NEILLY GROUP ENGINEERING

HANSEN ENVIRONMENTAL CONSULTING

DAWSON SOUTH MINE

FLOOD ASSESSMENT REPORT

MARCH 2024

Document Control

Details and distribution

	Details
Document Title	Hansen Environmental Consulting Dawson South Mine Flood Assessment Report
Revision Number	2
Project Reference	23098
Author(s)	Brett Twycross
Distribution	Rebecca Miller (Hansen Environmental Consulting) Peter Hansen (Hansen Environmental Consulting)
Citation	Neilly Group Engineering, 2023. *Hansen Environmental Consulting Dawson South Mine Flood Assessment Report*, prepared by Neilly Group Engineering for Hansen Environmental Consulting

Revision History

Revision	Date	By	Nature of change	Checked By	Approved By
1	27/10/2023	Brett Twycross	Original issue	Sarah Bloom	Brett Twycross
2	5/03/2024	Sarah Bloom	Update of figures and referencing details	Brett Twycross	Brett Twycross

Table of Contents

Figures

Tables

Acronyms

Acronym	Meaning
AEP	Average Exceedance Probability
AHD	Australian Height Datum
ARR	Australian Rainfall & Runoff
DEM	Digital Elevation Model
DES	Department of Environment and Science
FFA	Flood Frequency Analysis
PMP	Probable Maximum Precipitation
SRTM	Shuttle Relay Topography Mission

1 Introduction

Neilly Group Engineering was engaged by Hansen Environmental Consulting to undertake flood modelling and reporting for pre-development conditions at Dawson South Mine for the 0.1% Annual Exceedance Probability (AEP) design flood event. An overview of the area of interest is shown in Figure 1.

The modelling of the pre-development 0.1% AEP design flood event, which has been developed using Australian Rainfall and Runoff (2019), is consistent with Section 41C of the Environmental Protection Regulation 2019 and the Department of Environment and Science (DES) Information sheet Voids in flood plains (ESR/2019/4966 – 11 March 2020).

1.1 Scope of works

The scope of works for this project is as follows:

- Hydrologic modelling for the 0.1% AEP design flood event.
- 2D hydrodynamic flood modelling for pre-development conditions for the 0.1% AEP design flood event.
- Prepare a standalone Flood Modelling Report including a detailed description of the hydrology and flood modelling methodology to develop the pre-development 0.1% AEP flood extent map.
- Hydrology, flood modelling and reporting consistent with the following guidelines/ documentation:
    - Environmental Protection Regulation 2019 (Section 41C)
    - DES Information sheet Voids in flood plains (ESR/2019/4966 – 11 March 2020)
    - Australian Rainfall and Runoff: A Guide to Flood Estimation, 2019.

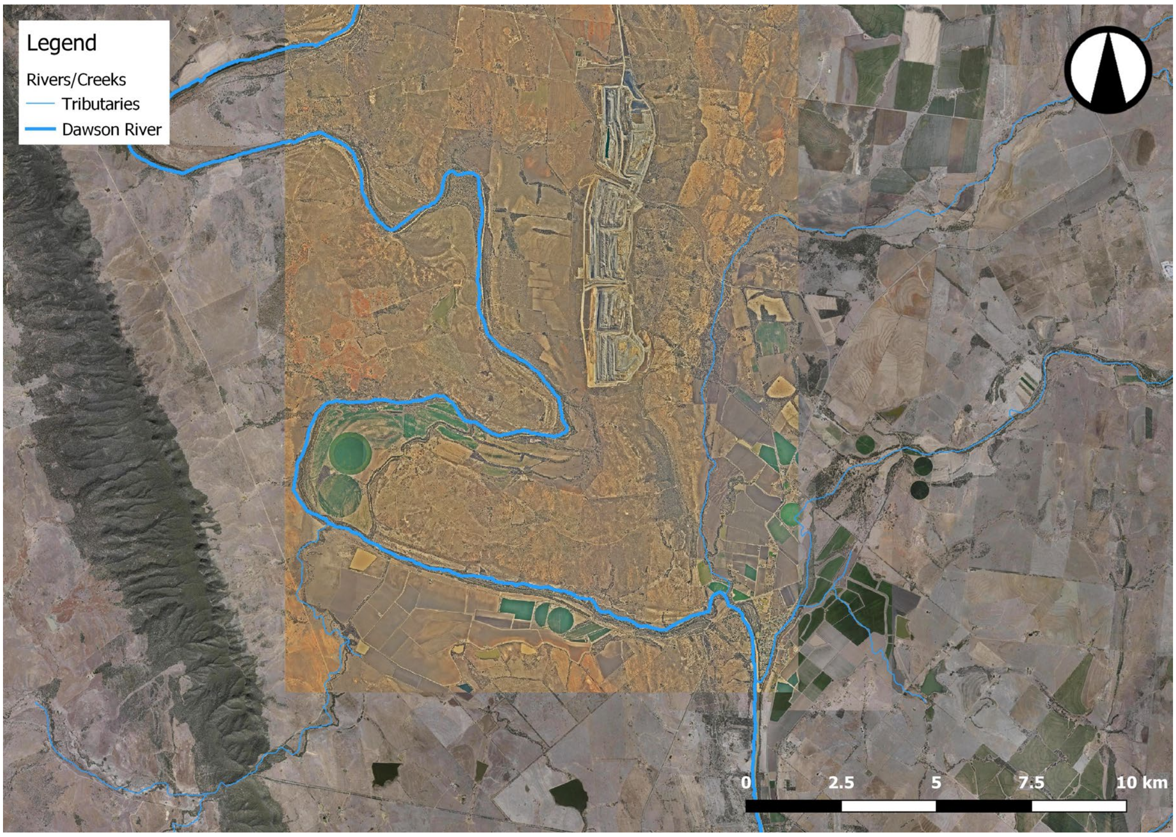

Figure 1. Overview of Dawson South Mine and surrounds

2 Hydrology

Detailed hydrologic modelling was undertaken for the Dawson River catchment to develop hydrographs for input into the Dawson South Mine 2D hydrodynamic flood model. The hydrologic modelling has been developed using Australian Rainfall and Runoff (2019).

The adopted peak design flow rate for the Dawson River at the Woodleigh gauging station located downstream of Dawson South Mine is shown in Table 1.

Table 1. Adopted peak design flow estimate for Dawson River at Woodleigh

Annual Exceedance Probability (AEP)	Peak flow estimate (m^3/s)
0.1%	10,598

Further details for the hydrologic modelling, including the calibration process, are presented in detail in Attachment A.

3 Flood modelling results

The flood model, the development of which is described in further detail in Attachment B, was used to determine the pre-development 0.1% Annual Exceedance Probability (AEP) design flood extent for the area surrounding Dawson South Mine. The flood modelling undertaken for this study is consistent with Section 41C of the Environmental Protection Regulation 2019 and the DES Information sheet Voids in flood plains (ESR/2019/4966 – 11 March 2020).

The range of depths and water surfaces are in the vicinity of Dawson South Mine are presented in Table 2 and Figure 2.

Table 2. Range of depth and water surface elevation near Dawson South Mine (0.1% AEP design flood)

Characteristic	Minimum	Maximum
Depth (m)	0 (edge of flood plain)	19 (centre of river)
Water Surface Elevation (m AHD)	135 (downstream)	144 (upstream)

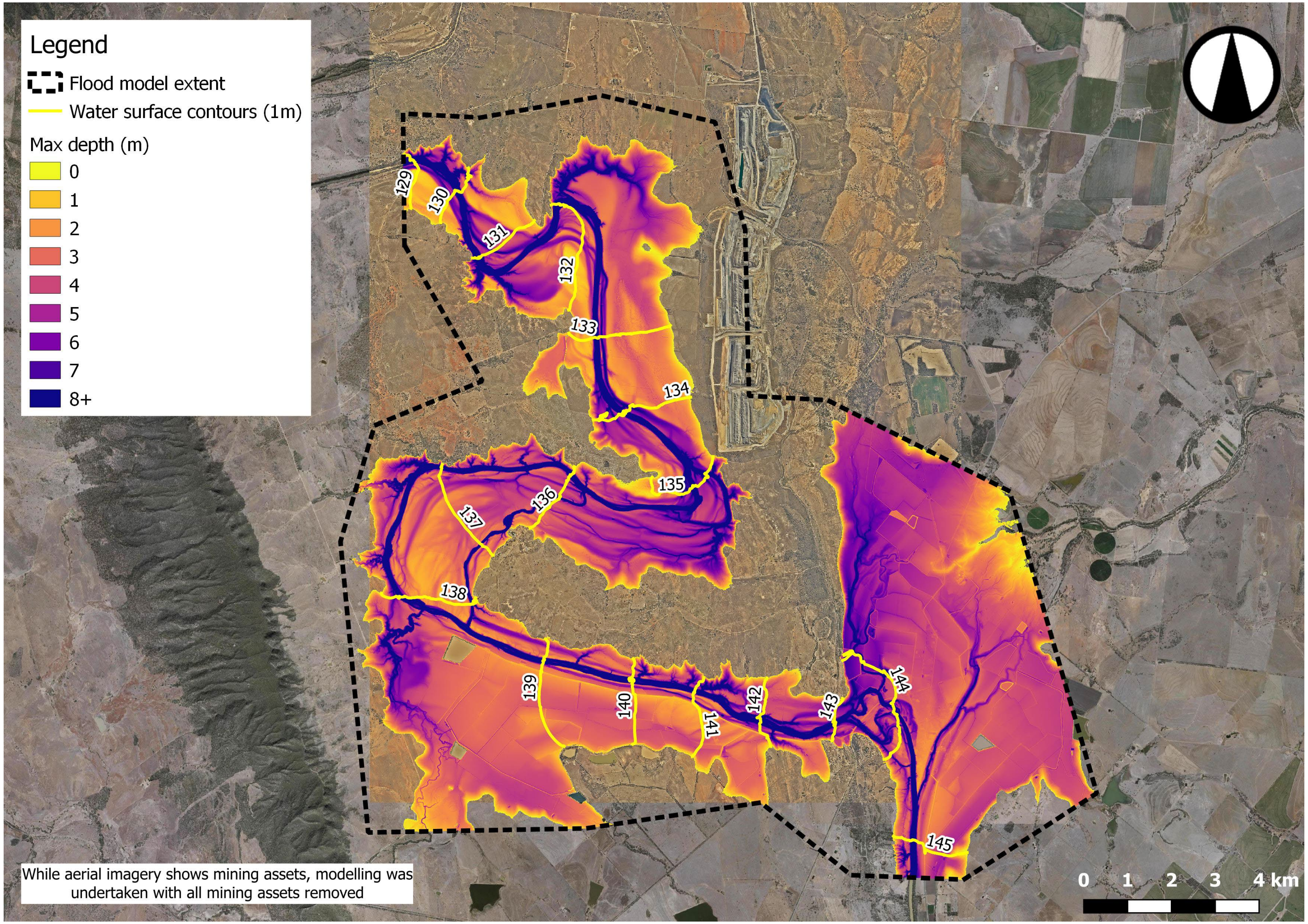

Figure 2. Dawson South Mine Pre-development conditions – 0.1% AEP design flood depths

4 References

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, *Elevation Information System (ELVIS)*, http://elevation.fsdf.org.au/.

KBR (2016), *Dawson River Flood Study Stage 2 Hydrological Assessment Report*, Report by Kellogg Brown & Root Pty Ltd for Banana Shire Council

Attachment A: Hydrology

Hydrology

Overview

Hydrographs were developed for the Dawson River for design flood events up to and including the 0.1% Annual Exceedance Probability (AEP) using Australian Rainfall and Runoff (2019). Note, that for this project, only the 0.1% AEP is directly relevant to the scope of work and is the only design event referred to in the main body of this report.

The estimates have been derived from a calibrated rainfall runoff model. The model was calibrated against four major flood events recorded at the streamflow gauges at Woodleigh (#130317). The resulting design estimates were further refined to account for uncertainty in extrapolating beyond the magnitude of the calibration events.

Catchment delineation

The catchment model was built upon the Shuttle Relay Topography Mission (SRTM) 1 arcsecond Digital Elevation Model (DEM) obtained from Geoscience Australia's Elevation Information System (ELVIS, http://elevation.fsdf.org.au/).

The resulting streamlines and boundaries of the catchment are shown in Figure 3. The outlet of the catchment was set on the Dawson River, 45km north northwest of Dawson South Mine. As delineated for this assessment, the catchment area is 29,185 km^2.

Initial hydrologic model setup

The parameters developed for the initial run of the uncalibrated model are listed in Table 3. The resulting peak design flow rate estimates are presented in Table 4.

Table 3. Hydrologic model parameters

Design event (AEP)	# of sub-catchments	K_c value	m value	Initial loss (mm)	Continuing loss (mm/hr)
Up to 1%	57	202.2	0.8	36.0	2.20
0.1%				8.26	1.81

The K_c value for the catchment was derived using the Weeks equation listed in Chapter 6 of Book 7 of Australian Rainfall and Runoff (ARR 2019). The Weeks equation takes the form of:

$$K_c=0.88A^{0.53}$$

Where A is the catchment area in square kilometres.

Table 4. Preliminary peak design flow rates for Dawson River at Woodleigh

	Batch run		Monte Carlo run	
AEP	**Peak flow estimate (m^3/s)**	**Critical duration**	**Peak flow estimate (m^3/s)**	**Critical duration**
10%	3,309	36 hours	2,927	36 hours
5%	4,536	36 hours	4,659	24 hours
2%	7,289	24 hours	7,275	24 hours
1%	9,559	24 hours	N/A	-
0.1%	24,770	36 hours	N/A	-

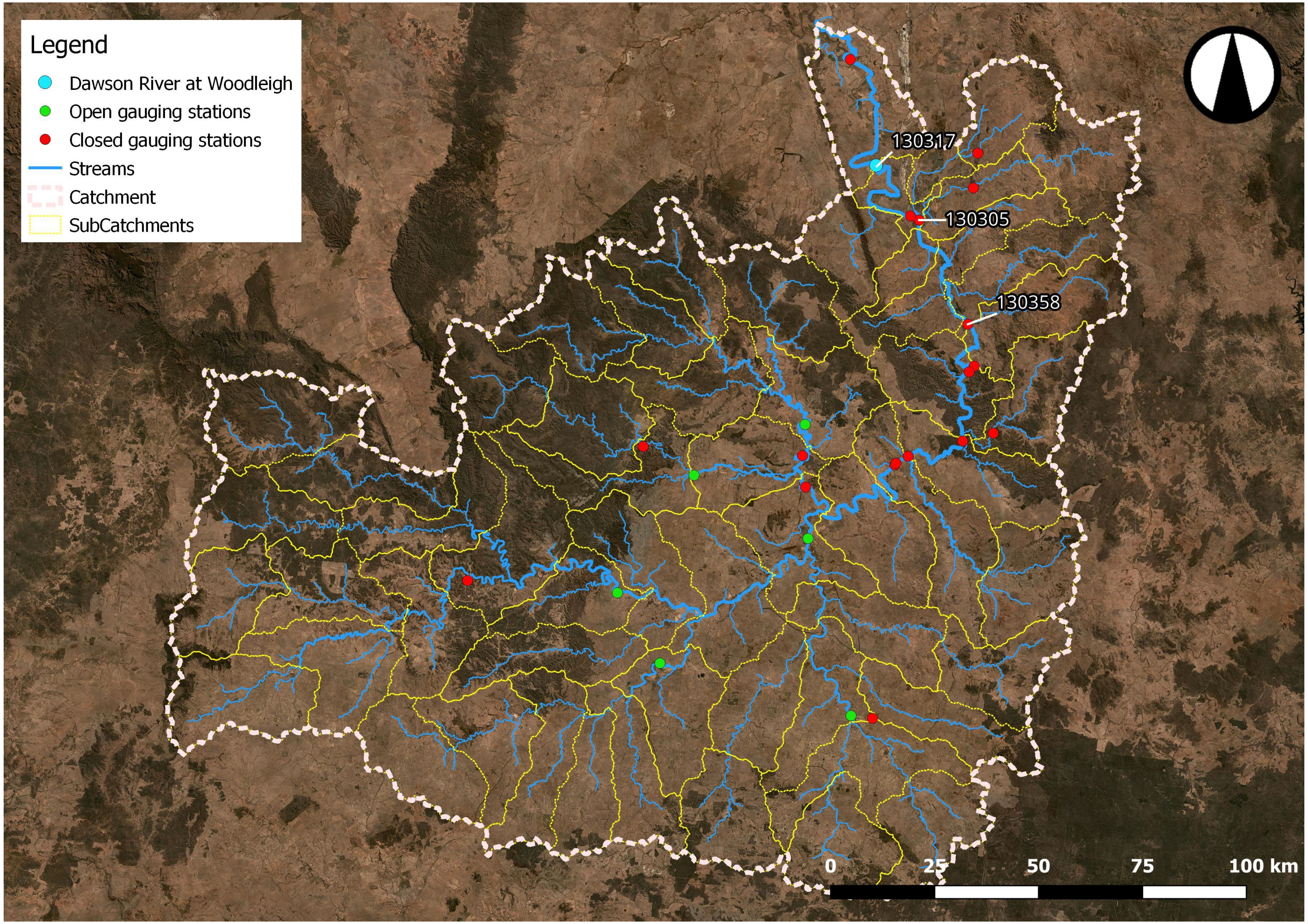

Figure 3. Dawson River catchment showing sub catchments, rivers and creeks

Flood frequency analysis

Flood Frequency Analysis (FFA) was undertaken for suitable gauges near Dawson South Mine. Three gauges were selected and are summarised in Table 5.

Table 5. Streamflow gauging stations on Dawson River near Dawson South Mine

Gauge #	Name	Location	Duration of records
130317	Dawson River at Woodleigh	Approximately 10km downstream of Dawson South Mine	Open since 1957
130305	Dawson River at Theodore	Approximately 5km upstream of Dawson South Mine	1924 - 2002
130358	Dawson River at Isla-Delusion Crossing	Over 30km upstream of Dawson South Mine	1993 - 2002

As shown in Table 6, there was some variation in the FFA outputs derived for each station however due to the differing duration of records and the events captured at each station, the records corelated sufficiently to have confidence in using the data from the Dawson River at Woodleigh station (#130317).

Table 6. FFA of stream flow gauging data from stations near Dawson South Mine

	Peak flow estimate (m^3/s)		
AEP	# 130317	# 130305	# 130358
10%	1,121	1,566	975
5%	1,653	2,151	1,302
2%	2,640	3,103	1,811
1%	3,691	3,997	2,267

Previous flood studies

KBR undertook the Dawson River Flood Study in 2016 (KBR, 2016) for the Banana Shire Council. The assessment included detailed hydrologic and flood modelling of Theodore, and the reach of the Dawson River extending downstream to include the area adjacent Dawson South Mine.

KBR undertook flood modelling, using calibrated hydrology, for the 10%, 5%, 2%, 1%, 0.2% and 0.05% AEP design flood events in addition to the Probable Maximum Precipitation (PMP) flood event (see Table 7).

Comparison of uncalibrated design flood peak estimates

Table 7 includes a comparison of the peak design flood estimates derived from the uncalibrated hydrologic model with estimates from KBR (2016) and an FFA undertaken with the data from the Dawson at Woodleigh gauging station (# 130317). The preliminary estimates, derived through hydrologic modelling, are significantly higher than the other estimates and demonstrates the need to calibrate the model. Designs developed from the uncalibrated hydrology would be significantly overestimated.

Table 7. Comparison of preliminary design peak flood estimates against external estimates

	Peak flow estimate (m^3/s)			
AEP	Preliminary Batch Run	Preliminary Monte Carlo Run	KBR (2016)	FFA (# 130317)
10%	3,309	2,927	1,572	1,121
5%	4,536	4,659	2,319	1,653
2%	7,289	7,275	3,789	2,640
1%	9,559	N/A	4,972	3,691
0.1%	24,770	N/A	7,830*	-

* Interpolated from the 0.2% and 0.05% AEP peaks

Model Calibration

Major flood events were identified from stream flow gauging records at the Dawson River at Woodleigh station site (# 130317). Data was then collected from rainfall and pluviograph stations in the catchment to facilitate the calibration of the hydrologic model.

Event selection

The five largest events were selected from the stream flow records at station #130317 as is shown in Figure 4.

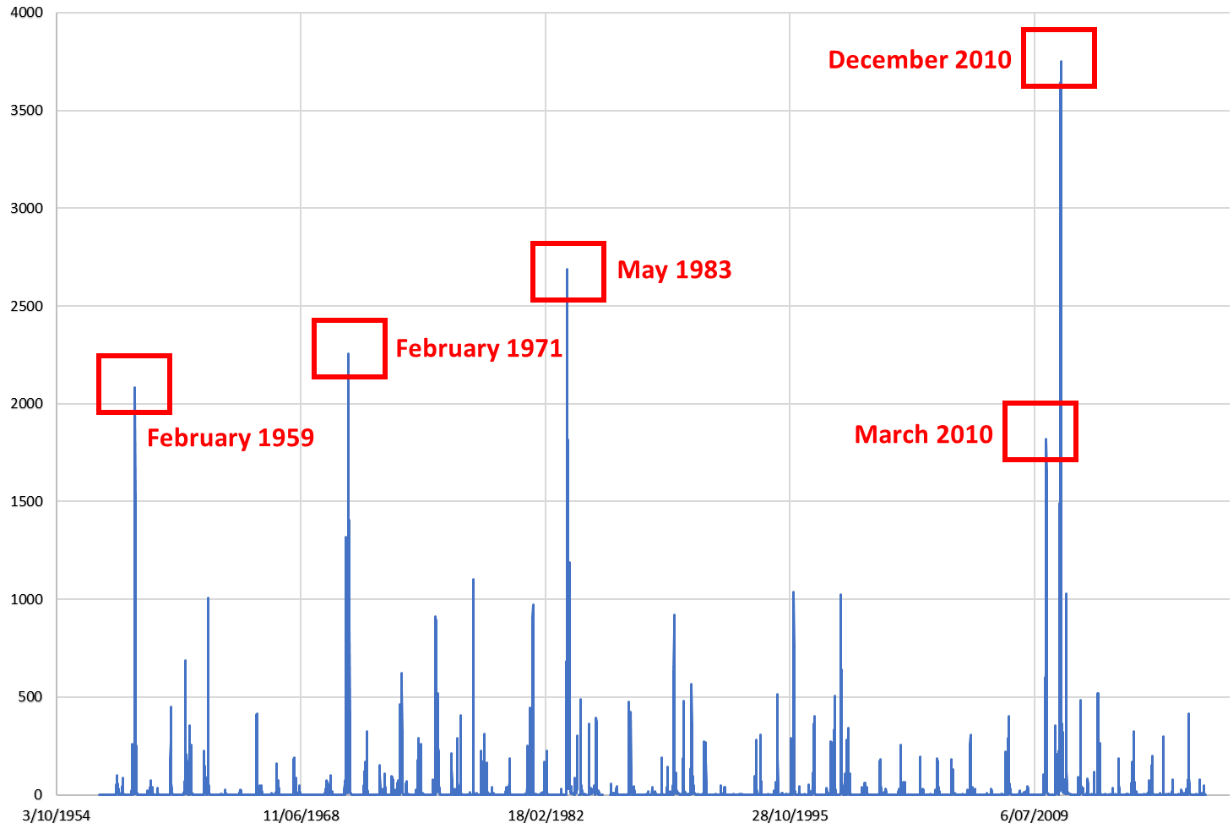

Figure 4. Flood events selected from streamflow gauging records at Station #130317

The events are summarised in Table 8. Note that, due to the lack of sub-daily rainfall data for the 1959 event, this event was discarded, leaving four events suitable for calibration.

Table 8. Major flood events recorded at Dawson River at Woodleigh (#130317)

Event	Peak (m^3/s)	Pluviograph station data	Daily rainfall station data	Comment
February 1959	2,083	0 stations	N/A	Discarded event
February 1971	2,256	2 stations	188 stations	
May 1983	2,691	8 stations	173 stations	
March 2010	1,820	5 stations	120 stations	
December 2010	3,751	8 stations	121 stations	

The following figures depict the rainfall distribution and available sub-daily rainfall data across the Dawson River catchment for 1971 (Figure 5), 1983 (Figure 6) and the two 2010 events (Figure 7 for March and Figure 8 for December).

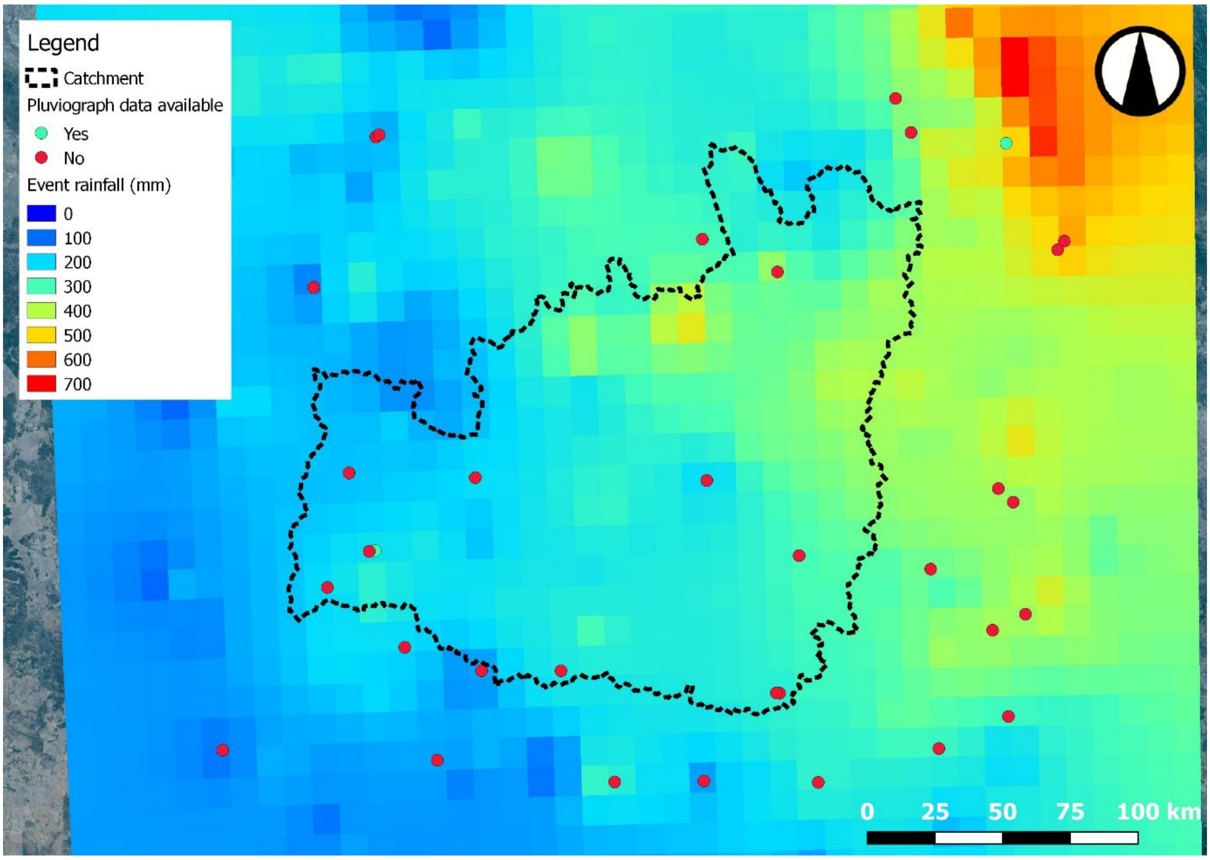

Figure 5. Rainfall data used to calibrate February 1971 flood event

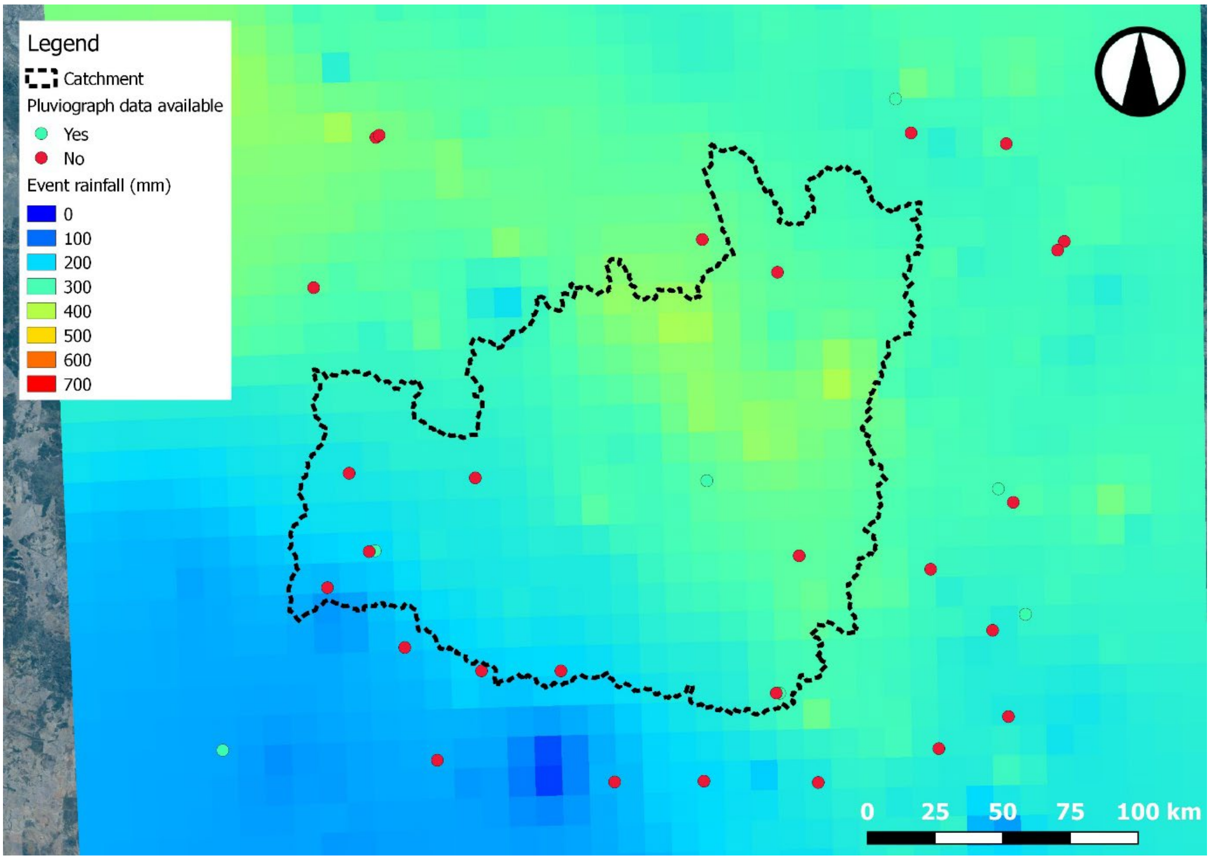

Figure 6. Rainfall data used to calibrate May 1983 flood event

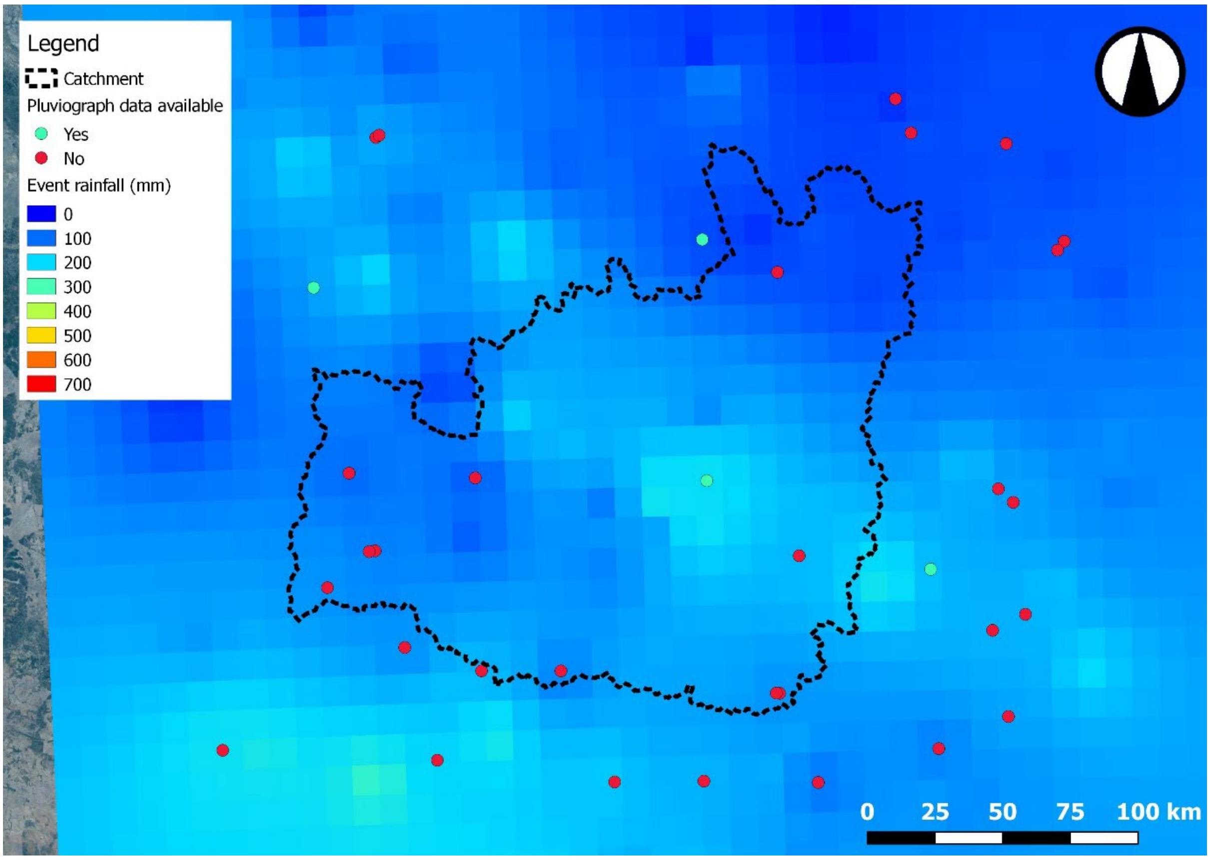

Figure 7. Rainfall data used to calibrate March 2010 flood event

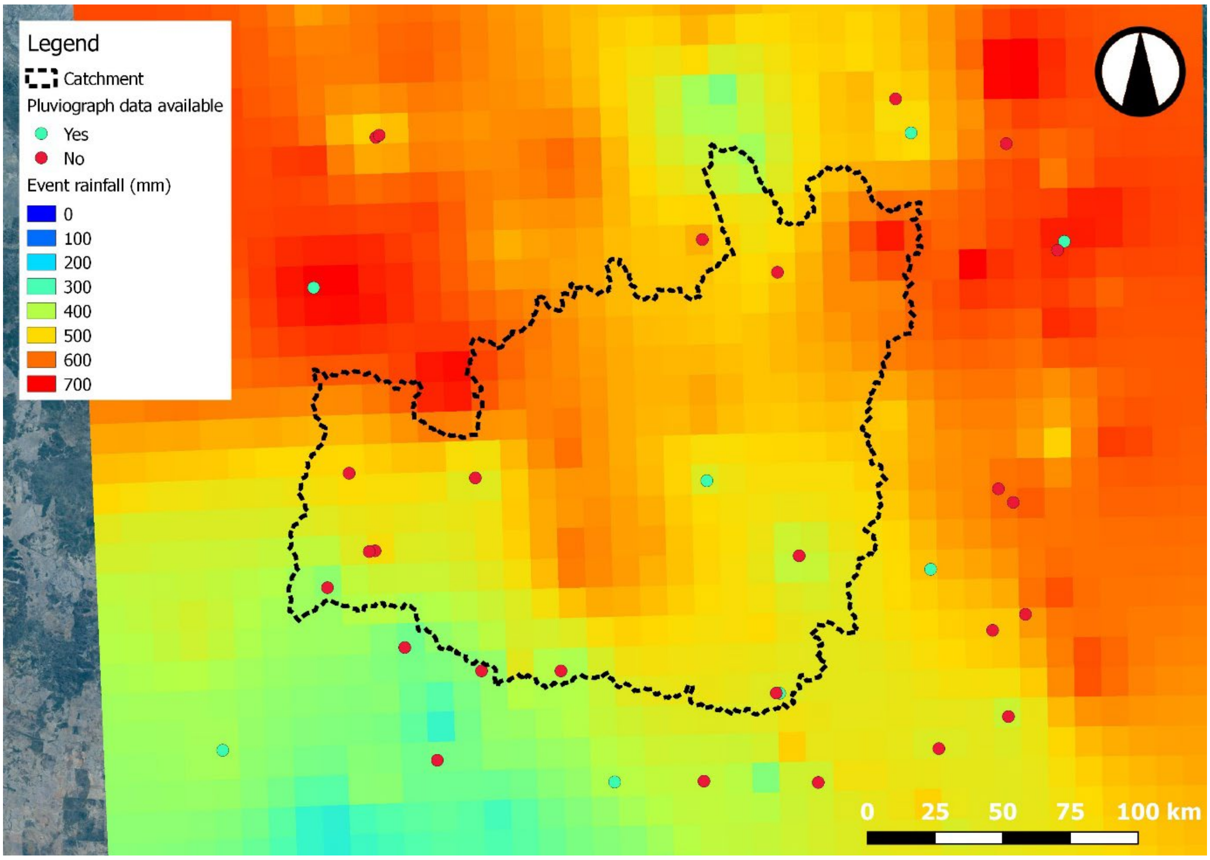

Figure 8. Rainfall data used to calibrate December 2010 flood event

Catchment storage

Before commencing the calibration process, an assessment was conducted on the storages within the catchment to identify any factors that could potentially undermine the reliability of the results. Three major storages were identified on the Dawson River upstream of Dawson South Mine (refer to https://storagelevels.sunwater.com.au/win/reports/win_storages.htm), as outlined in Table 9, and compared to the flood event runoff volumes summarised in Table 10.

Table 9. Major storages on Dawson River upstream of Dawson South Mine

Event	Volume (ML)
Theodore Weir	4,760
Glebe Weir	17,706
Gyranda Weir	16,499
Total	38,965

Table 10. Major flood event volumes

Event	Event runoff volume (ML)	Storage volume % of event, assumed empty
February 1971	1,570,000	2.5%
May 1983	1,960,000	2.0%
March 2010	1,230,000	3.2%
December 2010	5,250,000	0.7%

Due to the relatively small storage volume, when compared to the flood volumes, the modelling was not adjusted to account for storage.

Event calibration

Using the daily rainfall, pluviograph (sub-daily) rainfall and the streamflow gauging data, the hydrologic model was calibrated to the four major flood events (see Table 11).

Table 11. Parameters to achieve calibration for the four major flood events

Event	Kc	m	Initial loss	Continuing loss	Comment
February 1971	590	0.8	70mm and 80mm	2.94 and 3.38mm/hour	Event separated into two bursts. Refer to Figure 9
May 1983	610	0.8	100mm	4.39mm/hour	Refer to Figure 10
March 2010	680	0.8	200mm	25.03mm/hour	Low confidence in calibration Refer to Figure 11
December 2010	550	0.8	100mm	3.33mm/hour	Refer to Figure 12

Overall, the calibration yielded reasonable results, except for the March 2010 event which required very high losses to achieve a similar volume to the streamflow records and also required the highest Kc value to bring the peak down to match the records.

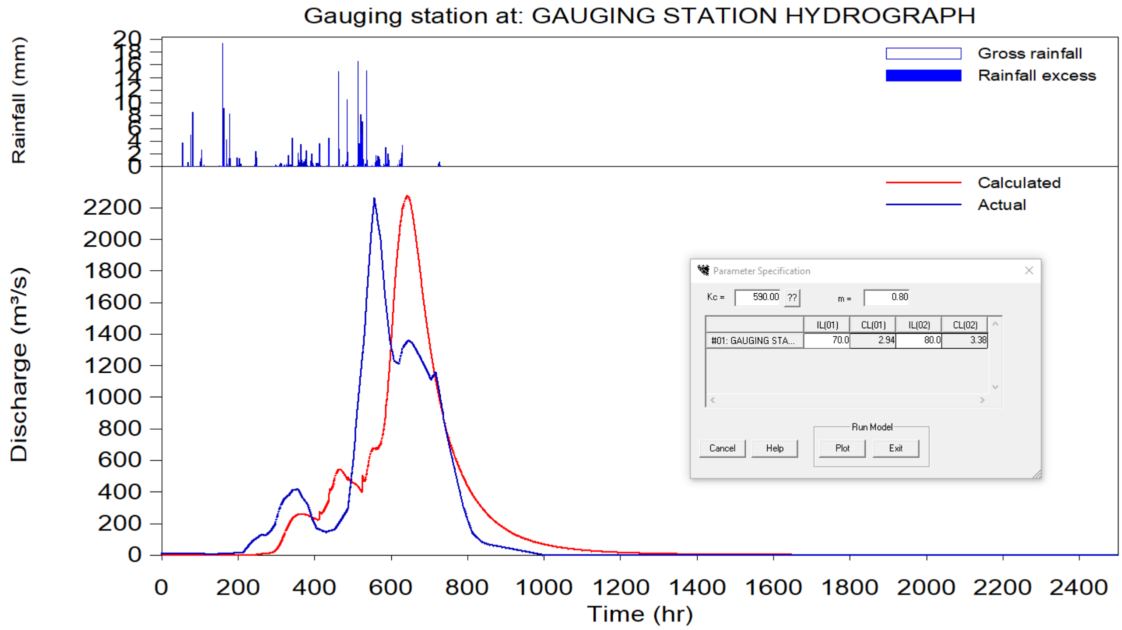

Figure 9. Calibration of February 1971 flood event

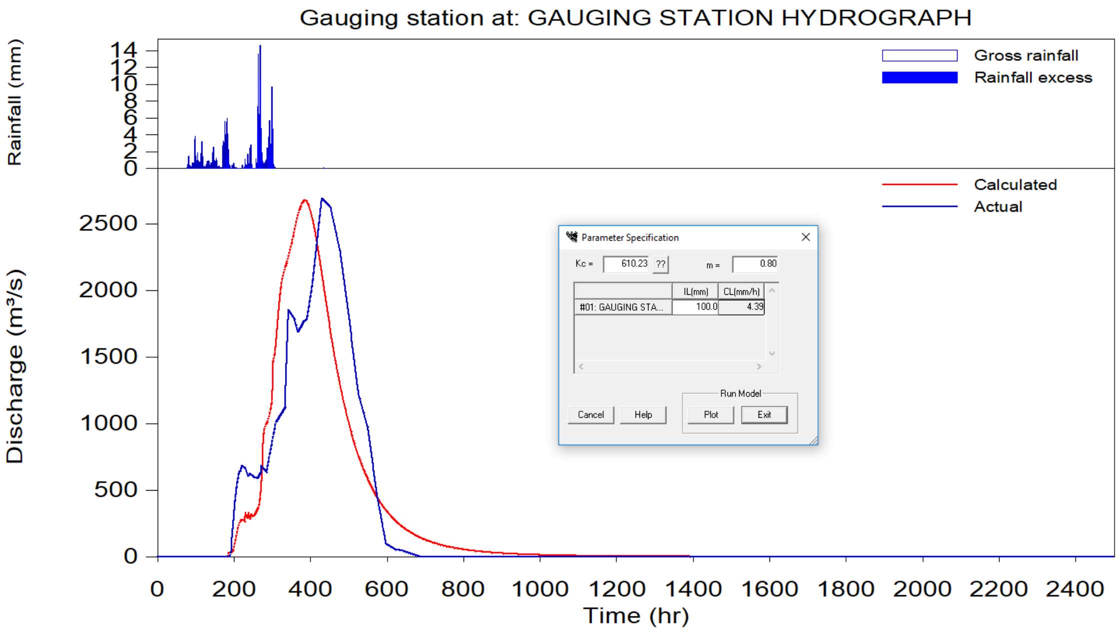

Figure 10. Calibration of May 1983 flood event

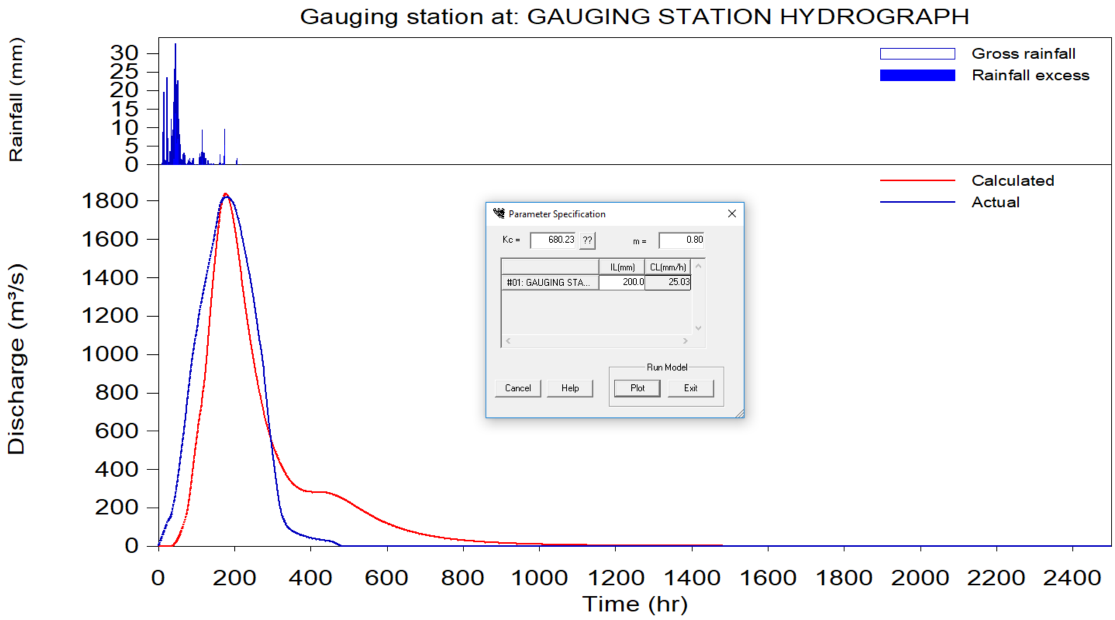

Figure 11. Calibration of March 2010 flood event

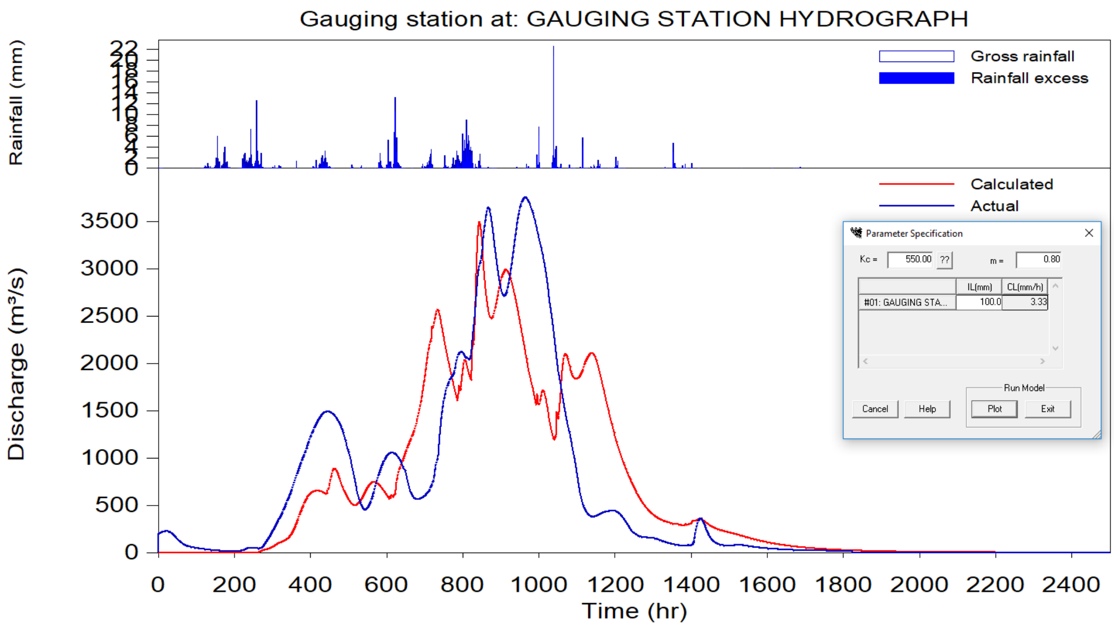

Figure 12. Calibration of December 2010 flood event

Following the calibration process, it was decided to adopt a preliminary Kc value of 550 (with m set to 0.8). The Kc value is the lowest of the three calibration events in which there is confidence in the estimates.

Design Model

Using ARR (2019), design rainfall inputs were developed to apply to the calibrated hydrologic model.

Design rainfall

ARR (2019) design rainfall for the Dawson River catchment is presented in Table 12.

Table 12. Rainfall depths for Dawson River catchment

Duration	AEP %				
Duration	10%	5%	2%	1%	0.1%
1 hour	55.8	65.3	78.5	89.1	121
3 hours	73.8	86.8	105	120	162
6 hours	86.4	102	122	140	188
12 hours	102	119	143	162	218
24 hours	123	142	169	191	258
36 hours	137	158	188	211	296
48 hours	148	171	202	227	319
72 hours	164	188	223	250	344
96 hours	174	200	237	265	358
120 hours	181	208	246	274	366
144 hours	185	213	251	280	372
166 hours	188	216	254	282	377

Design losses

The design loss values are presented in Table 3. For events up to and including the 1% AEP, the value is specified directly by ARR (2019). For the 0.1% AEP the losses were interpolated using the method outlined in section 4.3.2.2 in Book 8 of ARR (2019).

Temporal pattern

The areal East Coast North temporal patterns were applied to the hydrologic model to temporally vary the rainfall inputs.

Design peak flow rates

Using the inputs discussed above, the peak design flow rates were determined and are presented in Table 13. Overall, the peak flow estimates for events up to the 1% AEP were low when compared to KBR (2016) and the FFA for Dawson River at Woodleigh. It was decided to lower the Kc value from 550 to 450 to lift the estimates to provide a better fit up to the 1% AEP, see Table 14. It should be noted that the calibrated model already yielded a peak flow estimate for the 0.1% AEP design flood event which was greater than the interpolated value from KBR (2016) and that lowering the Kc value further increases the difference, however, due to the considerable uncertainty in extrapolating the peak flow estimates, it was decided to adopt this approach.

Table 13. Comparison of calibrated design peak flood estimates against preliminary and external estimates

	Peak flow estimate (m^3/s)			
AEP	**Preliminary Batch Run**	**Calibrated Batch Run**	**KBR (2016)**	**FFA (# 130317)**
10%	3,309	**988**	1,572	1,121
5%	4,536	**1,387**	2,319	1,653
2%	7,289	**2,373**	3,789	2,640
1%	9,559	**2,899**	4,972	3,691
0.1%	24,770	**8,366**	7,830	-

Table 14. Adopted design peak flow estimates for Dawson River at Woodleigh

AEP	Peak flow estimate (m^3/s)
10%	1,266
5%	1,774
2%	2,987
1%	3,713
0.1%	10,598

Attachment B: Flood model configuration

Flood model configuration

The layout of the flood model is depicted in Figure 13. The key details for the flood model are presented in Table 15.

Table 15. Flood model details

Parameter	Detail
Software version	TUFLOW 64bit, version 2020-10-AA (the latest version at the time the modelling was undertaken). The "HPC GPU" solution scheme was used.
Terrain model	The terrain model was developed from the 20 July 2019 LiDAR survey flown by AAM and provided to Neilly Group Engineering on 7 August 2019.
Model area	200.3km^2
Cell size	The topography was represented using a 10-metre cell size. The size was sufficiently small to depict the key features in the catchment without requiring modification to better represent the terrain.
Hydrology	The hydrologic inputs developed for the 2D model are discussed in Attachment A. The input locations are depicted in Figure 13.
Manning roughness	The Manning's roughness values applied across the model are depicted in Figure 14 and were based on the following values: 0.020 – water surface 0.025 – bare earth 0.040 – Low density vegetation 0.050 – Medium density vegetation 0.060 – Dense vegetation The site visit undertaken on 14 May 2019 assisted with refining the chosen values used in the model.
Initial water levels	No initial water levels were intentionally added to the model however there were water surfaces present in the LiDAR. Generally, the captured water surface was due to either ponded weirs in the Dawson River or water stored in dams. Due to the magnitude of the event being modelled, it was not considered necessary to remove either.
Outfall boundary conditions	A "HQ" boundary was used with a slope of 1m/km, which is slightly steeper than the average slope downstream of Dawson South Mine (at 0.4m/1km) however the outfall is located over 13km downstream and has negligible impact on water surface elevation in the area of interest.

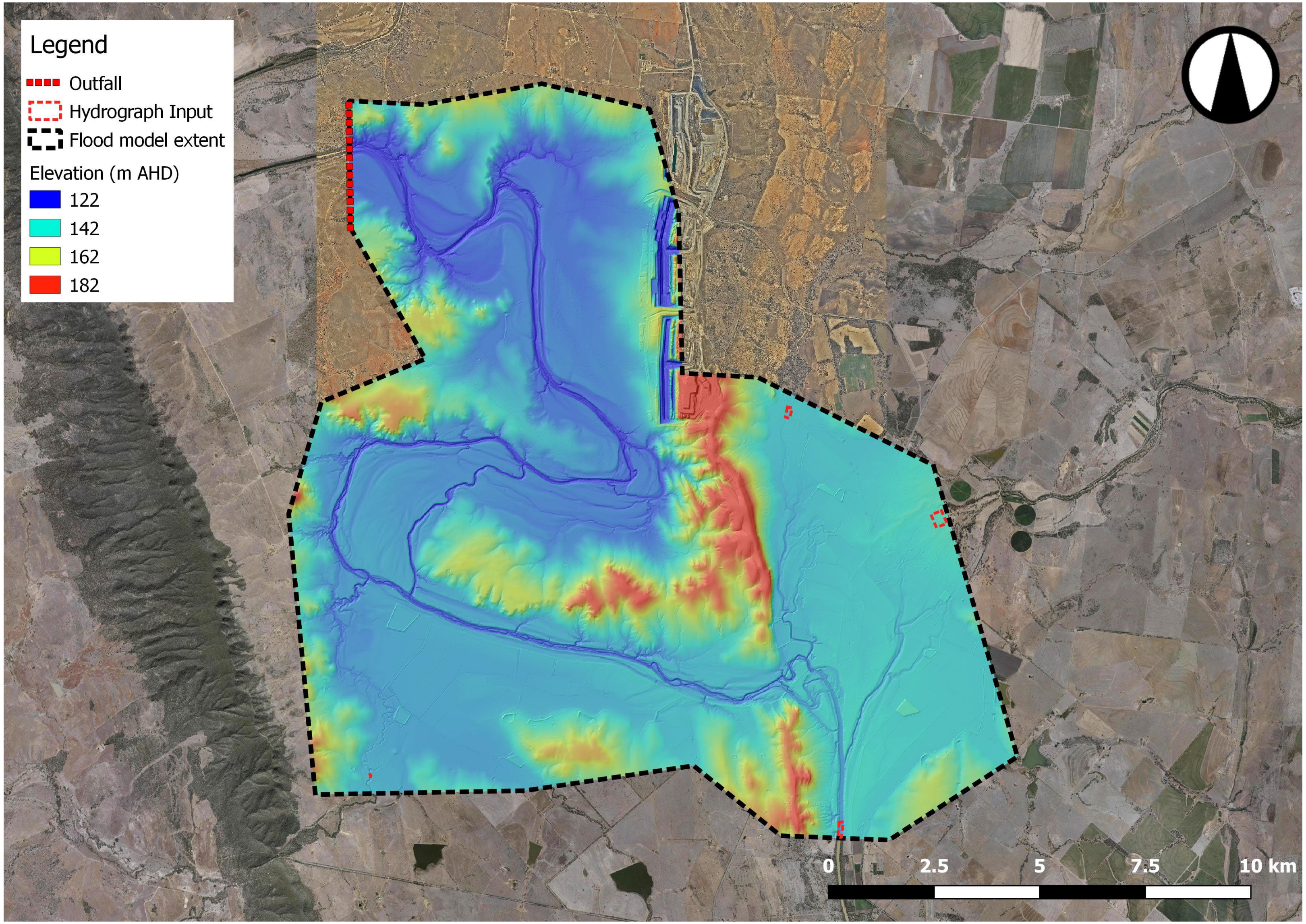

Figure 13. Flood model configuration

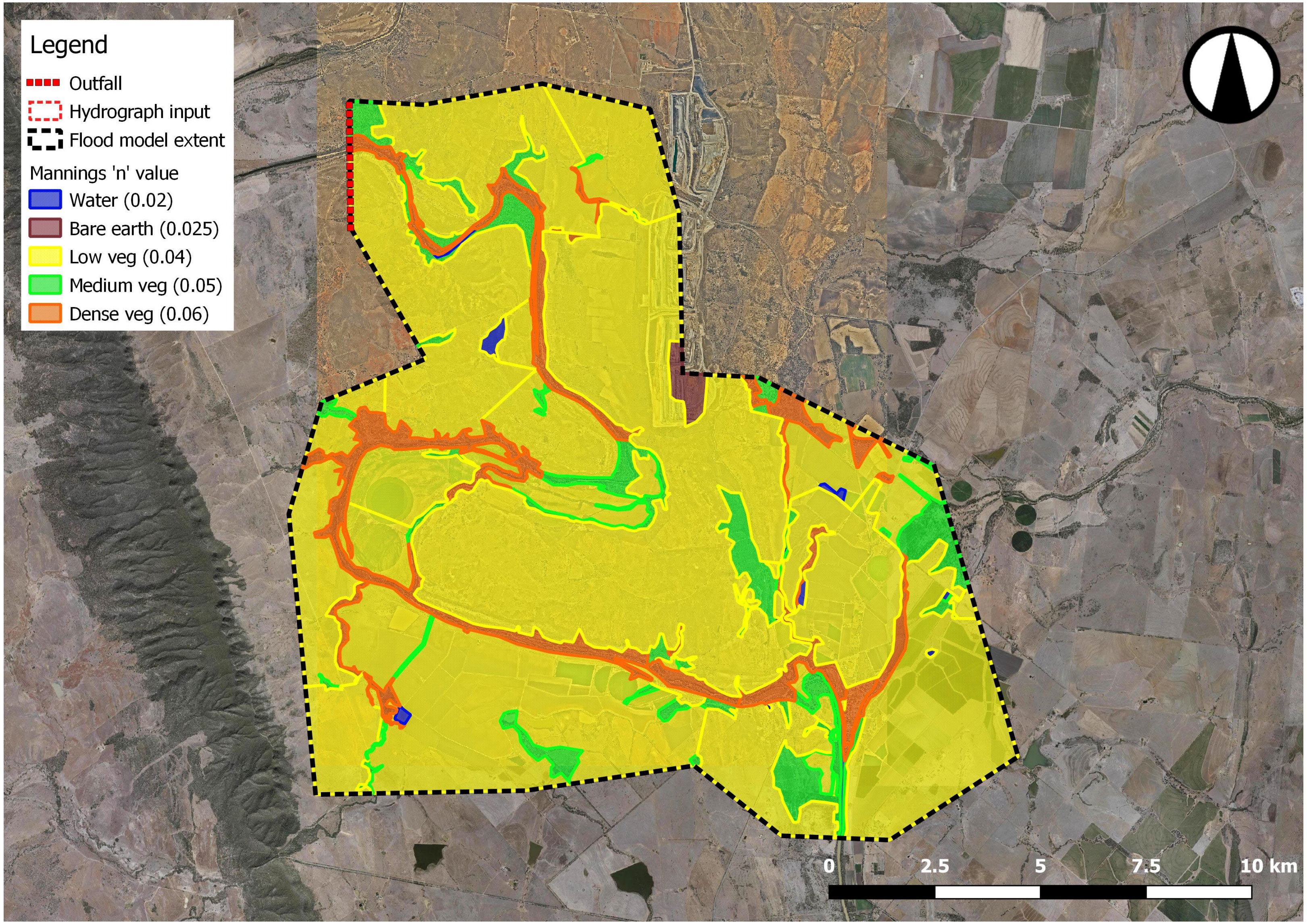

Figure 14. Manning's 'n' delineation