Data Review and Validation Report

Stawell Flood Investigation (C14 2022/23)

Northern Grampians Shire Council

02 December 2024

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Cover Image: *Cato Park 2022 Flood Event*

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GLOSSARY

Annual Exceedance Probability (AEP)	Refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year. A 90% AEP flood has a high probability of occurring or being exceeded; it would occur quite often and would be relatively small. A 1% AEP flood has a low probability of occurrence or being exceeded; it would be fairly rare but it would be of extreme magnitude.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datums.
Average Recurrence Interval (ARI)	Refers to the average time interval between a given flood magnitude occurring or being exceeded. A 10 year ARI flood is expected to be exceeded on average once every 10 years. A 100 year ARI flood is expected to be exceeded on average once every 100 years. The AEP is the ARI expressed as a percentage.
Cadastre, cadastral base	Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Design flood	A design flood is a probabilistic or statistical estimate, being generally based on some form of probability analysis of flood or rainfall data. An average recurrence interval or exceedance probability is attributed to the estimate.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from elevated sea levels and/or waves overtopping coastline defences.
Flood frequency analysis	A statistical analysis of observed flood magnitudes to determine the probability of a given flood magnitude.
Flood hazard	Potential risk to life and limb caused by flooding. Flood hazard combines the flood depth and velocity.
Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Flood storages	Those parts of the floodplain that are important for the temporary storage, of floodwaters during the passage of a flood.

Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Intensity frequency duration (IFD) analysis	Statistical analysis of rainfall, describing the rainfall intensity (mm/hr), frequency (probability measured by the AEP), duration (hrs). This analysis is used to generate design rainfall estimates.
LiDAR	Spot land surface heights collected via aerial light detection and ranging (LiDAR) survey. The spot heights are converted to a gridded digital elevation model dataset for use in modelling and mapping.
Peak flow	The maximum discharge occurring during a flood event.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a fuller explanation see Average Recurrence Interval.
Probable Maximum Flood	The flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area.
RORB	A hydrological modelling tool used in this study to calculate the runoff generated from historic and design rainfall events.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Topography	A surface which defines the ground level of a chosen area.

1 INTRODUCTION

1.1 Overview

Water Technology was commissioned by Northern Grampians Shire Council (NGSC) to undertake the Stawell Flood Investigation. The investigation covers two study areas; the Stawell town local catchment (including Pleasant Creek), and the golf course catchment to the north of Stawell, as shown in Figure 1-1.

No previous flood studies have been undertaken for either of the study areas. The Mt William Creek Flood Investigation (2014) included the Pleasant Creek catchment which covers the southern areas of Stawell. The study utilised RORB hydrologic modelling and TUFLOW two-dimensional hydraulic modelling and was calibrated to streamflow gauge records, flood frequency analysis and historic flood level data. However, the flood mapping produced only covered a minor part of southeastern Stawell.

In 2021/2022 Water Technology undertook a hydraulic assessment of flooding in Stawell caused by runoff from Big Hill, located in the eastern portion of the town. The study covered most of central Stawell and utilised a direct rainfall on grid (RoG) modelling approach. The model was not calibrated and limited survey data for hydraulic and topographic features was available. The flood study is required to address the uncertainty around flood risk within Stawell and to develop an understanding flooding behaviour to inform future land use, prospective mitigation options and emergency management actions.

The study will produce reliable flood intelligence for use in emergency management situations, assess the current flood impact/exposure in terms of annual average damages caused by flooding in Stawell, investigate structural and non-structural mitigation options, investigate and make recommendations for establishing a flood warning system for the town.

This report is one of a series documenting the outcomes of the Stawell Flood Investigation. Each reporting stage is shown below:

- **R01 - Data Review and Validation Report - This Report**
- R02 – Model Development and Calibration Report
- R03 – Design Modelling Report
- R04 – Flood Intelligence and Warning Report
- R05 – Flood Damages and Mitigation Report
- R06 – Final Summary Report

The data available for this study has been collated and reviewed. This report documents a summary of the available streamflow, rainfall, topographic and structure data (pipes/pits/culverts) as well as the relevant previous projects and other information relevant to the study, highlighting any data gaps. The report also details verification of the available topographic datasets and details the hydrological and hydraulic modelling approach.

Following project inception, NGSC has undertaken survey of structure details, waterway cross sections and ground levels for the purpose of LiDAR data verification as detailed in the project brief. The data captured and its use is discussed in this report.

1.2 Objectives and Outputs

The Stawell Flood Investigation outputs are required to meet several floodplain management objectives as highlighted in the project brief prepared by NGSC. The objectives of the investigation are described below:

- Provide flood intelligence and data for a range of flood event magnitudes to understand flood behaviour and flood risk under existing and developed conditions, including climate change conditions, compliant with the DEECA Flood Spatial Data Specification;
- Provide flood data, including water surface elevation, flow depth, velocity and hazard for the full suite of flood events to inform statutory and strategic planning;
- Provide insight into the performance of existing stormwater infrastructure;
- Provide appropriate mapping for the 1% AEP event including climate change, to enable amendment of the Northern Grampians Shire planning scheme, and if required, assist with planning scheme amendments and a Floodplain Development Plan;
- Provide appropriate quality flood data and inform emergency response planning by drafting the appropriate content for the Municipal Flood Emergency Plan;
- Provide hydrologic and hydraulic tools (e.g. flood frequency analysis data files, hydraulic models) to assist the Wimmera CMA to analyse local flood risk issues;
- Provide a Floodplain Management Plan with recommended measurements for managing flood risk, including a mitigation assessment and storage management;
- Provide a Flood Warning Assessment and assist in the cost benefit analysis of a Total Flood Warning System; and
- Assist in the preparation of community flood awareness and education products.

1.3 Study Area

Stawell is in Victoria's Wimmera region on the Western Highway, located approximately 110 km northwest of Ballarat and 140 km southwest of Bendigo. There are no major watercourses within or near the town, instead flood risk is mainly caused by local stormwater runoff from elevated areas east of the town including Big Hill. The southwestern parts of town are located within the Pleasant Creek catchment. Pleasant Creek originates approximately 8 km south of Stawell at the Black Range, flowing northwest along the Western Highway past southwestern Stawell, before eventually running into Lake Lonsdale, 9 km west of Stawell. The Pleasant Creek catchment upstream of Stawell is approximately 28 km^2 and consists of bushland in the upper reaches and cleared pasture in the lower reaches upstream of Stawell, see Figure 1-2.

Stawell was founded as a gold mining town in the mid 1800s with gold discovered in numerous locations, both alluvial and reef gold. Mining around Big Hill dictated a some of the surrounding historic development and therefore road network and drainage infrastructure. As is typical of mining towns with older drainage networks, issues can arise with lack of underground capacity. NGSC have undertaken a range of infrastructure works to mitigate stormwater issues, including works at Cato Lake, Big Hill and south of the Stawell Hospital.

Stawell can be separated into two distinct types of potential inundation; short duration stormwater flooding and longer duration riverine flooding from Pleasant Creek, to the southwest of town. While stormwater flooding is the primary driver of damage, Pleasant Creek has still historically caused issues but affects a smaller portion of the population.

The Stawell Golf Course study area is characterised by the Jerrywell Creek catchment. Jerrywell Creek originates on the eastern slope of Big Hill and flows north crossing the Stawell-Avoca Road. Multiple large overland flow paths from the Deep Lead Nature Conservation Reserve feed into the creek before it joins Concongella Creek, and finally the Wimmera River. The Jerrywell Creek catchment within the study area is largely cleared agricultural land with some vegetated areas in the upper reaches, see Figure 1-2.

Stawell has most recently experienced flooding in April 2024 and January and December 2011. While January was of longer duration and larger magnitude, December 2011 was significantly shorter and more intense causing urban flooding, similar to April 2024.

The Stawell/Pleasant Creek and golf course study areas include the following key structures which require consideration as part of the study:

- Main waterway bridges at the following roads:
  - Western Highway
  - Donald-Stawell Road
  - Stawell-Avoca Road
  - Black Range Road
  - Grampians Road
- Major and minor culverts
- Underground pit and pipe drainage network within Stawell
- The Melbourne to Adelaide railway running southeast to northwest through Stawell and associated hydraulic structures.
- Several off-stream dams and ponds

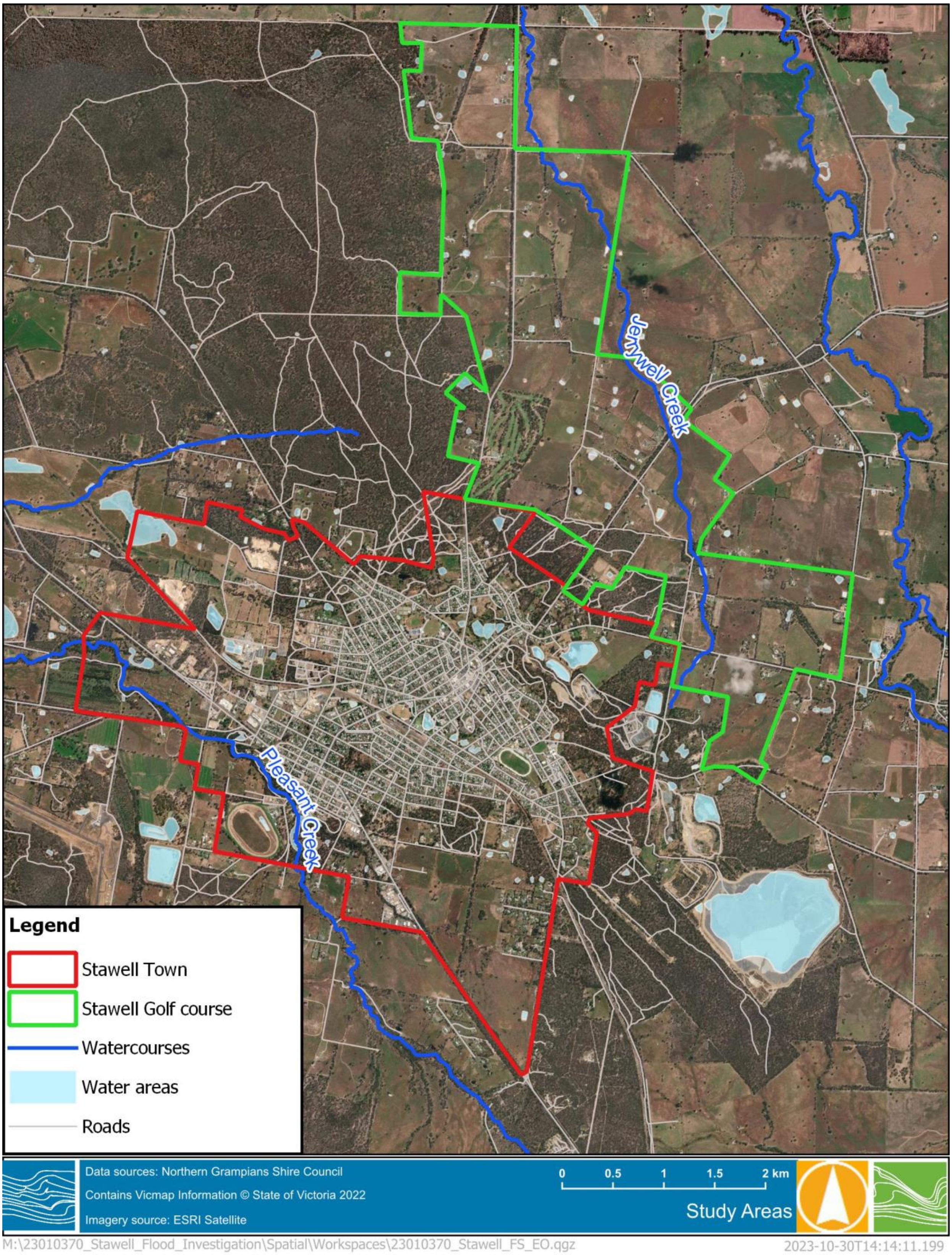

FIGURE 1-1 STAWELL STUDY AREAS

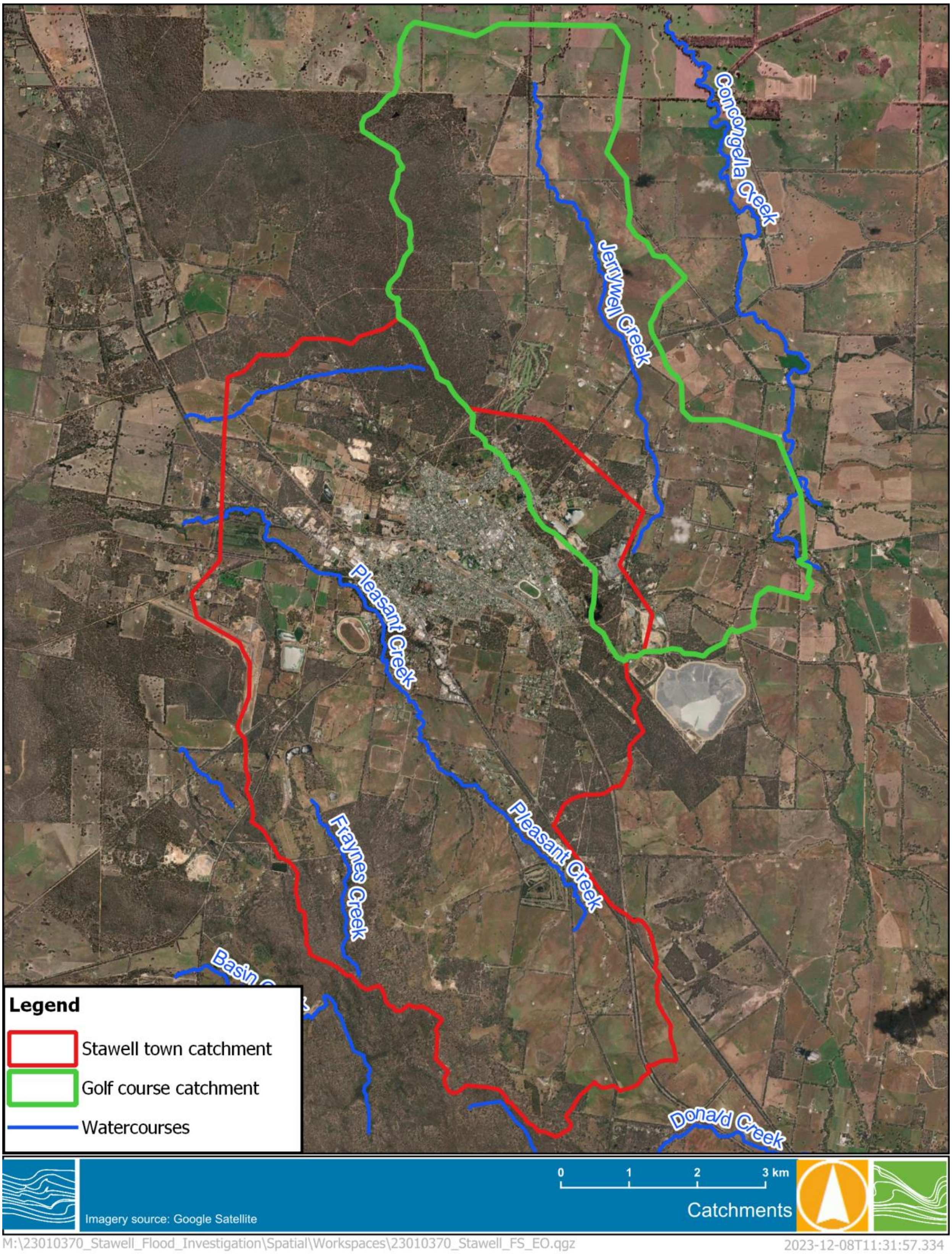

FIGURE 1-2 STAWELL CATCHMENTS

2 DATA SUMMARY

2.1 Previous Studies

The following previous studies were identified as part of the data collation and review:

- Mt William Creek Flood Investigation.
- Stawell Flood Investigation (Big Hill).

A synopsis of each study is given below.

Mt William Creek Flood Investigation (BMT WBM, 2014)

Following the widespread flooding across Victoria in September 2010 and January 2011 the Minister for Water announced funding for the Mount William Creek Flood Investigation, available through the Victorian Coalition Government's Flood Warning Network - Repair and Improvement initiative and the Australian Government's Natural Disaster Resilience Grants Scheme. The Wimmera Catchment Management Authority (WCMA), in partnership with the Department of Environment and Primary Industries (DEPI), Northern Grampians Shire Council (NGSC), Horsham Rural City Council (HRCC) and Ararat Rural City Council (ARCC) commissioned this investigation.

The 1,450 km^2 Mount William Creek catchment includes Mount William Creek, Salt Creek, Fyans Creek, Pleasant Creek, Sheepwash Creek and Golton Creek along with their tributaries. The study utilised RORB hydrologic modelling and TUFLOW two-dimensional hydraulic modelling and was calibrated to streamflow gauge records, flood frequency analysis and historic flood level data. The study outputs included catchment wide flood mapping, flood damages assessment, mitigation assessment and flood warning assessment.

Stawell Flood Investigation (Big Hill) (Water Technology, 2022)

The Stawell Flood Investigation (Big Hill) assessed the cause and potential solutions for inundation in areas south of Big Hill, Stawell, with a particular focus on inundation of the Skeene Street Specialist School. Mitigation modelling was undertaken for several options, including a proposed retarding basin upstream of Fisher Street. The study area encompassed the eastern parts of Stawell, Victoria, below Big Hill in the northeast Flood Information. Hydraulic modelling of direct rainfall and local catchment inundation was undertaken to produce flood impact mapping.

2.1.1 Flood Records

One of the largest gaps in available data is historic flood observations. There is no streamflow data available for the Pleasant Creek and Jerrywell Creek catchments. The 1974, 1996 and 2011 flood events were assessed in the Mt William Creek Flood Investigation (2014); however, the assessment of these events was not specific to the Pleasant Creek or Jerrywell Creek catchments. Instead, the sources listed below were used to form a basis of the known historic flooding in Stawell. There is limited information available due to limited flood damage caused by these events. Historic flood information is limited to the following:

- Historic data related to Stawell, Pleasant Creek and Jerrywell Creek flooding collated via Trove (a free online database of historical newspapers etc.)
- Anecdotal evidence gathered from an initial community consultation meeting
- Agency staff survey amongst CFA, local SES, and Council staff

Numerous individual pieces of historical flood record became available from a range of sources during the course of the flood study. Continuously collected data will be part of the model calibration and included in the Calibration Report.

2.1.2 Major Events

The January 2011 flood event was the largest flood on record for most river systems in the north central Victorian region, occurring only a few months after several events in 2010. The following information is available for those and other flood events in Stawell:

- Photographs and videos taken by Council staff during and after the following events:
  - January 2011
  - December 2011
  - January 2015
  - October 2022
- Community consultation information:
  - Photos and anecdotal records from several flood events
- Photos from the Stawell Times News published on December 20, 2011 (see below)
- In addition to the above information, investigations of historic news articles identified significant flood events in Stawell in 1909 and 1923.

Young Georgia O'Sullivan looks on in disbelief as floodwater gushes up to the fence at the property of her grandparents, Terry and Robyn O'Sullivan in Pomonal Road. Water filled the property and the Stawell Racecourse, causing extensive damage. Pictures: MARK MCMILLAN.

Jayson, Marnie, Hamish and Jai Smith in the floodwaters that have caused extensive damage.

FIGURE 2-1 IMAGES OF FLOODING FROM STAWELL TIMES NEWS – DECEMBER 2011

FIGURE 2-2 IMAGES OF FLOODING FROM STAWELL TIMES NEWS – DECEMBER 2011

2.2 Streamflow Data

There are no active streamflow gauges within the study areas. The only gauge on Pleasant Creek (415253 Pleasant Creek @ Illawarra) was only open between 1988 and 1992, providing a too short record to be of value for this study.

2.3 Rainfall Data

2.3.1 Overview

Historic daily and sub daily rainfall data is required for the hydrologic and hydraulic model calibration. Daily rainfall gauges are used to provide a representation of spatial rainfall variation while sub daily gauges provide a representation of temporal rainfall distribution.

2.3.2 Daily Rainfall

Table 2-1 summarises the daily rainfall information available within or near the Stawell Town and Stawell Golf Course catchments, the closest active rainfall gauge being Stawell Aerodrome located 4 kilometres south from Stawell Town centre. The locations of the rainfall gauges are shown in Figure 2-3.

TABLE 2-1 DAILY RAINFALL STATION INFORMATION

Station Name	Dist. From Stawell	Station No.	Start	End
Stawell Aerodrome	*4 km S*	*079105*	*1996*	*Current*
Great Western (Seppelt)	*16 km SE*	*079019*	*1891*	
Glenorchy	*24 km NW*	*079015*	*1913*	
Halls Gap	*25 km SW*	*079074*	*1958*	

Station Name	Dist. From Stawell	Station No.	Start	End
Morrl Morrl (Valley View)	*26 km NW*	*079032*	*1902*	
Moyston (Barton Estate)	*30 km S*	*079050*	*1906*	
Ararat Prison	*30 km SE*	*089085*	*1969*	
Wartook Reservoir	*30 km W*	*079046*	*1890*	
Grampians (Mount William)	*30 km SW*	*079103*	*2005*	
Dadswells Bridge	*31 km NW*	*079077*	*1968*	
Navarre	*34 km NE*	*079037*	*1897*	
Maroona (Hillenvale)	*36 km S*	*089080*	*1968*	
Warranooke (Glenorchy)	*37 km N*	*079016*	*1878*	
Navarre (Avon No.3)	*37 km NE*	*079086*	*1973*	

2.3.3 Pluviograph Rainfall

Three (3) of the available daily gauges also record sub daily rainfall, typically every 6 minutes. These are Ararat Prison, Wartook Reservoir and Navarre (Avon No.3). These gauges are also highlighted in Figure 2-3.

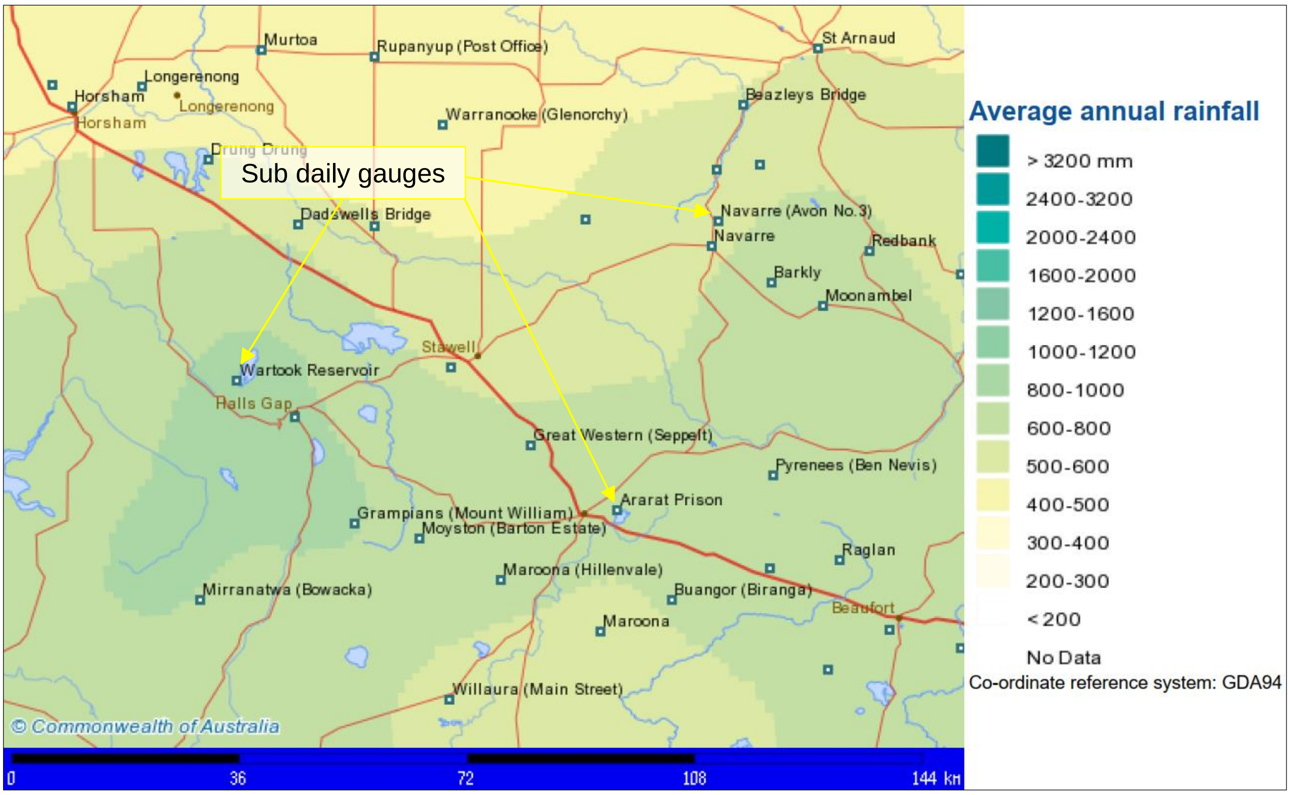

FIGURE 2-3 DAILY RAINFALL STATIONS NEAR THE STUDY AREA

2.4 Storages

There are several large dams within recreational areas of Stawell, including:

- Dams east of Darlington Street Public Park Reserve
- Dams north of Maud Street within the Normal Castle Reserve and the Stawell Recreation and Drainage Reserve
- Cato Park dam
- Stawell Wastewater Treatment Plant west of the Stawell Racecourse
- Retarding basins north of Curtis Street
- Mooray Water Reserve north of Big Hill
- A large number of farm dams within the Pleasant Creek and Jerrywell Creek catchments

2.5 Major hydraulic structures

The major hydraulic feature within the study area is the Stawell Main Drain, an open channel running from the Stawell railway station along the railway almost to Griffith Street, before turning south running through southern Stawell before joining Pleasant Creek at Federation Park. The Main Drain features a large number of major culvert and bridge crossings.

2.6 Road and Drainage Infrastructure

Within the study area, there are road structures on Pleasant Creek, Jerrywell Creek and throughout Stawell. Major structures are listed in Table 2-2 and are highlighted in Figure 2-4.

Data was obtained from the NGSC Asset Database and will be used to improve modelling accuracy. The council-owned minor structures (mainly culverts) are also shown in Figure 2-4, but the township underground drainage network is omitted. Data for the structures was available through NGSC. It should be noted that feature survey of the township pit and pipe network, culverts, the Stawell Main Drain and topographical features has recently been completed and not all surveyed structures are included in the table below.

TABLE 2-2 PLEASANT CREEK, JERRYWELL CREEK AND OTHER MINOR CREEK STRUCTURES

Crossing	Owner	Existing data source	Data collected
Pleasant Creek			
Black Range Road	VicRoads	Northern Grampians Shire Council Asset Database	Bridge
Grampians Road	VicRoads	Northern Grampians Shire Council Asset Database	Bridge
Stinky Creek/Main Drain			
Western Highway/Freeway	VicRoads	Northern Grampians Shire Council Asset Database	Bridge
Jerrywell Creek			

Crossing	Owner	Existing data source	Data collected
Stawell-Avoca Road	VicRoads	Northern Grampians Shire Council Asset Database	Bridge
Gambettas Creek			
Donald-Stawell Road	VicRoads	Northern Grampians Shire Council Asset Database	Bridge
Minor Unnamed Creeks			
Sutherland Street	Northern Grampians Shire Council	Northern Grampians Shire Council Asset Database	Major culvert 2 x 900mm pipe culvert
Granard Park Road	Northern Grampians Shire Council	Northern Grampians Shire Council Asset Database	Major culvert 1200 x 600 box culvert
Concongella School Road	Northern Grampians Shire Council	Northern Grampians Shire Council Asset Database	Major culvert 1200 x 600 box culvert
Concongella School Road	Northern Grampians Shire Council	Northern Grampians Shire Council Asset Database	Major culvert 1200 x 600 box culvert
Gilchrist Road	Northern Grampians Shire Council	Northern Grampians Shire Council Asset Database	Major culvert 750 mm diameter pipe culvert
Darlington Mine Road	Northern Grampians Shire Council	Northern Grampians Shire Council Asset Database	Major culvert 1500 x 1800 box culvert

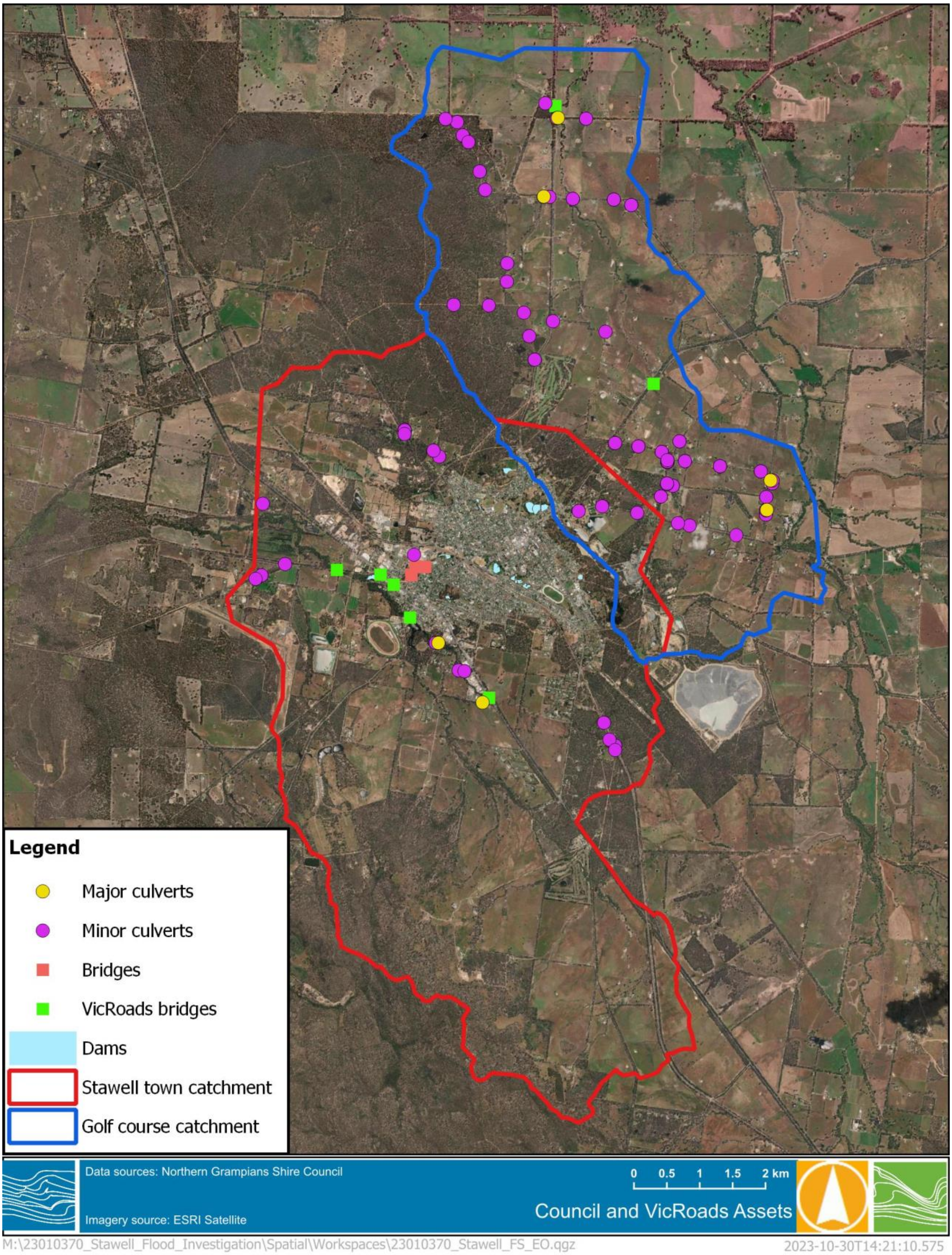

FIGURE 2-4 STRUCTURES IN STAWELL

2.7 Topography and Survey Data

2.7.1 Survey Data

NGSC has recently completed extensive survey of the underground pit and pipe network, the Stawell Main Drain, culverts, bridges and areas of known topographic change since LiDAR was produced. The survey data will be used for verification of the LiDAR dataset and model refinement.

A number of roads have undergone upgrades since the LiDAR was produced. Feature survey of the previous road surface will be used for LiDAR verification, while as built drawings will be used to update the road topography for the design modelling, representing current conditions.

2.7.2 LiDAR Data

2.7.2.1 Overview

Three (3) LiDAR datasets were available for the study area including:

- 2009-10 Victorian State Wide Rivers LiDAR Project – North Central CMA
  - This 1m LiDAR was flown for the state wide mapping project undertaken in 2009-12 to accurately map the riparian vegetation and physical form components (metrics) of the Index of Stream Condition (ISC). It has a vertical accuracy of ±0.10m and a horizontal accuracy of ±0.19m and covers limited areas along Pleasant Creek and Jerrywell Creek.
- 2005-2006 GWMWater Wimmera Mallee Pipeline Project
  - 2m LiDAR flown for the GWMWater Wimmera Mallee Pipeline Project. It has a vertical accuracy of ±0.15m and a horizontal accuracy of ±0.4m and covers the entire study area.
- VicMap 10m digital terrain model (DEWLP)
  - Elevation digital terrain model (DTM) with a 10-metre resolution providing a raster representation of the area. The vertical and horizontal accuracy is coarse at ±5 m and ±12.5 m, respectively, relative to the Australian Height Datum (AHD). The DTM extends across the entire catchment.

The only high-resolution dataset covering the entire hydraulic study area was the 2005-2006 GWMWater LiDAR Project, which was used for modelling and is presented in Figure 2-5.

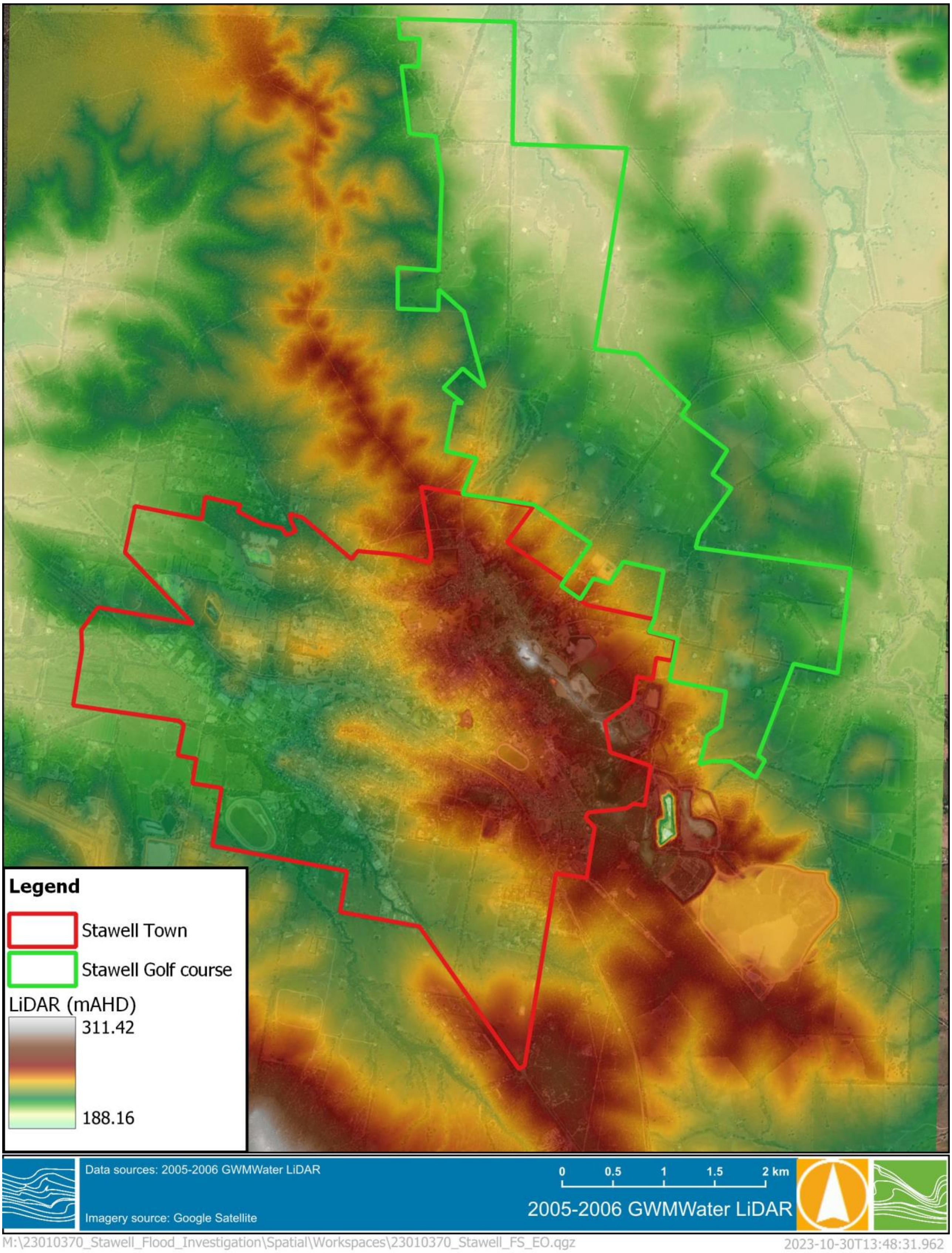

FIGURE 2-5 STUDY AREA TOPOGRAPHY

2.7.2.2 LiDAR Verification

Topographic data was the major base dataset used in this project, the data available was validated to ensure the hydraulic model can accurately replicate observed flooding behaviour within the study area and its outputs are robust.

The only high-resolution topographic dataset covering the entire study area was the 2m LiDAR flown for the GWMWater Wimmera Mallee Pipeline Project in 2006. Verification of this LiDAR dataset was completed based on a comparison to road transect survey undertaken prior to various road upgrade works and provided by NGSC in October 2023.

Figure 2-6 to Figure 2-10 show a comparison between the LiDAR dataset and the feature survey at five surveyed locations. Transect comparisons were made at road centrelines, see Figure 2-11. The average, maximum, minimum and standard deviation of the difference between each LiDAR dataset and the surveyed levels is shown in Table 2-3.

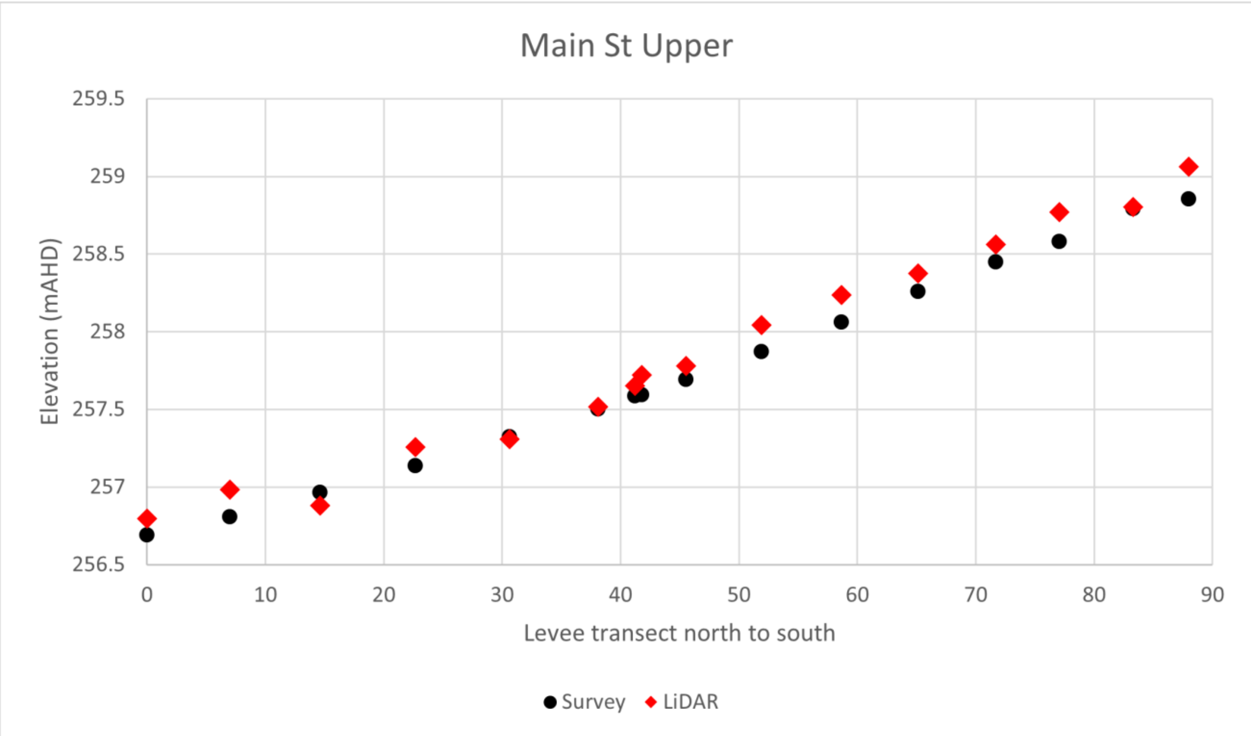

FIGURE 2-6 MAIN ST UPPER - SURVEY AND LIDAR DATA COMPARISON

FIGURE 2-7 MAIN ST LOWER - SURVEY AND LIDAR DATA COMPARISON

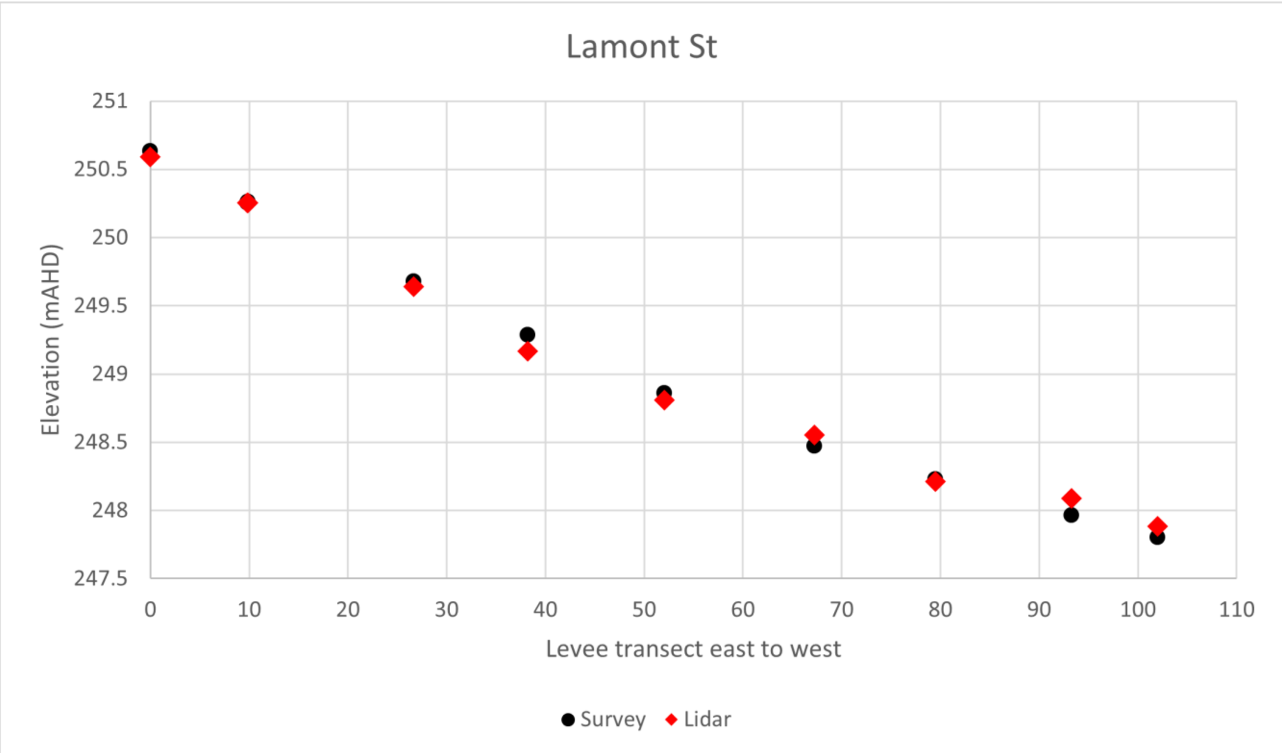

FIGURE 2-8 LAMONT ST - SURVEY AND LIDAR DATA COMPARISON

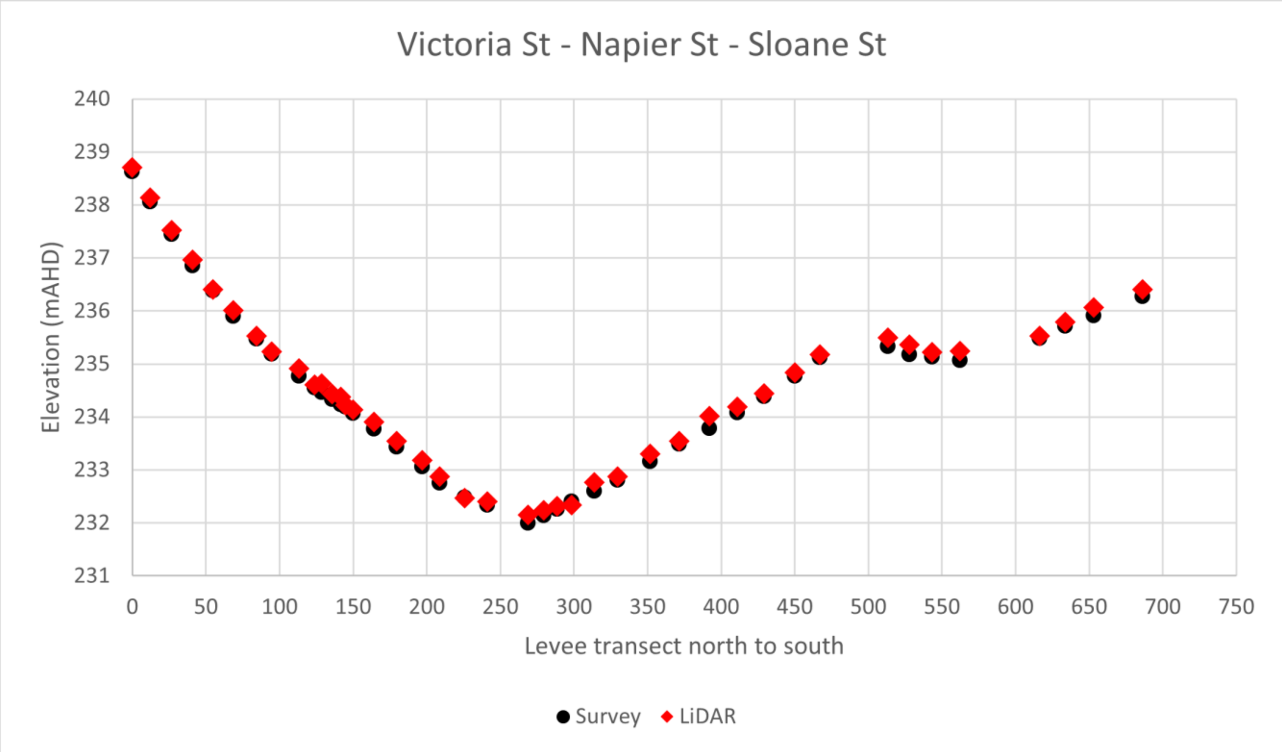

FIGURE 2-9 VICTORIA ST - NAPIER ST - SLOANE ST- SURVEY AND LIDAR DATA COMPARISON

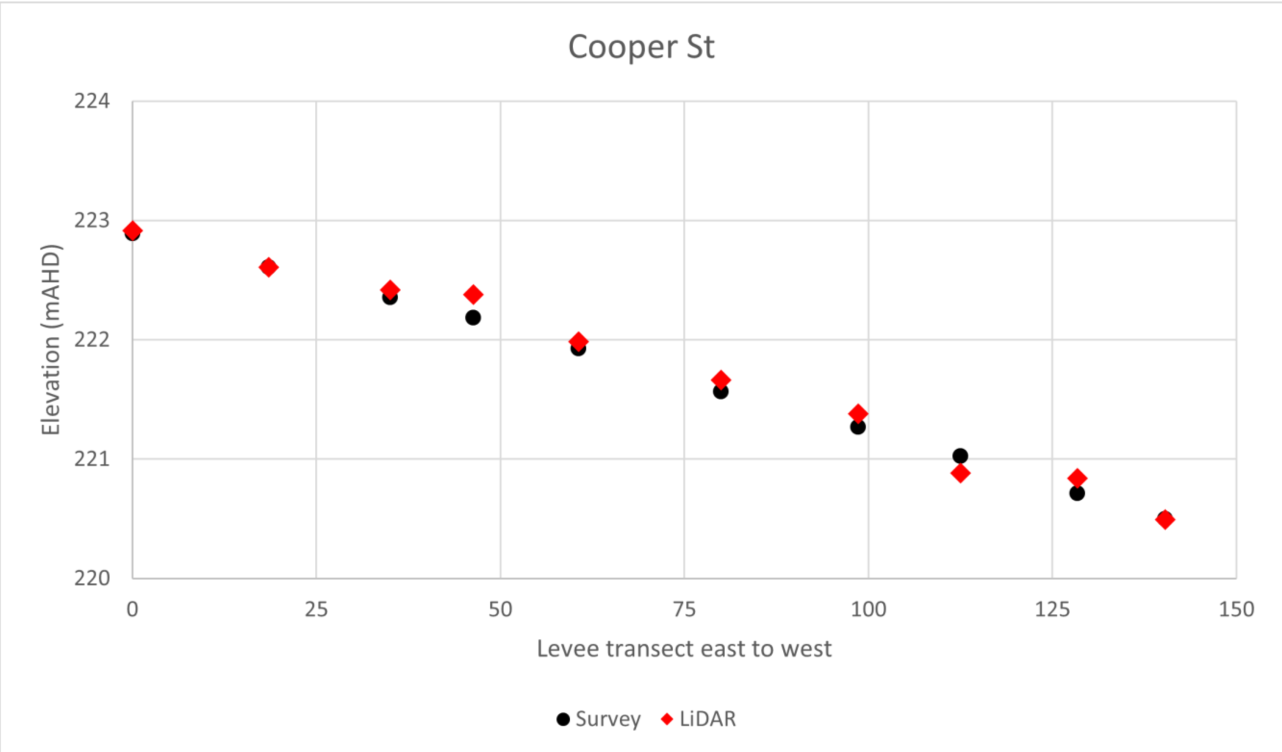

FIGURE 2-10 COOPER ST - SURVEY AND LIDAR DATA COMPARISON

FIGURE 2-11 SURVEY TRANSECT POINTS

TABLE 2-3 LEVEE – SURVEY AND LIDAR DATA COMPARISON

Difference	GWMWater LiDAR
Mean (m)	0.08
Maximum (m)	0.22
Minimum (m)	-0.14
Standard Deviation (m)	0.07

Figure 2-12 displays a comparison histogram between the LiDAR dataset and the surveyed data values. There were 84 surveyed data values in total along the analysed transects. The average difference for the LiDAR dataset was 0.08 m higher than the surveyed elevation, with a standard deviation of 0.07 m, these values are within the stated level of data accuracy provided by the LiDAR supplier. However, the LiDAR dataset is generally higher than the surveyed values, and only lower than the survey in a few locations. It is recommended the LiDAR data be lowered by 0.08 m, bringing it into line with the survey data. The LiDAR was captured in 2005/2006 and is assumed to represent 2011 conditions sufficiently, while topography updates are required for design modelling. The LiDAR data will be completed with survey data of road surfaces and topography modifications post LiDAR capture.

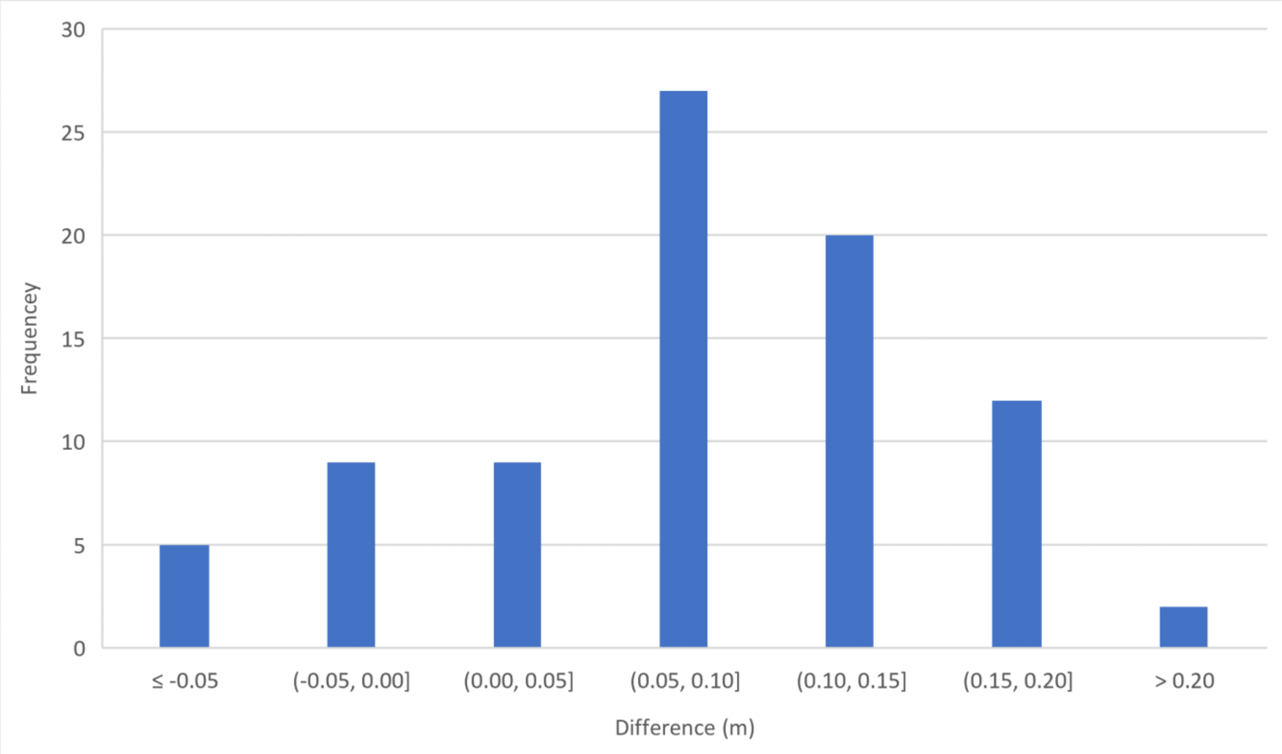

FIGURE 2-12 SURVEY AND LIDAR DATA COMPARISON – POINT HISTOGRAM

2.7.3 Floor Level Survey

Floor level survey was conducted based on initial modelling highlighting properties at risk for above floor flooding. Floor level survey of 522 buildings was captured within the study area, including 163 commercial and 359 residential buildings.

3 MODELLING METHODOLOGY

3.1 Model Development

The Stawell Flood Investigation (Big Hill) (2022) produced a hydraulic model covering a large part of the current study area and included a majority of the underground drainage network. The analysis undertaken during the project will be fully reviewed and updated based on the most recent survey data, as well as expanded to cover the entire Stawell/Pleasant Creek and golf course study areas. Due to the limited area of the Pleasant Creek catchment and lack of streamflow gauges, direct hydraulic modelling of rainfall on grid (RoG) was deemed the most appropriate approach. The design modelling approach update will be consistent with the recommendations of Australian Rainfall Runoff 2019 (ARR2019) to produce design rainfall and flow estimates.

The hydraulic modelling will be completed in TUFLOW HPC. This section will detail the methodology for the hydraulic model builds, calibration and design modelling for the study areas.

3.2 Hydraulic Modelling

3.2.1 Hydraulic Model Development

Two hydraulic models will be built, one covering the Pleasant Creek and the Stawell township, with the main flow paths running in a northwestern/western direction, and one covering the Jerrywell Creek and golf course catchment, with flows predominantly moving north and northeast.

The modelling will utilise the TUFLOW (HPC) hydraulic modelling package. All key bridges, culverts, pipes and pits and weirs will be included in the TUFLOW hydraulic model as detailed 1D structures or layered 2D flow constrictions.

A Rain-on-Grid (RoG) approach will be used to directly apply rainfall to the study areas. This modelling approach will provide a better understanding of overland flow and drainage paths through the township and Golf Course contributing local catchments. The critical duration and temporal pattern will be determined by the RoG modelling.

A series of industry standard roughness values will be applied to the various roughness types identified by analysis of aerial imagery and VicMap planning layers and modified to match observed flood heights.

Downstream boundaries will be located approximately where Pleasant Creek and Jerrywell Creek leave the study areas and will utilise a TUFLOW 2D HQ boundary which will allow the water to leave the model without having to set a boundary level. Additional outflow boundaries will be located where overland flow paths exit the study areas.

3.2.2 Hydraulic Model Calibration

As identified earlier, there is minimal historic survey or flood marks to calibrate to, therefore the hydraulic validation process will be undertaken based on one historic flood event (January 2011) and the draft 1% AEP flood mapping. This will be presented at a later community meeting and also discussed with the WCMA and NGSC.

3.3 Design Event Modelling

Design flood hydrographs for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% Annual Exceedance Probabilities (AEP) and 1 in 2000 Annual Recurrence Interval (ARI) flood events including climate change modelling for the

1% AEP flood events, and the Probable Maximum Flood (PMF) at key inflow locations to the hydraulic model will be derived using the calibrated TUFLOW model and appropriate design modelling parameters.

4 COMMUNITY CONSULTATION PLAN

The following community consultation sessions are planned for the project:

- During the project data review – This meeting was held at the start of the project to collect historical flood extent and level data from community members, using preliminary January 2011 flood maps for discussion.
- At the completion of the calibration modelling and initial design modelling – This meeting will be used to provide further validation of the calibration modelling and mapping to the community and allow community input into what is next for the progress of the project and what it means for them (i.e., planning scheme amendment). It will also be used to seek community feedback regarding mitigation options and flood control changes.
- At the completion of study – defining what is next now the technical part of the work is done and what the results mean for the Stawell community, as well as answering questions.

5 SUMMARY AND NEXT STEPS

This report details the data captured as part of the data collation and review process, including rainfall, topographic and hydraulic structure data, to be used in the Stawell Flood Investigation.

The LiDAR data shows a sufficient representation of the ground surface which can be further improved with survey data. It is recommended the LiDAR be lowered by 0.08m to bring the mean difference between the LiDAR and the survey to zero. Infrastructure survey is currently being undertaken and historical flood data collected during the initial project stages will be used for model calibration. Despite there being no streamflow data to undertake a calibration process, community input will provide suitable data to undertake a validation of the hydrology and hydraulic model results. The following data gaps were identified:

- Survey data for road works and topographical changes - to be collected by NGSC
- Survey of flood marks described by community members - to be collected by NGSC
- Structure data for Council assets – recently completed by NGSC
- A general lack of streamflow, flood depth and extent data to be used in calibration. Calibration will be done to surveyed flood marks and photos provided by community members.

The collated data will be used in the next project stage which includes hydraulic modelling. If required, attempts will be made to close any further data gaps observed during this stage.

Next steps in the project include:

- Hydraulic Model Refinement
- Hydraulic Validation
- Community Consultation (round 2)
- Design Modelling

6 REFERENCES

BMT WBM (2014). *Mt William Creek Flood Investigation* for WCMA.

Water Technology (2022). *Stawell Flood Investigation* for Northern Grampians Shire Council.

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