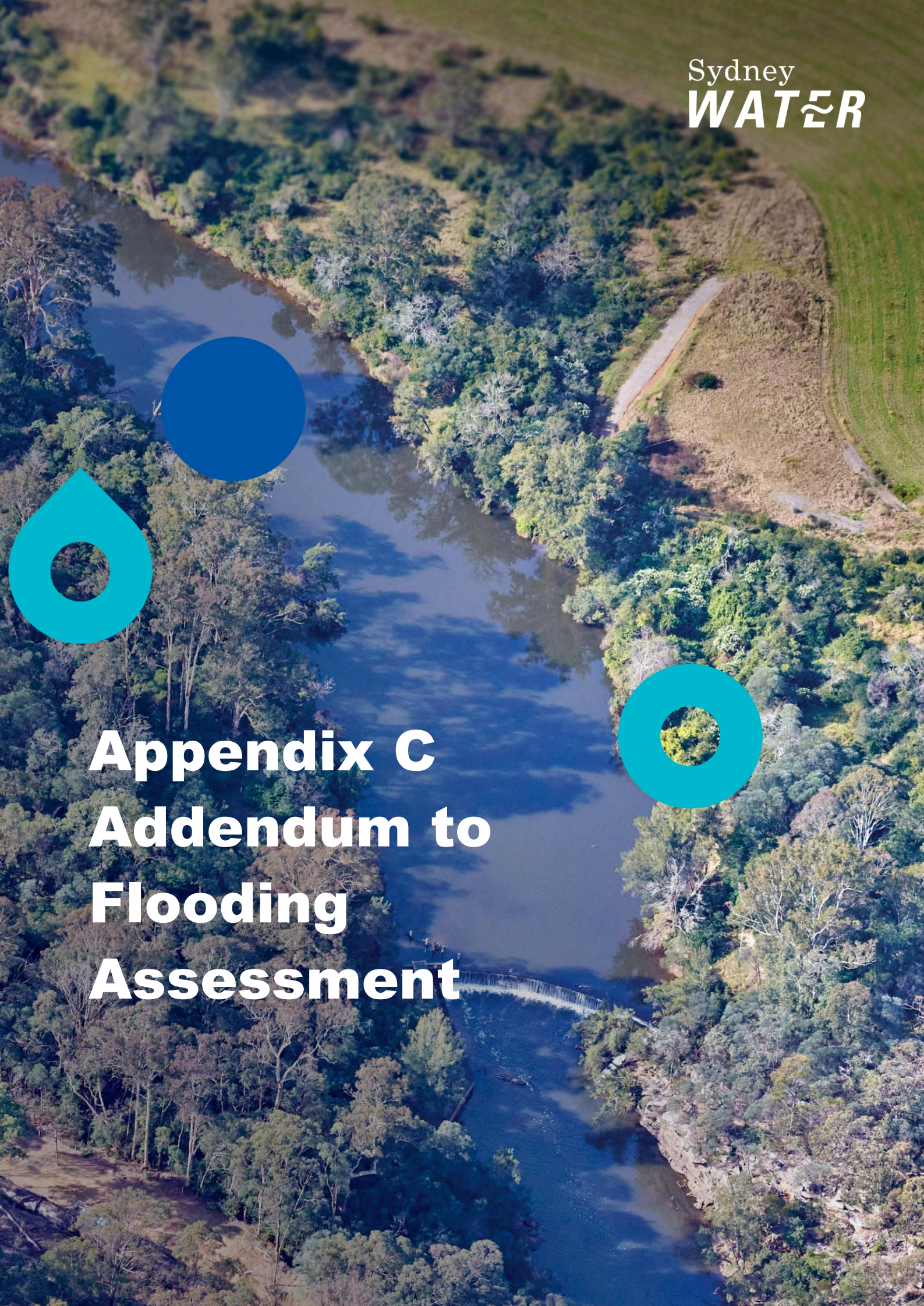

Sydney WATER

Appendix C Addendum to Flooding Assessment

To	Nat Swannack	From	Peter Gillam
Copy		Reference	
Date	24/02/2022	Pages (including this page)	9
Subject	Upper South Creek AWRC EIS – Flooding – Flood model validation using 1% AEP hydrographs from INSW		

1 Introduction

Comments from Penrith City Council and DPE BCD on the AWRC EIS Flood Impact Assessment (Aurecon Arup, 2021) have pointed to a lack of consistency between peak 1% Annual Exceedance Probability (AEP) flood flows adopted in the AWRC EIS Flood Impact Assessment (Aurecon Arup, 2021) and Government (Advisian, 2020 and WorleyParsons, 2015) flood studies. Comments were also made about defining existing flood conditions and recommended that alternative models to those held by Penrith City Council (WorleyParsons, 2015) should be properly validated.

The AWRC EIS Flood Impact Assessment uses a refined version of the TUFLOW model from the Western Sydney Aerotropolis South Creek Flood Study (AAJV, 2019). It was considered there was little benefit in modelling the AWRC within Penrith's regional model due to the granularity and age of this model. A finer scale and more contemporary model is necessary, to test flood impact of a discrete development within the floodplain. Furthermore, it was considered important to utilise a model that includes more recent topographic data than was in the 2015 Penrith Council model at the commencement of the EIS. For these reasons it was preferable to use Sydney Water's existing model with refinements to represent the local floodplain in greater detail.

To address Penrith City Council and DPE BCD concerns additional modelling has been undertaken using 1% AEP flood hydrographs provided by Infrastructure NSW (INSW) (ref: *210617_Base+Case+1%+AEP+Flows+(Rev+H)+-+Elizabeth+Drive+(Advisian).xlsx*) in the AWRC EIS hydraulic model and this provides consistency with Government flood studies (Advisian, 2020 and Worley Parsons, 2015) and gives certainty that the AWRC EIS hydraulic model (TUFLOW) (Aurecon Arup, 2021) has adequately defined existing flood conditions.

This modelling supplements the approaches in the AWRC EIS Flood Impact Assessment (Aurecon Arup, 2021) and gives certainty that the AWRC EIS hydraulic model adequately define existing 1% AEP flood conditions by validating the AWRC EIS hydraulic model with all the data that Sydney Water has been able to obtain from INSW (Section 4.1).

The technical note demonstrates that the AWRC EIS hydraulic model using the 1% AEP flood hydrographs provided by INSW has been validated against the following data:

- 1988 and 1986 historical flood markers as done by the *Updated* South *Creek Flood Study* (WorleyParsons, 2015)
- Penrith Council's *Updated South Creek Flood Study* (WorleyParsons, 2015) 1% AEP flood levels
- Recent 1% AEP flood extents provided by INSW (ref: South Ck Sector - 1% AEP Flood Extent [Peak of Peaks]_Rev G (Oct 2020).zip) and understood to be as shown in recent Government flood studies (Advisian, 2020)

A comparison of the AWRC EIS hydraulic model outputs with the above datasets is described in sections 2.1, 2.2, and 2.3.

Furthermore, a comparison between predevelopment and post development flood levels is also provided using the AWRC EIS hydraulic model using the 1% AEP flood hydrographs provided by Infrastructure NSW.

2 Hydraulic Model Validation

2.1 Comparison to 1988 and 1986 Historical Flood Markers

Hydrographs provided by INSW were applied to the AWRC EIS hydraulic model and the results were compared to Penrith City Council's 2015 Updated South Creek Flood Study (WorleyParsons, 2015) and INSW data sets below.

The resultant flood levels were compared to historical flood markers reproduced in the 2015 Updated South Creek Flood Study (WorleyParsons, 2015) for an event in 1988 and 1986. These events were reported to have an AEP of approximately 1% and were used to calibrate the 2015 Updated South Creek Flood Study.

These historical flood markers are reproduced from the 2015 Updated South Creek Flood Study in Figure 1 below for reference.

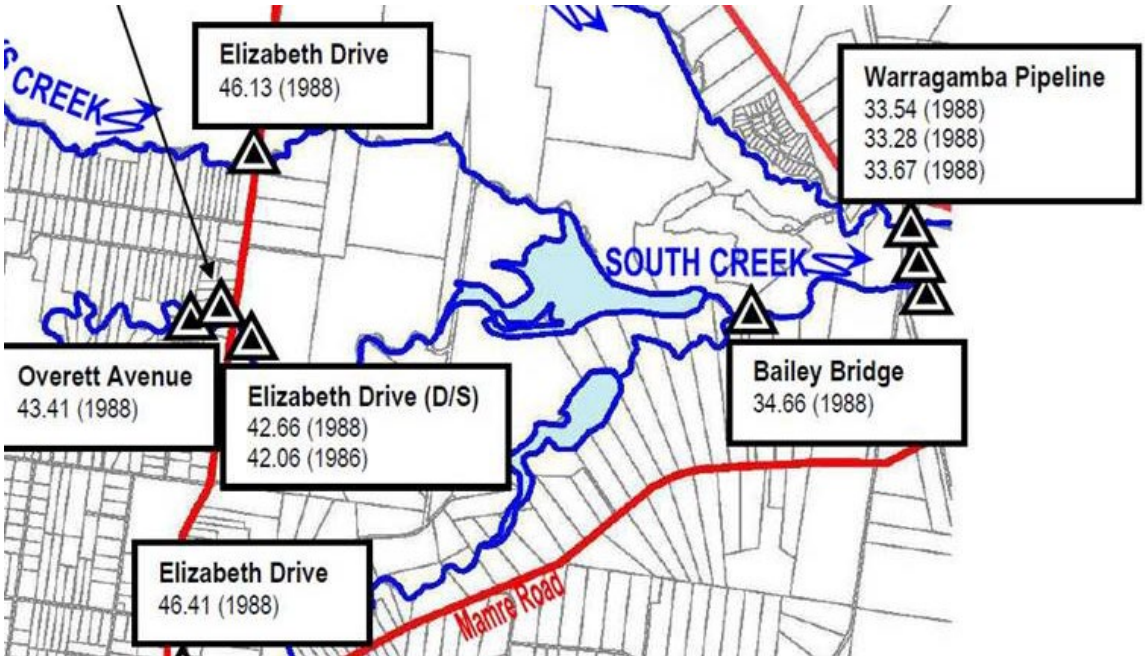

Figure 1 Flood markers used to validate AWRC EIS hydraulic model results

The flood levels produced by the AWRC EIS hydraulic model using INSW 1% AEP flood hydrographs were compared with the historical flood markers reproduced in Table 1 and Figure 1.

Table 1 Comparison of AWRC EIS flood model results to historical flood markers

Flood Marker Location	AWRC EIS Model Results	1988 Event Marker	Difference (m)	1986 Event Marker	Difference (m)
Warragamba Pipeline A	33.60	33.54	0.06		
Warragamba Pipeline B	33.86	33.28	0.58		
Warragamba Pipeline C	33.59	33.67	-0.08		
Bailey Bridge	35.37	34.66	0.71		
Elizabeth Drive D/S South Creek	42.25	42.66	-0.41	42.06	0.19
Elizabeth Drive D/S Badgerys Creek	45.92	46.13	-0.21		
Elizabeth Drive D/S Kemps Creek	46.51	46.41	0.1		
Average of absolute differences			**0.3**		**0.19**

The comparison between flood markers is not an absolute match but shows there are reasonable agreement at Elizabeth Drive and the Warragamba Pipelines. A poor match is achieved at the Bailey Bridge flood marker, however at this location the AWRC EIS hydraulic model predicts a very similar 1% AEP flood level predicted by both the 1990 South Creek Flood Study (Department of Water Resources, 1990) and Updated South Creek Flood Study (Worley Parsons, 2015). It is therefore considered that the AWRC EIS hydraulic model is as accurate as other models at Bailey Bridge, and that the calibration data at that location may be inaccurate.

It should be noted that the terrain in the AWRC EIS hydraulic model includes changes since the 1988 event including floodplain filling between Elizabeth Drive and Warragamba Pipelines. It is also noted that flood markers can be inaccurate and are difficult to accurately locate from the figures provided. Flood markers are used here as a guide of historical flood levels.

Despite this, the AWRC EIS hydraulic model results generally compare well to historical markers with the exception of Bailey Bridge, where other flood models also predict higher flood levels than recorded. There is agreement between these flood markers and this provides confidence that the AWRC EIS hydraulic model reproduces reasonable representation of 1% AEP design flood conditions.

On the basis that the AWRC EIS hydraulic model can reproduce historical flood markers (Table 1 above), the AWRC EIS hydraulic model predicts the hydraulic characteristics of the floodplain and provides a sound basis for testing flood impacts associated with changes in the floodplain.

2.2 Comparison to Penrith City Council's 2015 Updated South Creek Flood Study

The INSW 1% AEP hydrographs were applied to the AWRC EIS hydraulic model and the results were compared to available Penrith City Council's 2015 Updated South Creek Flood Study (WorleyParsons, 2015) results in Figure 2 below.

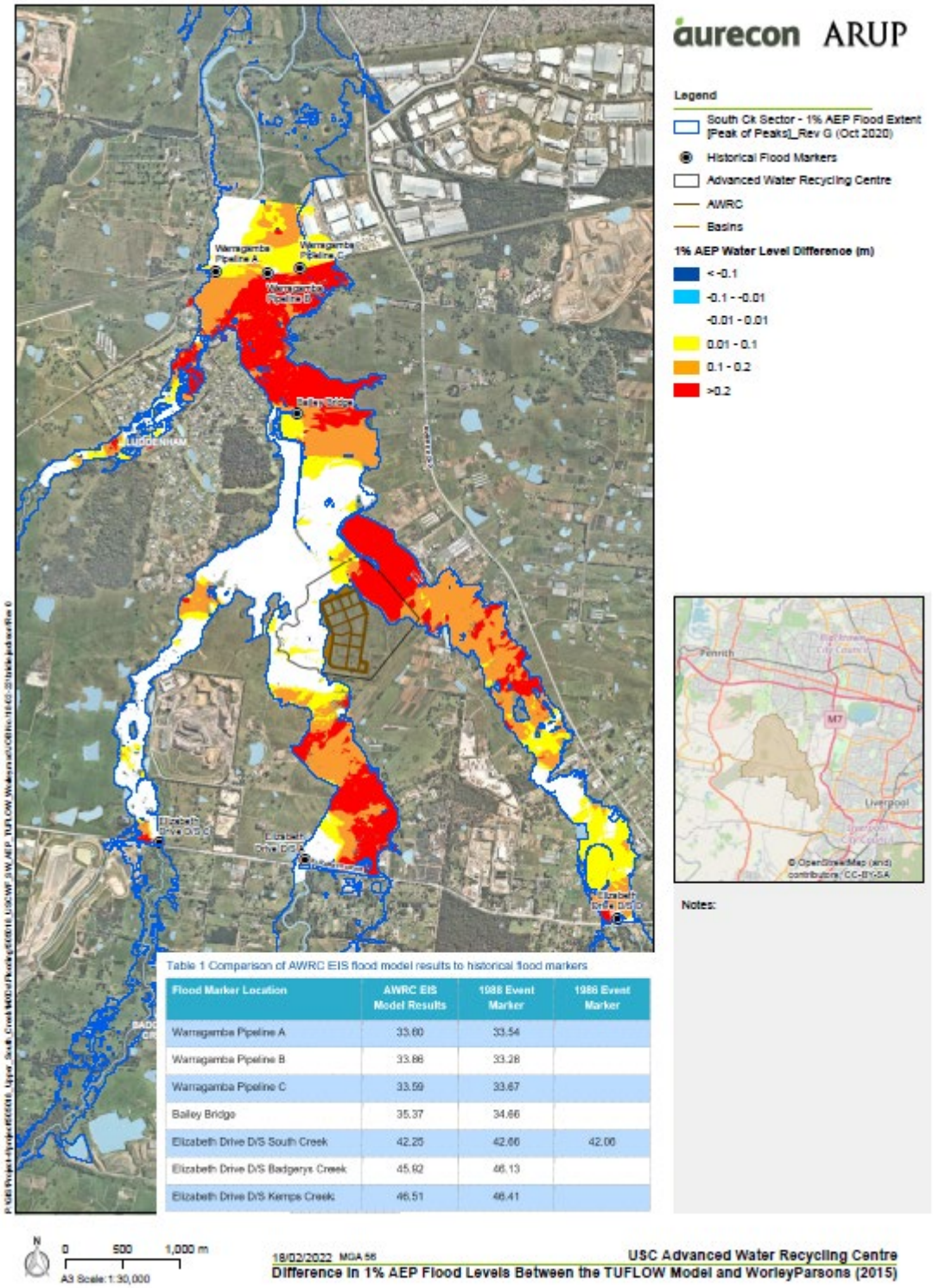

Table 1 Comparison of AWRC EIS flood model results to historical flood markers

Flood Marker Location	AWRC EIS Model Results	1988 Event Marker	1986 Event Marker
Warragamba Pipeline A	33.60	33.54	
Warragamba Pipeline B	33.88	33.28	
Warragamba Pipeline C	33.59	33.67	
Bailey Bridge	35.37	34.66	
Elizabeth Drive D/S South Creek	42.25	42.66	42.00
Elizabeth Drive D/S Badgerys Creek	45.92	46.13	
Elizabeth Drive D/S Kemps Creek	46.51	46.41	

Figure 2 Differences in the 1% AEP flood levels between the AWRC EIS hydraulic model, Penrith City Council's flood model (WorleyParsons, 2015) and historical markers

Generally, comparison between the 2015 1% AEP Updated South Creek Flood Study model and AWRC EIS hydraulic model results are within 10mm of 2015 Updated South Creek Flood Study results immediately adjacent to the AWRC site and downstream of the site in the Wianamatta-South Creek floodplain.

Where the AWRC EIS hydraulic model flood results vary from 2015 Updated South Creek Flood Study, this can be explained by differences in the terrain models adopted in both hydraulic models. Analysis and

discussion of this is provided section 4.4.7 and shown in Figure 4-12 of the EIS which compares the model topography adopted in both models. It is noted that the 2015 Updated South Creek Flood Study adopts significantly older topography than the AWRC model. To the east of the AWRC and upstream of the AWRC, differences in floodplain topography have resulted in flood levels varying by up to 500mm when compared to the 2015 Updated South Creek Flood Study. Three significant areas causing differences in hydraulic modelling results are highlighted in Figure 3 below.

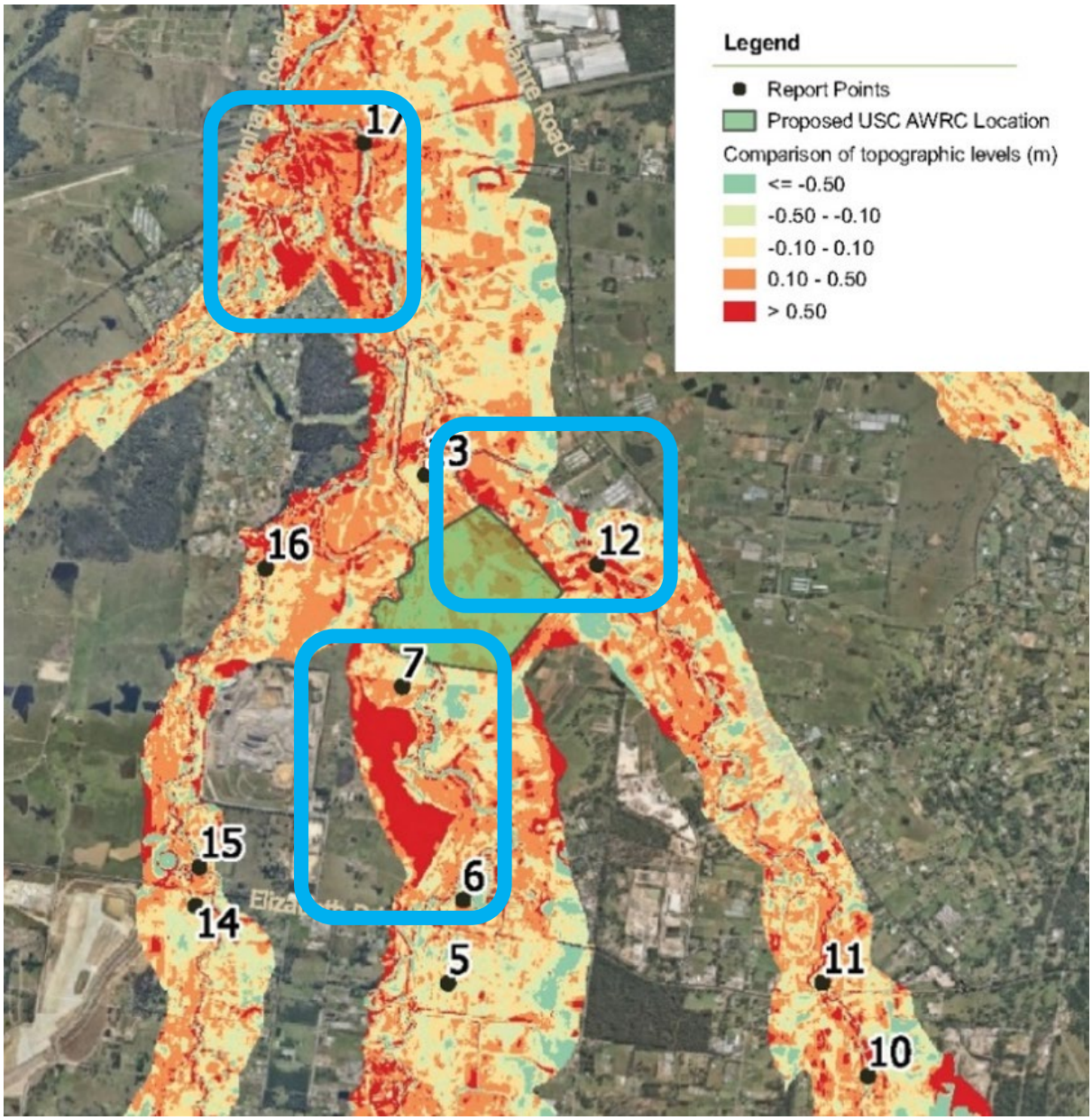

Figure 3 Topographic differences between AWRC EIS hydraulic model and Penrith City Council's flood model (WorleyParsons 2015)

It is also noted that the 2015 Updated South Creek Flood Study results varied by up to 500mm when compared to the previously adopted Council study prepared in 1990 (Department of Water Resources, 1990), which is outlined in Table D1 of the 2015 Updated South Creek Flood Study, Volume 2.

The AWRC EIS hydraulic model results compare well (within 10mm) to the 2015 Updated South Creek Flood Study hydraulic model results where the adopted terrain models are similar. It is reasonable to expect that the model results would differ where the terrain models differ (up to 500mm in some cases).

While it is important that the models agree, it is considered more appropriate that the AWRC model reflects the current topography of the floodplain. A comparison to more recent Government flood modelling (Advisian, 2020) with current topography is provided below in Section 2.3.

2.3 Comparison to South Creek Sector Review Flood Extents

The INSW 1% AEP hydrographs were applied to the AWRC EIS hydraulic model and the results were compared to 1% AEP flood extent mapping provided by INSW (Flood extent mapping titled South Ck Sector - 1% AEP Flood Extent [Peak of Peaks]_Rev G (Oct 2020), as shown in the 2020 Advisian study) which has used recent topographic data of the floodplain.

Sydney Water has not been able to obtain flood level data from INSW at this time which means AWRC EIS hydraulic model flood levels cannot be compared with the 2020 Advisian flood study. However the South Creek Sector 1%AEP flood extent (Advisian, 2020) provides an indication of where flood levels intersect natural topography. Where flood extents match or are similar, it can be assumed that flood levels are also within a similar range.

A comparison between the 1% AEP model extents are provided above in Figure 2 which shows a good level of agreement between the INSW hydraulic model results (Advisian, 2020) (blue outline) and AWRC EIS hydraulic model results (block colour ramp).

The proposed USC AWRC operational area are shown orange and it is noted that the works are located on lands that are currently outside of the 2015 Updated South Creek Flood Study 1% AEP extent.

On this basis, the AWRC EIS hydraulic model results closely match the INSW South Creek Sector Review flood extent mapping undertaken in 2020. The AWRC EIS hydraulic model therefore reasonably predicts the hydraulic characteristics of the 1% AEP event and provides a sound modelling basis for testing flood impacts.

2.4 Conclusion

Application of the 1% AEP hydrographs provided by INSW to the AWRC EIS hydraulic model provides consistency for comparing model results and defining existing 1% AEP flood conditions.

The AWRC EIS hydraulic model results generally compare well to the 1986 and 1988 flood markers given changes in the floodplain that have occurred in the floodplain since that time.

The same hydraulic modelling results are within 10mm and 500mm of the 2015 Updated South Creek Flood Study results. Differences in flood level are again explained by differences in LiDAR topographic data sets adopted in both studies shown in Figure 3 above. There is a good level of agreement between the model results in the South Creek floodplain immediately adjacent to the AWRC reference design works area.

The AWRC EIS hydraulic model results also provide a very similar 1% AEP flood extent to recent flood modelling undertaken by INSW (Advisian, 2020). Given that AWRC EIS hydraulic model closely matches recent flood extent mapping by INSW which adopts recent LiDAR and the same 1% AEP hydrology for Kemps and South Creeks, the AWRC EIS hydraulic model therefore reasonably predicts the hydraulic characteristics of the existing floodplain during 1% AEP event and is therefore fit for purpose in testing the flood impacts of the AWRC reference design

While the hydraulic model will not be used to define flood planning levels (which is the role of Penrith City Council's 2015 Updated South Creek flood model), the AWRC EIS hydraulic model is appropriate (fit for purpose) for demonstrating changes in floodplain hydraulic conditions and or increases in flood level (afflux) resulting from the reference USC AWRC design.

3 1% AEP Flood Impacts with INSW 1% AEP Hydrology

Using INSW 1% AEP flood hydrographs, the AWRC EIS hydraulic model were used to compare flood afflux with and without the AWRC reference design operational area in the floodplain.)

Comparison of existing and post development 1% AEP flood levels are presented in Figure 4 which shows minor, localised changes in 1% AEP flood level resulting from the proposed drainage works and landscaping on the floodplain in the south western corner of the site.

The model results show no significant impacts to 1% AEP flood levels (within 10mm) outside of the site boundary to the west, east or downstream of the AWRC. The modelling shows no flood afflux downstream or upstream of the site.

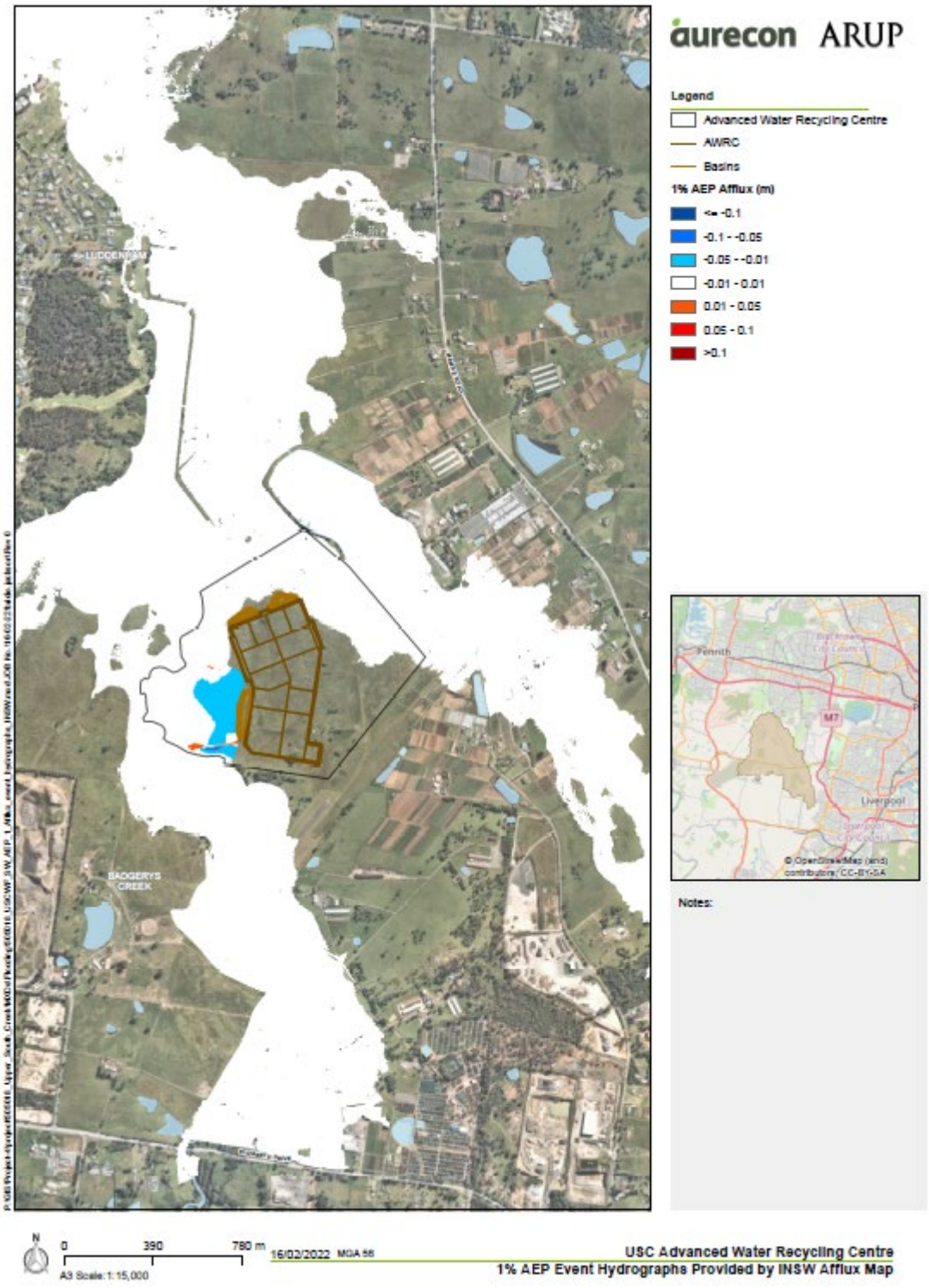

Figure 4 Afflux mapping using 1% AEP Event hydrographs provided by INSW

This confirms further the findings of the AWRC Flood Impact Assessment (Aurecon Arup, 2021) in the EIS that the reference design has an acceptable impact on flooding outside of the AWRC site for a range of flows:

- No detectable flood impact for minor events
- No detectable flood impacts up to the 1% AEP event
- Acceptable flood impacts in the PMF.

4 Concluding remarks

Additional hydraulic modelling using the AWRC EIS hydraulic model provides validation that the AWRC EIS hydraulic model results agree with existing data sets provided by Penrith City Council (WorleyParsons 2015) and INSW (Advisian, 2020) (described above). The AWRC EIS hydraulic model is therefore suitable for defining flood hydraulics of the existing floodplain and predicting changes in flood behaviour associated with the AWRC. The AWRC EIS hydraulic model is fit for the purpose of flood impact assessment to meet the EIS objectives.

In adopting the above Council and INSW data sets to validate the model and test flood impacts of the AWRC reference design, this memo incorporates data produced by Council and the State Government in applying the Floodplain Development Manual. This means that the AWRC EIS hydraulic model, as demonstrated by this memo, compares favorably with other models and flood data when the consistent hydrograph inputs are applied.

The results from the flood model can be used confidently to assess the merits of the AWRC reference design with confidence that the AWRC reference design will not impact on flood events associated with Council's adopted 1% AEP flows. Given the findings of the main EIS Flood Impact Assessment report, the AWRC reference design will also have an acceptable impact on a range of events greater and smaller than the 1% AEP event.

4.1 References

Flood Study Report South Creek (Department of Water Resources, 1990) (reproduced in the Updated South Creek Flood Study, 2015)

Updated South Creek Flood Study (WorleyParsons, 2015) (on behalf of Penrith City Council)

Western Sydney Aerotropolis South Creek Flood Study (AAJV, 2019)

Wianamatta (South) Creek Flood Study – Existing Conditions Report (Advisian, 2020) (on behalf of INSW)

Upper South Creek AWRC Flood Impact Assessment Draft for Comment (Aurecon Arup, 2021)

The following datasets comprise data that has been obtained from INSW:

- 1% AEP flood hydrographs (File name reference: 210617_Base+Case+1%+AEP+Flows+(Rev+H)+-+Elizabeth+Drive+(Advisian).xlsx) received from INSW December 2021 (Advisian, 2020)
- 1% AEP flood extents (File name reference: South Ck Sector - 1% AEP Flood Extent [Peak of Peaks]_Rev G (Oct 2020).zip zip)) received from INSW December 2021 (Advisian, 2020)

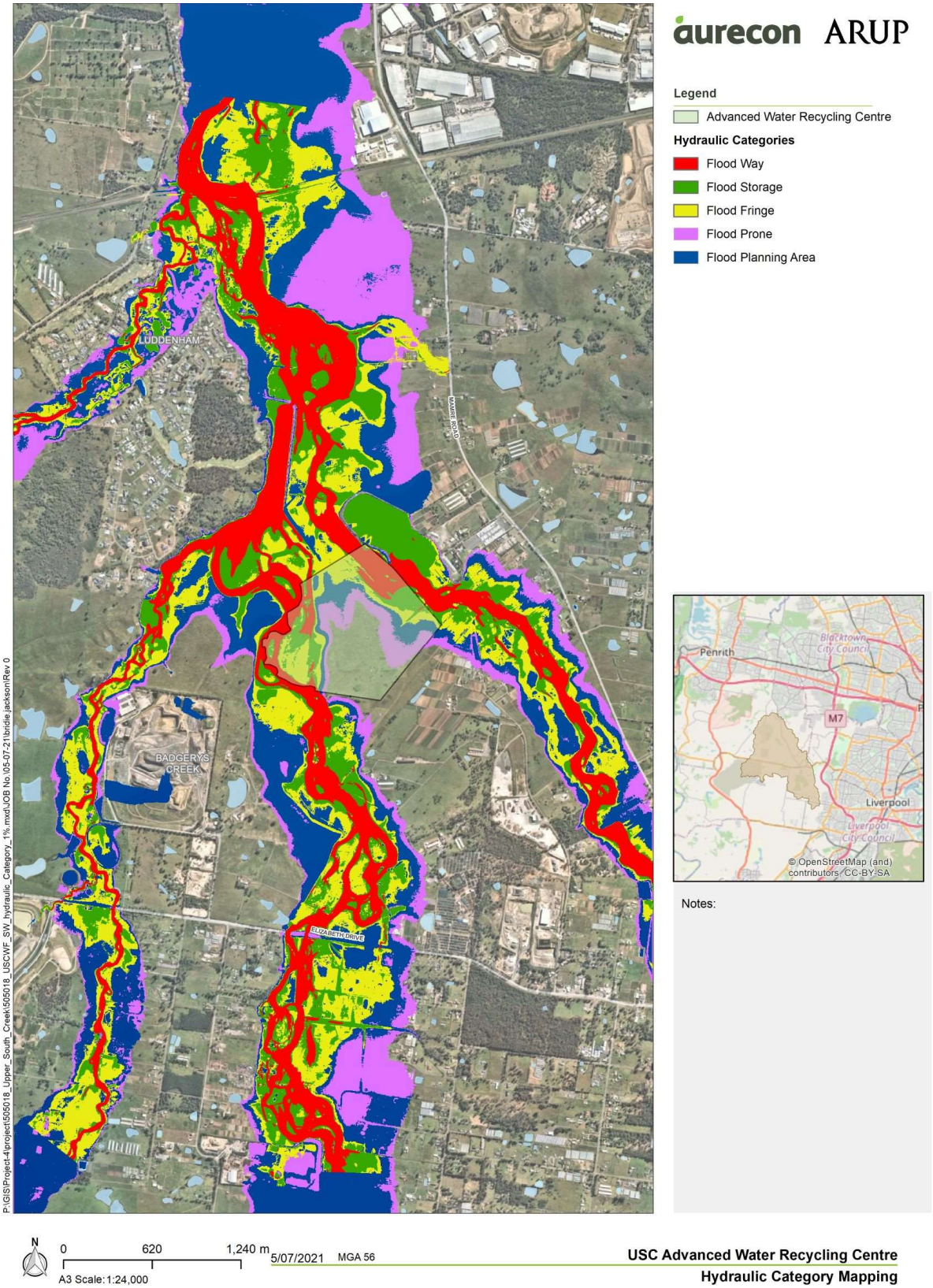

Figure 6-30 Hydraulic Category Mapping

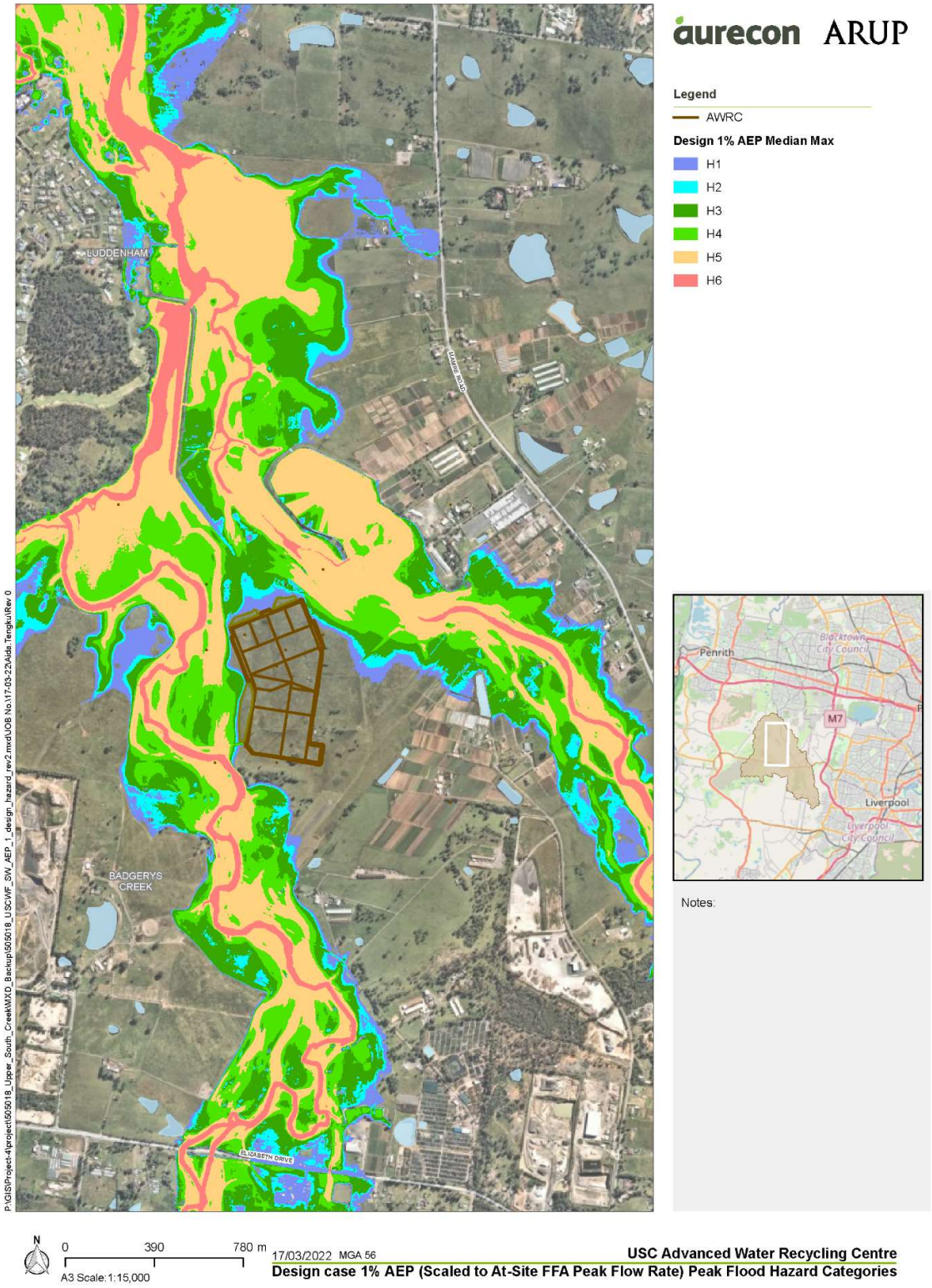

Figure 6-53 Design case 1% AEP FFA flood hazard categories