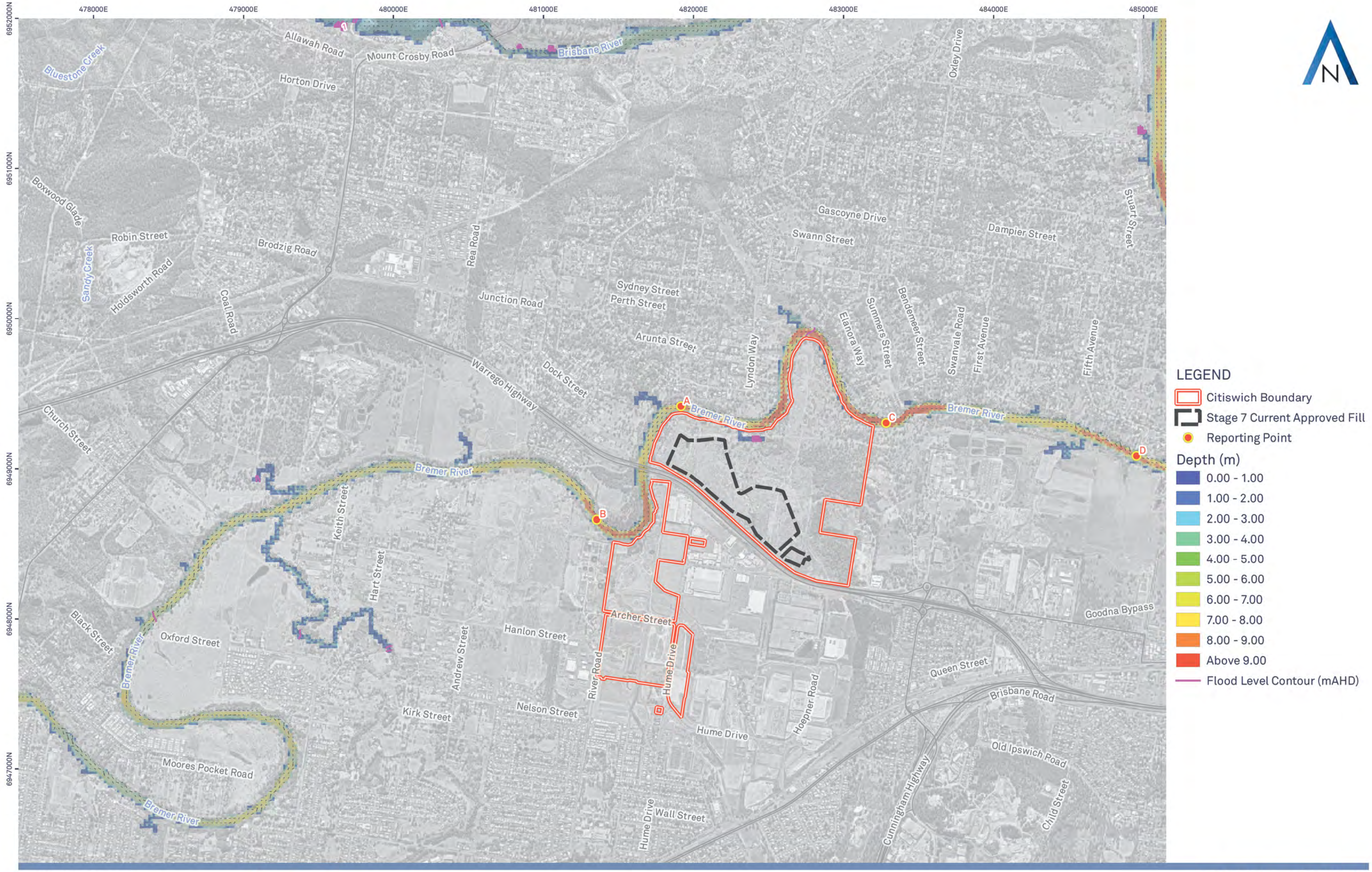
THESE FIGURES ILLUSTRATE THE PEAK FLOOD DEPTH, IN DISTINCT COLOUR BINS, ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).

APPENDIX B.1

FLOOD DEPTHS – CRITICAL DURATION (BASE SCENARIO)

ILLUSTRATES THE PEAK DEPTH RESULTS FROM THE CRITICAL DURATION FOR EACH DESIGN EVENT. I.E. THE STORM DURATION THAT YIELDS THE HIGHEST FLOOD LEVEL WITHIN THE STUDY AREA.

THESE FIGURES ILLUSTRATE THE PEAK FLOOD DEPTH, IN DISTINCT COLOUR BINS, ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).



CRS GDA94 / MGA zone 56

Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

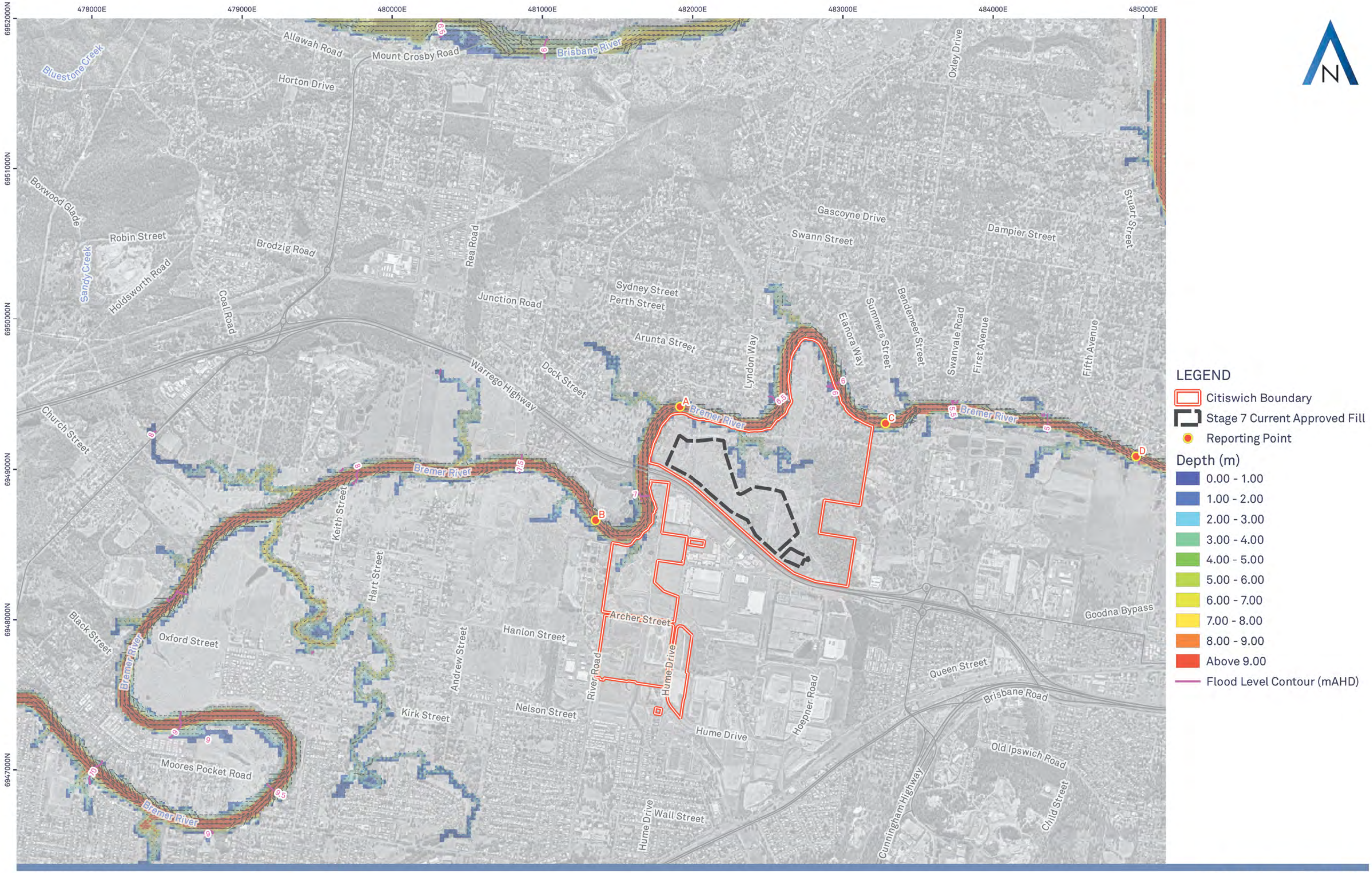
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B1.02.1

BRCFS FULL MODEL - 50% AEP FLOOD DEPTH (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

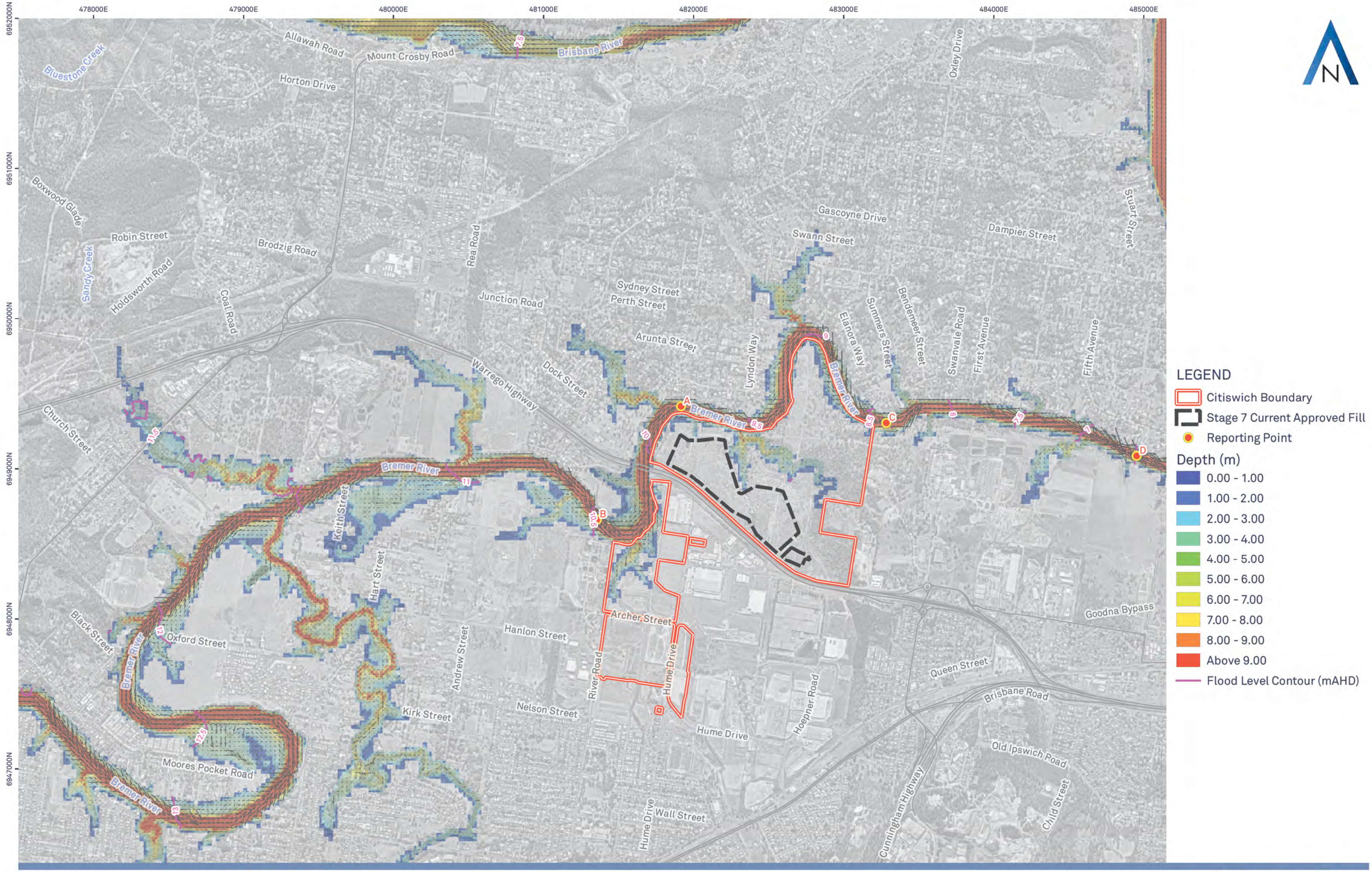
ALLAN & DENNIS

DATE 07 July 2023	SIZE A3
REFERENCE J17015	SCALE 1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B1.03.1
BRCFS FULL MODEL - 20% AEP FLOOD DEPTH (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



LEGEND

▭ Citiswich Boundary

▭ Stage 7 Current Approved Fill

● Reporting Point

Depth (m)

- 0.00 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 6.00
- 6.00 - 7.00
- 7.00 - 8.00
- 8.00 - 9.00
- Above 9.00
- Flood Level Contour (mAHD)

CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

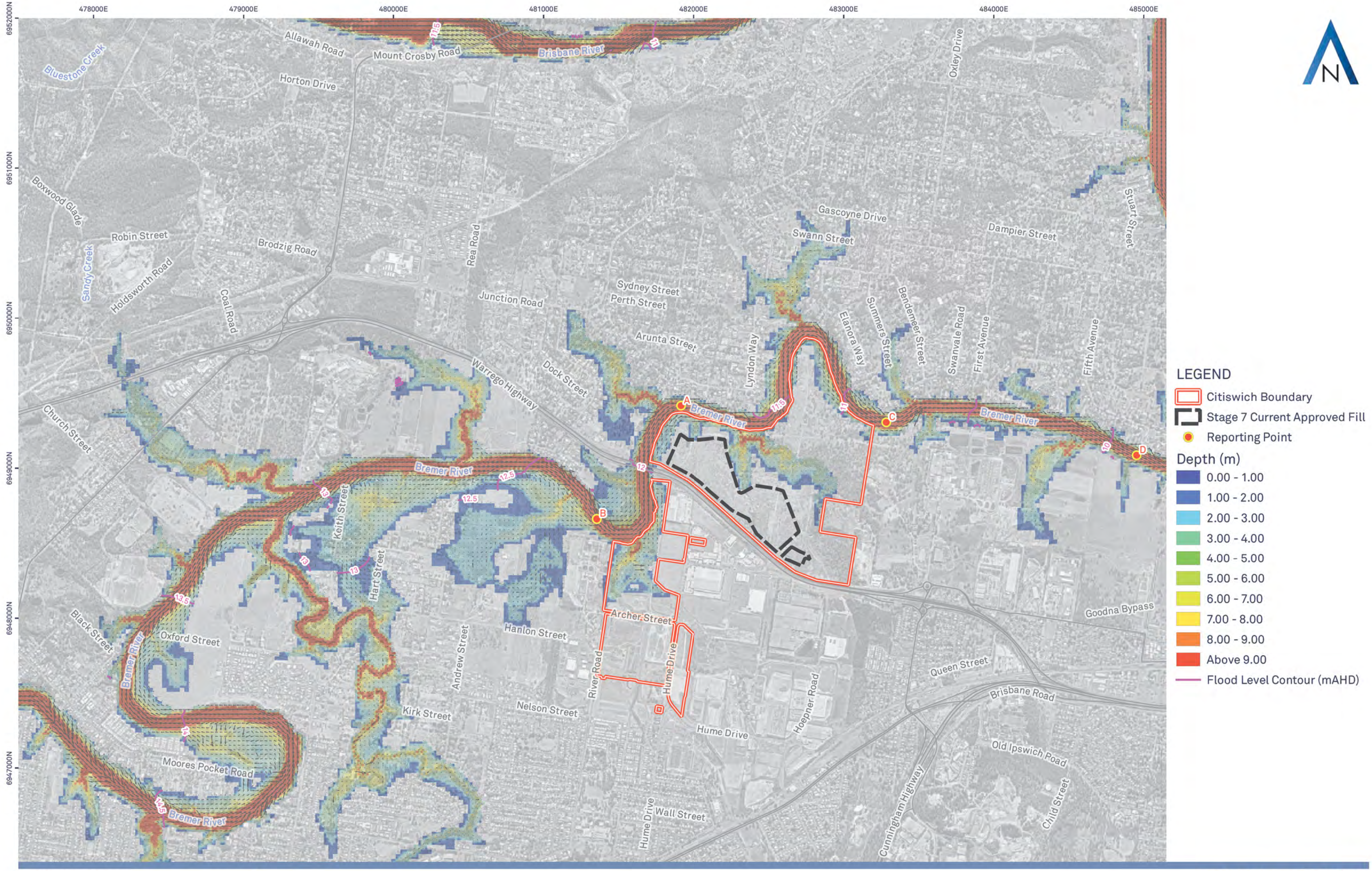
DATE	SIZE
07 July 2023	A3
REFERENCE	SCALE
J17015	1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B1.04.1

BRCFS FULL MODEL - 10% AEP FLOOD DEPTH (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

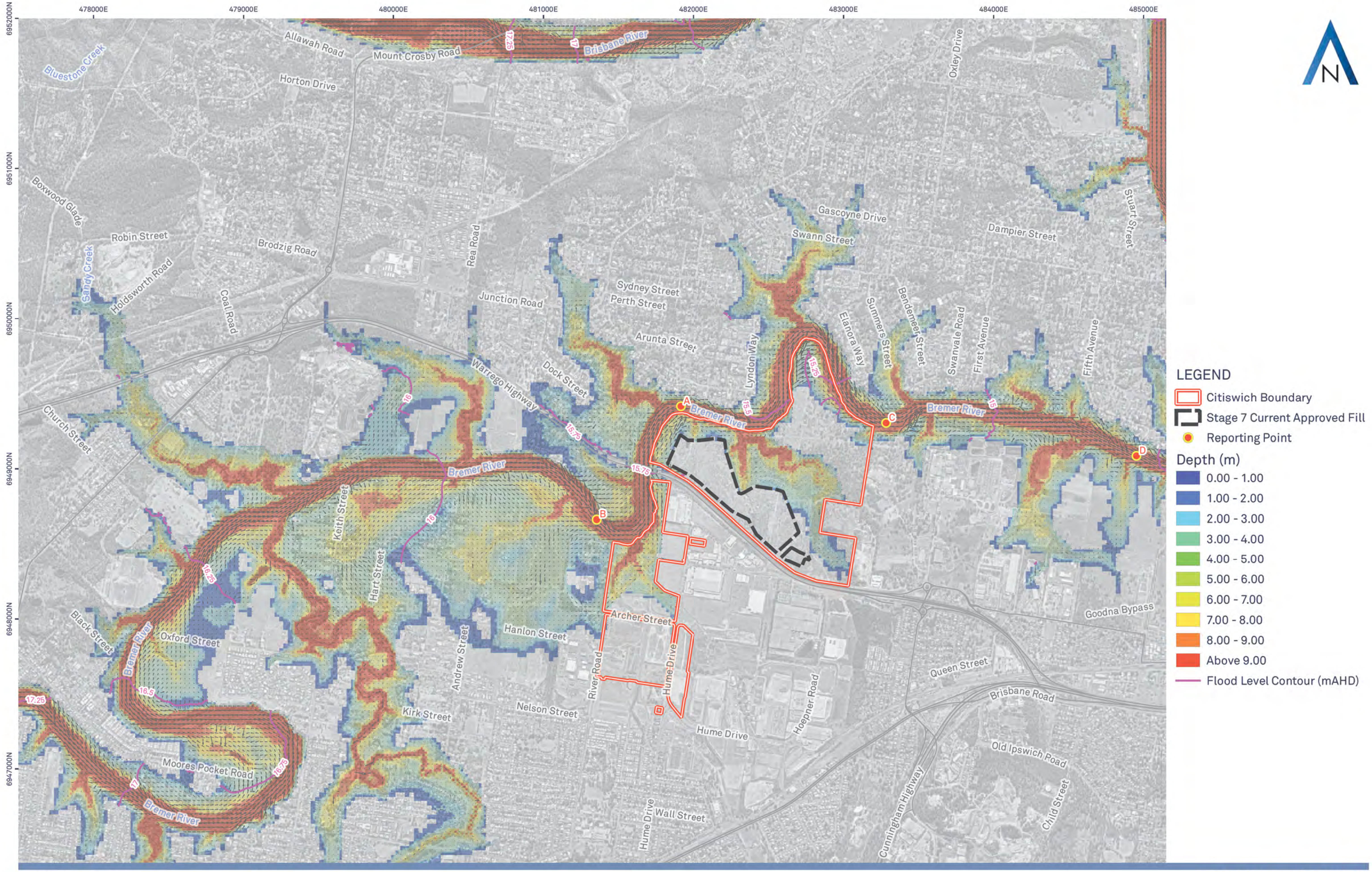
REFERENCE
J17015

SCALE
1:22,500

FIGURE B1.05.1

BRCFS FULL MODEL - 5% AEP FLOOD DEPTH (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

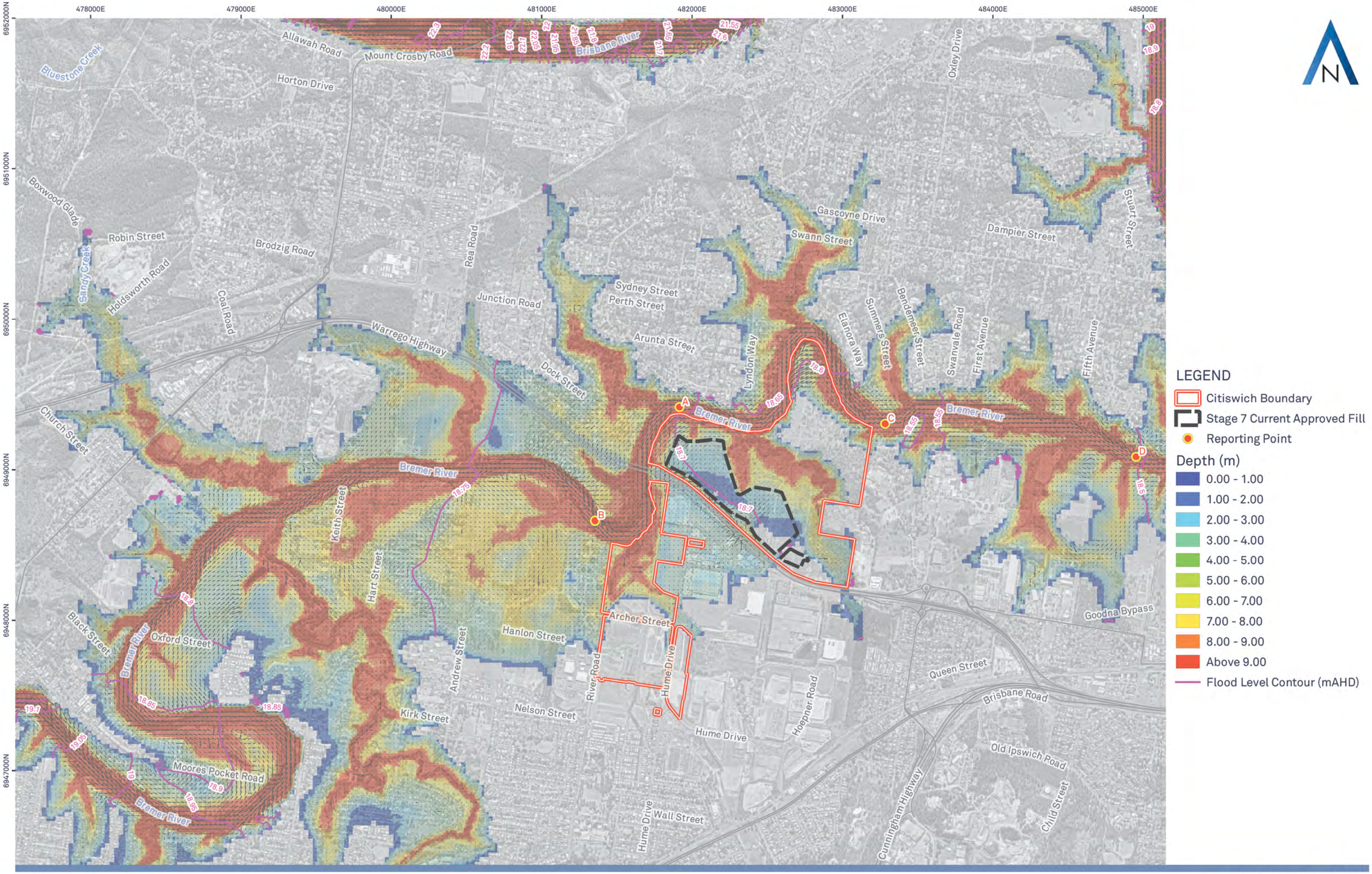
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B1.06.1

BRCFS FULL MODEL - 2% AEP FLOOD DEPTH (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B1.07.1

BRCFS FULL MODEL - 1% AEP FLOOD DEPTH (EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd

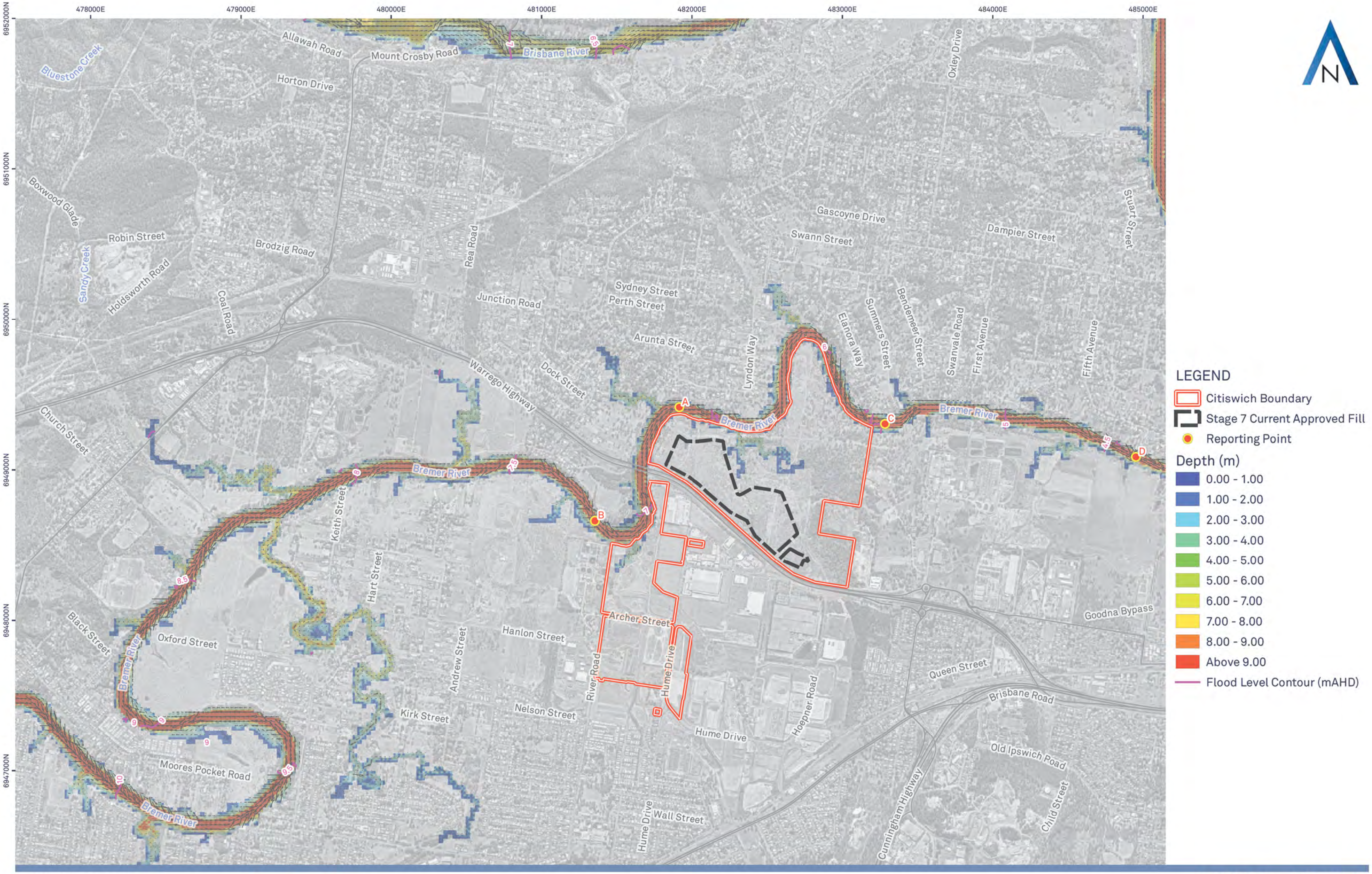
APPENDIX B.2

FLOOD DEPTHS – CRITICAL DISCHARGE (BASE SCENARIO)

ILLUSTRATES THE PEAK DEPTH RESULTS FROM THE CRITICAL DISCHARGE FOR EACH DESIGN EVENT. I.E. THE STORM DURATION THAT YIELDS THE HIGHEST FLOOD LEVEL WITHIN THE STUDY AREA.

THESE FIGURES ILLUSTRATE THE PEAK FLOOD DEPTH, IN DISTINCT COLOUR BINS, ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).

IT IS NOTED THAT THE STORM DURATION PRODUCING THE PEAK DISCHARGE FOR THE 50%, 10% AND 5% AEP ARE THE SAME THAT PRODUCE THE PEAK WATER LEVEL IN THE PREVIOUS APPENDIX, AS SUCH THOSE EVENTS ARE OMITTED.



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

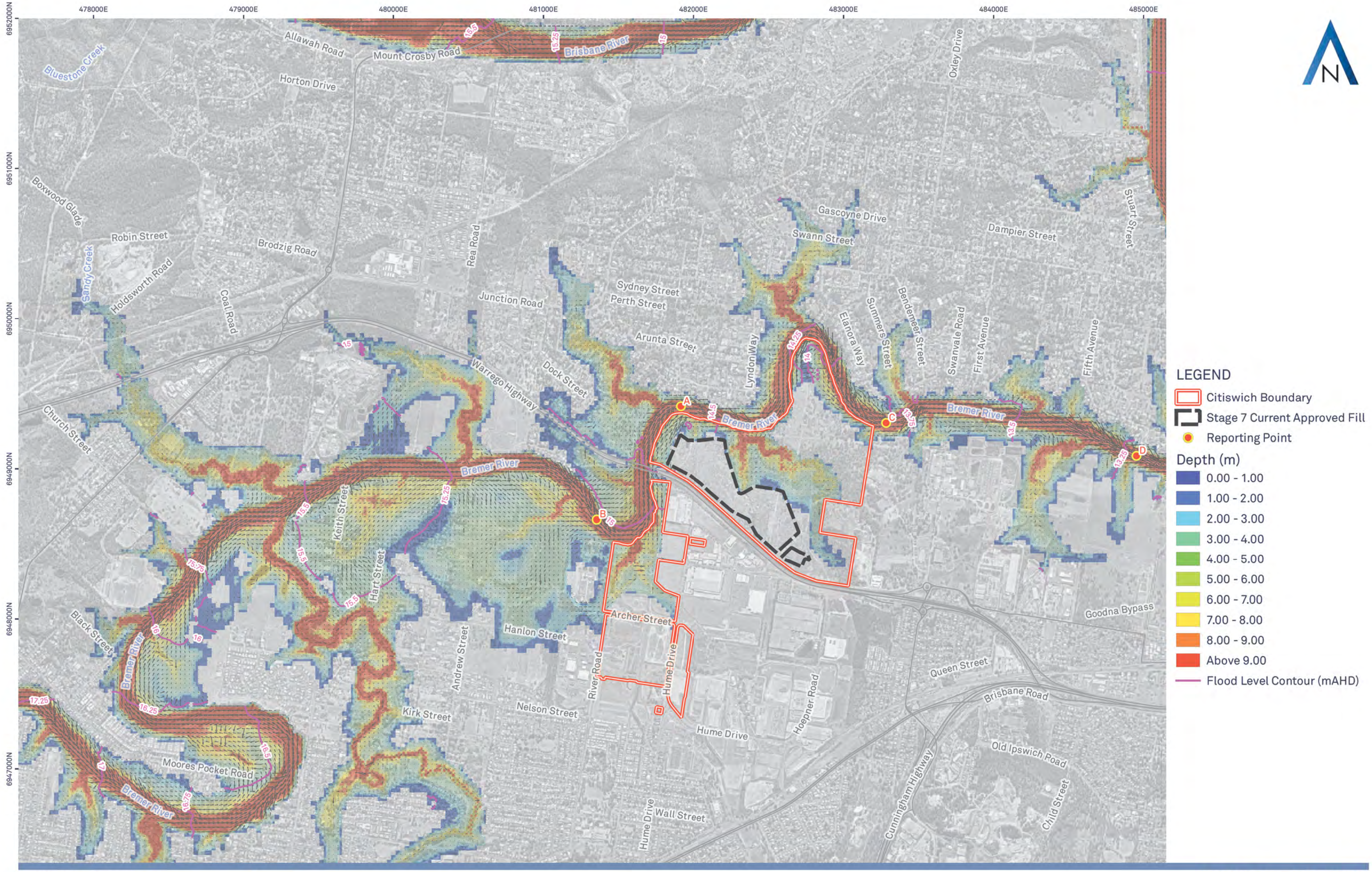
SIZE
A3

REFERENCE
J17015

SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B2.03.1
BRCFS FULL MODEL - 20% AEP FLOOD DEPTH (EX05g_CDQ)
Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

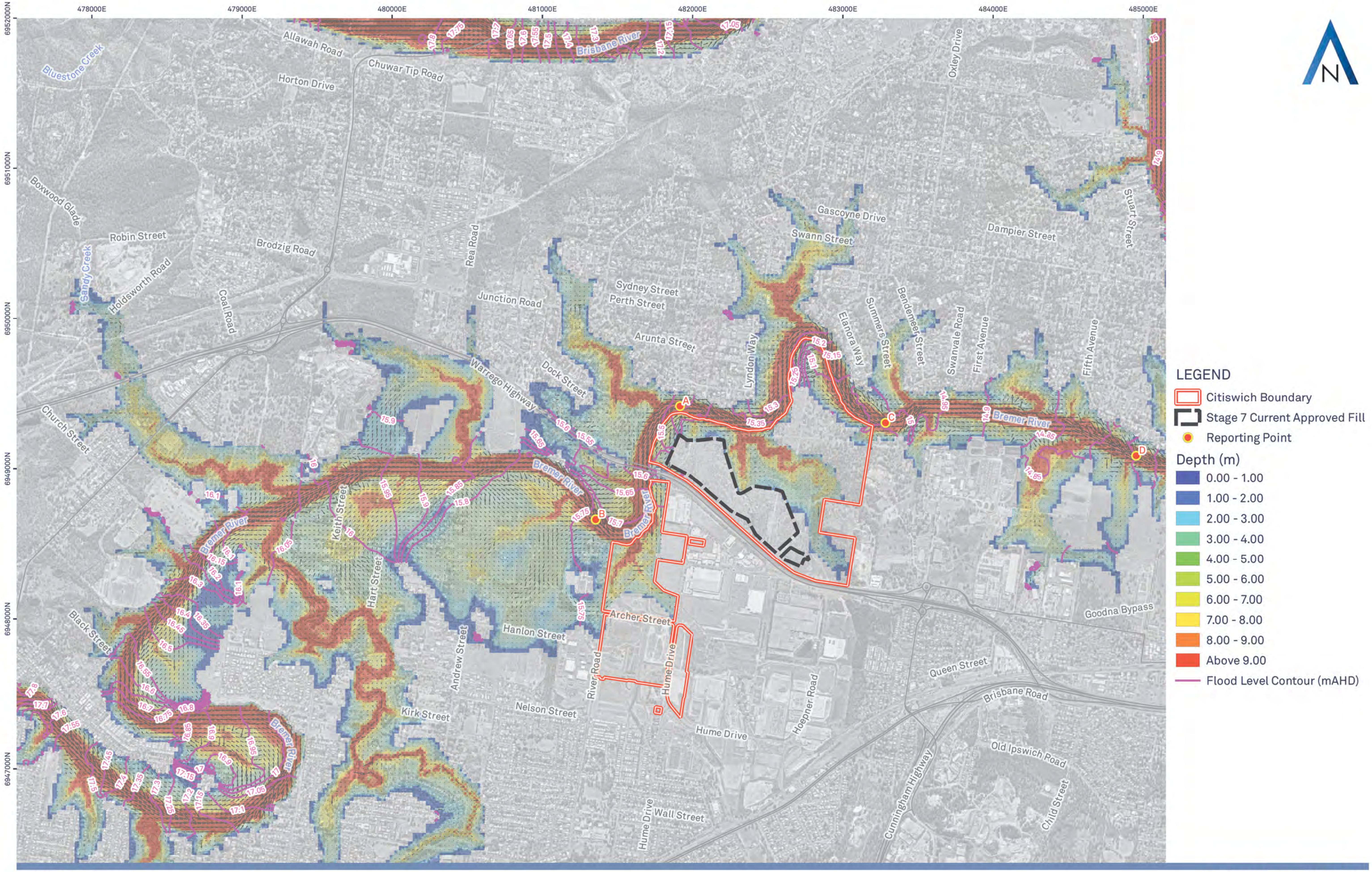
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B2.06.1

BRCFS FULL MODEL - 2% AEP FLOOD DEPTH (EX05g_CDQ)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE B2.07.1

BRCFS FULL MODEL - 1% AEP FLOOD DEPTH (EX05g_CDQ)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd

APPENDIX C

PROPOSED SCENARIO FLOOD RESULTS

ILLUSTRATES THE RELATIVE DIFFERENCE IN PEAK FLOOD LEVELS BETWEEN THE PROPOSED AND BASE SCENARIOS

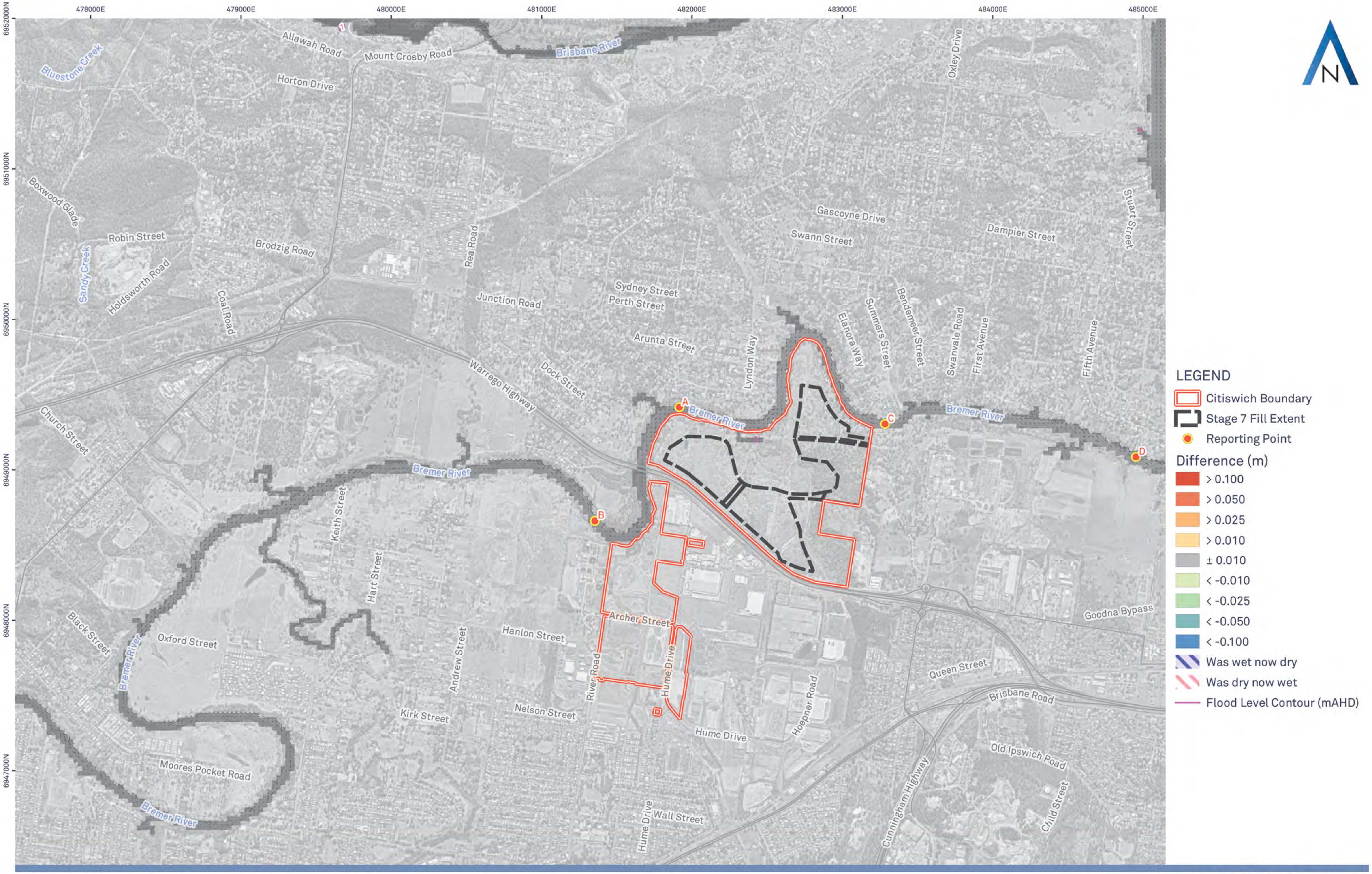
THESE FIGURES ILLUSTRATE THE FLOOD DIFFERENCE, IN DISTINCT COLOUR BINS (SHADES OR RED/ORANGE INDICATING A RELATIVE INCREASE, SHADES OF BLUE/GREEN INDICATING A RELATIVE DECREASE), ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).

APPENDIX C.1

FLOOD LEVEL DIFFERENCE – CRITICAL DURATION (PROPOSED SCENARIO)

ILLUSTRATES THE RELATIVE DIFFERENCE IN PEAK FLOOD LEVELS BETWEEN THE PROPOSED AND BASE SCENARIOS FROM THE CRITICAL DURATION FOR EACH DESIGN EVENT. I.E. THE STORM DURATION THAT YIELDS THE HIGHEST FLOOD LEVEL WITHIN THE STUDY AREA.

THESE FIGURES ILLUSTRATE THE FLOOD DIFFERENCE, IN DISTINCT COLOUR BINS (SHADES OR RED/ORANGE INDICATING A RELATIVE INCREASE, SHADES OF BLUE/GREEN INDICATING A RELATIVE DECREASE), ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

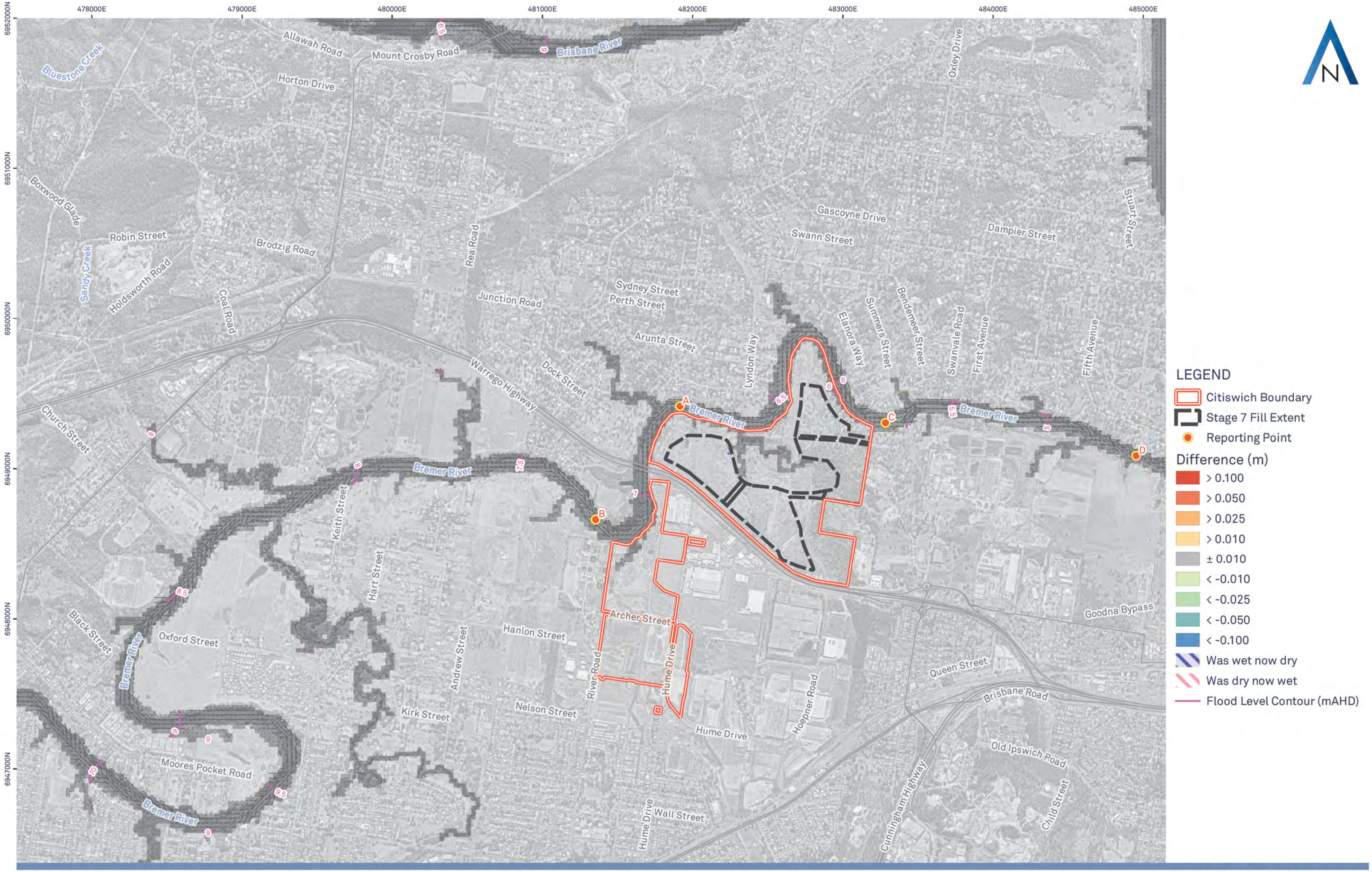
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C1.02.4

BRCFS FULL MODEL - 50% AEP FLOOD LEVEL DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

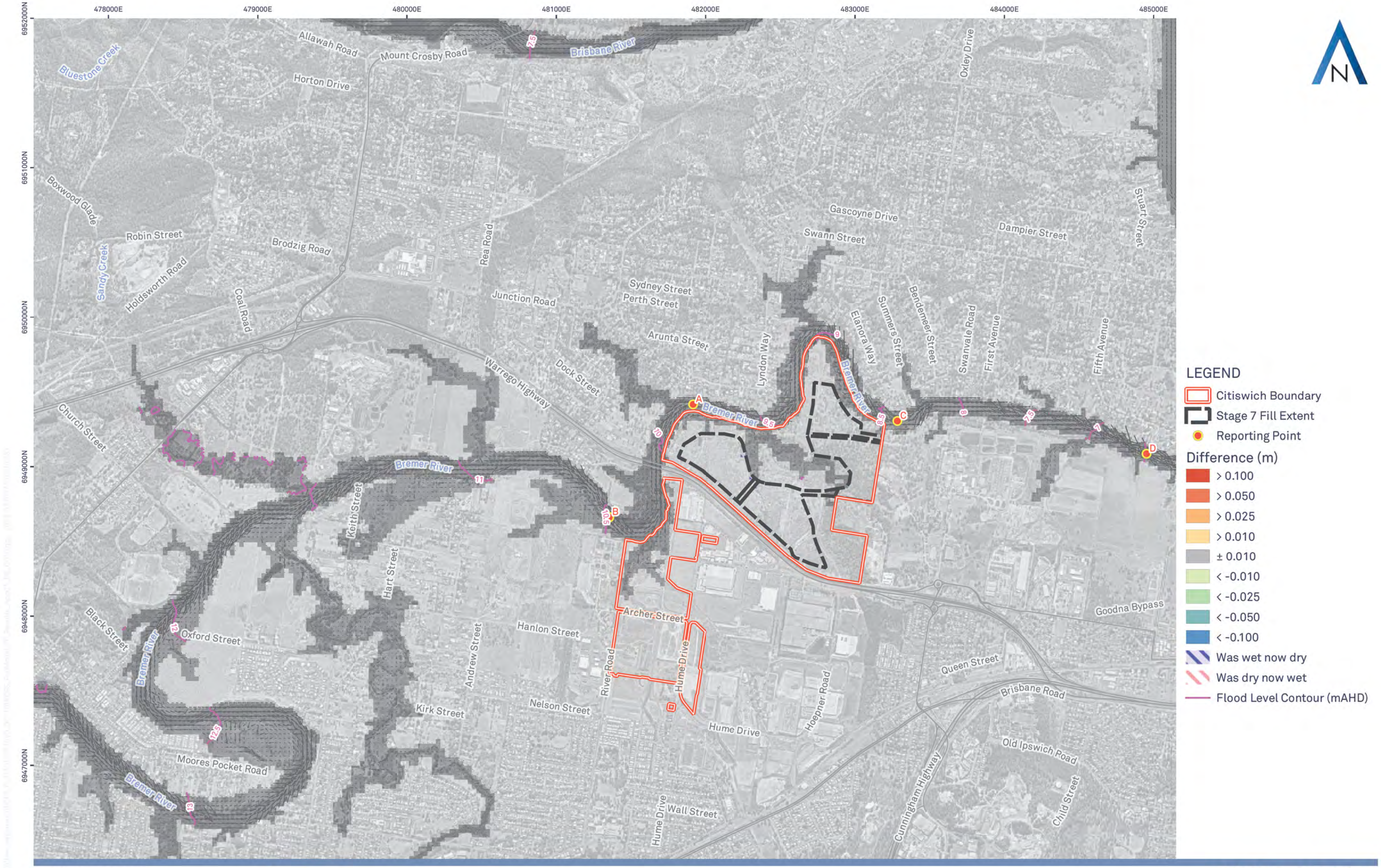
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C1.03.4

BRCFS FULL MODEL - 20% AEP FLOOD LEVEL DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

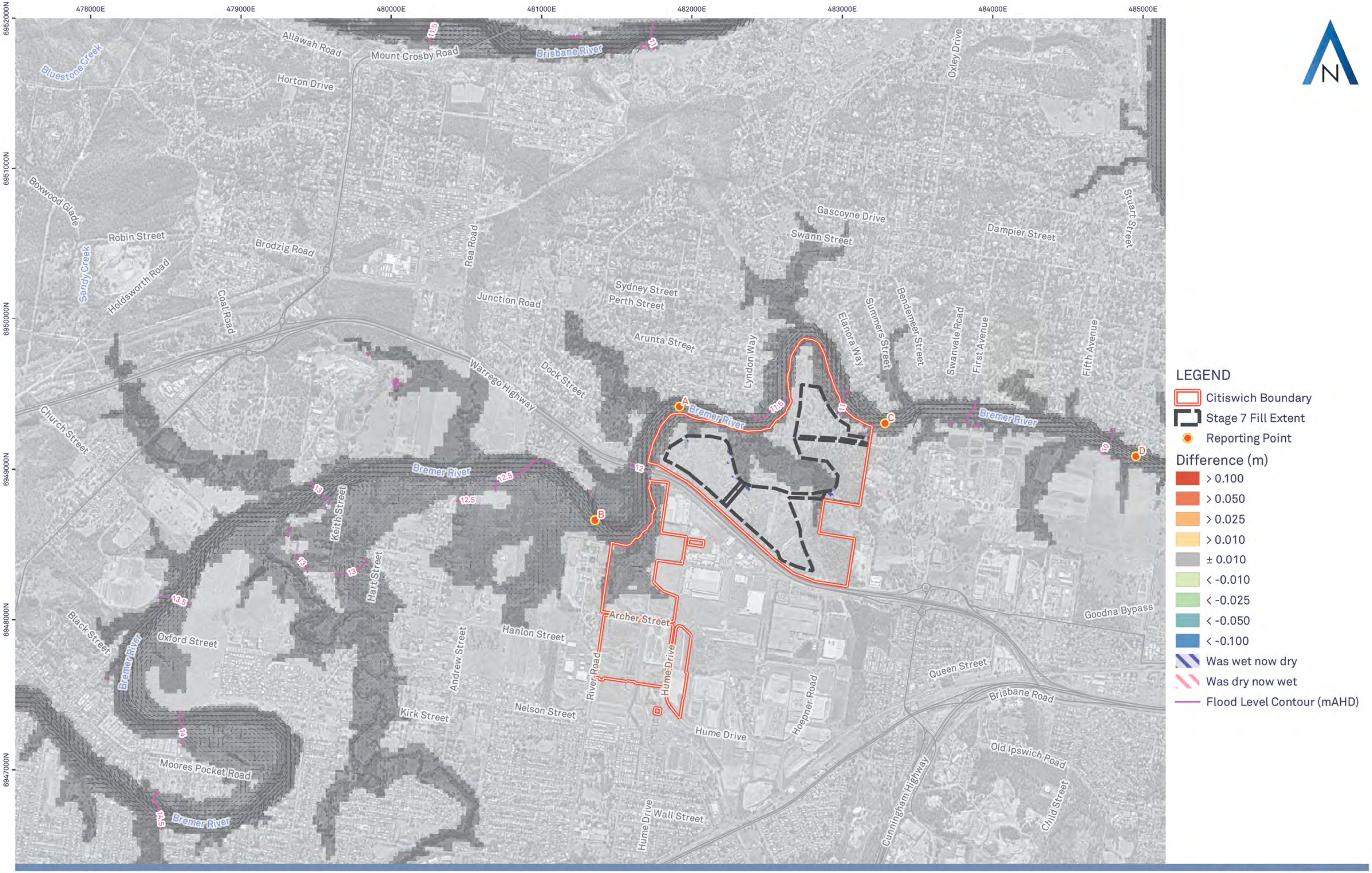
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C1.04.4

BRCFS FULL MODEL - 10% AEP FLOOD LEVEL DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

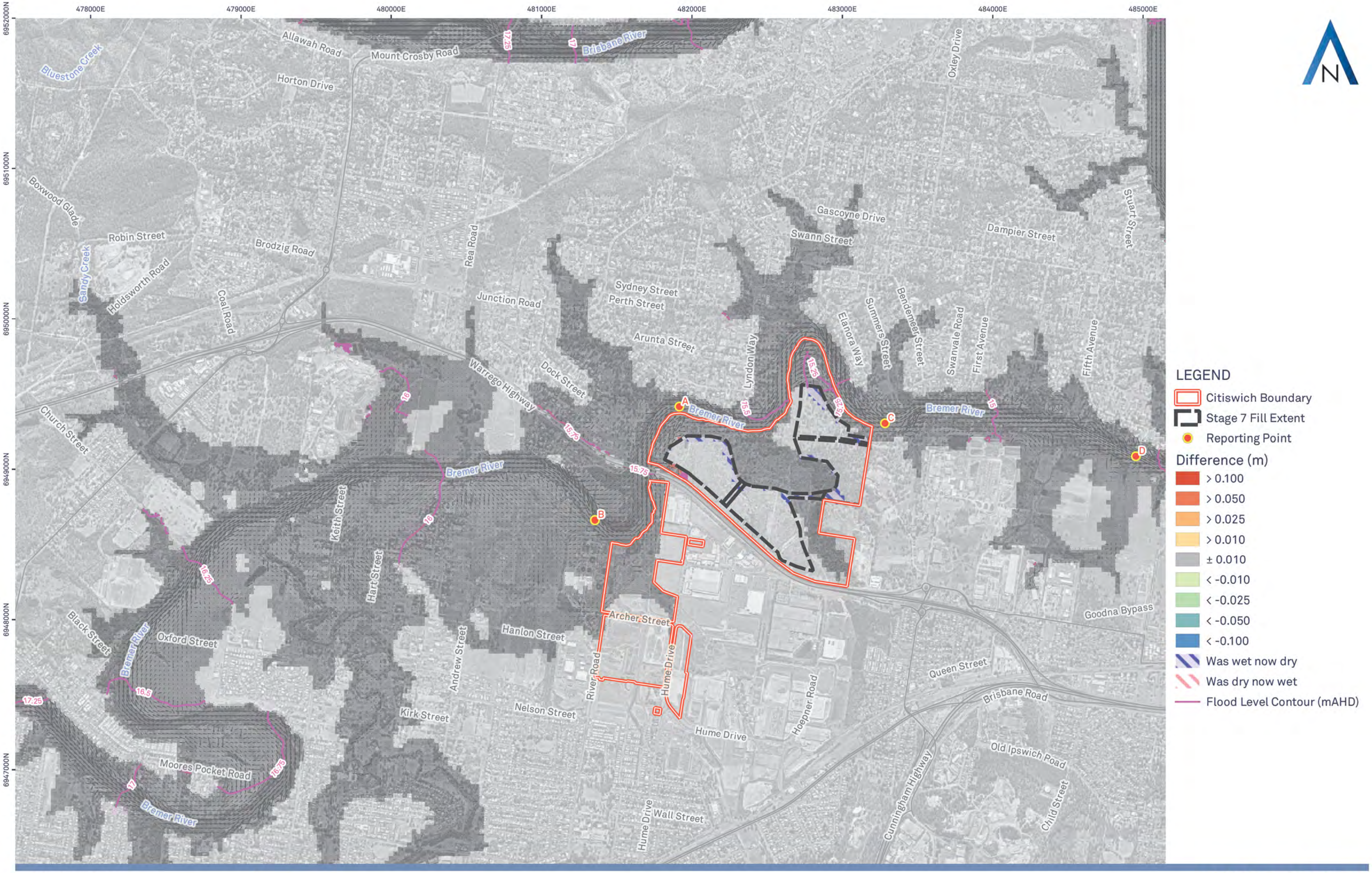
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C1.05.4

BRCFS FULL MODEL - 5% AEP FLOOD LEVEL DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

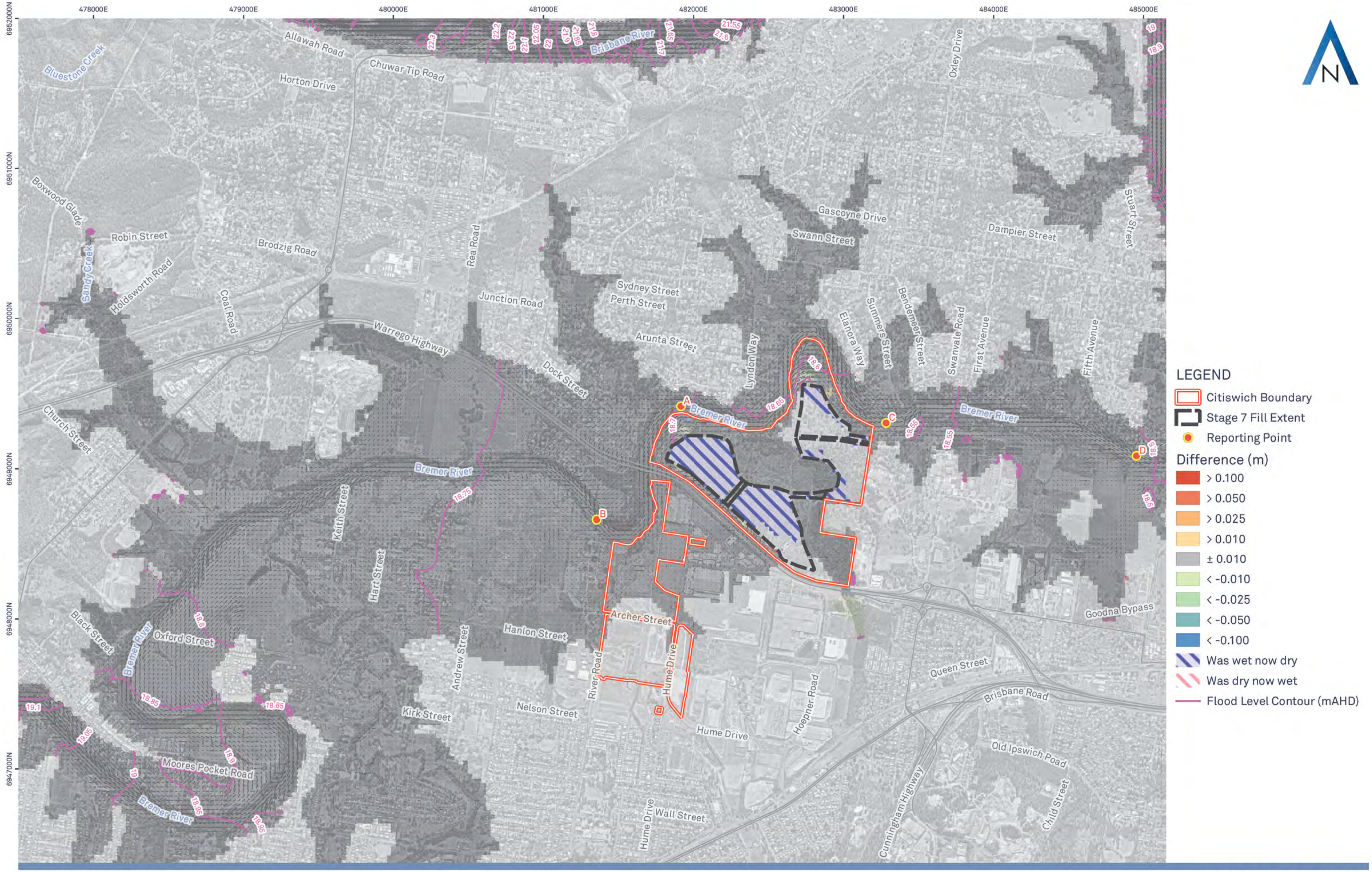
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C1.06.4

BRCFS FULL MODEL - 2% AEP FLOOD LEVEL DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C1.07.4

BRCFS FULL MODEL - 1% AEP FLOOD LEVEL DIFFERENCE (DE11-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd

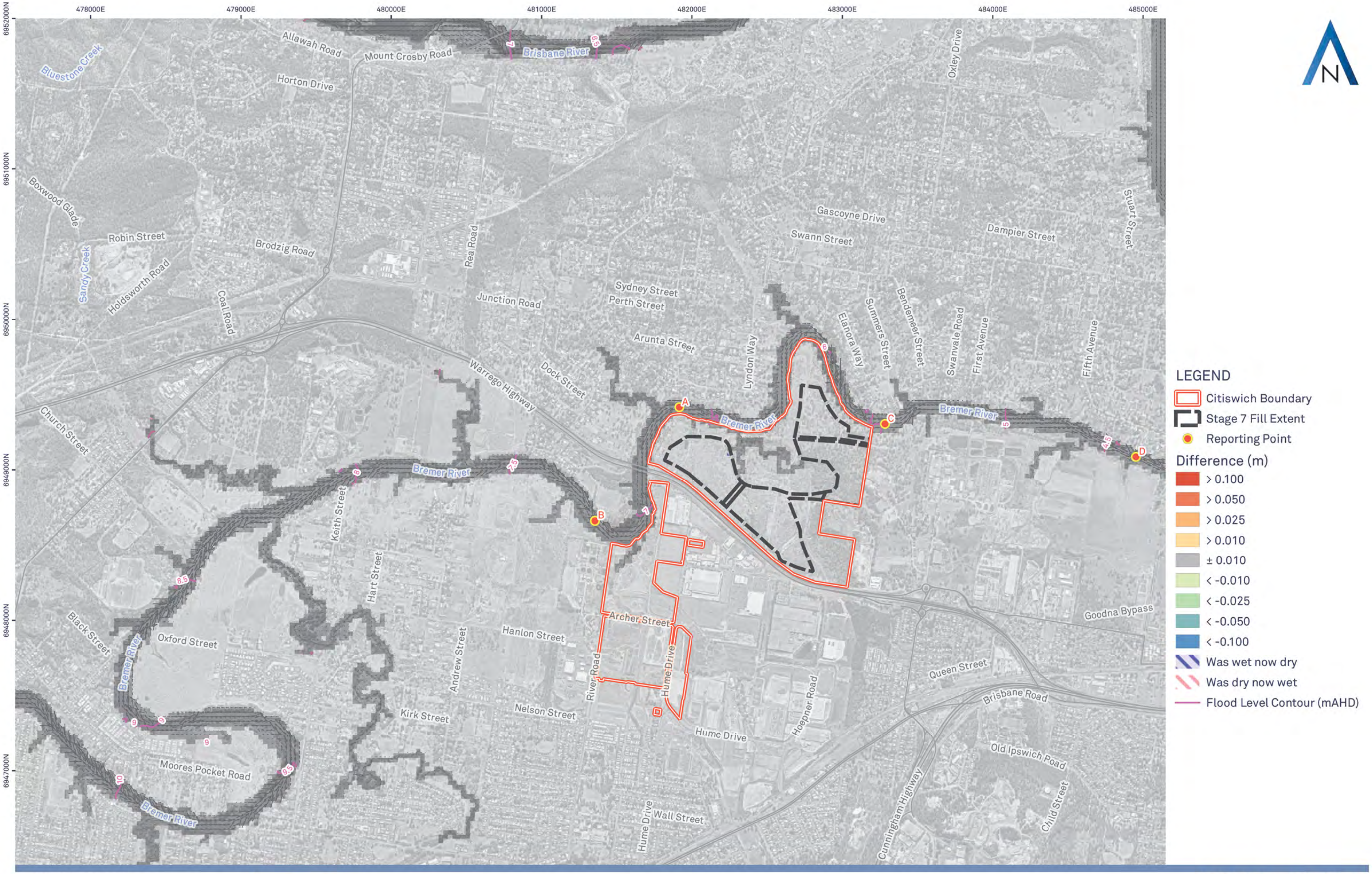
APPENDIX C.2

FLOOD LEVEL DIFFERENCE – CRITICAL DISCHARGE (PROPOSED SCENARIO)

ILLUSTRATES THE RELATIVE DIFFERENCE IN PEAK FLOOD LEVELS BETWEEN THE PROPOSED AND BASE SCENARIOS FROM THE CRITICAL DISCHARGE FOR EACH DESIGN EVENT. I.E. THE STORM DURATION THAT YIELDS THE HIGHEST FLOOD LEVEL WITHIN THE STUDY AREA.

THESE FIGURES ILLUSTRATE THE FLOOD DIFFERENCE, IN DISTINCT COLOUR BINS (SHADES OR RED/ORANGE INDICATING A RELATIVE INCREASE, SHADES OF BLUE/GREEN INDICATING A RELATIVE DECREASE), ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).

IT IS NOTED THAT THE STORM DURATION PRODUCING THE PEAK DISCHARGE FOR THE 50%, 10% AND 5% AEP ARE THE SAME THAT PRODUCE THE PEAK FLOOD LEVEL IN THE PREVIOUS APPENDIX, AS SUCH THOSE EVENTS ARE OMITTED.



CRS GDA94 / MGA zone 56

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

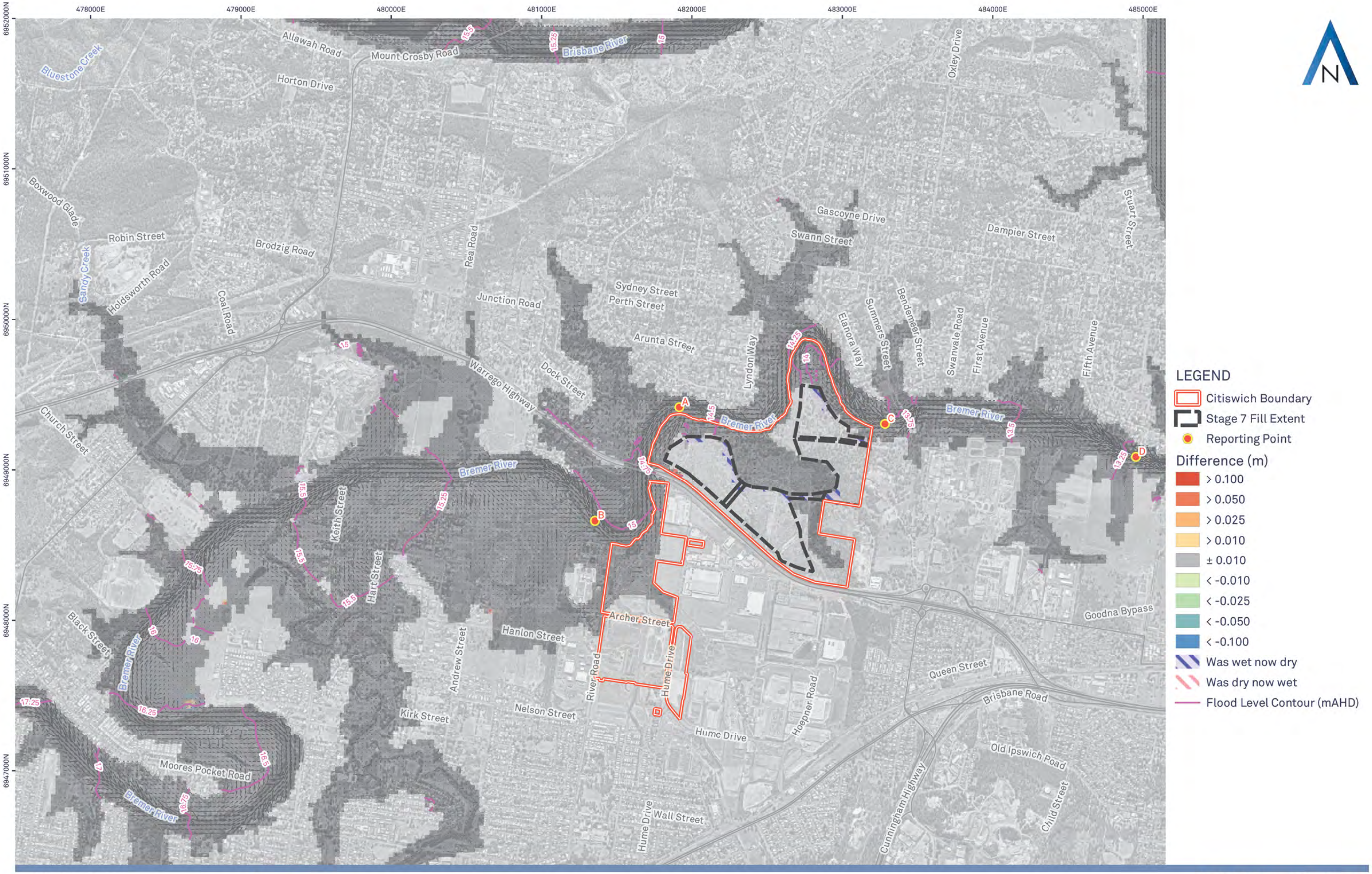
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C2.03.4

BRCFS FULL MODEL - 20% AEP FLOOD LEVEL DIFFERENCE (DE11_CDQ-EX05g_CDQ)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

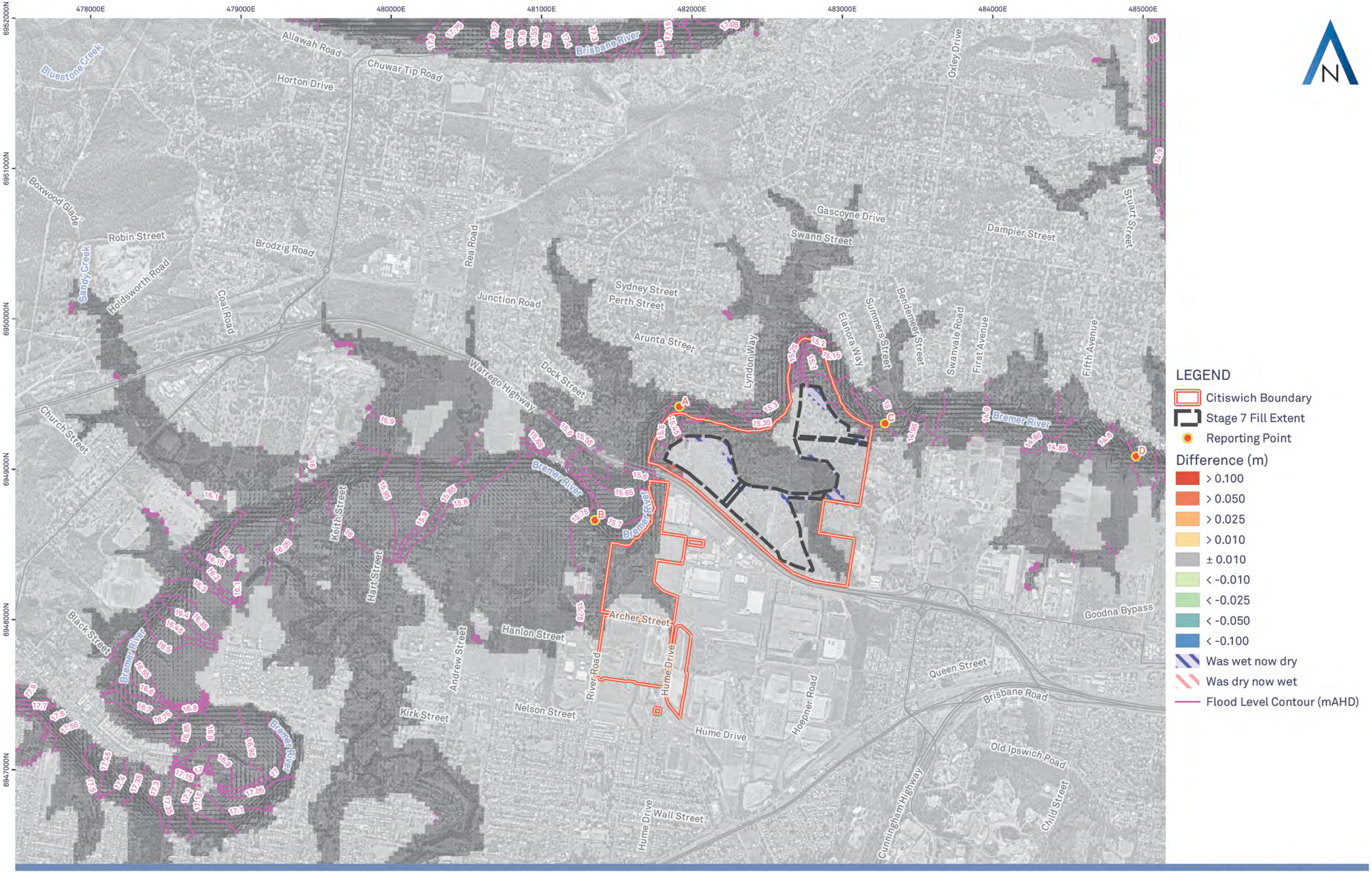
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C2.06.4

BRCFS FULL MODEL - 2% AEP FLOOD LEVEL DIFFERENCE (DE11_CDQ-EX05g_CDQ)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE C2.07.4

BRCFS FULL MODEL - 1% AEP FLOOD LEVEL DIFFERENCE (DE11_CDQ-EX05g_CDQ)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd

APPENDIX D

RIPARIAN VEGETATION SCENARIO FLOOD RESULTS

ILLUSTRATES THE RELATIVE DIFFERENCE IN PEAK FLOOD LEVELS BETWEEN THE RIPARIAN VEGETATION AND BASE SCENARIOS

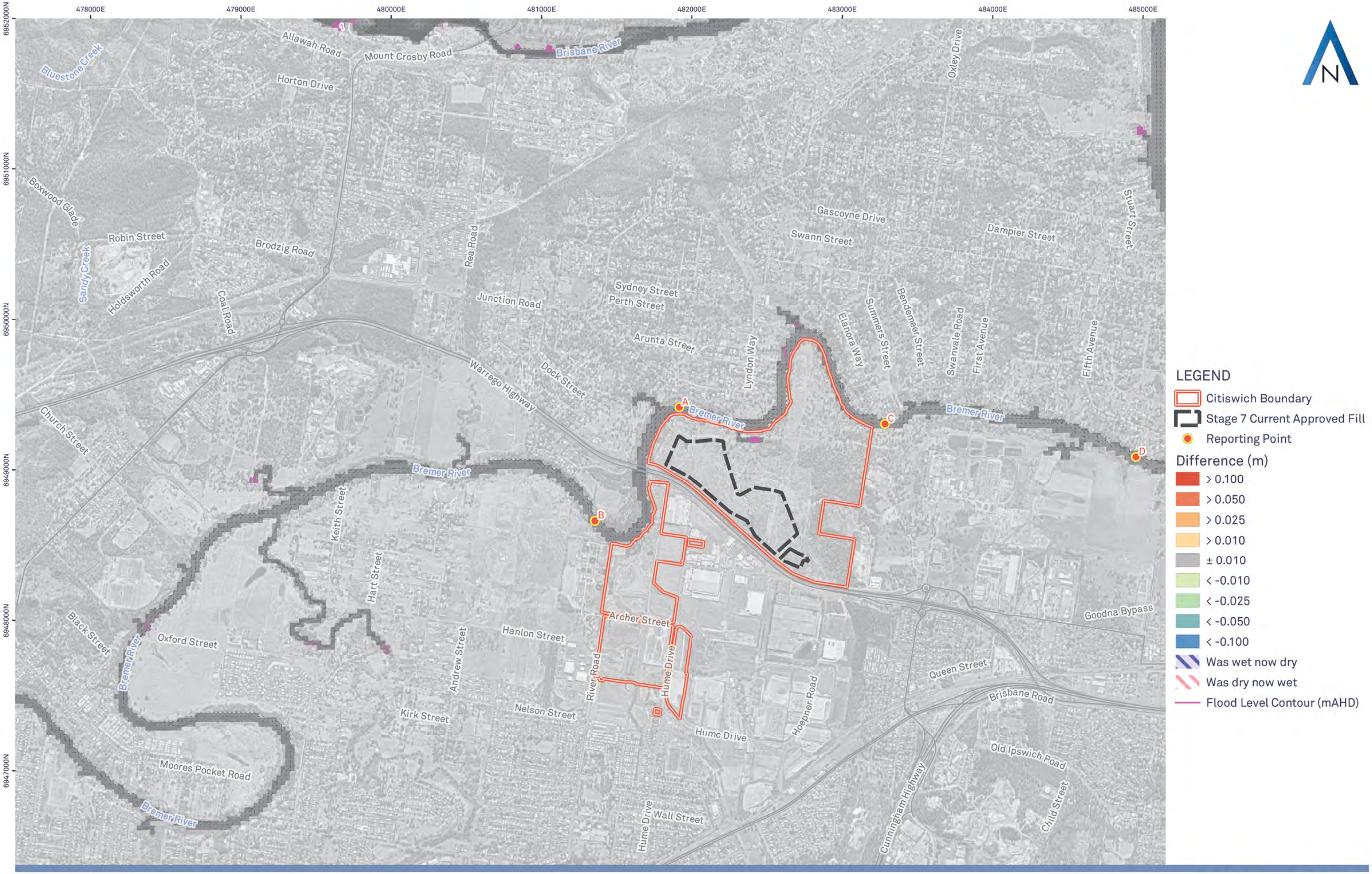
THESE FIGURES ILLUSTRATE THE FLOOD DIFFERENCE, IN DISTINCT COLOUR BINS (SHADES OR RED/ORANGE INDICATING A RELATIVE INCREASE, SHADES OF BLUE/GREEN INDICATING A RELATIVE DECREASE), ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).

APPENDIX D.1

FLOOD LEVEL DIFFERENCE – CRITICAL DURATION (RIPARIAN VEGETATION SCENARIO)

ILLUSTRATES THE RELATIVE DIFFERENCE IN PEAK WATER LEVELS BETWEEN THE RIPARIAN VEGETATION AND BASE SCENARIOS FROM THE CRITICAL DURATION FOR EACH DESIGN EVENT. I.E. THE STORM DURATION THAT YIELDS THE HIGHEST FLOOD LEVEL WITHIN THE STUDY AREA.

THESE FIGURES ILLUSTRATE THE FLOOD DIFFERENCE, IN DISTINCT COLOUR BINS (SHADES OR RED/ORANGE INDICATING A RELATIVE INCREASE, SHADES OF BLUE/GREEN INDICATING A RELATIVE DECREASE), ALONG WITH PEAK FLOOD LEVEL CONTOURS (PINK LINES) AND INDICATIVE PEAK VELOCITY VECTORS (BLACK ARROWS).



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

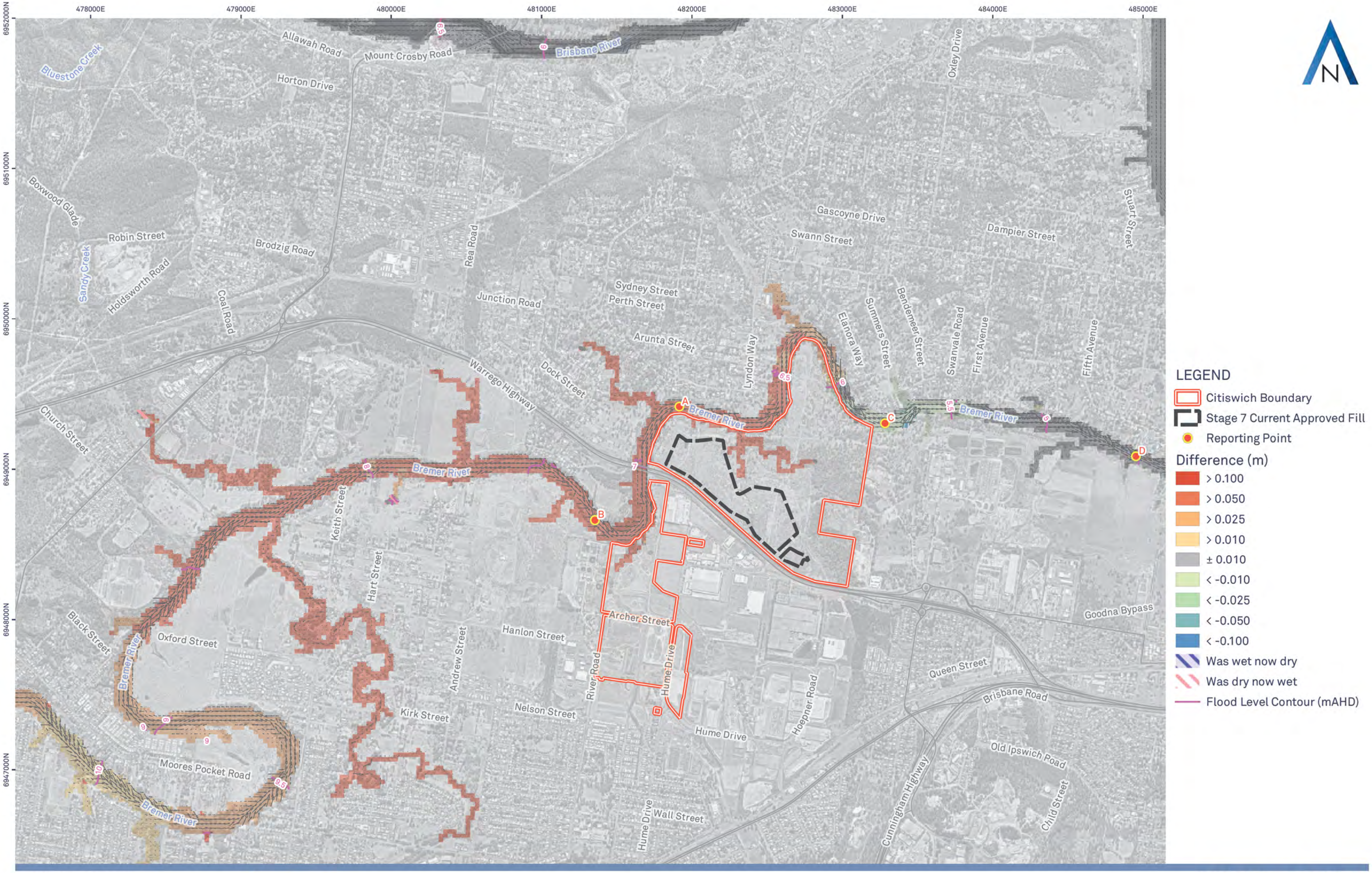
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE D1.02.4

BRCFS FULL MODEL - 50% AEP FLOOD LEVEL DIFFERENCE (EX05g_F3-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

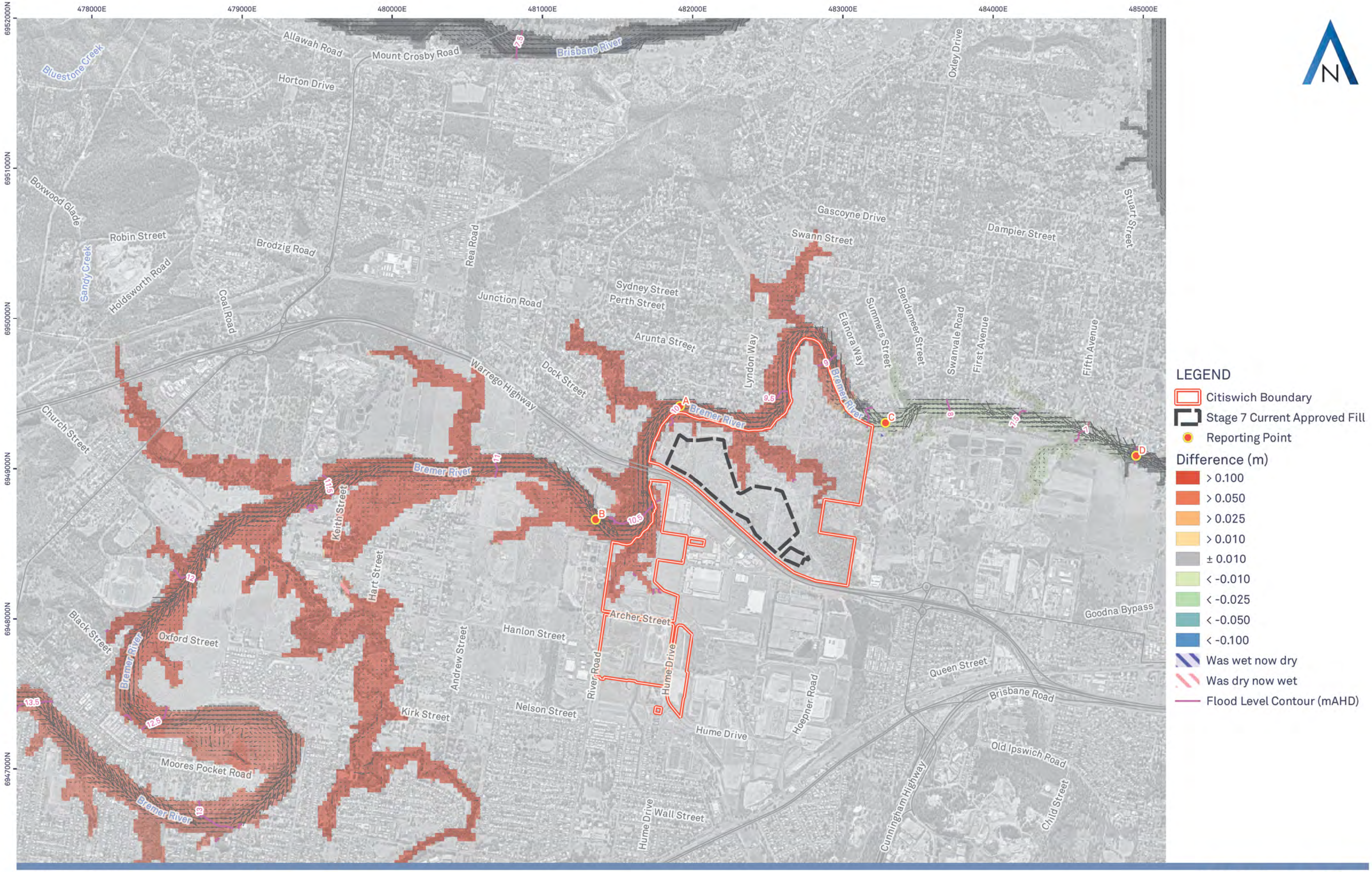
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE D1.03.4

BRCFS FULL MODEL - 20% AEP FLOOD LEVEL DIFFERENCE (EX05g_F3-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

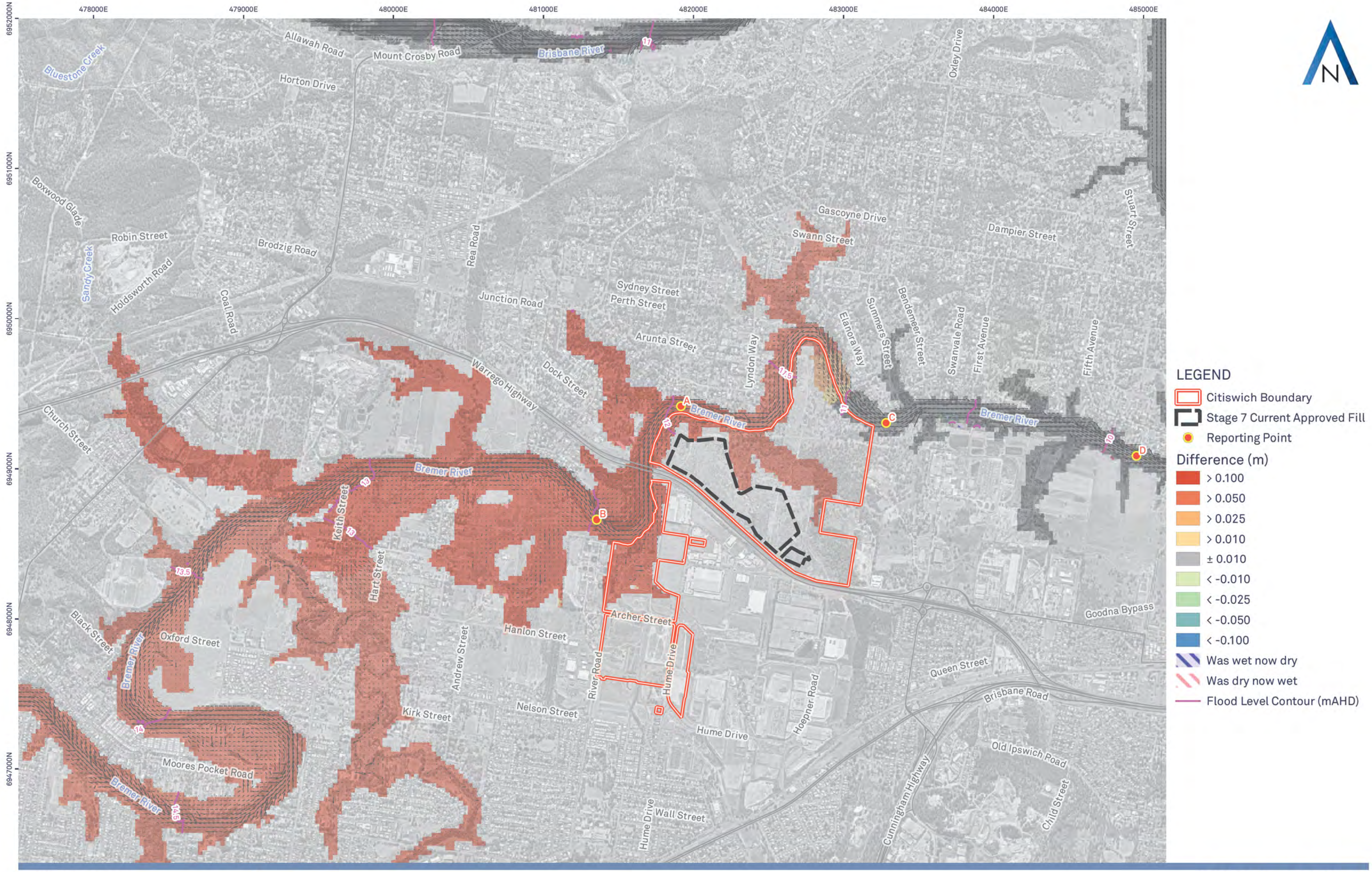
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE D1.04.4

BRCFS FULL MODEL - 10% AEP FLOOD LEVEL DIFFERENCE (EX05g_F3-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

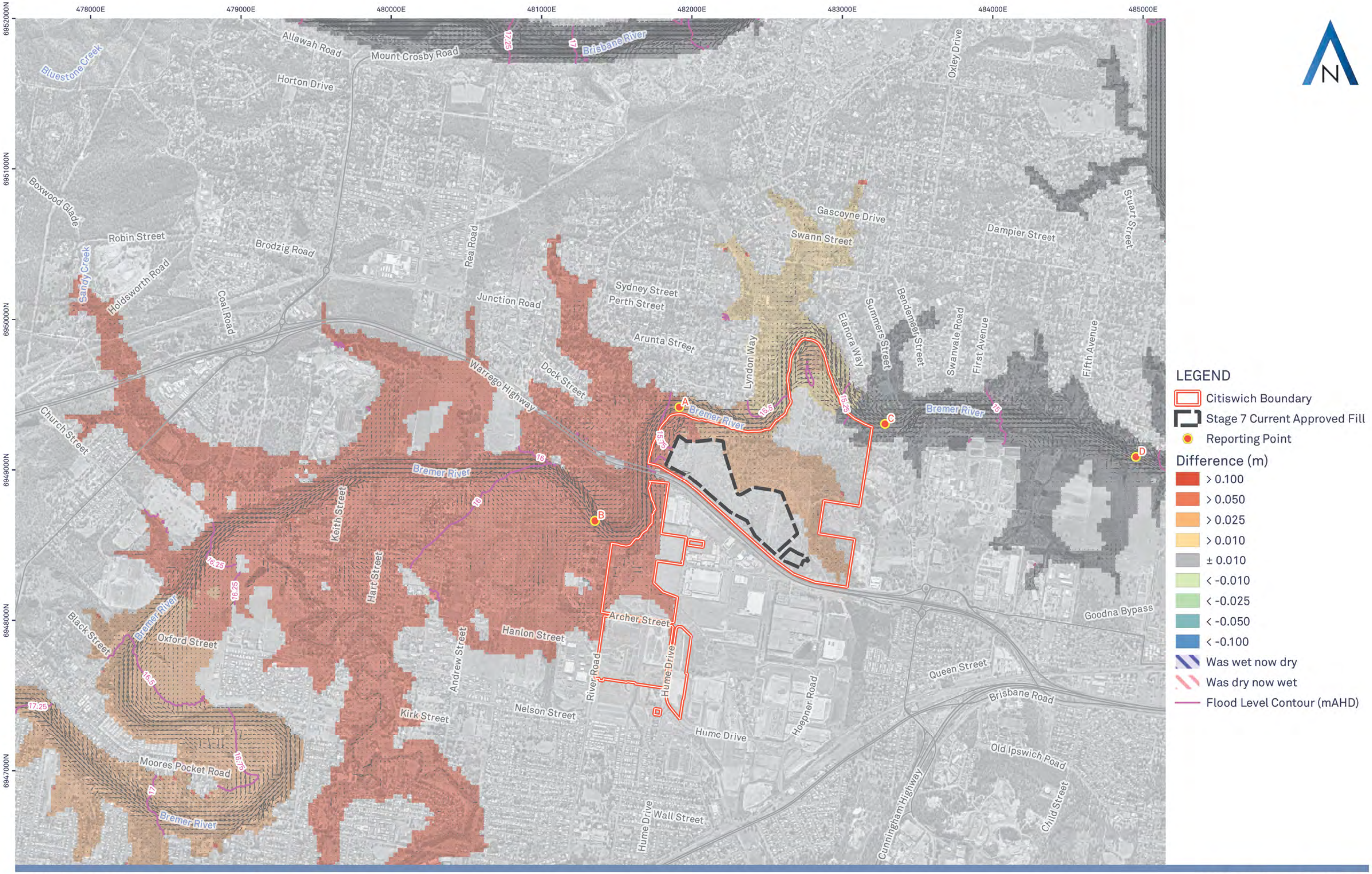
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE D1.05.4

BRCFS FULL MODEL - 5% AEP FLOOD LEVEL DIFFERENCE (EX05g_F3-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56
Aerial Imagery Copyright Nearmap, 2023.

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

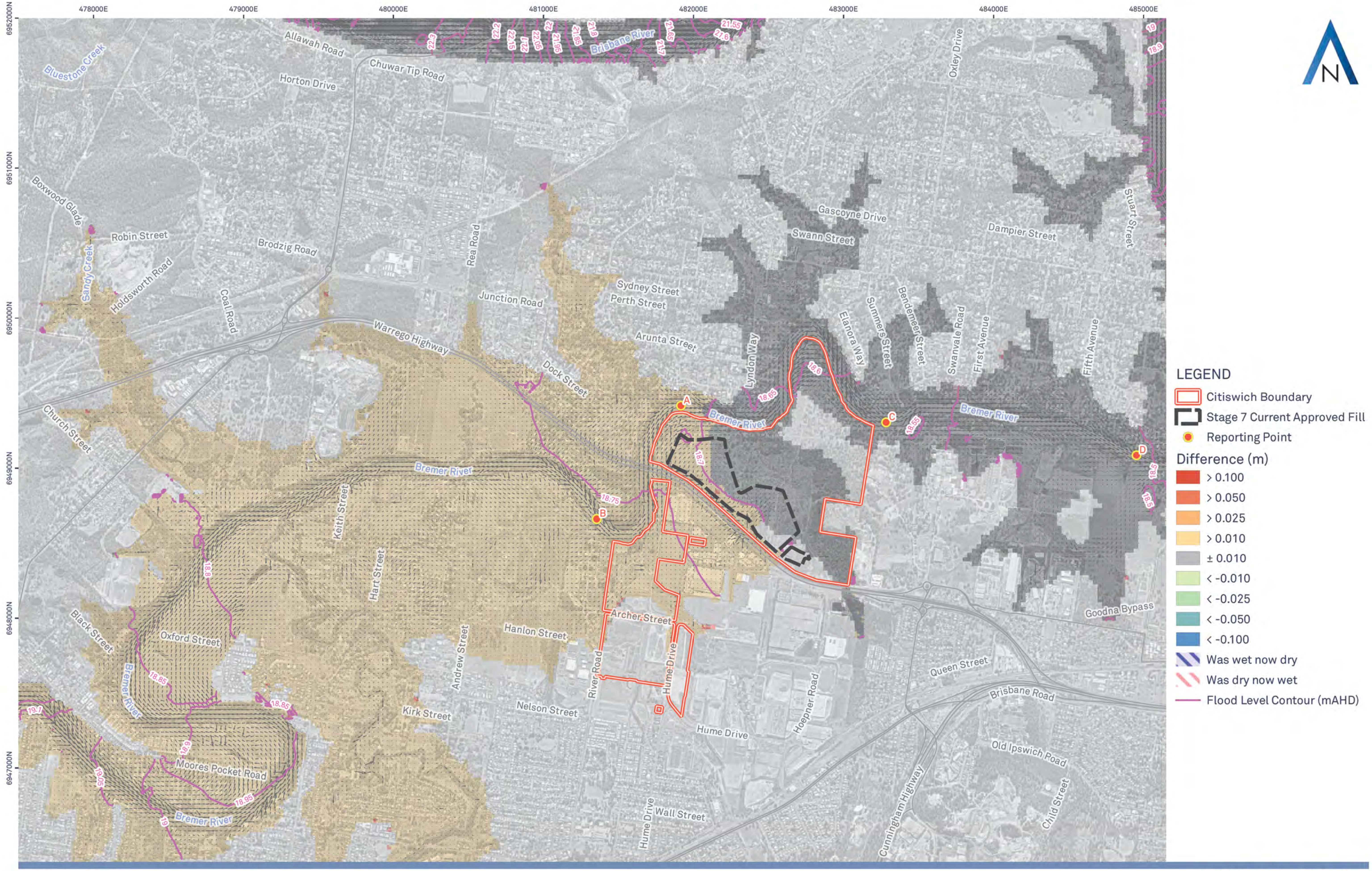
SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE D1.06.4

BRCFS FULL MODEL - 2% AEP FLOOD LEVEL DIFFERENCE (EX05g_F3-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd



CRS GDA94 / MGA zone 56

ALLAN & DENNIS

DATE
07 July 2023

SIZE
A3

REFERENCE
J17015

SCALE
1:22,500

0 0.5 1 1.5 2 2.5 km

FIGURE D1.07.4

BRCFS FULL MODEL - 1% AEP FLOOD LEVEL DIFFERENCE (EX05g_F3-EX05g)

Citiswich, Bundamba
Regional Flood Impact Assessment
Walker Corporation Pty Ltd