The flood mark comparison in **Appendix C** shows that the TUFLOW model produces peak flood levels that are most commonly higher than surveyed flood marks, with the average absolute difference being 0.35 m. However, 2 of the 11 surveyed flood marks have been identified as potentially erroneous values based on their elevation compared to nearby flood marks. Poor reception impacted several survey measurements as noted in **Appendix C**. With two potentially problematic flood marks removed, the average absolute difference between simulated and surveyed flood marks reduced to 0.1 m.

The stage hydrograph comparison between observed and simulated water levels at the Upper Colo Gauge (212290) (**Appendix C**) shows the simulated water levels provide a reasonable correlation of the time variation in water levels at the Upper Colo gauge. However, the peak simulated flood level is approximately 1.8 metres higher than the recorded gauge peak. The Upper Colo gauge is located along a moving sand bar with the current gauge zero reported at 1.468 mAHD with a the 'cease to flow' at 0.62 m. A recent cross-sectional survey completed at the gauge conducted as part of this study showed a bed level of 3.5-4.3 mAHD, which is roughly 1.5 m higher than the combined gauge zero and cease to flow level. A separate survey of the Upper Colo bridge in 2020, located downstream from the gauge, showed the bed level at 3.1 mAHD. Thus, concerns were raised about the accuracy of the gauge zero for Upper Colo gauge and the issue is currently being investigated by WaterNSW. The survey collected as part of this study would suggest the gauge zero level be increased by at least 1.5 m to 2.968 mAHD, which would bring the simulated and recorded flood levels into much better alignment.

5.3.6.2 Macdonald River

Calibration of the TUFLOW computer model was attempted based upon 37 surveyed flood marks and the water level record at the St Albans gauge (212218).

Peak floodwater depths were extracted from the results of the July 2022 flood simulation and are included on **Map RG-001-2**

A longitudinal surface water profile along the Macdonald River for the July 2022 event is provided in **Appendix C**. A comparison between the peak flood levels generated by the TUFLOW model and the surveyed flood marks for the July 2022 flood is also provided in **Appendix C**.

The flood mark comparison in **Appendix C** shows that the TUFLOW model produces peak flood levels that are most commonly lower than surveyed flood marks, with the average absolute difference being 0.44 m.

The stage hydrograph comparison between observed and simulated water levels at the St Albans Gauge (212228) (**Appendix C**) indicates a peak simulated flood level of 13.02 mAHD that is roughly 0.33 m higher than the recorded gauge value of 12.69 mAHD. However, surveyed flood marks in St Albans suggest that peak July 2022 flood levels were between 13.0 to 13.4 mAHD. Thus, these results suggest that the gauge zero for the St Albans of 2.76mAHD gauge could also be too low.

5.3.7 March 2022 Flood Results

5.3.7.1 Colo River

Calibration of the TUFLOW computer model was then undertaken based upon 10 surveyed flood marks and water level record at the Upper Colo gauge (212290) for the March 2022 flood. A comparison between the peak flood levels generated by the TUFLOW model and the surveyed flood marks for the March 2022 flood are presented in **Map RG-00-002-1.** A longitudinal surface water profile and a stage hydrograph comparison for the Upper Colo gauge site is also included in **Appendix C**.

The flood mark comparison table shows that the TUFLOW model produces peak flood levels that are most commonly lower than surveyed flood marks, with the average absolute difference being 0.23 m.

The stage hydrograph comparison between observed and simulated water levels at the Upper Colo Gauge (212290) for the March 2022 event indicates a peak simulated flood level of 19.58 mAHD that s higher than the recorded flood peak of 18.12 mAHD. However, as noted in the previous section, it is likely that the gauge zero for the Upper Colo gauge should be increased by 1.5 metres which would bring the recorded flood peak into good alignment with the simulated flood peak.

5.3.7.2 Macdonald River

Calibration of the TUFLOW computer model to the March 2022 flood was undertaken based upon 19 surveyed flood marks along the Macdonald River and water levels recorded at the St Albans gauge (212218). Peak floodwater depths were extracted from the results of the March 2022 flood simulation and are included on **Map RG-002-2**. A comparison between the peak flood levels generated by the TUFLOW model and the surveyed flood marks for the March 2022 flood is also provided in **Appendix C** along with a longitudinal profile along the Macdonald River as well as stage hydrograph comparison at the St Albans gauge.

The flood mark comparison in **Appendix C** and the longitudinal profile shows that the TUFLOW model produces peak flood levels that are most commonly higher than surveyed flood marks, with the average absolute difference being 0.59 m. However, the quality of most flood marks was classified as low, and improved agreement between surveyed and simulated peak flood levels are found for survey sites with higher quality.

The stage hydrograph comparison at the St Albans Gauge (212228) indicates a peak simulated flood level of 11.85 mAHD which is roughly 0.79 m higher than the recorded gauge value of 11.06 mAHD. However, surveyed flood marks near the St Albans gauge suggest that March 2022 flood levels were between 11.3 to 11.6 mAHD in the area. Similar to the July 2022 event, these results suggest that the gauge zero for the St Albans gauge could to low.

5.3.8 February 2020 Flood Results

5.3.8.1 Colo River

Validation of the TUFLOW computer model for the Colo River was restricted to the recorded water levels at the Upper Colo gauge (212290). Modelled flood depths and levels from the February 2020 event are shown in **Map RG-00-003-1.** The stage hydrograph comparison plot is provided in **Appendix C** for the Upper Colo Gauge shows a simulated peak flood level of 17.87 mAHD that is roughly 0.65 m above the observed flood level peak of 17.21 mAHD. This difference of 0.65 m between simulated and observed peak flood levels for the Upper Colo gauge, is less than the ~1.5 m difference found for the March 2022 and July 2022 events. This lower difference in simulated vs observed peak flood levels could potentially be attributed to several factors, including the fact that the model was calibrated for higher flow rates, as well as the uncertainty associated with the hydrological inputs and potential bed movement at the gauge location. Nevertheless, without additional evidence such as flood marks, the performance of the model was deemed acceptable.

5.3.8.2 Macdonald River

Map RG-00-003-2 shows the simulated flood depths and levels for the February 2020 event in the Macdonald River. The stage hydrograph comparison for the St Albans gauge (refer to **Appendix C**) shows a simulated water level roughly 1.0 m above the observed flood level peak of 7.96 mAHD. This difference is largely consistent with the results of the March and July 2022 floods simulations, although could be further skewed by erosion of the riverbed between the 2020 and 2022 floods.

5.3.9 March 1978 Flood Results

5.3.9.1 Colo River

The March 1978 validation for the Colo River was based upon water level records extracted from Figure 4 in the *March 1978 Flood Report* for the Upper Colo and Moran's Rock locations. It should be noted that the "Upper Colo" location presented in Figure 1 of the *March 1978 Flood Report* is situated approximately 1.5 km downstream of the current Upper Colo gauge location.

Map RG-00-004-1 shows the simulated flood depths and levels for the March 1978 event in the Colo River. The stage hydrograph comparison plot in **Appendix C** for the Upper Colo location shows a simulated peak water level of 20.7 mAHD which agrees closely to the observed flood level peak of 20.66 mAHD. However, the stage hydrograph comparison for the Moran's Rock location (near Putty Road Bridge) shows a simulated water level that is around 1.0 m below the observed flood level peak of 15.74 mAHD. It was noted that the Moran's Rock location is situated on the outer bend of the Colo River where a localised a build-up of water and superelevation of the water surface may have resulted in localised water level increases at that location that may not be fully reflected in the simulated hydrograph.

Appendix C shows the simulated surface water profile Colo River for the March 1978 event. Four peak flood levels are shown on the profile, which were extracted from Table 1 in the March 1978 Flood Report. This includes the peak flood level of 20.66 mAHD observed at the Upper Colo Gauge, 17.86 mAHD at Central Colo, 15.74 mAHD at Moran's Rock and 10.42 mAHD at Jones Road. Simulated peak flood levels match well at Upper Colo and Jones Road, while recorded flood peaks at Central Colo and Moran's Rock are roughly 1.0 m above simulated levels. This underestimation of peak flood levels is only reflected in the middle reaches of the Colo River (i.e., upstream and downstream levels correlate well). Although these differences are higher than desirable, it is acknowledged that the peak recorded flood levels presented in the March 1978 Flood Report have several associated uncertainties, including their exact locations and accuracy of measurements.

5.3.9.2 Macdonald River

Validation of the TUFLOW computer model was also attempted based upon a stage hydrograph documented in Figure 4 in the *March 1978 Flood Report*.

Map RG-00-004-1 shows the modelled depths and water levels for the March 1978 event.

The stage hydrograph comparison plot for the St Albans Gauge location (**Appendix C**) shows a simulated water level of 12.20 mAHD that is 0.95 m above the extracted peak flood level of 11.25 mAHD. This difference in peak flood levels could potentially be attributed to several factors, including the uncertainty associated with the extracted water level time series from Figure 4 in the *March 1978 Flood Report* and the uncertainty related to the downstream boundary condition for this event (the water levels at St Albans are impacted by the prevailing water levels in the Hawkesbury River). However, the largest area of uncertainty concerns the rainfall distribution across the upstream catchment due to the limited availability of rain gauge data.

5.4 Design Flood Parameters

The following section describes the parameters that were applied to each TUFLOW model for the design flood simulations.

5.4.1 Boundary Conditions

5.4.1.1 Inflow boundaries

As discussed in the previous chapter, a WBNM hydrologic model was used to simulate the transformation of rainfall into runoff and generate discharge hydrographs throughout the catchment for each design storm. The discharge hydrographs generated by the WBNM model were used to define inflow boundary conditions for each TUFLOW model. The adopted temporal patterns and storm durations that were selected for application to the TUFLOW models for each AEP are summarised in **Table 5-5** and **Table 5-6**.

Table 5-5 Adopted storm durations and temporal patterns for the Colo River and Macdonald River

AEP	Design Storm Durations and Temporal Pattern ID					
	Macdonald River				Colo River	
	24 hr	36 hr	48 hr	96 hr	48 hr	96 hr
20%	-	-	-	586	-	593
10%	-	-	-	585	-	594
5%	-	-	-	587	-	594
2%	-	-	407 405	-	-	594
1%	228	-	407	-	-	591
1 in 200	-	-	407	-	416	591
1 in 500	-	316	408	-	416	-
1 in 1000	-	316	-	-	418	-
1 in 2000	-	316	-	-	418	-

Table 5-6 Adopted storm durations and temporal patterns for Greens Creek and Webbs Creek

AEP	Design Storm Durations and Temporal Pattern ID			
	Greens Creek			Webbs Creek
	6 hr	9 hr	12 hr	24 hr
20%	-	4770	-	210
10%	-	4763	-	208
5%	4729	-	-	208
2%	-	-	4747	202
1%	-	-	4787	207

AEP	Design Storm Durations and Temporal Pattern ID			
	Greens Creek			Webbs Creek
	6 hr	9 hr	12 hr	24 hr
1 in 200	-	-	4787	208
1 in 500	-	-	4787	208
1 in 1000	-	-	4787	208
1 in 2000	-	-	4787	208

5.4.1.2 Downstream boundary

All four of the study area catchments drain into the Hawkesbury River. Accordingly, the prevailing water level within the Hawkesbury River can have a significant impact on flood behaviour across the downstream reaches of each watercourse. Therefore, it is important to define a reliable Hawkesbury River boundary condition as part of the design flood simulations. At the same time, it was also considered important to note that the goal of the current study is to define flood behaviour for the each of the four study area catchments, and not re-define flood behaviour for the Hawkesbury River, which was completed as part of the Hawkesbury-Nepean River Flood Study (Rhelm CSS, 2024).

Firstly, it is unlikely that floods of equivalent frequency will occur simultaneously in each study area catchment and the Hawkesbury River, due to the different characteristics of each catchment, particularly during large events.

The correlation between Hawkesbury River flooding, and flooding in the Colo River and Macdonald River is complex, as it depends not only on the peak levels and flows, but also on the timing of the Colo River and the Macdonald River. Rhelm CSS (2024) demonstrated that the timing of the flows can be influential on the overall levels in the Lower Hawkesbury River. While in many events the Colo River and Macdonald River peaks occur more than a day before the Hawkesbury River, there are events, such as the July 2022 event, where the peaks were more closely aligned.

Recognising the uncertainty around the timing of the peaks, a review was undertaken on the peaks in both the Colo and Macdonald River, compared with the Hawkesbury River at Windsor (where there is a long historic record). This comparison is shown in Figure 5-6 and Figure 5-7.

Generally, there is not a strong correlation between large events on the Hawkesbury River compared with Colo River and Macdonald River floods. Furthermore, for the smaller catchments of Greens Creek and Webbs Creek, an even weaker correlation is expected between catchment driven events and large events on the Hawkesbury River.

Following an approach adopted by other tributary flood studies within the Hawkesbury-Nepean Rivers catchment, an envelope approach was adopted. This involves simulating a combination of high local tributary flows with a lower Hawkesbury River flow, and a high Hawkesbury River flow with a lower local tributary flow. The resulting flood combinations are then 'enveloped' together to produce the final design results for each flood frequency.

For local catchment floods in Colo River and Macdonald River, it was assumed that floods of equivalent severity occurred only in frequent floods (i.e., up to and including the 10% AEP). For larger catchment floods, it was assumed that a 5% AEP Hawkesbury River level would be more suitable. The only exception is the PMF, where a 1% AEP Hawkesbury River level was adopted as a downstream boundary (i.e., a PMF within the local catchment is likely to also generate higher flood levels within adjoining catchments including the broader Hawkesbury River catchment).

For local catchment floods in Greens Creek and Webbs Creek, a High High Water Solstices Spring (HHWSS) tidal level was adopted as the Hawkesbury River level across all events. The only exception is the PMF, where a 20% AEP Hawkesbury River level was adopted as a downstream boundary.

The combinations of local catchment flood frequency and Hawkesbury River flood frequency that were combined to form each design flood event is presented in **Table 5-7** for the Colo River and Macdonald River, **Table 5-8** for Greens Creek and Webbs Creek. **Table 5-9** presents the actual Hawkesbury River design water level at each downstream model boundary.

This correlation between the adopted local catchment and Hawkesbury River floods is also plotted on **Figure 5-6** and **Figure 5-7**.

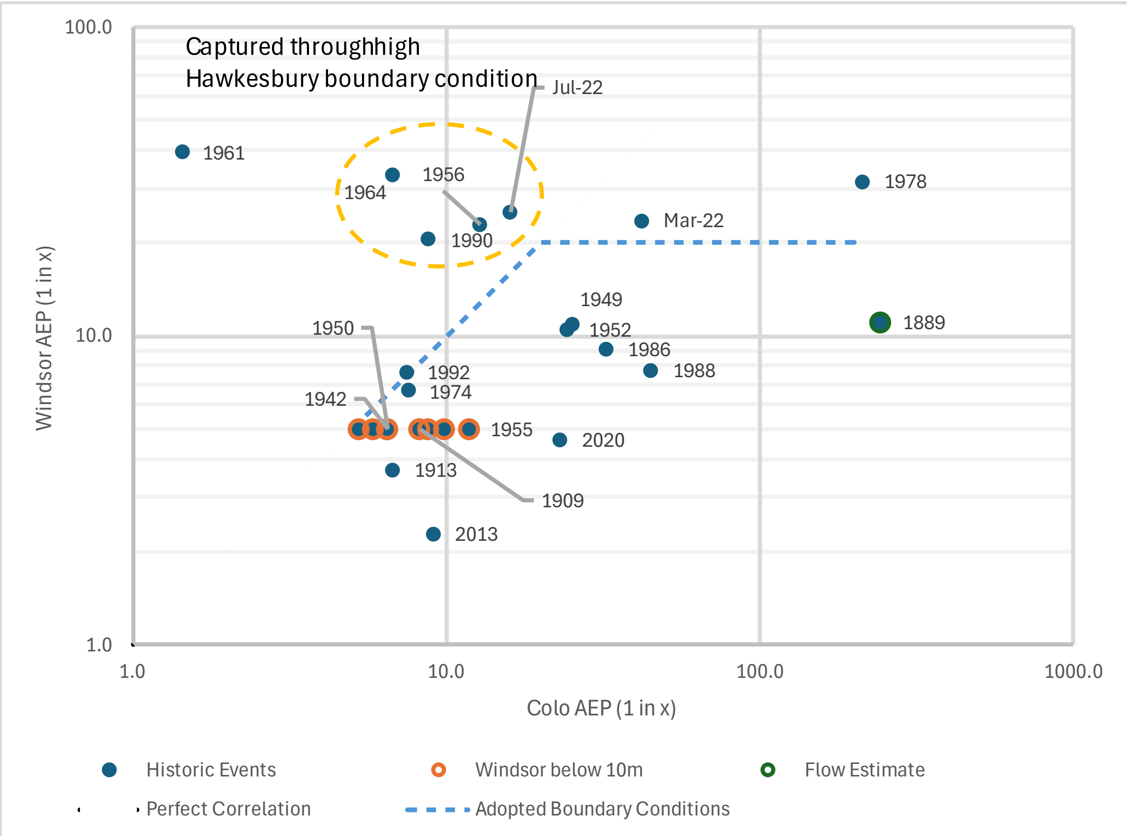


Figure 5-6. Peak Level Correlation between Windsor and Colo River

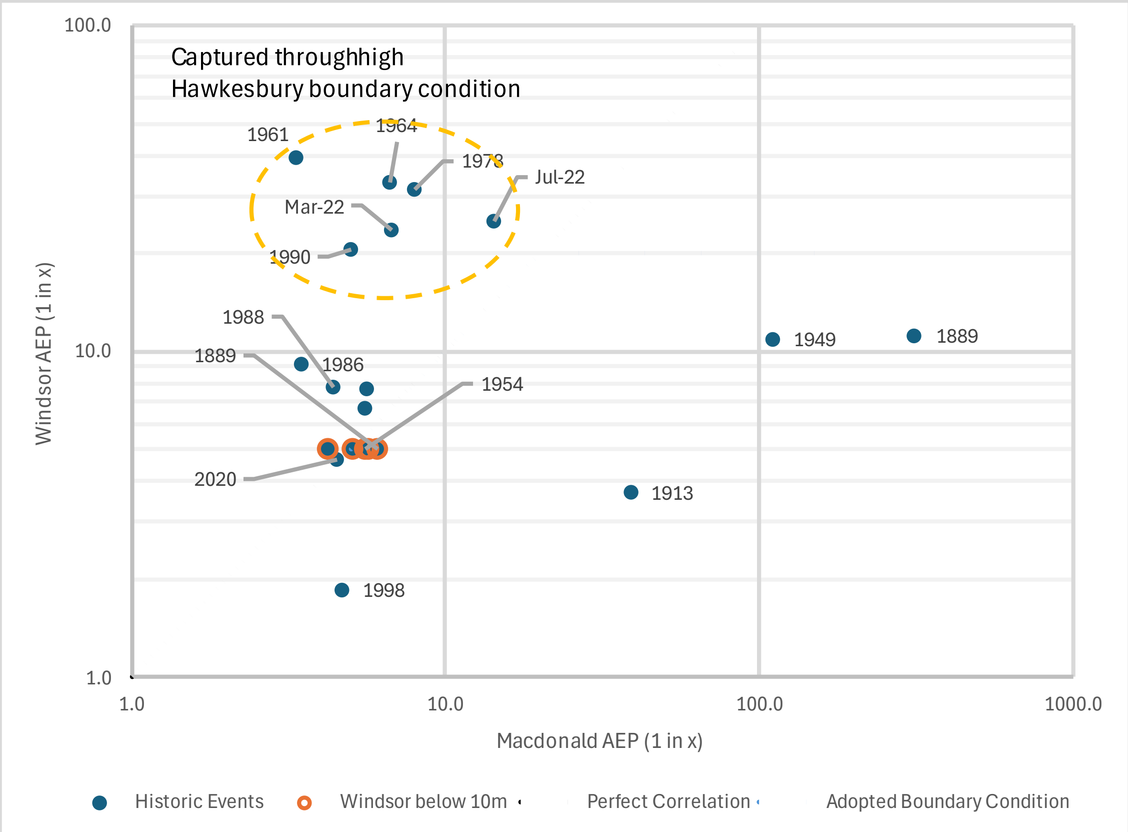


Figure 5-7. Peak Level Correlation between Windsor and Macdonald River

Table 5-7 Adopted downstream boundary conditions for local catchment driven events (AEP)

Design flood event (AEP)	Design flood in local catchment (AEP)	Design flood level at Hawkesbury River junction (AEP)
20%	20%	20%
10%	10%	10%
5%	5%	5%
2%	2%	5%
1% (level)	1%	5%
1% (velocity		ISLW
1in 200	1in 200	5%
1in 500	1in 500	5%
1in 1000	1in 1000	5%
1 in 2000	1 in 2000	5%
PMF	PMF	1%

Table 5-8 Adopted downstream boundary conditions for local catchment driven events in Greens Creek and Webbs Creek

Design flood event (AEP)	Design flood in local catchment (AEP)	Design flood level at Hawkesbury River junction (AEP)
20%	20%	HHWSS
10%	10%	HHWSS
5%	5%	HHWSS
2%	2%	HHWSS
1% (level)	1%	HHWSS
1% (velocity)		ISLW
1in 200	1in 200	HHWSS
1in 500	1in 500	HHWSS
1in 1000	1in 1000	HHWSS
1 in 2000	1 in 2000	HHWSS
PMF	PMF	20%

Table 5-9 Adopted Hawkesbury River design water levels

AEP	Hawkesbury River Flood Level (mAHD)			
	Lower Portland Colo Junction	Greens Creek Junction	Webbs Creek Junction	Macdonald Junction
ISLW^	-0.66	-0.69	-0.78	-0.78
HHWSS^	1.23	1.24	1.25	1.24
20%*	4.0	3.4	2.3	2.2
10%*	5.8	5.0	3.2	3.2
5%*	7.6	6.5	4.4	4.3
2%*	9.8	8.4	5.6	5.5
1%*	11.0	9.5	6.6	6.5
1in 200*	12.8	11.1	8.0	8.0
1in 500*	15.0	13.2	10.2	10.2
1in 1000*	17.0	15.0	11.5	11.5
1 in 2000*	18.7	16.6	12.9	12.9
PMF*	26.6	23.6	19.2	19.3

^Extracted from Figure 5-12 in Manly Hydraulic Laboratory (2023).

Extracted from Hawkesbury-Nepean River Flood Study (Rhelm CSS, 2024)

As shown **Table 5-7** and **Table 5-8**, each catchment driven event was combined with a single Hawkesbury River level to represent each design flood. The only exception is the 1% AEP event, where an additional combination of catchment runoff and Hawkesbury River water level was simulated to encompass an expanded range of flood characteristics (notably peak velocity) given the importance of this design flood for planning purposes.

As discussed earlier, although this study is focussed on defining "mainstream" flood behaviour for the four catchments, it was considered important to capture the potential impact of Hawkesbury River flooding. In this regard, separate simulations were completed by enveloping a small local catchment with large design floods along the Hawkesbury River. The differing design frequencies along the Hawkesbury River versus each local catchment, again, reflects the different catchment characteristics that are unlikely to produce flood of equivalent frequencies at the same time. As shown in **Table 5-10**, the 10% AEP local catchment flood was adopted to reflect local catchment flood behaviour with each Hawkesbury River design flood. All Hawkesbury River driven events were defined using a static Hawkesbury River design water level (refer to **Table 5-9**).

Table 5-10 Adopted downstream boundary conditions for Hawkesbury River driven events

Design flood event in local catchment	Design flood level in Hawkesbury River at junction
10%	2%
10%	1%
10%	1in 200
10%	1in 500
10%	1in 1000
10%	1 in 2000
10%	PMF

5.4.2 Hydraulic Structure Blockage

Blockage factors for each mainstream bridge and culvert were estimated based upon recommendations in Chapter 6 of Book 6 of 'Australian Rainfall & Runoff' (Ball et al, 2019). This involved calculating 'base' blockage factors for each structure which were subsequently adjusted up or down depending on the severity of the design event (i.e., higher blockage factors during larger/rarer floods and lower blockage factors during smaller/more frequent floods). The blockage scenarios that were adopted for each design simulation are presented in **Appendix F** and are summarised below:

- Low blockage scenario: 20% AEP, 10% AEP
- Medium blockage scenario: 5% AEP, 2% AEP, 1% AEP and 1 in 200 AEP
- High blockage scenario: 1 in 500 AEP, 1 in 1000 AEP, 1 in 2000 AEP and PMF

6 Flood Model Results

As discussed, a range of design storm durations and temporal patterns were simulated for each design event as well as local catchment plus Hawkesbury River driven floods. Therefore, the results from each simulation for each design flood frequency were combined to form a "design flood envelope" for each design flood. It is this "design flood envelope" comprising the most critical depths, velocities and levels from a risk management perspective that forms the basis for the results documented in the following sections.

6.1 Peak Depths, Levels and Velocities

Peak results were extracted from the final design flood envelopes and were used to prepare a range of flood maps for the 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP, 1 in 200 AEP, 1in 500 AEP, 1 in 1000 AEP and 1 in 2000 AEP floods as well as the PMF. This information is provided in:

- Flood Depths and Levels: **Map RG-00-101 to Map RG-00-110**
- Flow Velocity: **Map RF-00-201 to Map RG-00-210**

Peak design floodwater surface profiles were also extracted for the catchment and are presented in **Appendix D**.

Design stage hydrographs were also extracted at the Upper Colo and St Albans gauge locations and are provided in **Appendix D**. In reviewing the stage hydrographs, the potential gauge datum issues documented in **Section 5.3.6.1** should be taken into consideration. Design stage hydrographs are also presented for Green Creeks (upstream of Greens Road crossing) and Webbs Creek (upstream of Chaseling Road Bridge) in **Appendix D**.

6.2 Comparison with Previous Macdonald River Study

Flood levels generated as part of the current study at key locations in the catchment have been compared against flood level results provided in the 2004 Lower Macdonald River flood study (WMAWater 2004).

Figure 6-1 shows the locations along the Macdonald River where flood levels have been compared. **Table 6-1** compares the design flood levels from the 2004 Lower Macdonald River flood study (WMAWater 2004) with the results of this study.

The comparison in **Table 6-1** shows that during more frequent events (20% AEP, 10% AEP and 5% AEP), the levels from the 2004 study are generally higher than the levels generated in this study. For the rarer events (2% AEP and larger), the design flood levels from this study are generally higher than the 2004 study. In the 1% AEP event at St Albans, the peak water level in this flood study is 1.26 m higher than the 2004 study.

The main reasons the flood levels in the 2004 study differ to the current study include:

- The downstream boundary conditions for the current study have been based on a coincident event analysis and updated Hawkesbury River water levels from the Hawkesbury Nepean River Flood Study (Rhelm, CSS 2024). This has resulted in adoption of lower tailwater levels for the Hawkesbury River and is the main reason for the lower design flood levels in the current study along the Lower Macdonald across all events.
- The hydraulic model used in the 2004 study was 1D while this study is based on a 2D hydraulic model. The 1D model from the 2004 study was based on cross sections that were spaced 1.5

km to 3 km apart. The widely spaced 1D cross sections would not represent local features in the floodplain between cross-section locations and may not account for bend losses. Analysis completed by Rhelm and CSS (2024) showed hydraulic losses around bends can be significant during larger floods in semi confined valley's, resulting in higher flood levels during such events.

- The 2004 study used only two "cross-section averaged" roughness coefficients across the model area, with the highest roughness coefficient being 0.041. The current study included a more detailed representation of hydraulic roughness including dense trees and vegetation across parts of the floodplain, which comprise a much higher roughness (i.e., more than double the highest roughness value adopted in the 2004 study). The impact of the higher roughness is more pronounced during larger floods where a greater proportion of flow travels outside of the river channel. This is one of the main reasons behind the higher flood levels in the current study during larger floods.
- The 2004 study did not model a PMF event but used a flow 3 times the 1% AEP flow to represent an extreme event. Based on this study, the PMF flow at St Albans is approximately 8 times larger than the 1% AEP event. Therefore, with the exception of the area near the confluence with the Hawkesbury River (Point 4 in **Figure 6-1**) the PMF levels in from this study are significantly higher than the extreme event levels from the 2004 study.

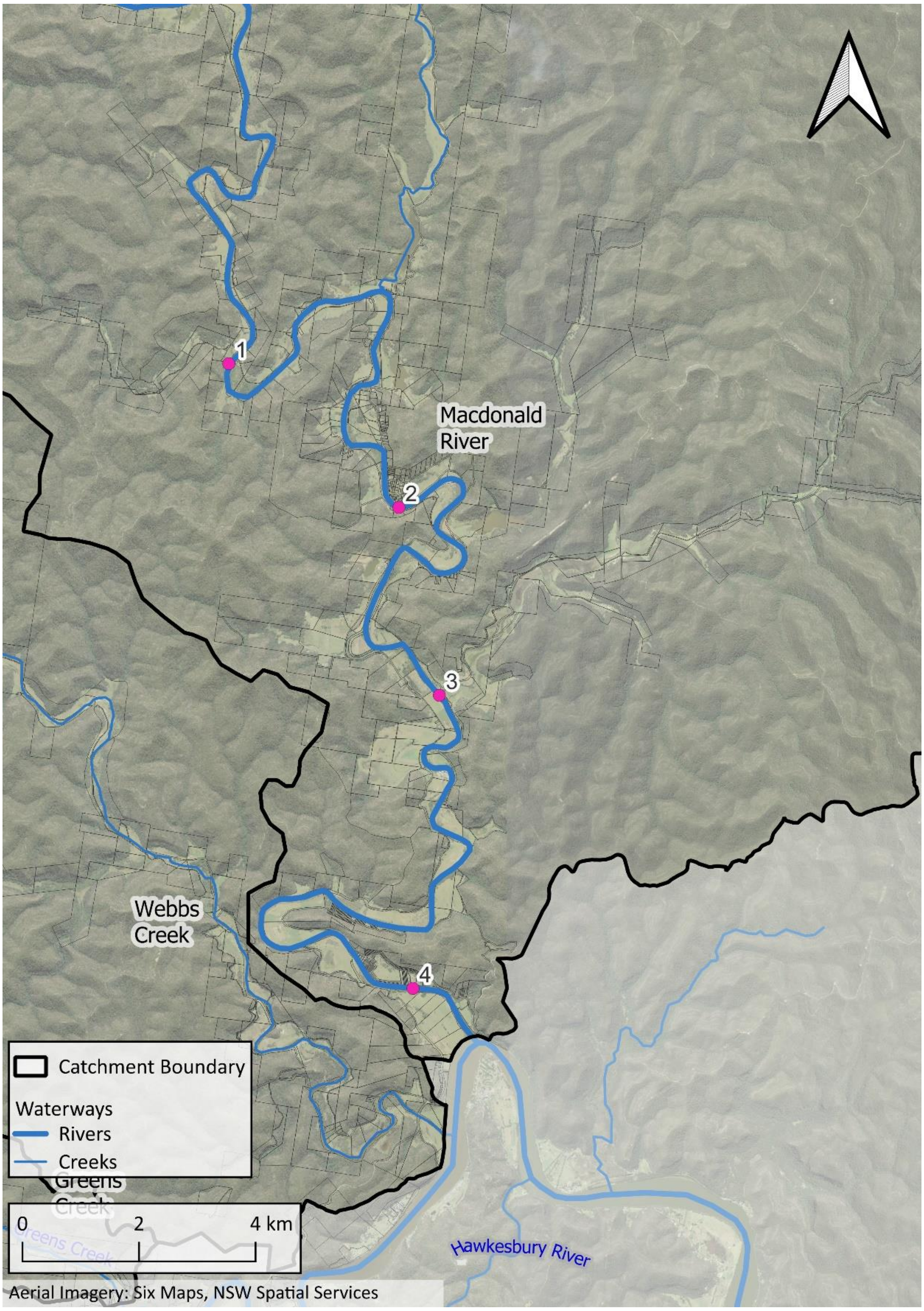


Figure 6-1 Flood level comparison locations

Table 6-1 Comparison of design flood levels in the Macdonald River from this study and the 2004 flood study

Event	Study	Location 1 Downstream of Gorricks Creek	Location 2 St Albans, upstream of St Albans Bridge	Location 3 Upstream of Wrights Creek	Location 4 Lower Macdonald
20% AEP	This Study	12.69	9.03	5.43	2.36
	2004 Study	12.50	10.10	7.00	3.20
	Difference	**0.19**	**-1.07**	**-1.57**	**-0.84**
10% AEP	This Study	13.73	9.92	6.24	3.27
	2004 Study	13.80	11.60	7.10	3.90
	Difference (m)	**-0.07**	**-1.68**	**-0.86**	**-0.63**
5% AEP	This Study	16.74	12.31	7.92	4.38
	2004 Study	15.0	13.0	8.9	4.4
	Difference (m)	**1.74**	**-0.69**	**-0.98**	**-0.02**
2% AEP	This Study	19.34	15.05	10.75	4.90
	2004 Study	16.20	13.70	10.10	5.60
	Difference (m)	**3.14**	**1.35**	**0.65**	**-0.7**
1% AEP	This Study	20.20	15.86	11.55	5.16
	2004 Study	17.20	14.60	11.00	6.70
	Difference (m)	**3.0**	**1.26**	**0.55**	**-1.54**
1 in 200 year	This Study	21.24	16.85	12.54	5.51
	2004 Study	18.10	15.50	11.90	8.00
	Difference (m)	**3.14**	**1.35**	**0.64**	**-2.49**
1 in 500 year	This Study	22.46	18.11	13.83	6.00
	2004 Study	19.30	16.70	12.90	9.60
	Difference (m)	**3.16**	**1.41**	**0.93**	**-3.6**
PMF (this study) / Extreme event (2004 study)	This Study	35.78	30.85	25.57	10.93
	2004 Study	22.50	19.60	16.30	16.30
	Difference (m)	**13.28**	**11.25**	**9.27**	**-5.37**

6.3 Flood Hazard

Flood hazard defines the potential impact that flooding will have on vehicles, people and property across different sections of the floodplain. More specifically, it describes the potential for floodwaters to cause damage to property, mobilise vehicles and result in loss of life/injury. For this study, the variation in flood hazard across the study was defined using flood hazard vulnerability curves presented in the NSW Government's 'Flood Risk Management Guideline FB03 – Flood Hazard' (2023b). The hazard curves are reproduced in **Figure 6-2**.

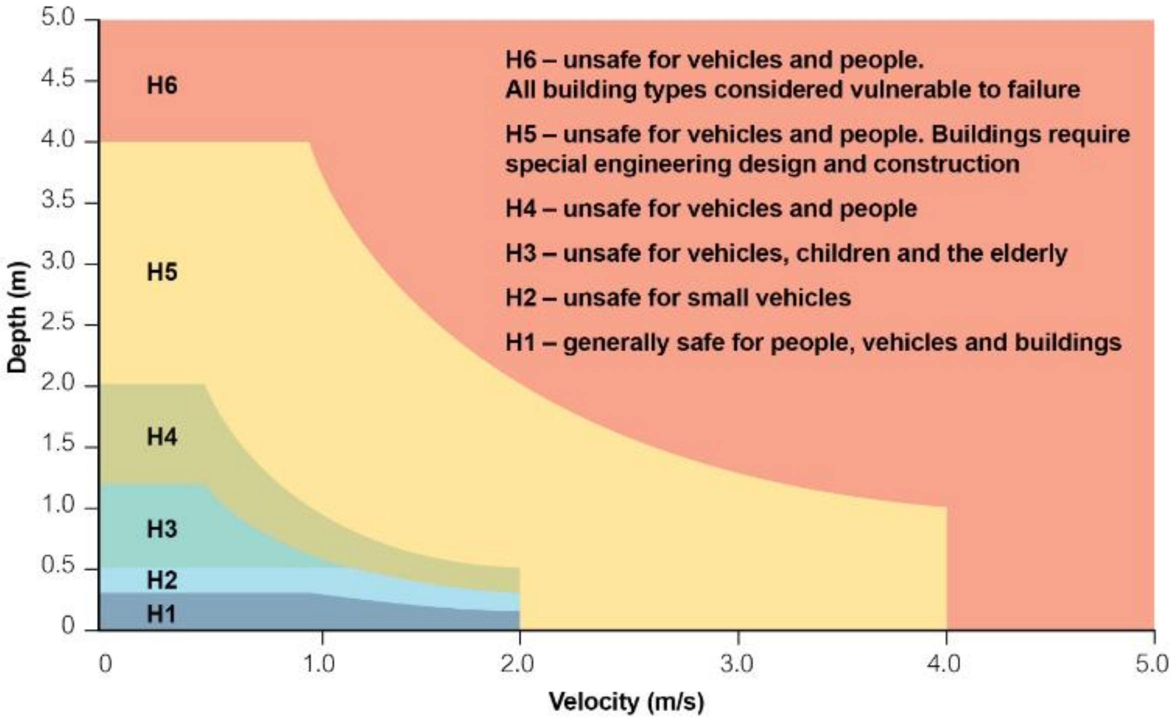


Figure 6-2 Flood hazard vulnerability curves (NSW Government, 2023b)

As shown in **Figure 6-2**, the hazard curves assess the potential vulnerability of people, cars and structures based upon the depth and velocity of floodwaters at a particular location. Therefore, peak depth, velocity and velocity-depth product outputs generated by the TUFLOW model were used to map the variation in flood hazard across the catchment based on the hazard criteria shown in **Figure 6-2** for each design flood. The resulting hazard category maps are shown in **Map RG-00-301 to Map RG-00-310** for the for the full range of flood events.

6.4 Flood function

The 'Flood Risk Management Manual' (NSW Government, 2023a) subdivides flood prone areas according to the three flood function categories presented in the first column of **Table 6-2**. The flood categories provide an indication of the potential for development across different sections of the floodplain to impact on existing flood behaviour and highlights areas that should be retained for the conveyance or storage of floodwaters.

Guidance for establishing flood function categories is provided in the '*Flood Risk Management Guideline FB02 - Flood Function*' (NSW Government, 2023c). However, explicit quantitative criteria for defining each category are not provided. This is because the extent of floodway, flood storage and flood fringe areas are typically specific to a particular catchment. Therefore, it was necessary to review the modelling results and use this information as a basis for developing criteria to describe each flood function category.

Table 6-2 Qualitative and quantitative criteria for flood function categories

Flood Function	Flood Risk Management Manual Definition	Adopted Criteria*
Floodway	Are generally areas which convey a significant portion of water during floods and are particularly sensitive to changes that impact flow conveyance. They often align with naturally defined channels.	Area within flowpaths that conveys 80% of the peak flow (conveyance technique).
Flood Storage	Are areas outside of floodways, are generally areas that store a significant proportion of the volume of water and where flood behaviour is sensitive to changes that impact on the storage of water during a flood.	• Not floodway and • Depth ≥ 0.2 m (Greens Creek and Webbs Creek) • Depth ≥ 0.5 m (Colo River and Macdonald River)
Flood Fringe	Are areas within the extent of flooding for the event but which are outside floodways and flood storage areas. Flood fringe areas are not sensitive to changes in either flow conveyance or storage.	Remaining areas of the floodplain not defined as floodway or flood storage

For this study, the following approach was employed to develop the flood function categories:

- Floodways
    - The conveyance technique was applied to the mainstream watercourse of each catchment. This approach identifies floodways as the area that conveys 80% of the peak flow. The VxD outputs generated by the hydraulic were used as a proxy to estimate the conveyance at regular intervals along each watercourse and, in turn, estimate the area of the watercourse containing 80% of the peak flow.
    - The suitability of the above floodway estimates was then cross-checked at selected locations by partly obstructing sections of floodway and confirming if a significant impact on flood behaviour/ or a significant redistribution of flow occurred. The outcome of this verification is presented in **Appendix E**.
- Flood Fringe
    - Floodways were removed.
    - A water depth threshold was then used to identify potential flood fringe areas.
    - The suitability of the flood fringe was tested by blocking out all flood fringe areas and re-running the design flood and confirming if this produced an unacceptable flood impact. Removing flood fringe areas should not have a significant impact on flood behaviour). For this study an “unacceptable impact” was quantified as a flood level increase of 0.1 m.

    - The depth threshold was adjusted iteratively until the flood level impacts were contained below 0.1 m. The outcome of this verification is presented in **Appendix E**
- Flood Storage
    - Remaining areas after floodway and flood fringe areas were removed.

The velocity and depth results produced by the TUFLOW model for each design flood were combined with the criteria detailed in **Table 6-2** to produce flood function category maps. The resulting maps are shown in the following maps:

- **Map RG-00-401 -** 1% AEP Flood Function
- **Map RG-00-402** - 1 in 200 AEP (0.5% chance per year)
- **Map RG-00-403** - 1 in 500 AEP (0.2% chance per year)
- **Map RG-00-404** - PMF

6.5 Discussion on Flood Behaviour

The flood mapping shows that inundation extents are generally contained close to each of the main waterways, even during events as large as the PMF. A comparison of the inundation extents also shows that the extent of inundation does not vary dramatically between events, which is a product of the incised nature of most of the catchment areas. However, the confined topography does produce a significant flood height range. This produces some significant increases in water depth as the severity of flooding increases. For example, at St Albans, the peak 20% AEP water depth within the Macdonald River channel is predicted to reach about 6.5 metres. During the 1% AEP flood, this is predicted to exceed 13.5 metres and during the 1 in 2000 AEP flood, the peak depth is predicted to exceed 17 metres. Therefore, although a significant area of additional floodplain is not necessarily activated as flood severity increases, the flood depth increases significantly in all catchments.

This increase in flood risk with increasing flood severity is also reflected in the flow velocity mapping. Along the Colo River, peak velocities along the river during the 20% AEP flood are typically contained well below 2 m/s. During the 1% AEP flood, peak velocities are commonly more than 2 m/s with localised areas (primarily river bends) exposed to velocities of more than 3 m/s.

As a result of the high-water depths and velocities, the flood hazard along each watercourse and floodplain is also predicted to be high. This includes:

- Colo River: H6 hazard is predicted across most low-lying areas during floods as frequent as the 5% AEP event. This includes the significant backwater area of Wheeny Creek
- Green Creek: H5 hazard is predicted across most of the inundated area during a 10% AEP flood. This is predicted to increase to H6 hazard during the 2% AEP flood.
- Webbs Creek: H5 hazard becomes prominent across the floodplain during the 5% AEP flood. This escalates quickly with much of the floodplain becoming exposed to H6 hazard during the 2% AEP flood:
- Macdonald River: H5 and H6 hazard areas are typically contained to formal watercourses during events up to and including the 5% AEP flood. Similar to Webbs Creek, the hazard escalates quickly in the 2% AEP flood, with much of the floodplain adjoining the Macdonald River exposed to H5 and H6 hazard. This includes parts of St Albans.

The water surface profiles confirm that backwater inundation from the Hawkesbury River is the dominant flooding mechanism for Green Creek.

The water level profiles also show that the PMF is significantly higher than each of the other design events along all four watercourses. This includes the PMF typically being 10 metres higher than the 1% AEP flood level. Although the chance of a PMF occurring is very rare, the significant increase in flood depths and velocities associated with this event must be considered as part of the flood risk management process.

6.6 Model Sensitivity

Computer flood models require the adoption of parameters that are not necessarily known with a high degree of certainty or are subject to variability. Each of these parameters can impact on the results generated by the model.

As outlined in Section 5.2 and Section 6.2, computer models are typically calibrated using recorded rainfall, stream flow and/or flood mark information. Calibration is achieved by adjusting the parameters that are not known with a high degree of certainty until the computer model is able to reproduce the recorded flood information. Calibration is completed to ensure the adopted model parameters are generating realistic estimates of flood behaviour.

As flood information for calibration is typically limited, it is important to understand how any uncertainties and variability in model input parameters may impact on the results produced by the model. Therefore, a model sensitivity analysis was undertaken to establish the sensitivity of the results generated by the computer model to changes in hydrologic and hydraulic model input parameter values. The outcomes of the sensitivity analysis are presented below.

6.6.1 Hydraulic Model Inputs

6.6.1.1 Roughness Coefficients

Roughness coefficients are used to describe the resistance to flow afforded by different land uses and surfaces across the catchment. However, they can be subject to variability (e.g., vegetation density in the summer would typically be higher than the winter leading to higher roughness values). Therefore, additional analyses were completed to quantify the impact that any uncertainties associated with roughness values may have on design flood behaviour.

The TUFLOW model was updated to reflect a 20% increase and a 20% decrease in the adopted design roughness values and additional 20% AEP and 1% AEP simulations were (no changes to hydrology were completed as part of this assessment). Downstream boundary (tailwater) conditions also remained unchanged.

Peak flood levels were extracted from the results of the modelling and were used to prepare flood level difference mapping, which are presented in **Maps RG-00-505 to Map RG-00-508.** General ranges of flood level differences were extracted for each catchment and are presented in **Table 6-4** and **Table 6-5** for the 20% AEP and 1% AEP events respectively.

Changes in the 20% AEP and 1% AEP flood levels associated with increases and decreases in roughness values are predicted to vary per catchment and also vary along the length of each watercourse. Due to design tailwater levels remaining unchanged, peak flood levels in the lowest reaches of each catchment undergo relatively minor increases/decreases in peak flood levels.

Greens Creek experiences minor increases/decreases (<0.1 m) in peak flood levels for both the 20% AEP and 1% AEP events, due to the greater influence of the Hawkesbury River tailwater level on the smaller catchment. Greater increases/decreases in peak flood level are experienced along the upper reaches of

Colo River, Webbs Creek and Macdonald River. For the 20% AEP event, peak flood level differences generally vary between 0.2-0.5 m for Colo River and Macdonald River, and 0.1-0.2 m for Webbs Creek. For the 1% AEP event, differences in peak flood level increase to 0.4-0.8 m for the Colo River and Macdonald River, and 0.1-0.3 m for Webb Creek.

The more significant increases in peak flood levels in Colo River, Macdonald River and Webbs Creeks indicates the model's sensitivity to changes in Manning's 'n' values. During the hydraulic model calibration (Section 5.3), it was found that the model is particularly sensitive to changes in assigned roughness to the majority land use category, ''Trees''. A 20% percentage increase/decrease across all roughness coefficients can disproportionately impact higher roughness categories, such as ''Trees'', in terms of absolute increases. Thus, it is likely that the increases/decreases in peak flood levels observed during the roughness coefficient sensitivity testing is predominantly caused by higher/lower roughness coefficients assigned to the "Trees" land use category.

6.6.1.2 Blockage

As discussed in Section 5.4.2, blockage factors were applied to all hydraulic structures as part of the design flood simulations. However, as it is not known which structures will be subject to what percentage of blockage during any flood, additional TUFLOW simulations were completed to determine the impact that alternate blockage scenarios would have on flood behaviour.

For culverts, the 'baseline' 20% AEP and 1% AEP simulations utilised the "AEP >5%" and "AEP 5% - 0.5%" design blockage level of 25% as documented in **Appendix F**. The sensitivity simulations were completed by updating the 20% AEP and 1% AEP flood simulations to use 0% blockage for a "low blockage scenario" and the less frequent (AEP < 0.5%) design blockage of 50% for a "high blockage scenario".

For bridges, modelled 2D layered flow constriction (2d_lfcsh) layers were updated to reflect a 0% blockage for L1 (below obvert) and L3 (handrail) for "low blockage scenario", while for the "high blockage scenario", L1 blockage was increased by an additional 10% over the baseline value and L3 blockage was set to 100%.

Peak flood levels were extracted from the results of the modelling and were used to prepare flood level difference mapping, which is presented in **Maps RG-00-501 to Map RG-00-504.**

The results indicate that changes in blockage levels produce localised changes of less than ±0.10 m in the immediate vicinity of some hydraulic structures for both the 20% AEP and 1% AEP events. More extensive changes in peak flood levels are experienced in Greens Creek, upstream and downstream of the Greens Road crossing, but these flood level differences are also less than 0.10 m.

6.6.2 Climate Change

Climate change refers to a significant and lasting change in temperature and weather patterns arising from both natural and human induced processes. In 2021, the Intergovernmental Panel for Climate Change (IPCC) released the Working Group I contribution to its sixth assessment report (AR6) (IPCC, 2021). The key findings are:

- It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.
- Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.

- It is very likely to virtually certain[1] that regional mean relative sea level rise will continue throughout the 21st century. Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur at least annually at more than half of all tide gauge locations by 2100 (high confidence). Relative sea level rise contributes to increases in the frequency and severity of coastal flooding in low-lying areas and to coastal erosion along most sandy coasts.

It is therefore important to provide an assessment of the potential impact that climate change may have on the flood risk across the study area. In this regard, additional simulations were completed to understand the potential impact that rainfall increases may have on current 20% and 1% AEP design flood estimates.

Climate change was incorporated using updated guidance from Book 1 Chapter 6 of ARR2019 v4.2 (2024). Climate change impacts were assessed across the study area based on 2050 and 2100 planning horizons. SSP3 was adopted for the assessment to simulate a high warming scenario. The assessment includes an update to hydrology underpinned by a rainfall intensity increase, with resultant outputs used as the inflows for the hydraulic models.

Based on the climate change guidance from ARR2019 v4.2, hydrology model parameters were updated using the values shown in **Table 6-3**. The SSP scenario is associated with a temperature increase. Combined with a rate of change (α) linked to the storm duration, a percent increase for the design storm rainfall intensity was calculated. Loss adjustments provided by ARR2019 v4.2 were also adopted. The updated climate change hydrology was applied to the critical storms determined by the design hydrology assessment (see **Section 4.4**). **Table 6-3** shows that under SSP3, peak for in 1% event is predicted to increase by around 20%-25% in by 2050 and around 40%-50% by 2100. Some of the potential flood planning implications of these significant increases are discussed in the flood risk management study.

[1] Very Likely refers to a probability of 90 – 100% , while Virtually Certain refers to a 99 – 100% probability (IPCC, 2010)

Table 6-3 Summary of sensitivity testing outcomes for the 20% AEP event

Updated Hydrology Model Parameter	Colo River	Greens Creek	Webbs Creek	Macdonald River
SSP3 – 2050 Parameters				
Temperature Increase	1.8°C	1.8°C	1.8°C	1.8°C
Rate of Change (α)	8	9 – 9.5 (dependent on duration)	8	8
Rainfall Intensity Increase	15%	17% – 18%	15%	15%
Initial Loss Increase	4%	4%	4%	4%
Continuing Loss Increase	7%	7%	7%	7%
20% AEP Peak Flow Increase	29%	32%	31%	45%
1% AEP Peak Flow Increase	25%	20%	21%	21%
SSP3 – 2100 Parameters				
Temperature Increase	3.3°C	3.3°C	3.3°C	3.3°C
Rate of Change (α)	8	9 – 9.5 (depends on duration)	8	8
Rainfall Intensity Increase	29%	33% – 35%	29%	29%
Initial Loss Increase	7%	7%	7%	7%
Continuing Loss Increase	14%	14%	14%	14%
20% AEP Peak Flow Increase	59%	66%	63%	91%
1% AEP Peak Flow Increase	48%	39%	41%	41%

The updated hydrology was then applied to the TUFLOW hydraulic models and re-simulate the current 20% and 1% AEP design flood under potential future climate change conditions. Peak flood levels were extracted from the results of the climate change modelling and were used to prepare flood level difference mapping. The 1% AEP sensitivity under SSP3 is presented in **Maps RG-00-601** for 2050 **and RG-00-602 for** 2100. General ranges of flood level differences were extracted for each catchment and are presented in **Table 6-4** and **Table 6-5.** The flood level difference mapping shows that rainfall increases have the potential to significantly increase existing design flood levels across most catchments. More specifically, peak flood levels along the Colo River and Macdonald River are predicted to increase by at least 0.5 metres at most locations. Localised increases of more than 2 metres are predicted along part sections of the Colo River.

Although the flood level increases due to rainfall increases along Greens Creek are not predicted to be as significant, it should be recognised that backwater flooding from the Hawkesbury River is the dominant flooding mechanism across this catchment. Although the impacts of climate change on Hawkesbury River flood levels were not considered as part of the current study, the 'Hawkesbury-Nepean River Flood Study' (Rhelm CSS, 2024) determined that peak 1% AEP flood levels along the Lower Hawkesbury River could increase by more than 2 metres under climate change conditions. Therefore, climate change also has the potential to significantly impact on current design flood levels for the Greens Creek catchment.

Table 6-4 Summary of sensitivity testing outcomes for the 20% AEP event

Sensitivity Simulation	Parameter Change	Typical peak flood level differences for 20% AEP (m)			
		Colo River	Greens Creek	Webbs Creek	Macdonald River
Hydraulic Model Inputs					
Roughness coefficients	±20%	0.2-0.5	<0.1	0.1-0.2	0.2-0.4
Blockage	Culverts - Low Blockage: 0% Culverts - High blockage: 50% Bridges - Low Blockage: L1 0%, L3 0% Bridges - High blockage: L1+10%, L3 100%	<0.1	<0.1	<0.1	<0.1
Climate Change					
SPP3-2050	1.8°C temperature increase	0.6-1.2	0.1-0.2	0.2-0.4	0.5-1.1
SPP3-2100	3.3°C temperature increase	1.1-2.5	0.3-0.4	0.5-0.8	0.9-2.2

Table 6-5 Summary of sensitivity testing outcomes for the 1% AEP event

Sensitivity Simulation	Parameter Change	Typical peak flood level differences for 1% AEP (m)			
		Colo River	Greens Creek	Webbs Creek	Macdonald River
Hydraulic Model Inputs					
Roughness coefficients	±20%	0.5-0.8	<0.1	0.1-0.3	0.4-0.7
Blockage	Culverts - Low Blockage: 0% Culverts - High blockage: 50% Bridges - Low Blockage: L1 0%, L3 0% Bridges - High blockage: L1+10%, L3 100%	<0.1	<0.1	<0.1	<0.1
Climate Change					
SPP3-2050	1.8°C temperature increase	1.2-1.5	0.1-0.2	0.4-0.6	0.4-0.9
SPP3-2100	3.3°C temperature increase	2.0-2.8	0.2-0.4	0.7-0.9	1.0-1.8

7 Conclusions and Recommendations

The Combined Macdonald River, Colo River, Webbs Creek & Greens Creek Flood Study has been prepared for Hawkesbury City Council City Council to define the existing flood behaviour in the study area. The flood study will form the basis for the flood risk management study and plan.

The flood study, which is a comprehensive technical investigation of flood behaviour that provides the main technical foundation for the development of a robust flood risk management plan. It aims to provide a better understanding of the full range of flood behaviour. It involves consideration of the local flood history, available collected flood data, and the development of hydrologic and hydraulic models that are calibrated and verified, against historic flood events.

Flood behaviour has been assessed using a WBNM hydrological model and TUFLOW hydraulic model. The WBNM hydrologic model was developed as part of the Hawkesbury Nepean River Flood Study (Rhelm CSS, 2024). Minor modifications were made to the WBNM model as part this study. TUFLOW hydraulic models were established for each catchment in the study area.

The models were calibrated using the July 2022, March 2022 events and validated using the February 2020 and March 1978 event.

The hydrological and hydraulic models were analysed for the Probable Maximum Flood (PMF), 1 in 2000 AEP, 1 in 1000 AEP, 1 in 500 AEP, 1 in 200 AEP , 1% AEP, 2% AEP, 10% AEP and 20% AEP events. The design events are based on ARR2019 methods. For the Macdonald and Colo Rivers, the design events have been calibrated using flood frequency analysis.

The flood study will form the basis for the flood management study and plan.

8 References

AIDR (2017). *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*. Handbook 7: Australian Disaster Resilience Handbook Collection. East Melbourne.

AWACS (1997). *Lower Hawkesbury River Flood Study*. Coastal and Floodplain Resources. Department of Land and Water Conservation. Report No. CFR97/06. Final Draft

Babister, M., Trim, A., Testoni, I. & Retallick, M (2016). *The Australian Rainfall & Runoff Datahub*, 37th Hydrology and Water Resources Symposium Queenstown NZ.

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

Bewsher (2012) *Hawkesbury Floodplain Risk Management Study and Plan*. Prepared for Hawkesbury City Council.

BoM (2006). *Guidebook to the Estimation of Probable Maximum Precipitation – Generalised Southeast Australia Method*, Hydrometeorological Advisory Service, October.

BoM (2016). *Design Rainfall Data System.* Available:

Rainfall IFD Data System: Water Information: Bureau of Meteorology (bom.gov.au)

BoM (2018). *P1 Network Audit Report*, Sydney.

Boyd, M. J., Rigby E. H., Van Drie, R., Schymitzek, I. (2017). *Watershed Bounded Network Model: Theory*.

Geoscience Australia (2021). *Elvis - Elevation and Depth - Foundation Spatial Data,* ©Commonwealth of Australia. Available:

Elvis (fsdf.org.au)

Manly Hydraulics Laboratory (2023). *NSW Tidal Planes Analysis. 2001-2020 Harmonic Analysis*. Report MHL2786. NSW Department of Planning and Environment. Biodiversity and Conservation Division.

Microsoft (2023). *Australian Building Footprints*. GitHub repository. Available:

https://github.com/microsoft/AustraliaBuildingFootprints

NSW Government (2005). *Floodplain Development Manual.*

NSW Government (2023a). *Flood Risk Management Manual: The policy and manual for the management of flood liable land*. Department of Planning and Environment.

NSW Government (2023b). *Flood Risk Management Guideline FB03: Flood Hazard*. Department of Planning and Environment.

NSW Government (2023c). *Flood Risk Management Guideline FB02: Flood Function*. Department of Planning and Environment.

NSW Spatial Services (2023). *NSW Digital Cadastral Database Clip and Ship.* Available:

SIX Maps - Clip & Ship (nsw.gov.au)

OEH (2019). *Review of Australian Rainfall and Runoff Design Inputs for NSW*. Available:

Review of Australian Rainfall and Runoff Design Inputs for NSW | NSW Environment and Heritage

Public Works Department (1979). *Hawkesbury River: March 1978 Flood Report*. Sydney, NSW.

Road and Traffic Authority of NSW (1994). *Bridge over Colo River at 24.9 km North of Windsor*. Schedule of Drawings.

Rhelm CSS (2024). *Hawkesbury-Nepean River Flood Study*. NSW Reconstruction Authority.

Ryan, C. (2013). *Using LiDAR Survey for Land Use Classification*. Paper presented at the 2013 Floodplain Management Authorities Conference, Tweed Heads.

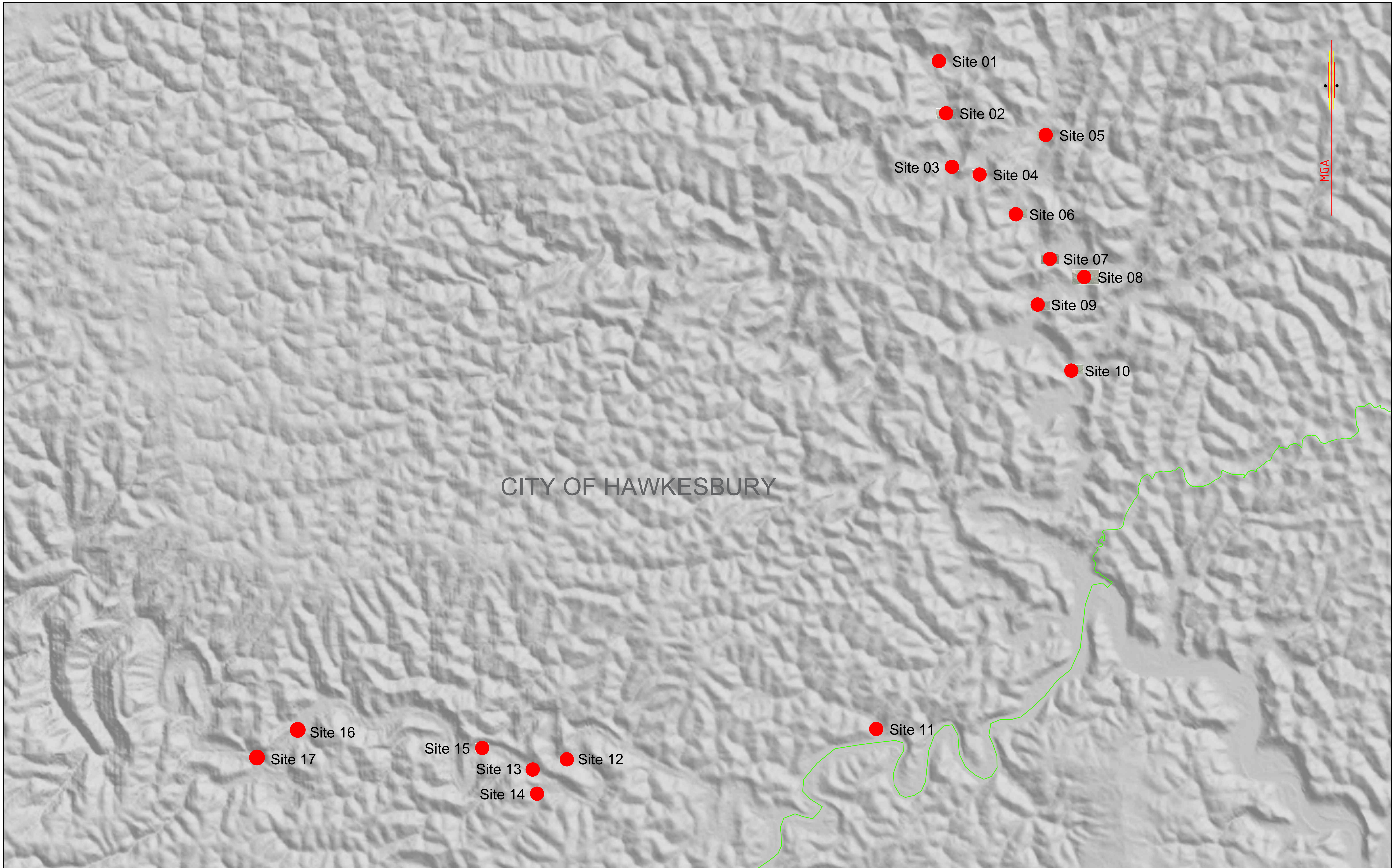
Smith & Wasko (2012). *Australian Rainfall and Runoff Revision Project 15: Two Dimensional Simulations in Urban Areas*. Water Research Laboratory, University of New South Wales

WMAWater (2025) *Hawkesbury Floodplain Risk Management Study and Plan Draft.* Prepared for Hawkesbury City Council.

Webb, McKeown & Associates (2004). *Lower Macdonald River Flood Study*. Hawkesbury City Council.

Appendix A

Survey



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A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:100,000

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

B C E SPATIAL
LICENSED & ENGINEERING SURVEYING CONSULTANTS

MacDonald River and Colo River Survey Site Locations Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

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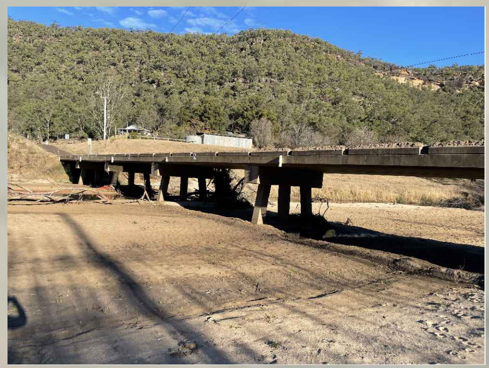

RIVER CROSS SECTION

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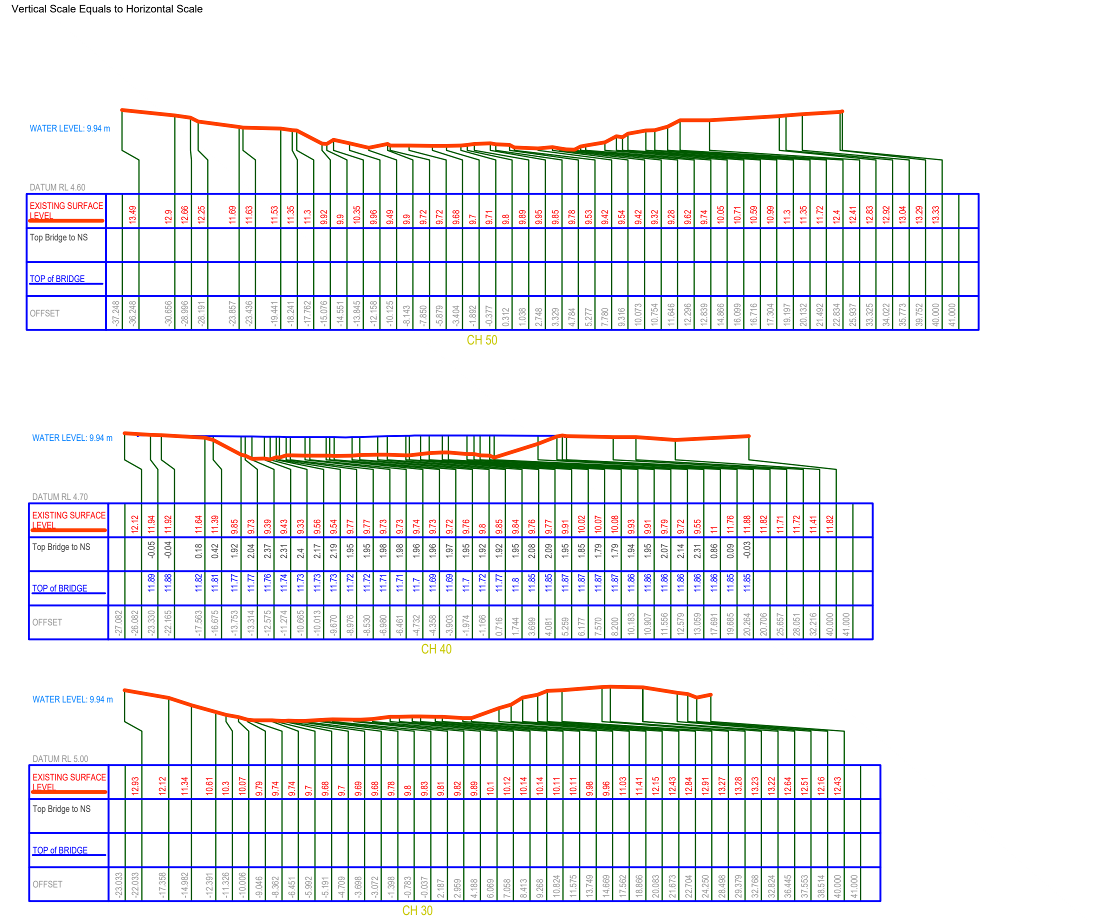

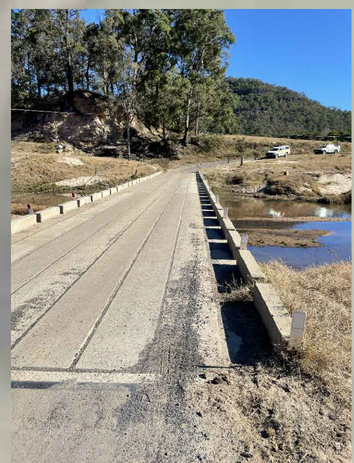

LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

NOTES:

1. Horizontal and Vertical control is related to MGA Zone 56 (GDA2020) and AHD via Survey Marks
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4. SUI may remain unmarked within the site extents if they were not part of the original scope of works.
5. All SUI is located in line with Australian Standards and with reference to DBYD records and other available plans as provided.
6. All marked services should be potholed to confirm actual location and depth.
7. Satellite imagery serves as general backdrop to line drawing and may not be up to date.

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COORDINATE DATUM

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VERTICAL : AHD 71
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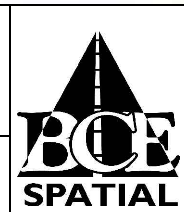

B C E SPATIAL
LICENSED & ENGINEERING SURVEYING CONSULTANTS

MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

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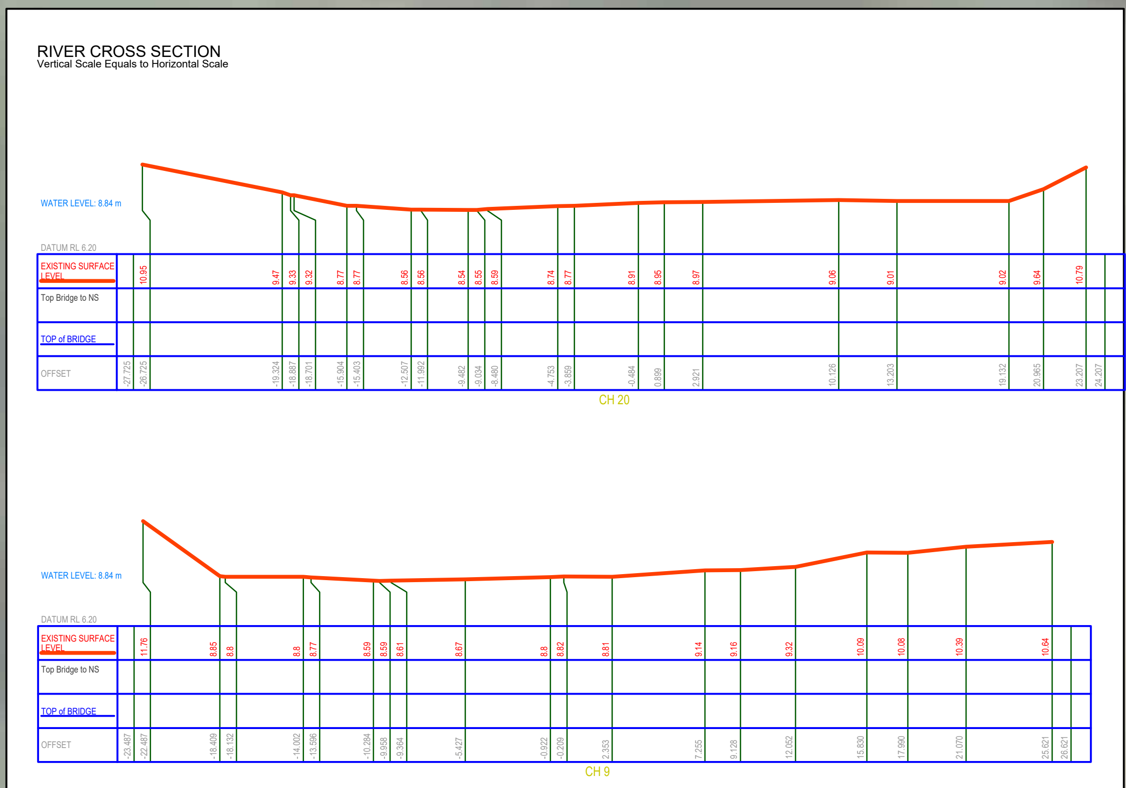

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- SEWER LINE
- BACK OF KERB

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
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Contour Interval : 0.5 meter

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B C E SPATIAL
LICENSED & ENGINEERING SURVEYING CONSULTANTS

BCE SPATIAL

MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

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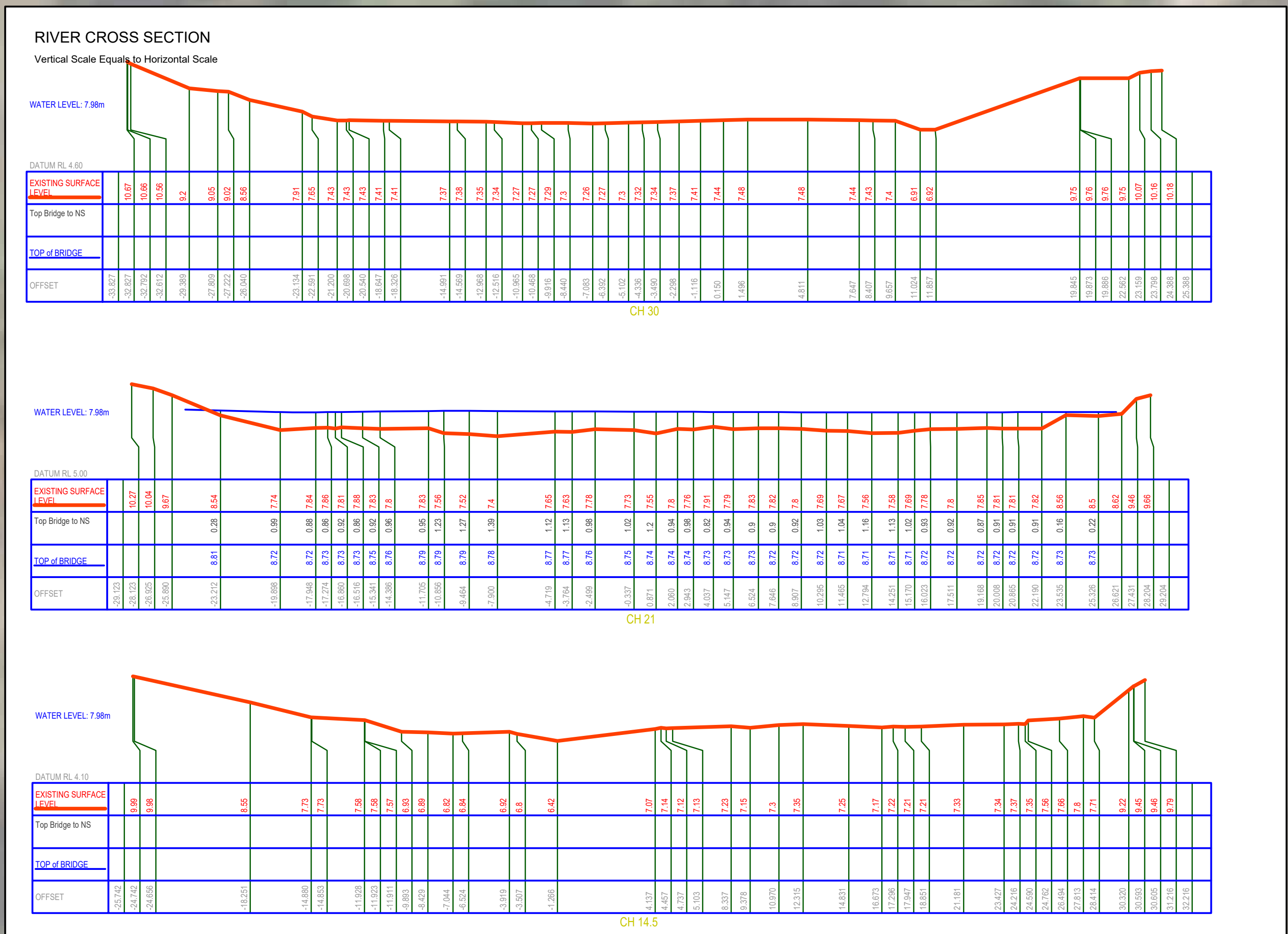

LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

NOTES:

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:500

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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LICENSED & ENGINEERING SURVEYING CONSULTANTS

MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235

PLAN No. N1235-03

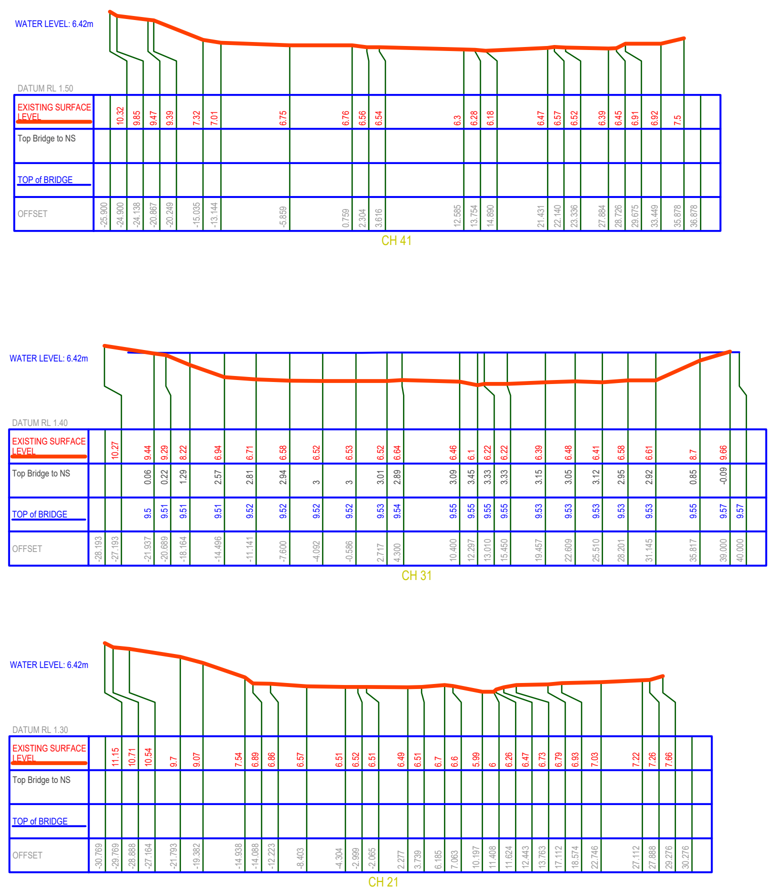
Sheet 1 of 1

SCALE: Scale 1 : 500 @ A3

REVISION: A

RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale



LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

NOTES:

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A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:500

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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BCE SPATIAL

MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

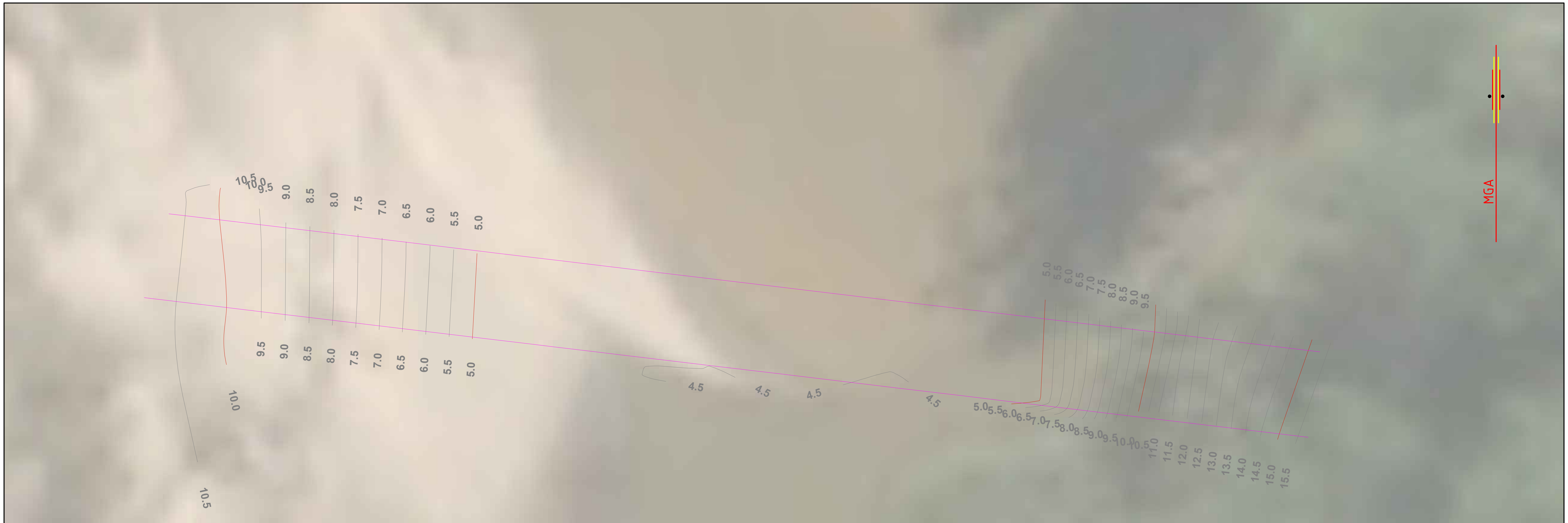
JOB No. N1235

PLAN No. N1235-04

Sheet 1 of 1

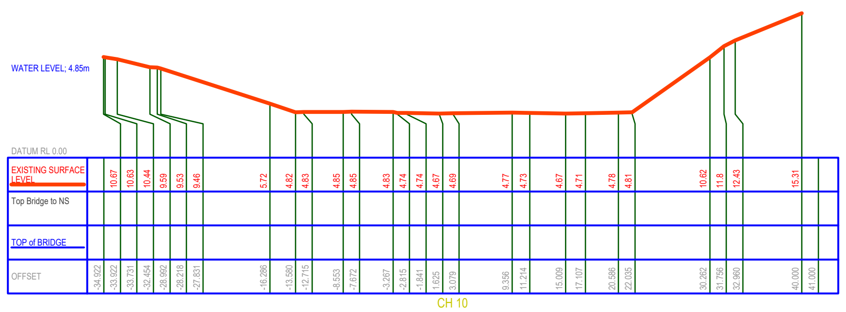
SCALE: Scale 1 : 500 @ A3

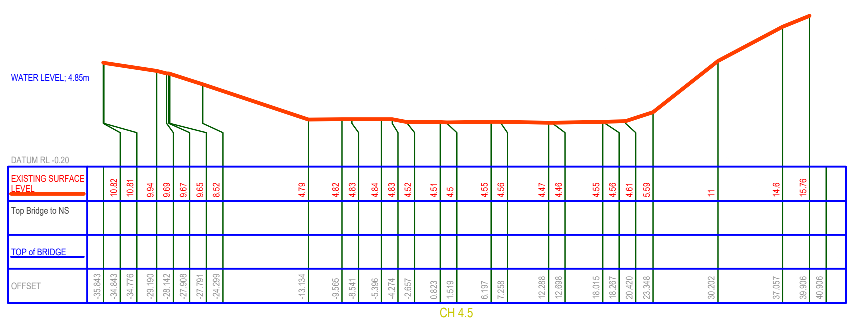
REVISION: A



RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale





LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

NOTES:

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A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:500

COORDINATE DATUM

HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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LICENSED & ENGINEERING SURVEYING CONSULTANTS

BCE SPATIAL

MacDonald River Survey
Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

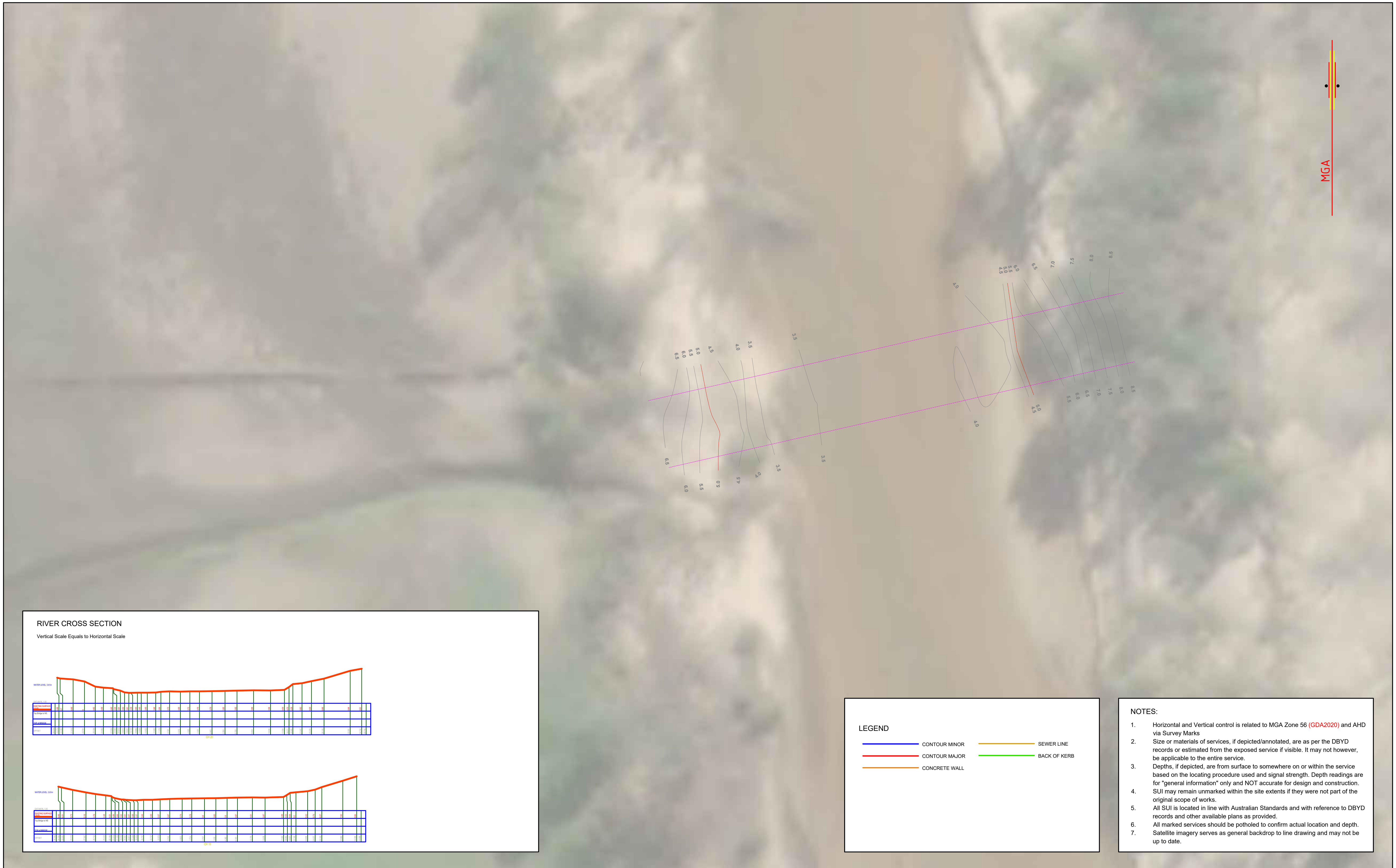
JOB No. N1235

PLAN No. N1235-05

Sheet 1 of 1

SCALE: Scale 1 : 250 @ A3

REVISION: A



RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale

LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

NOTES:

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:100,000

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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BCE SPATIAL

MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235

PLAN No. N1235-00

Sheet 1 of 1

SCALE: Scale 1 : 100K @ A3

REVISION: A

LEGEND

CONTOUR MINOR	SEWER LINE
CONTOUR MAJOR	BACK OF KERB
CONCRETE WALL	

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A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:100,000

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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LICENSED & ENGINEERING SURVEYING CONSULTANTS

MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

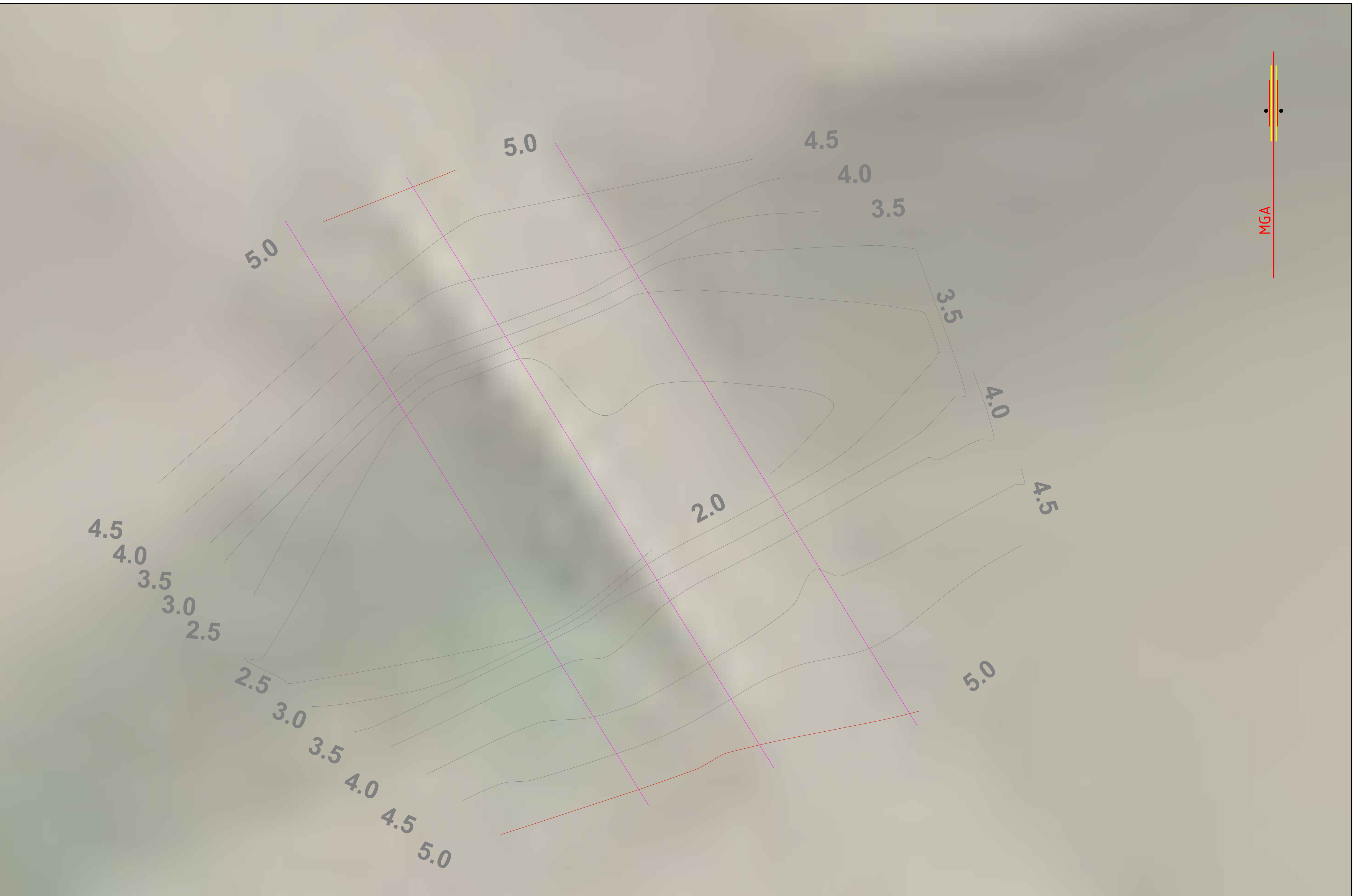
JOB No. N1235

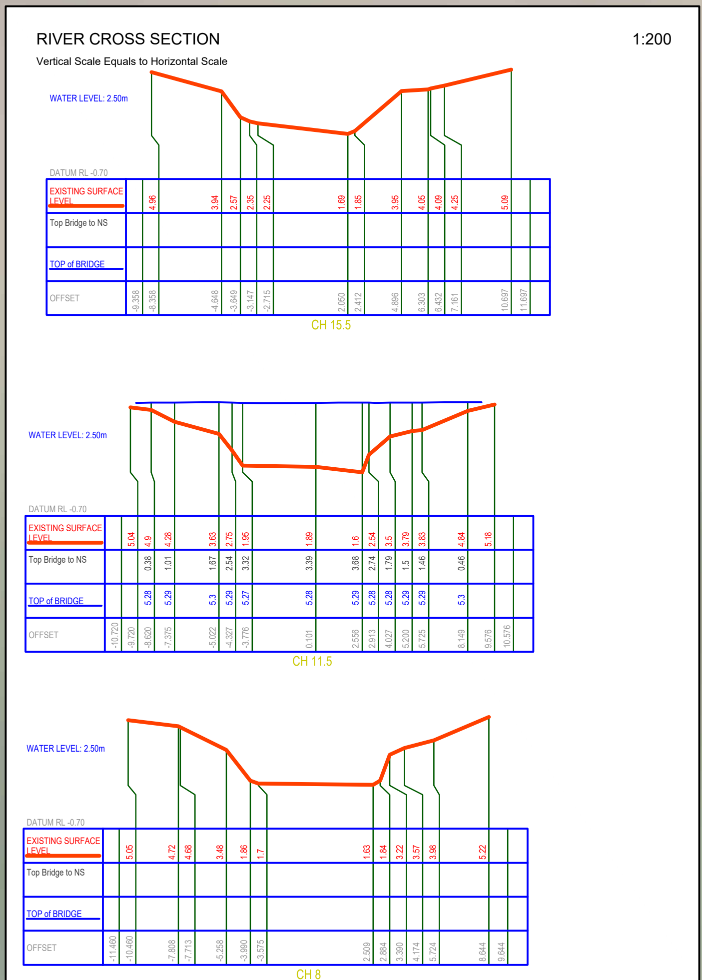
PLAN No. N1235-07

Sheet 1 of 1

SCALE: Scale 1 : 100K @ A3

REVISION: A





LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
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CLIENT: Hawkesbury City Council

SCALE: 1:125

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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BCE SPATIAL

Weltums Creek Survey
Hawkesbury,
New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235
PLAN No. N1235-08
Sheet 1 of 1
SCALE: Scale 1 : 125 @ A3
REVISION: A

LEGEND

CONTOUR MINOR	SEWER LINE
CONTOUR MAJOR	BACK OF KERB
CONCRETE WALL	

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A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:500

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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MacDonald River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

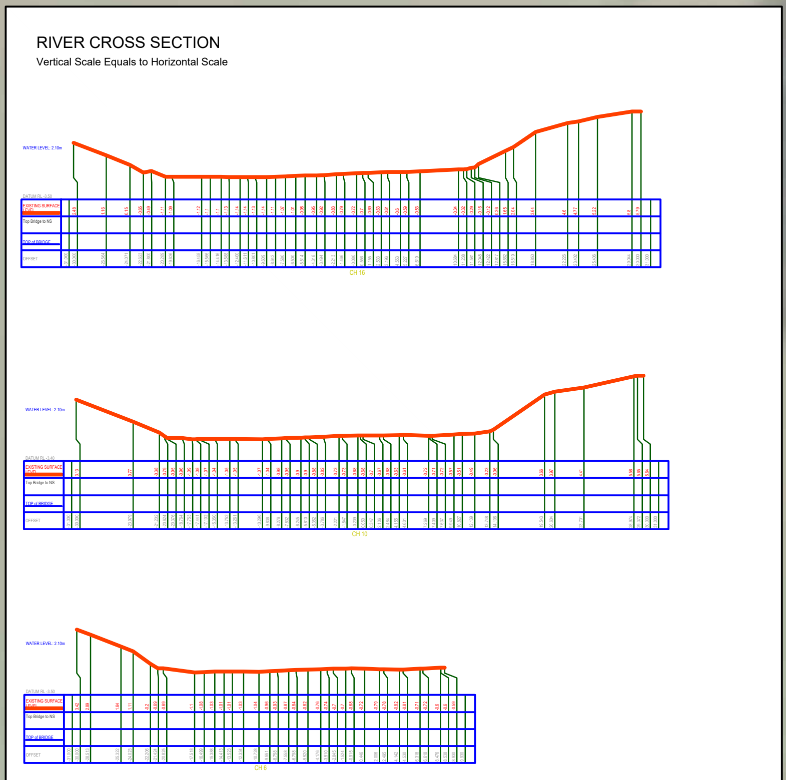
JOB No. N1235

PLAN No. N1235-09

Sheet 1 of 1

SCALE: Scale 1 : 500 @ A3

REVISION: A



LEGEND

CONTOUR MINOR	SEWER LINE
CONTOUR MAJOR	BACK OF KERB
CONCRETE WALL	

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CLIENT: Hawkesbury City Council

SCALE: 1:500

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

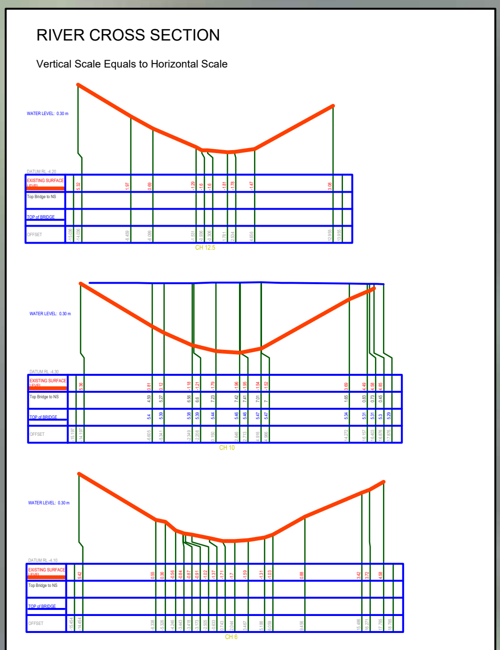
JOB No. N1235

PLAN No. N1235-10R

Sheet 1 of 1

SCALE: Scale 1 : 500 @ A3

REVISION: A



LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:250

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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Wrights Creek Survey Hawkesbury, New South Wales

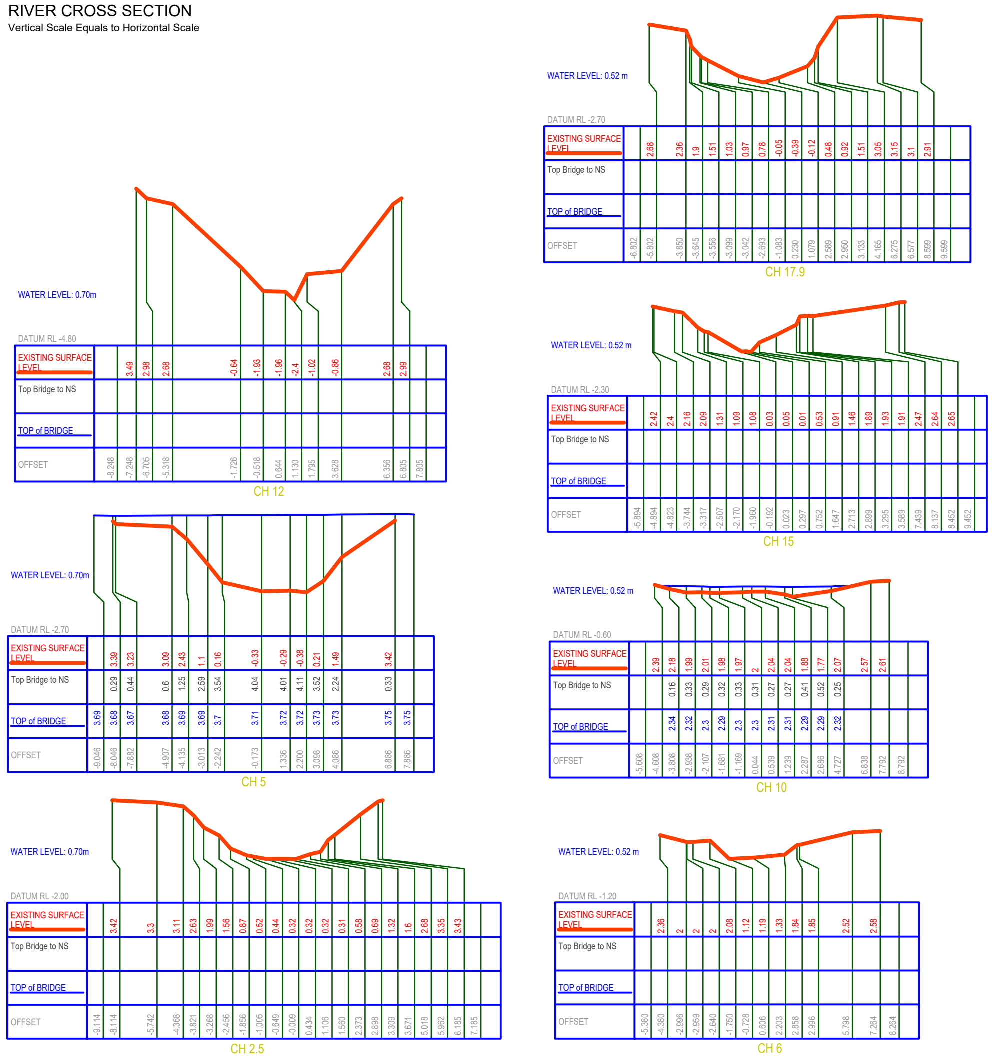
PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235
PLAN No. N1235-10S
Sheet 1 of 1
SCALE: Scale 1 : 250 @ A3
REVISION: A

RIVER CROSS SECTION
Vertical Scale Equals to Horizontal Scale



LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

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A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:250

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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BCE SPATIAL

Green Swamp Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235

PLAN No. N1235-11

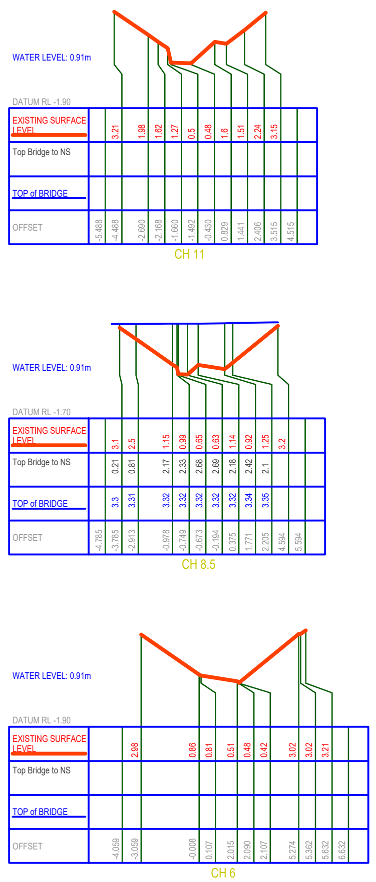
Sheet 1 of 1

SCALE: Scale 1 : 250 @ A3

REVISION: A

RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale



LEGEND

CONTOUR MINOR	SEWER LINE
CONTOUR MAJOR	BACK OF KERB
CONCRETE WALL	

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
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CLIENT: Hawkesbury City Council

SCALE: 1:125

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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Whatleys Creek Survey
Hawkesbury,
New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

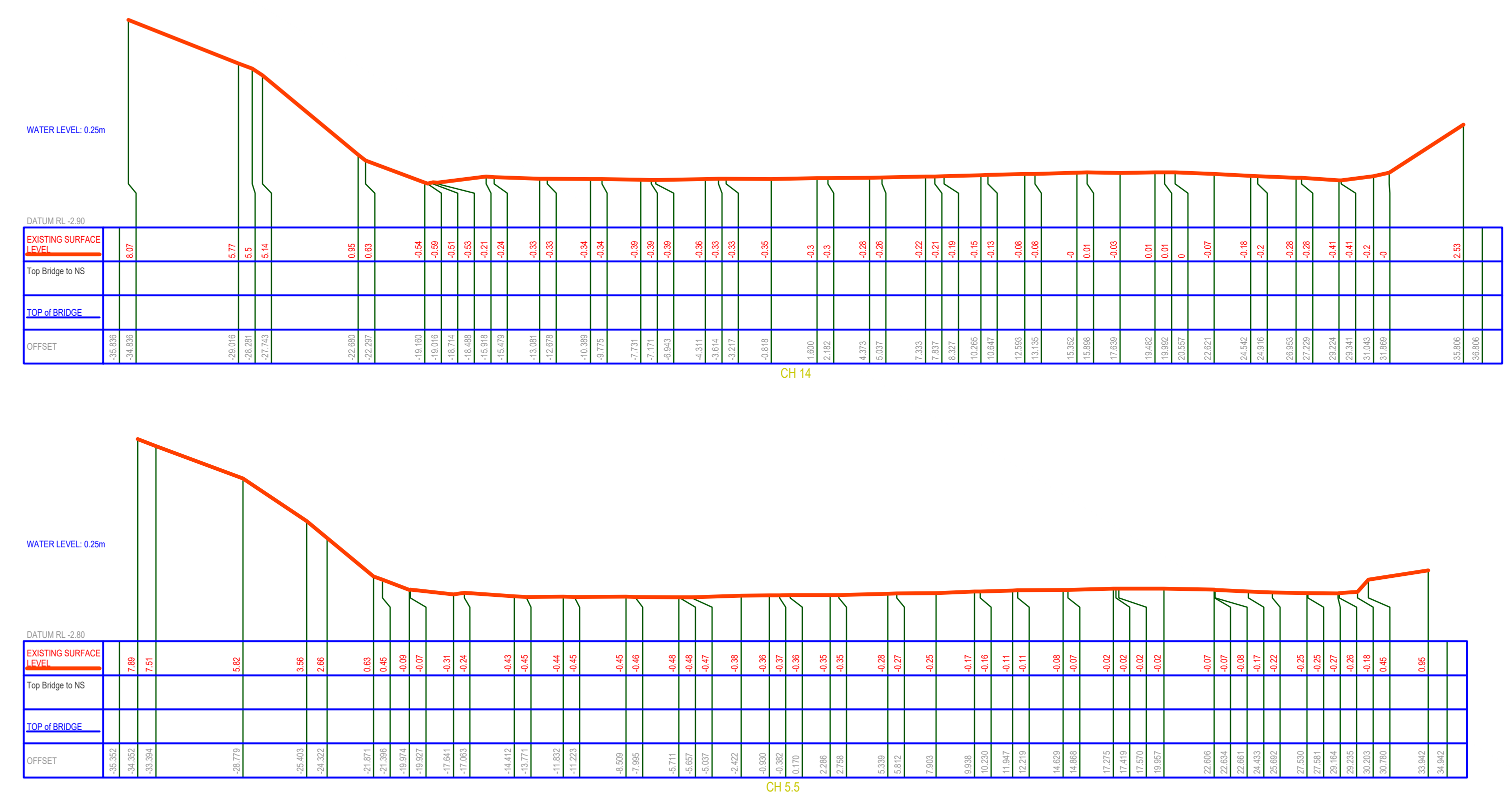
BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

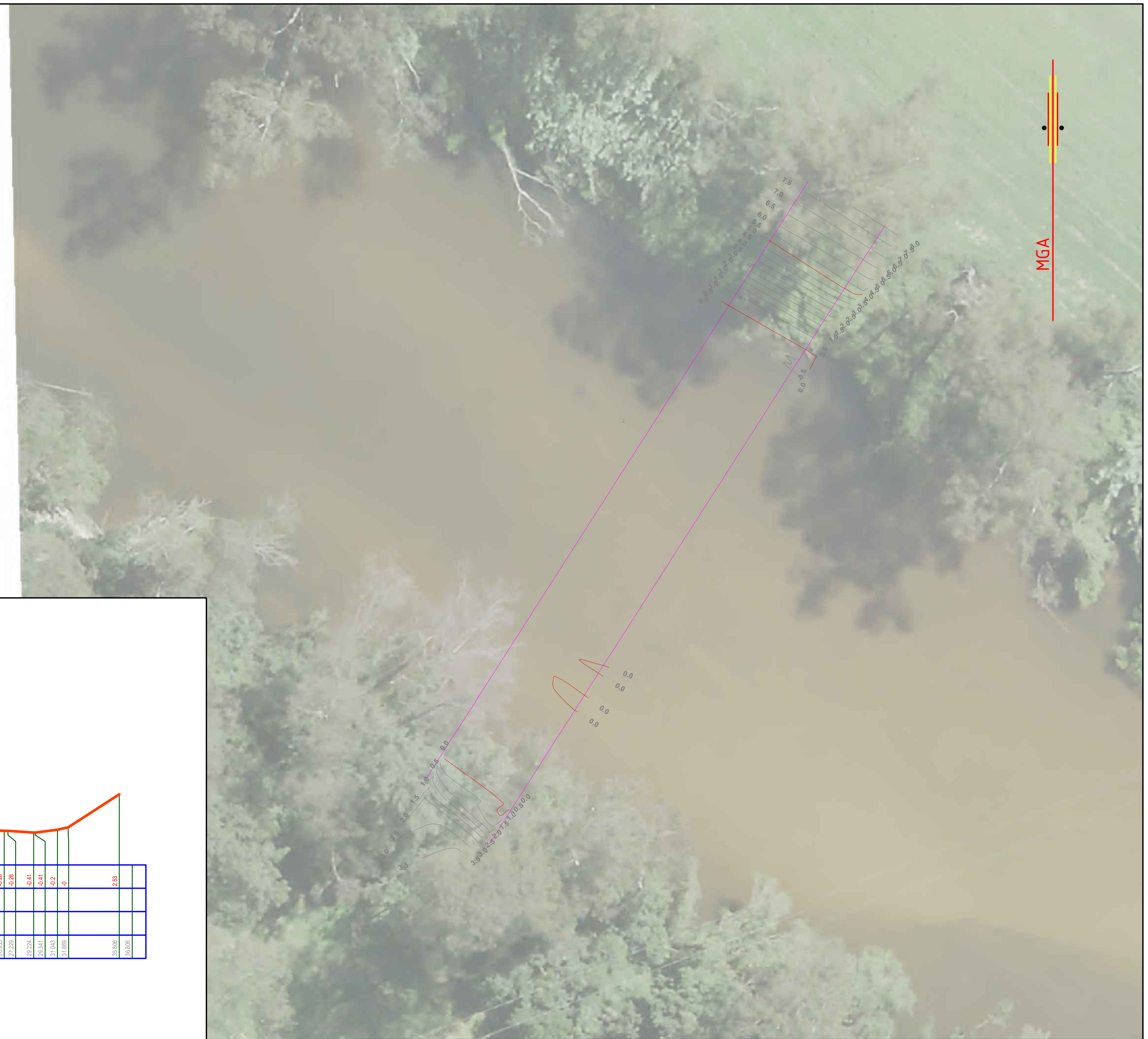
SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235
PLAN No. N1235-12
Sheet 1 of 1
SCALE: Scale 1 : 125 @ A3
REVISION: A

RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale





LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

NOTES:

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:500

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COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

B C E SPATIAL
LICENSED & ENGINEERING SURVEYING CONSULTANTS

MacDonald River and Colo River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235

PLAN No. N1235-13

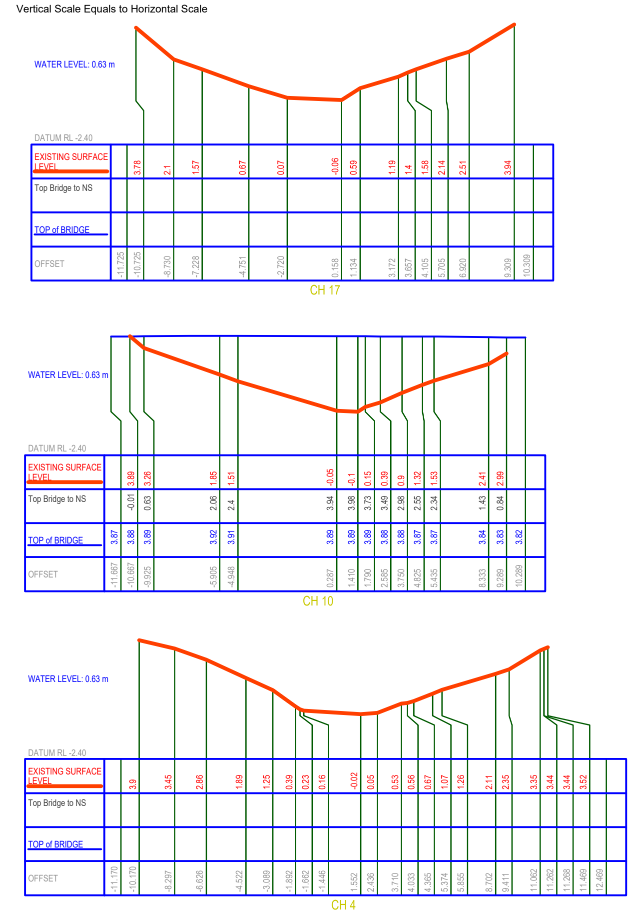
Sheet 1 of 1

SCALE: Scale 1 : 500 @ A3

REVISION: A

RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale



LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

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REV	DATE	DESCRIPTION	DRAWN	SURVEYOR	APPROVED
A	10/08/2023	Initial Issue	DN	MD	LM

CLIENT: Hawkesbury City Council

SCALE: 1:250

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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B C E SPATIAL
LICENSED & ENGINEERING SURVEYING CONSULTANTS

BCE SPATIAL

Wheeny Creek Survey
Hawkesbury,
New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

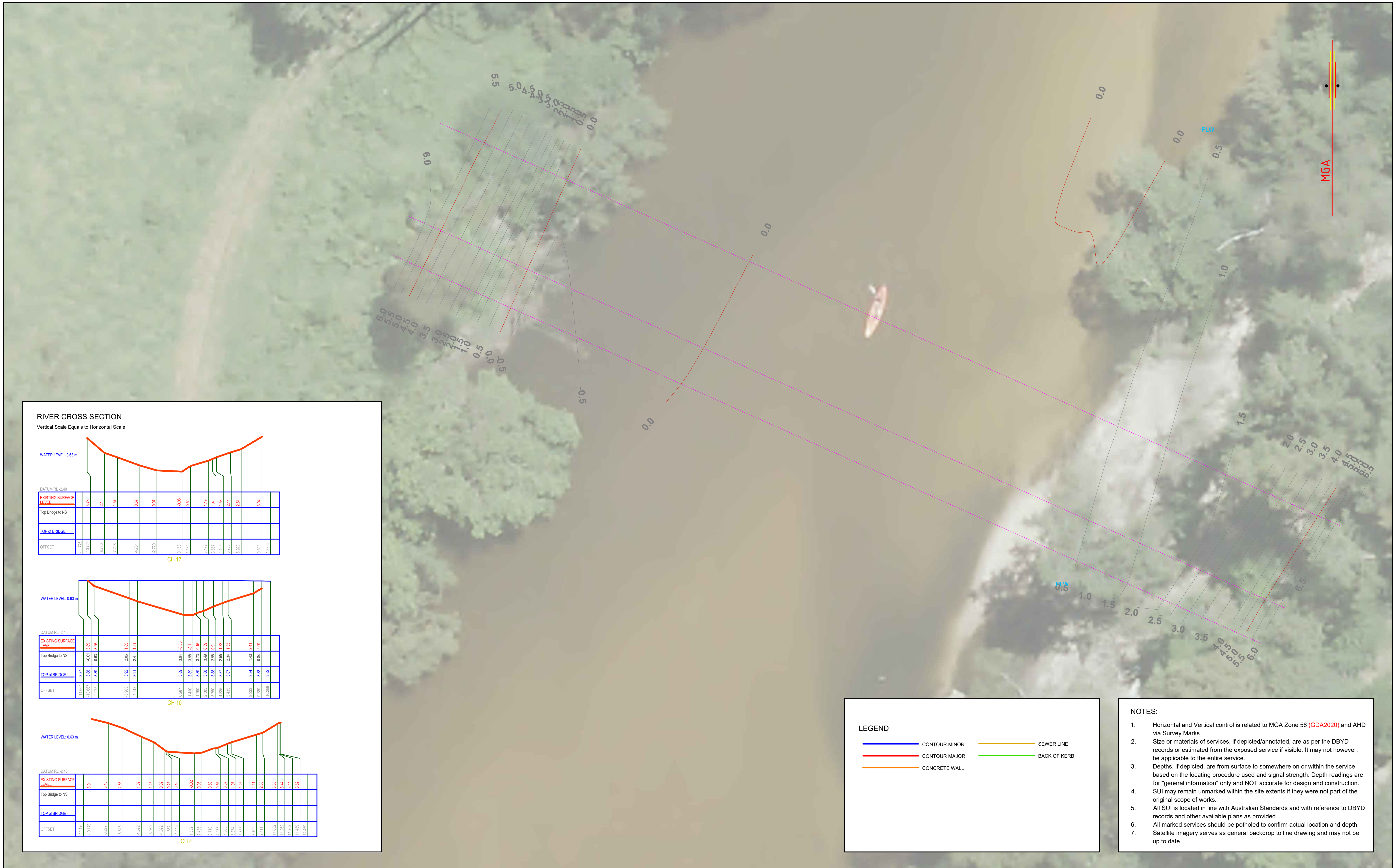
JOB No. N1235

PLAN No. N1235-14

Sheet 1 of 1

SCALE: Scale 1 : 250 @ A3

REVISION: A



RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale

WATER LEVEL: 0.63 m

DATUM RL -2.40

OFFSET	EXISTING SURFACE LEVEL	Top Bridge to NS	TOP of BRIDGE
-11.725			
-10.725	3.78		
-8.730	2.1		
-7.228	1.57		
-4.751	0.67		
-2.720	0.07		
0.158	-0.06		
1.134	0.59		
3.172	1.19		
3.657	1.4		
4.105	1.58		
5.705	2.14		
6.920	2.51		
9.309	3.94		
10.309			

CH 17

WATER LEVEL: 0.63 m

DATUM RL -2.40

OFFSET	EXISTING SURFACE LEVEL	Top Bridge to NS	TOP of BRIDGE
-11.667			3.87
-10.667	3.89	-0.01	3.88
-9.925	3.26	0.63	3.89
-5.905	1.85	2.06	3.92
-4.948	1.51	2.4	3.91
0.287	-0.05	3.94	3.89
1.410	-0.1	3.98	3.89
1.790	0.15	3.73	3.89
2.585	0.39	3.49	3.88
3.750	0.9	2.98	3.88
4.825	1.32	2.55	3.87
5.435	1.53	2.34	3.87
8.333	2.41	1.43	3.84
9.289	2.99	0.84	3.83
10.289			3.82

CH 10

WATER LEVEL: 0.63 m

DATUM RL -2.40

OFFSET	EXISTING SURFACE LEVEL	Top Bridge to NS	TOP of BRIDGE
-11.170			
-10.170	3.9		
-8.297	3.45		
-6.626	2.86		
-4.522	1.89		
-3.089	1.25		
-1.892	0.39		
-1.662	0.23		
-1.446	0.16		
1.552	-0.02		
2.436	0.05		
3.710	0.53		
4.033	0.56		
4.365	0.67		
5.374	1.07		
5.855	1.26		
8.702	2.11		
9.411	2.35		
11.062	3.35		
11.262	3.44		
11.268	3.44		
11.469	3.52		
12.469			

CH 4

LEGEND

- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE WALL
- SEWER LINE
- BACK OF KERB

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CLIENT: Hawkesbury City Council

SCALE: 1:250

COORDINATE DATUM
HORIZONTAL : MGA 2020 ZONE 56
VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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LICENSED & ENGINEERING SURVEYING CONSULTANTS

Colo River Survey Hawkesbury, New South Wales

JOB No. N1235

PLAN No. N1235-14

Sheet 1 of 1

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
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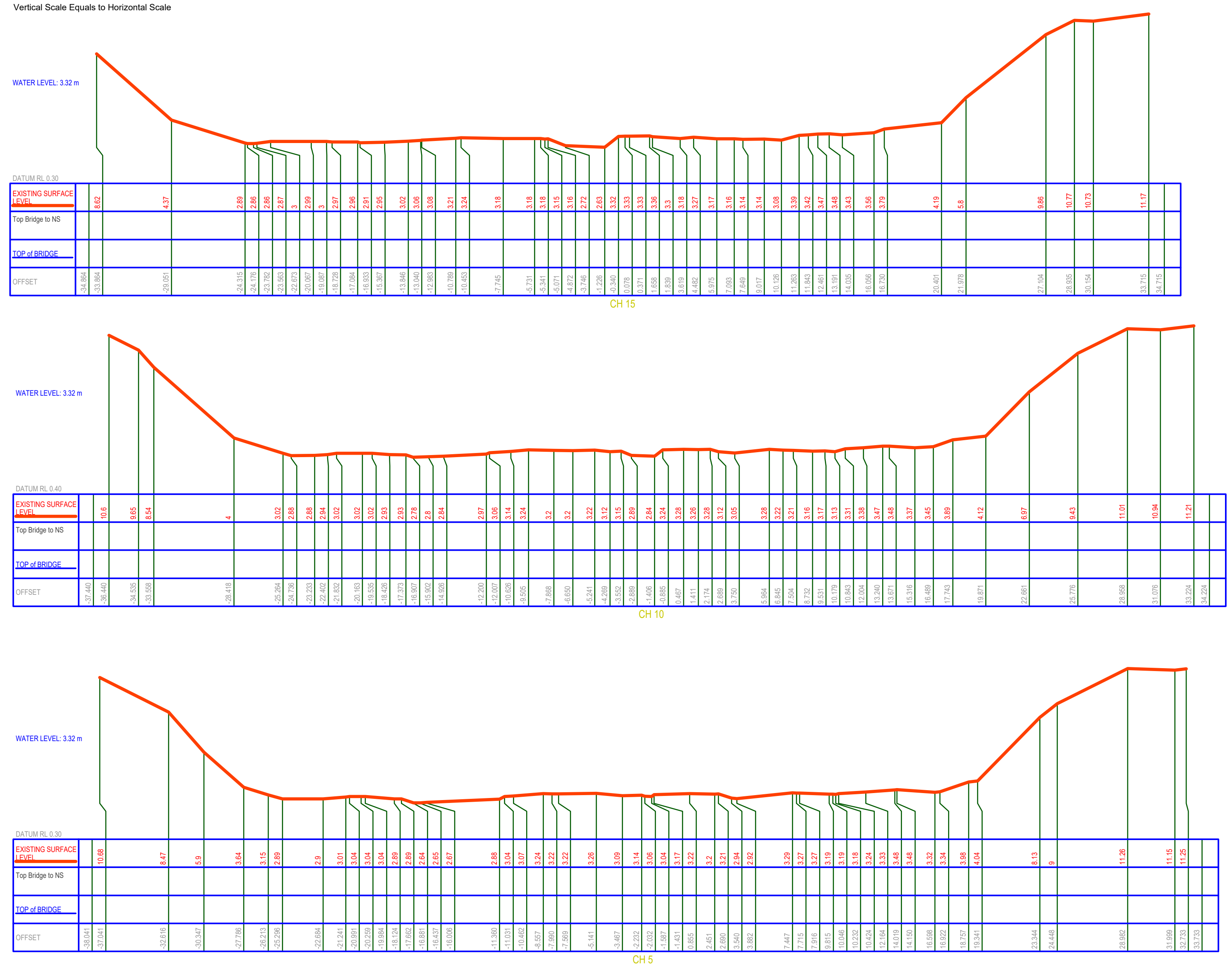
SCALE: Scale 1 : 250 @ A3

REVISION: A

RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale



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SCALE: 1:500

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VERTICAL : AHD 71
Contour Interval : 0.5 meter

NORTH POINT

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LICENSED & ENGINEERING SURVEYING CONSULTANTS

BCE SPATIAL

Colo River Survey Hawkesbury, New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

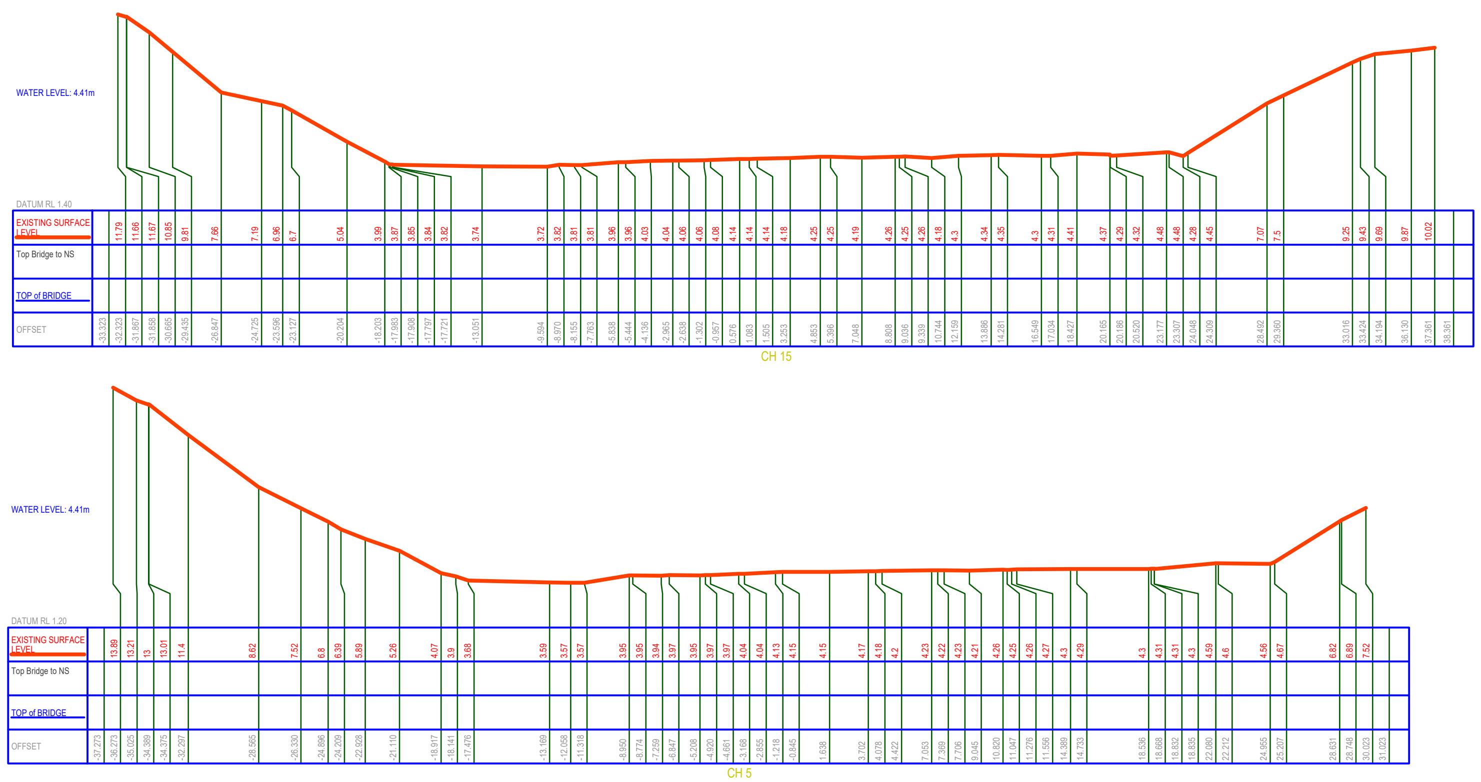
BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph (08) 9791 7411
Fax (08) 9791 9315
admin@bcesurveying.com.au

SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235
PLAN No. N1235-16
Sheet 1 of 1
SCALE: Scale 1 : 500 @ A3
REVISION: A

RIVER CROSS SECTION

Vertical Scale Equals to Horizontal Scale



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LICENSED & ENGINEERING SURVEYING CONSULTANTS

MacDonald River and Colo River Survey
Hawkesbury,
New South Wales

PERTH
9/7 KINTAIL ST
APPLECROSS WA 6153
Mobile: 0457 741 120
admin@bcesurveying.com.au

BUNBURY
24 MOLLOY STREET
BUNBURY WA 6230
Ph:(08) 9791 7411
Fax:(08) 9791 9315
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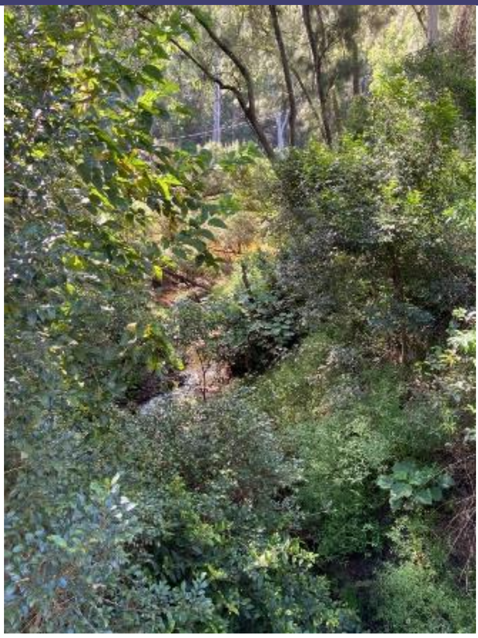
SYDNEY
Suite 3, 720 Old Princes Hwy
Sutherland NSW 2232
Mobile : 0428 617 411
admin@bcesurveying.com.au

JOB No. N1235
PLAN No. N1235-17
Sheet 1 of 1
SCALE: Scale 1 : 500 @ A3
REVISION: A

Appendix B

Site Inspection Photographs

Colo River 17/02/2022	
 Looking towards Upper Colo River Guage from Upper Colo Road	 Looking across to Upper Colo Reserve from Upper Colo Road
 Culvert beneath Upper Colo Road connecting tributary to Upper Colo River	 Looking North from Upper Colo Road

Colo River 17/02/2022	
 Looking down at damaged Upper Colo Bridge from Colo Heights Road	 Upper Colo Bridge. Damaged by flooding in 2021
 Tributary leading north to Upper Colo River from Upper Colo Road	 Looking north from Bielany Campground across mid-Colo River

Colo River 17/02/2022	
 Putty Road Bridge, looking upstream	 Looking west across Lower Colo River from Lower Colo Road
 Looking north towards Whatleys Creek, a tributary of lower Colo River	 Looking north across lower Colo River floodplain

Colo River 17/02/2022	
 Looking east at the Colo River from Lower Colo River Road across from Hebron Farm	 Looking west at Greens Road Bridge from the confluence of Colo and Hawkesbury Rivers

Macdonald River 18/02/2022	
 Looking upstream from Upper MacDonald Road Bridge towards Macdonald Inflow	 Looking upstream from bridge at intersection of Upper MacDonald Road and Kander Road
 Looking downstream from bridge at intersection of Upper MacDonald Road and Kander Road	 Looking south from Wollombi Road at Mago Creek