Greater Shepparton City Council

Tallygaroopna Flood Scoping Study

Final Report

February 2024

Project	Tallygaroopna Flood Scoping Study
Client	Greater Shepparton City Council
Client's Representative	Alex Smith / Jennifer Brewis
Confluence Group Project Manager	Trevor Clark

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Cover photograph – March 2012 flood event – view looking north-west across Tallygaroopna (photograph taken by Shepparton News at 1.27pm on Thursday 1 March 2012).

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1 Introduction

The township of Tallygaroopna was severely impacted by flooding in March 2012 when most of the town was subject to inundation. The town is also known to have been affected by flooding in 1919, 1939, 1956, 1974 and 1993.

The need for a flood scoping study at Tallygaroopna is nominated by the Goulburn Broken Regional Floodplain Management Strategy 2018 – 2028 (Goulburn Broken CMA, 2018).

The 2018 - 2028 Strategy notes that Tallygaroopna is almost entirely free of flood overlays despite the extensive flood inundation coverage in 2012. The strategy recommends that improved mapping be prepared in the short term, with subsequent consideration to be given for a possible detailed modelling based flood study to assess flood mitigation measures.

Flooding is generally categorised as either riverine flooding or local runoff flooding. Riverine flooding is typically associated with significant waterways and the runoff from their catchments. The nearest natural waterways to Tallygaroopna are Congupna Creek located approximately 1 km to the east and north, and Pine Lodge Creek located approximately 3 km to the west. These creeks have significant catchment areas and can also receive Broken River breakaway inflows which notably occurred in 1993.

Local runoff flooding is associated with rainfall runoff from the surrounding area before the runoff reaches a receiving waterway. Local runoff can be concentrated into what is commonly referred to as major local overland flow.

This scoping study focuses on investigating the nature, influences and impacts of flooding conditions at Tallygaroopna township.

In summary the scoping study has been commissioned to:

- Investigate the nature of flooding conditions at the Tallygaroopna township by reviewing all the available data and consulting with the community regarding past observations and impacts.
- Preparation of rudimentary flood mapping for the township area using the available data.
- Documentation of the flood impacts / risks to existing development.
- Make recommendations as to whether a detailed floodplain risk mitigation study incorporating hydrologic and hydraulic modelling is required for the Tallygaroopna township.

2 Town and Surrounds Description

2.1 Overview

The township of Tallygaroopna is located 16 km north of Shepparton on the Goulburn Valley Highway, occupying an area of approximately 50 hectares (refer to Figure 1).

The township population at the time of the 2011 census was 252. The 2019 Tallygaroopna Community Plan nominates a population of 264 for Tallygaroopna township.

As at October 2023, there are 118 residential dwellings (houses) within the township. Also present are:

- Tallygaroopna Recreation Reserve including the main oval and pavilion, bowling green and pavilion and netball courts
- Tallygaroopna Primary School
- Tallygaroopna Children's Centre
- Soldiers Memorial Hall
- Fire Station
- Post Office
- Tallygaroopna Men's Shed
- Service centre station at the Goulburn Valley Highway (under reconstruction)

The Tocumwal railway line runs parallel to the east side of the Goulburn Valley Highway at Tallygaroopna. The railway has been present since 1881.

2.2 Terrain Description

LiDAR terrain elevation data acquired in 2022 (refer to Figure 2) shows the following:

- The predominant land fall surrounding Tallygaroopa is in a north westerly direction at an average slope of 1 in 1,900.
- There is very little fall within the township area itself. Natural ground surface elevations generally vary from 106.8 to 107.4 m AHD.
- The railway line on the western side of the township has an embankment crest elevation varying from 107.5 m AHD at the southern edge of town, to 107.6 m AHD at Victoria Street, to 107.3 m AHD at the northern edge of town.
- The Goulburn Valley Highway which runs parallel to the west side of the railway has a crown elevation of approximately 107.4 m AHD at the southern edge of town, 107.5 m AHD opposite Victoria Street and 107.4 m AHD at the northern edge of town.

The highest ground at the township is at the recreation reserve. The centre of the oval is at 107.8 m AHD. The bowling green surface is at 108.0 m AHD.

The nearest waterways are Congupna Creek and Pine Lodge Creek. Both these creeks flow generally in a north west direction. The creeks have been significantly modified as engineered trapezoidal shaped open drains.

The creeks receive inflows from their local catchment areas, including incoming Goulburn Murray Water (GMW) rural drains. They also receive inflows from the Broken River when the river is in major flood such as occurred in October 1993.

Figure 1 Local Area Plan

Typically, in Broken River flood events, northern breakaway flows from the Broken River discharge into a network of creeks, which include O'Keefe Creek and Daintons Creek in addition to Pine Lodge Creek and Congupna Creek.

The October 1993 Broken River flood is the largest Broken River flood on record since at least 1870 by a considerable margin. Major flooding was experienced in the creek systems around Tallygaroopna in 1993, driven by the incoming breakaway flows from the Broken River.

The rural area surrounding Tallygaroopna is part of the GMW Shepparton Irrigation Area. Supply channels and drainage channels criss-cross the area. These channels can impact on local runoff conditions, although cross drainage structures are generally present at natural drainage crossing points.

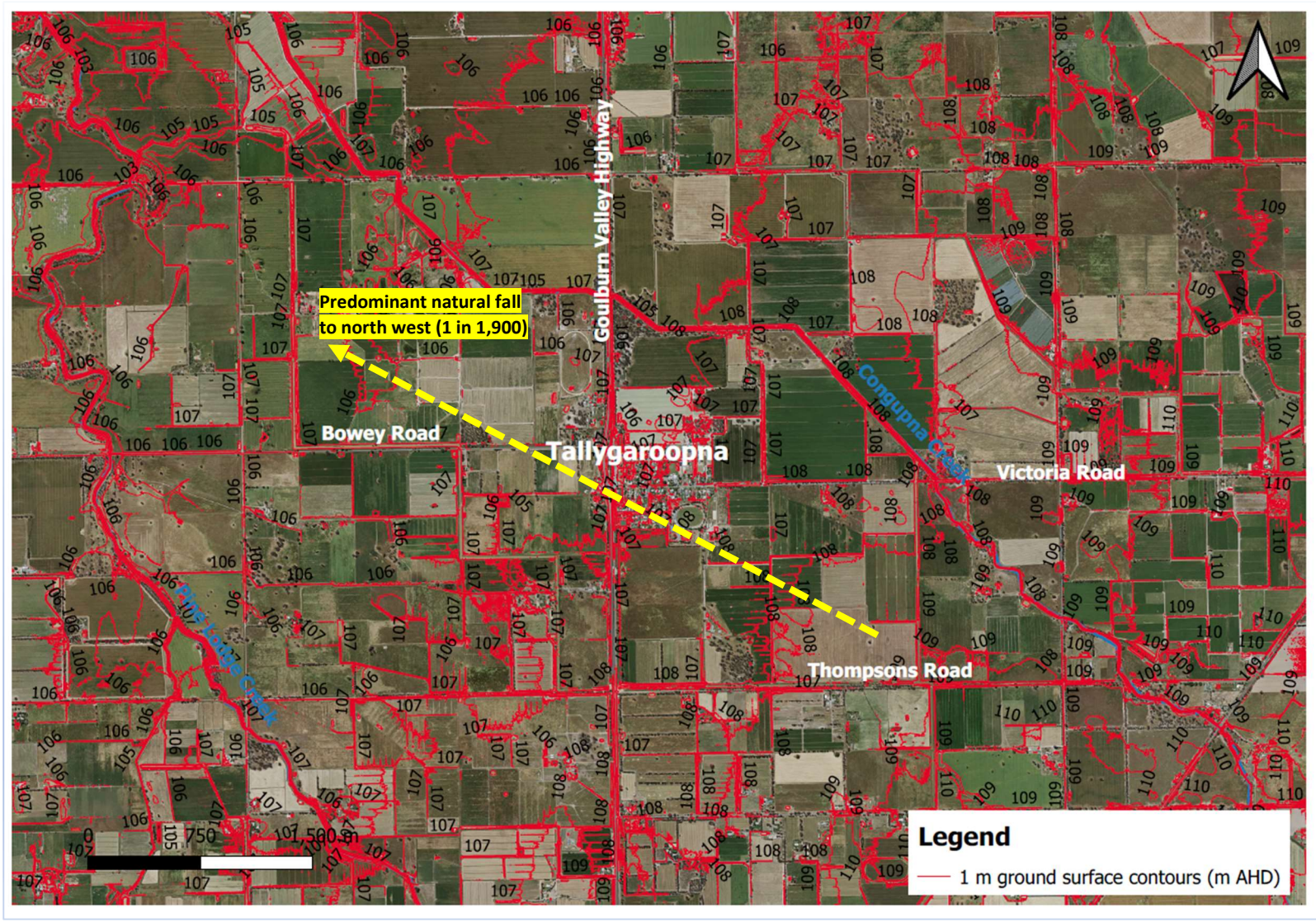


Figure 2 **LiDAR defined Ground Surface Contours**

2.3 Stormwater Drainage Infrastructure

A network of local stormwater collector drains is present within the township (refer to Figure 3). Notable stormwater features are:

- Collector pipe network servicing Smith Street, Church Street, Fowler Street, Victoria Street, Parkland Drive and North Street.
- Pipe network discharges into a retarding basin located at the western end of North Street, on the east side of the railway.

Most of the runoff from the town discharges into the retarding basin. Retarding basin outflows are pumped to a large open drain which discharges northwards down the east side of the Goulburn Valley Highway road reserve to inlets into Congupna Creek (GMW Drain 2/11). Stormwater flows entering GMW drains are required to be limited to 1.2 litres/sec/ha.

A large residential estate (Parklands Estate) is currently under development on the north side of the township. A new retarding basin has been constructed on the west side of the new estate for receiving stormwater inflows. The new estate basin is connected to the old township basin via a pipeline.

2.4 Rural Drainage Infrastructure

The following GMW drains are located in the vicinity of the town (refer to Figure 4):

- Drain 2/11. This 'drain' is the Congupna Creek. The original waterway has been modified in the form of an engineered trapezoidal shaped open earth channel. Bridges are located along the drain route at road and farm access crossings. Congupna Creek is located within 700 m of the township on the north side of town.
- Drain 11. This 'drain' is the Pine Lodge Creek. It has also been modified in the form of an engineered channel. Pine Lodge Creek is located 3.3 km west of the Goulburn Valley Highway opposite Tallygaroopna.
- Drain 3B/11. This drain is located 1.2 km to the south of Tallygaroopna. It crosses the Goulburn Valley Highway and discharges westwards to the Pine Lodge Creek.

Current GMW drain capacity design standards are for servicing runoff from a rainfall event of 50 mm over a 24 hour period. A 50 mm rainfall event in 24 hours is equivalent to approximately a 3 year ARI Bureau of Meteorology (BoM) design rainfall event.

Drains for discharging local runoff from the rural surrounds around Tallygaroopna are shown on Figure 4. Runoff from the rural area adjoining the south side of the township is intended to be discharged to open drains which discharge northwards down the railway / highway corridor, bypassing the town stormwater system.

Drainage culverts under the railway line are shown on Figures 3 and 4. Railway cross drainage culverts are located 390 m and 40 m south of Victoria Street, and 870 m north of Victoria Street.

Drainage culverts under the Goulburn Valley Highway are shown on Figures 3 and 4. Highway culverts are located 250 m and 870 m north of Victoria Street.

A drain in Slaughterhouse Road to the east of Tallygaroopna discharges rural runoff to the Congupna Creek. Rural runoff does currently enter the township drainage system, notably from the rural area south of Victoria Road to the east of town. There is a culvert present under a raw water storage channel designed to discharge rural runoff to the railway culvert located 390 m south of Victoria Street.

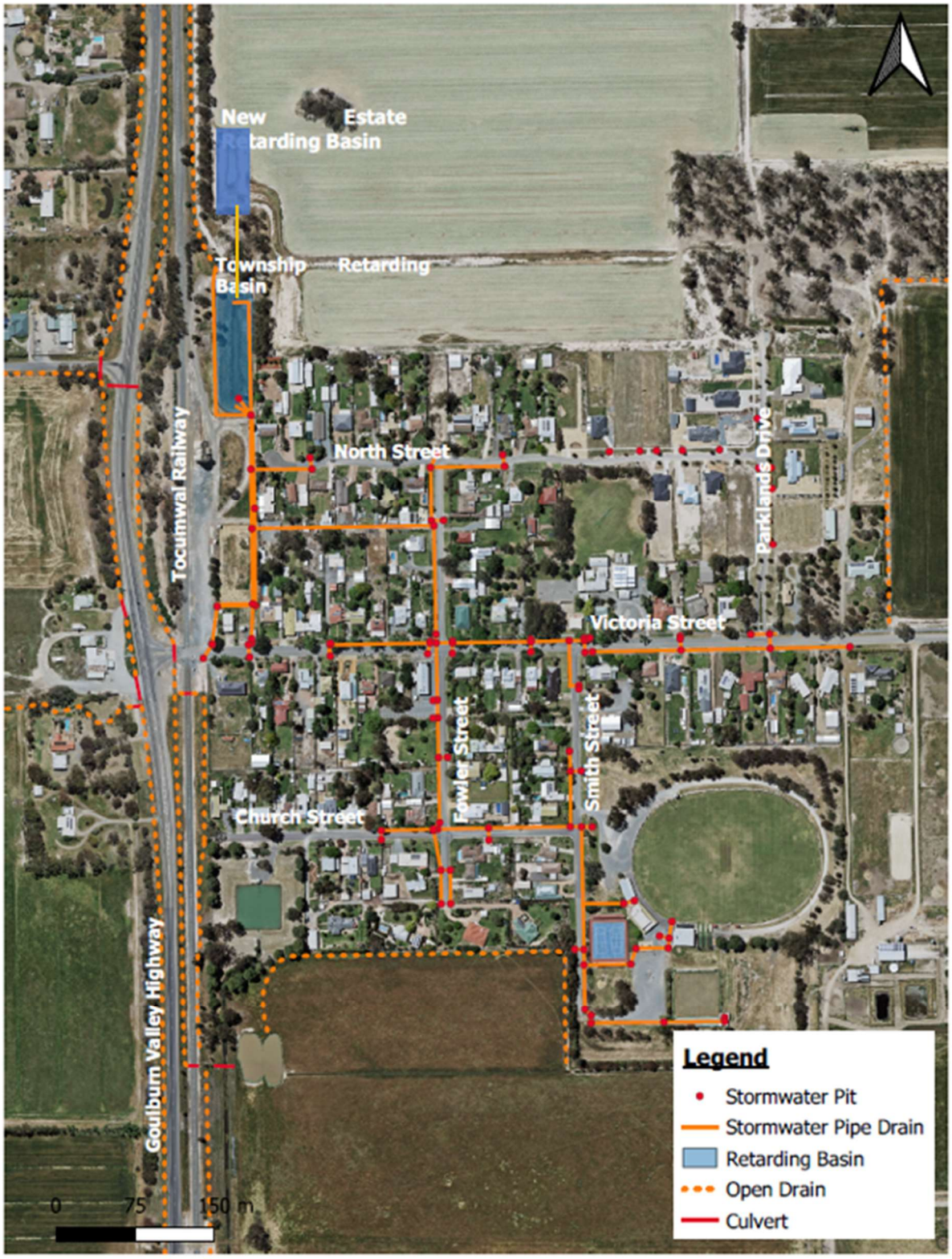


Figure 3 Stormwater Drainage Infrastructure at Tallygaroopna

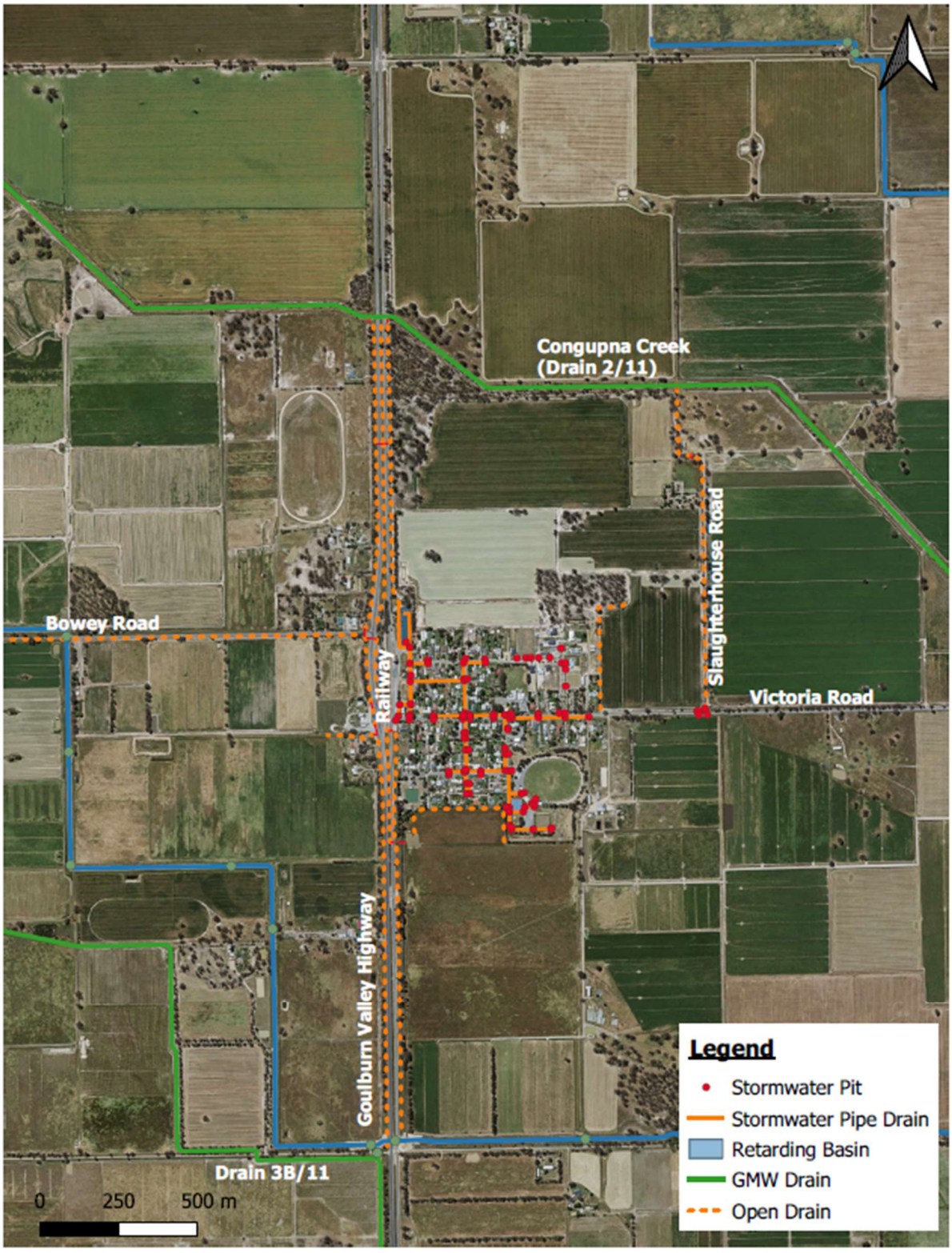


Figure 4 **Drainage Infrastructure at Tallygaroopna**

3 Consultation

3.1 Steering Committee and Community Reference Group

3.1.1 Steering Committee

A Steering Committee was established by Greater Shepparton City Council for the project. The Steering Committee consists of representatives from:

- Greater Shepparton City Council
- Goulburn Broken CMA
- Victorian State Emergency Service (VICSES)

The Steering Committee met on three occasions during the course of the project. Meetings were held as follows:

- Steering Committee meeting 1 (inception meeting) – 27 April 2023
- Steering Committee meeting 2 – 1 August 2023
- Steering Committee meeting 3 – 30 November 2023

3.1.2 Community Reference Group

The Steering Committee oversaw the formation of a Community Reference Group (CRG). The CRG consisted of a mixture of government agency representatives and local residents as follows:

- Greater Shepparton City Council – two members
- Goulburn Broken CMA – one member
- VICSES – one member
- GMW – two members
- Regional Transport – one member
- Community residents - five members

The CRG met on two occasions at meetings held at Tallygaroopna. Meetings were held on:

- Meeting 1 – 14 June 2023
- Meeting 2 – 6 December 2023

Issues raised at the CRG Meeting 1 during discussions are summarised in Table 1.

Table 1 CRG Meeting 1 – Summary of Flood and Drainage Management Issues

Issue Location	Issue Description / Comment (as raised at CRG meeting on 14 June 2023)
Rural runoff from surrounding eastern and southern areas	Runoff from the rural areas adjoining the south and east sides of the township discharges into town, overloading the stormwater drainage system capacity. Rural runoff needs to be diverted around the town.
Whole town - stormwater drainage infrastructure	Stormwater system infrastructure is undersized as identified by the 2014 'Concept Drainage Report' by Heil Consulting. The report identifies that additional retardation volume is required to service runoff from the township area.
Southern edge of township	Rural runoff flows are currently entering the township on the west side of Smith Street opposite the netball courts. This needs to be addressed by ensuring that the rural runoff discharges to the railway / highway bypass drains via the culverts structures at the GVW supply channel and the railway, hence bypassing the town.
Western edge of town, south of Victoria Road	No measures currently in place to prevent runoff from the rural area on the south side of Victoria Road from discharging into the town.
Railway and Highway reserve corridor	The drainage infrastructure present in the railway and highway corridor would benefit from improved maintenance.
Whole town - stormwater pipe and pit network	35 to 40 mm of rainfall is enough to initiate roadway flooding similar to what occurred recently on the 8 June 2023. The resulting runoff exceeds the stormwater system capacity.
Whole town - above floor house flooding	Numerous instances of house above floor flooding thought to have occurred in 2012.
Whole town	Agreement that the 2012 flood at Tallygaroopna was more severe than 1993.
New Woodlands Estate retarding basin	This basin filled on the 8 June 2023. The link pipe connecting the new basin to the old township basin was still sandbagged off at this time prior to commissioning.
Channel 17 siphon at railway / Thompsons Road).	A 5 m opening between the Channel 17 embankment and the railway line embankment at Thompsons Road needs to be sandbagged in flood events to avoid rural runoff discharging through the opening and onwards to Tallygaroopna.
Railway line	The railway line holds back floodwater, exacerbating flooding of Tallygaroopna township.
Inflows to Congupna Creek	The gates on the pipe inflow points to Congupna Creek need to be open, unless flood levels within the creek get high enough to prevent gravity inflows, at which time the gates should be closed to prevent creek flows surcharging back out the pipe drainage inlets.
Bowey Road	Flows discharge westwards under the GV Highway via a large culvert on the south side of Bowey Road. Dumped fill present hinders the discharge of runoff westwards down Bowey Road, resulting in flows being forced northwards down the west side of the GV Highway.
Town retarding basin pump	Pump was not operating in 2012 event, which exacerbated the situation.

3.2 Government Agency Consultation

3.2.1 Greater Shepparton City Council

Council is responsible for the provision of stormwater drainage services at Tallygaroopna.

Stormwater system data supplied by Council is described in Section 4.7 of this report. The stormwater system caters for local runoff from the immediate township area.

3.2.2 Goulburn Broken CMA

The CMA is responsible for floodplain management. This includes the provision of flooding related advice upon request drawing on available flood related knowledge held by the CMA or others.

The 2018-2028 Goulburn Broken Regional Floodplain Strategy (GBCMA, 2018) identified the need for this Scoping Study to develop improved knowledge of flooding conditions at Tallygaroopna.

Flood Data supplied by the CMA included flood height data (refer to Section 4.4 of this report).

3.2.3 Victoria State Emergency Service

The Victoria State Emergency Service (VICSES) is responsible for emergency management in flood events. This includes preparation, response and recovery related activities.

The VICSES provided a list of logged response calls relating to flooding for Tallygaroopna and the surrounding rural area during the 2012 flood.

The VICSES also provided copies of aerial March 2012 flood photography originally obtained by Shepparton News. This includes the cover photograph of this report and the photographs shown in Figures 5 and 6.

3.2.4 Goulburn-Murray Water

GMW supplied GIS data for their rural drainage and supply channel networks in the vicinity of Tallygaroopna. GMW was represented on the CRG.

3.2.5 Goulburn Valley Water

Goulburn Valley Water (GVW) were contacted in the early stages of the project. GVW advised that:

- Wastewater servicing within the township of Tallygaroopna is by individual property private septic tank systems.
- GVW does not have any specific concerns or issues to raise in relation to flooding and drainage related conditions at Tallygaroopna.

3.2.6 VicTrack

VicTrack are responsible for rail infrastructure in Victoria. In response to a written request, VicTrack did not provide any data relating to the railway cross drainage structures, previous drainage reports relevant to Tallygaroopna, or records of flooding impacts on the railway line in the vicinity of Tallygaroopa. VicTrack did not respond to an invitation for a representative from VicTrack to sit on the project CRG.

3.2.7 Department of Transport and Planning – Regional Transport

The Department of Transport and Planning was represented by one of their regionally based officers on the CRG.

Figure 5 Aerial Photograph 1 – 1 March 2012 Flood

Figure 6 Aerial Photograph 2 – 1 March 2012 Flood

3.3 Resident Consultation Activities

3.3.1 Overview of Activities

Consultation with residents of Tallygaroopna encompassed the following activities:

- Representation on the CRG (five local residents on the 14 person CRG).
- Presentation of project information on Council's web site https://shaping.greatershepparton.com.au
- Project resident questionnaire distributed to all residential and other properties at Tallygaroopna.
- Drop in project information exchange session held at Tallygaroopna on the 14 June 2023.
- Follow up interviews with selected residents following the first CRG meeting, the receipt of the completed questionnaires and after the drop in session.

The purpose of the consultation activities was to develop an improved understanding of the impacts of flooding and what residents consider to be influencing these impacts.

3.3.2 Resident Drop-In Session

Seven residents called in during the course of the three hour drop-in session held at the Soldiers Memorial Hall on the 14 June 2023.

A summary of issues raised by the seven residents is provided in Table 2.

Table 2 Drop-In Session – Summary of Issues

Issue Location	Issue Description / Comment (as raised by residents who attended the drop-in session on 14 June 2023)
South side town boundary	Rural runoff flowing into the town on the west side of Smith Street opposite the netball courts. A berm previously prevented this until the berm was lowered / partly removed some years ago.
South end of Slaughterhouse Road	The rural landholder on the south side of Victoria Road opposite Slaughterhouse Road indicated that he would like to direct his surplus drainage water into the Slaughterhouse Road drain, but has indicated he was advised by Council that he could not do this. At the moment, his surplus drainage water runs into town, impacting adversely on the town stormwater system. Surplus runoff from the same property is also discharged westwards to the area on the south side of the town, which can enter the town drainage system at Smith Street.
Fowler Street residential property	The resident of a Fowler Street property indicated that they sandbagged and pumped water to protect their house from flooding in 2012.
Second Fowler Street property	The resident of a second Fowler Street property advised that they have a reliable 2012 peak flood height mark on the door of their garage.
Goulburn Valley Highway – west side drain north of Bowey Road	Comment that flows may be prevented from discharging down the roadside drain due to blockage at driveway access culverts.

3.3.3 Resident Questionnaire

Questionnaires were distributed to all occupied properties at Tallygaroopna. This amounted to:

- Approximately 118 residential properties
- Approximately 5 non residential properties

The questionnaire was also able to be accessed and filled out on-line at Council's web site.

A total of 20 questionnaire responses were received. A summary of information derived from the questionnaires is provided in Table 3.

Table 3 Questionnaire Responses – Summary of Issues

Item	Response Information
Above floor house flooding	1 response
Minor buildings flooding	14 responses
Grounds& roadway flooding	16 responses
Recorded flood height marks available	6 responses
Flood photographs available	8 responses
Features nominated as exacerbating flooding	• Railway line (4 responses) • Runoff from rural areas outside town (4 responses) • Drain blockages (1 response) • Poor stormwater drains (4 responses)
Main flood management issues for Tallygaroopna	• Town retarding basin pump not reliable • Rural runoff inflows • Flat drains • New development (Woodlands Estate)
Possible actions for reducing flood impacts	• Maintain basin pump in working order (3 responses) • Improved railway cross drainage (5 responses) • Divert rural runoff away from town • More maintenance of drains in railway / highway corridor • Fix the Parklands Drive drains
Other issues / comments	• Concern raised that new Parklands Estate drainage may not be adequate • Stormwater inlet in front of Fowler Street bus stop needs attention • Town drainage has not been improved since 2012

3.3.4 On-site Resident Interviews

Following the first CRG meeting, the community drop-in session and the receipt of completed questionnaires, individual residents were contacted to arrange for meetings on-site at Tallygaroopna to discuss issues related to the project. These on-site meetings were conducted in late June and early July 2023.

Interviews were conducted with the occupants of 12 different properties. A summary of information derived from the resident interviews is provided in Table 4.

Table 4 Resident Interviews – Summary of Issues

Issue	Description
Flood height marks from the 2012 flood identified for survey	40 Victoria Street – point on floor of shed 17 Fowler Street – texta mark on inside garage door 12 North Street – point on wall next to front doorway 8 Church Street – top of step, below front verandah 1 North Street – mark drawn and still present on side fence 11 Church Street – mark on external garage wall
Inflows into Congupna Creek	Gates at drainage inlets into Congupna Creek are not always open when they should be open and closed when they should be closed.
Banks at rural channels and drains	Banks were raised between 1993 and 2012 at multiple channels and drains (e.g. Channel 5/17). This diminished the influence of Congupna Creek in 2012.
Bund along town southern edge	This bund was lowered in recent years when a new landholder took over the property. Rural outflows now occur into the town stormwater system at Smith Street opposite netballs courts.
GVW cross drainage culvert	Post 1993, a culvert was installed to discharge rural runoff westwards across a water supply channel south of the Church St GVW facility. Possible that pipe may be blocked or partially blocked.
Church Street above floor house flooding	A person renting a property in Church Street indicated that they are aware that the sunken lounge floor area flooded to above floor level in 2012.
Church Street above floor unit flooding	Person living in the rear unit at this property confirmed the front unit (converted garage) flooded to above floor level in 2012.
Slaughterhouse Road drain	Minimal drain fall limits capacity.
Outfall drain – town retarding basin to Congupna Creek	Requires a clean out. Clogged up with vegetation.
Street sweeping	Leaves clog up the stormwater drainage inlets in autumn. Increased frequency of street sweeping is desirable.
Drainage inlets to Channel 17	Request for GMW to open drainage inlets along the Channel 17 route east of the Goulburn Valley Highway
Railway line cross drainage culverts	Insufficient capacity. Inspection and upgrades desirable.
Rural runoff entering town from east and south	Runoff from the property south of Victoria Road at the eastern side of the town is entering the town stormwater system. It would be very easy to direct runoff from this property into the Slaughterhouse Road drain.
Dainton's Creek	The Dainton's Creek flow path is no longer active north of Channel 17. Inlets ('slides') present into Channel 17 at the two locations where the Dainton's Creek flow path crosses the channel. Runoff draining to Katamatite-Shepparton Road / Lemnos North Road intersection now discharges down Edwards Road within a large continuous drain all the way to the Congupna Creek.
Channel 5/17	Channel 5/17 east of Tallygaroopna acts as a de facto levee. The channel banks have been raised since the 2012 flood.

4 Flood Data Review

4.1 Streamflow Data

The nearest waterway to Tallygaroopna is the Congupna Creek which is located approximately 1 km to the east and north of the town (refer to Figure 1). Pine Lodge Creek is located approximately 3 km to the west of town.

There are no streamflow gauging stations located on either Congupna Creek or Pine Lodge Creek. Flood height gauges have been installed at road crossing locations along each creek route (refer to Section 4.4).

4.2 Historical Rainfall Data

There are no automatic weather stations (AWSs) located in the vicinity of Tallygaroopna. The nearest AWS station is located approximately 21km away at Shepparton Airport.

The closest daily manually read BoM rainfall stations are listed in Table 5. There is no BoM station located at Tallygaroopna township.

The nearest open BoM station is located at Numurkah, 16 km to the north. Rainfalls at these stations are nominally read at 9am on each day (i.e. each daily total is for the 24 hours prior to 9am on that day).

Table 5 BoM Daily Rainfall Stations

Station Number	Station Name	Period Operation	Distance from Tallygaroopna (km)
081076	Tallygaroopna Homestead	1927 - 1941	4
080052	Tallygaroopna State School	1909 - 1950	7
081023	Katandra West	1927 - 1996	11
080101	Numurkah	1968 – still open	16
081125	Shepparton Airport AWS	1996 – still open	21
081013	Dookie Agricultural College	1879 - 2019	28
081051	Tungamah	1889 - 2015	42

4.3 Design Rainfall Data

Design rainfall intensity frequency duration (IFD) data for Tallygaroopna is given in Table 6. The design rainfall data was sourced from the BoM.

Table 6 BoM 2016 Design Rainfall IFD Data at Tallygaroopna

Duration (hours)	Rainfall (mm)						
	50% AEP (1.4 yr ARI)	20% AEP (4.5 yr ARI)	10% AEP (9.5 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)	0.5% AEP (200 yr ARI)
0.5	14	19	23	27	32	37	42
1	17	24	29	33	40	45	51
3	23	32	38	44	52	59	67
6	29	39	46	53	63	71	80
12	35	47	56	65	78	88	100
24	43	59	70	82	99	113	128
48	52	72	87	103	126	144	165
72	56	80	97	115	141	163	187

4.4 Flood Heights

4.4.1 Creek System

Congupna Creek

Recorded flood heights along Congupna Creek were available in the form of the recorded staff heights at three road crossings New Dookie Road, Tungamah Congupna Road and Katamatite Shepparton Road, and from data within the Victorian Spatial Data Specification (SDS), previously the Victorian Flood Database (VFD).

Recorded flood heights for Congupna Creek are provided in Table 7. The 1993 recorded flood heights are higher than the 2012 heights with the exception of immediately upstream and downstream of the Railway / Goulburn Valley Highway crossing, and at McKenzie West Road, where the 2012 heights are higher. The reason for this is unknown.

Pine Lodge Creek

Recorded flood heights along Pine Lodge Creek were available in the form of the recorded staff heights at three road crossings New Dookie Road, Lemnos North Road and Katamatite Shepparton Road, and from the data within the SDS.

Recorded flood heights for Pine Lodge Creek are provided in Table 8. The 1993 Pine Lodge Creek recorded flood heights are all higher than the 2012 heights.

Nine Mile Creek / Boosey Creek

Recorded flood levels within the SDS indicate that the recorded Nine Mile Creek and Boosey Creek system 2012 flood levels were higher than the 1993 flood levels, in contrast to the Congupna Creek and Pine Lodge Creek. The reason for this is the Nine Mile Creek and Boosey Creek flood levels were triggered by local catchment runoff, not Broken River breakaway inflows as was the case for Congupna Creek and Pine Lodge Creek.

Table 7 Congupna Creek – Recorded Flood Heights

Location	Source	Flood Height (m or m AHD)	
		October 1993	March 2012
New Dookie Road	Staff	2.06	1.65
Tungamah-Congupna Road	Staff	2.94	2.51
Katamatite Shepparton Road	Staff	2.58	2.23
Katamatite Shepparton Road	VFD / SDS	110.09	109.63
Edwards Road	VFD / SDS	109.04	108.86
Victoria Road	VFD / SDS	108.57	108.43
Upstream Railway	VFD / SDS	**107.15**	**107.21**
Downstream of GV Highway	VFD / SDS	**106.83**	**106.91**
McKenzie Road West	VFD / SDS	**106.08**	**106.18**

Table 8 Pine Lodge Creek – Recorded Flood Heights

Location	Source	Flood Height (m or mAHD)	
		October 1993	March 2012
New Dookie Road	Staff	2.58	1.95
Lemnos North Road	Staff	2.36	2.21
Katamatite Shepparton Road	Staff	2.45	2.30
Katamatite Shepparton Road	VFD / SDS	110.54	110.15
Upstream of Railway	VFD / SDS	109.41	108.70
Downstream GV Highway	VFD / SDS	109.23	108.76
Wisely Road	VFD / SDS	106.97	106.49
Bowey Road	VFD / SDS	106.86	106.31
McKenzie West Road	VFD / SDS	106.20	105.78
Boundary Road (downstream of Congupna Creek inflows)	VFD / SDS	105.81	105.34

4.4.2 Tallygaroopna Township

There are 14 flood height marks at Tallygaroopna within the Victorian SDS. During the community consultation undertaken for this scoping study, a further six flood height marks for the March 2012 flood were identified and subsequently surveyed in July 2023. Details for these additional flood height marks are provided in Appendix A.

With the addition of the six newly obtained flood height marks, there are a total of 20 recorded flood heights at Tallygaroopna township. Details for each flood height are provided in Table 9. Summary details are:

- Nine marks for the March 2012 flood surveyed in 2012:
    - Eight marks located upstream of the railway
    - Eight marks vary from 107.05 to 107.26 m AHD
    - Average height for the eight marks is 107.15 m AHD
    - One mark located downstream of the railway – 106.95 m AHD
- Six marks for the March 2012 flood surveyed in 2023:
    - All six marks located upstream of the railway
    - Six marks vary from 107.17 to 107.32 m AHD
    - Average height for the six marks is 107.24 m AHD
- Five marks for the October 1993 flood:
    - All five marks located upstream of the railway
    - Five marks vary from 106.95 to 107.09 m AHD
    - Average height for the five marks is 107.01 m AHD

The average height of the above 2012 flood height marks is 0.16 m higher than the average height for the 1993 recorded flood height marks.

Figure 7 **Recorded Flood Height Marks**

Table 9 Recorded Flood Height Marks

Mark No.	Mark Description	Event	Year surveyed	Elevation (m AHD) Survey in 2012	Reliability Assigned
21218	Victoria St – just west of Fowler St	March 2012	2012	107.10	High
21220	North side Victoria St – 50 m east railway line	March 2012	2012	107.18	Medium
21222	West side GV Highway – just south of Victoria St	March 2012	2012	106.95	Low
21224	North side of Church St – 180 m west of Fowler St	March 2012	2012	107.16	High
21226	Fowler St – just north of Church St	March 2012	2012	107.15	Medium
21228	Smith Street – 110 m south of Church St	March 2012	2012	107.26	High
21230	North St – just west of Fowler St	March 2012	2012	107.05	Medium
21235	North side of North St – 120 m west of Fowler St	March 2012	2012	107.16	High
21237	Victoria St – 40 m east of Parkland Dr	March 2012	2012	107.16	High
4008	South side of North St – 100m west of Fowler St	October 1993	1993	106.95	Low
4017	North side of North St cul de sac	October 1993	1993	107.09	Low
4066	South side of Victoria St – 60 m east of railway	October 1993	1993	106.96	Low
4102	East side of Fowler St – 50 m south of North St	October 1993	1993	106.96	Low
250809	Victoria St at railway	October 1993	1993	107.09	High
FM2023-T1	40 Victoria Street	March 2012	2023	107.18	Medium
FM2023-T2	17 Fowler Street	March 2023	2023	107.32	Medium
FM2023-T3	8 Church Street	March 2012	2023	107.27	Medium
FM2023-T4	12 North Street	March 2012	2023	107.17	Medium
FM2023-T5	1 North Street	March 2012	2023	107.26	High
FM2023-T6	11 Church Street	March 2012	2023	107.26	High

Note:

1. Mark locations are shown on Figure 7.
2. FM2023 mark details are provided in Appendix A of this report.

4.5 Ground Elevation Data

LiDAR data for Tallygaroopna and the broader surrounds was obtained in 2022 as part of a broad scale Victorian State Government program (Coordinated Imagery Program). The 2022 LiDAR data was the principle terrain data source used during the scoping study.

Additional survey points were obtained during the July 2023 flood height mark survey for comparison with the LiDAR elevation data. The points obtained for this purpose are located at the netball / tennis courts at the Recreation Reserve. This comparison exercise identified that the LiDAR elevations are within +/- 0.02 m of the July 2023 GPS acquired survey elevations at the same locations, confirming the accuracy of the acquired LiDAR ground elevation data.

4.6 Aerial Flood Imagery

Aerial flood imagery at Tallygaroopna was available as follows:

- Oblique aerial photography of the 2012 flood as shown on Figures 5 and 6 (acquired by Shepparton News, 1 March 2012).
- Vertical aerial photography of the 2012 flood supplied by the Goulburn Broken CMA (acquired on the 5 March 2012). This imagery is shown below in Figure 8.
- Vertical aerial photography of the October 1993 flood (HydroTechnology, 1995). This imagery is shown in Figure 9.

Figure 8 2012 Aerial Flood Photography – 5 March 2012

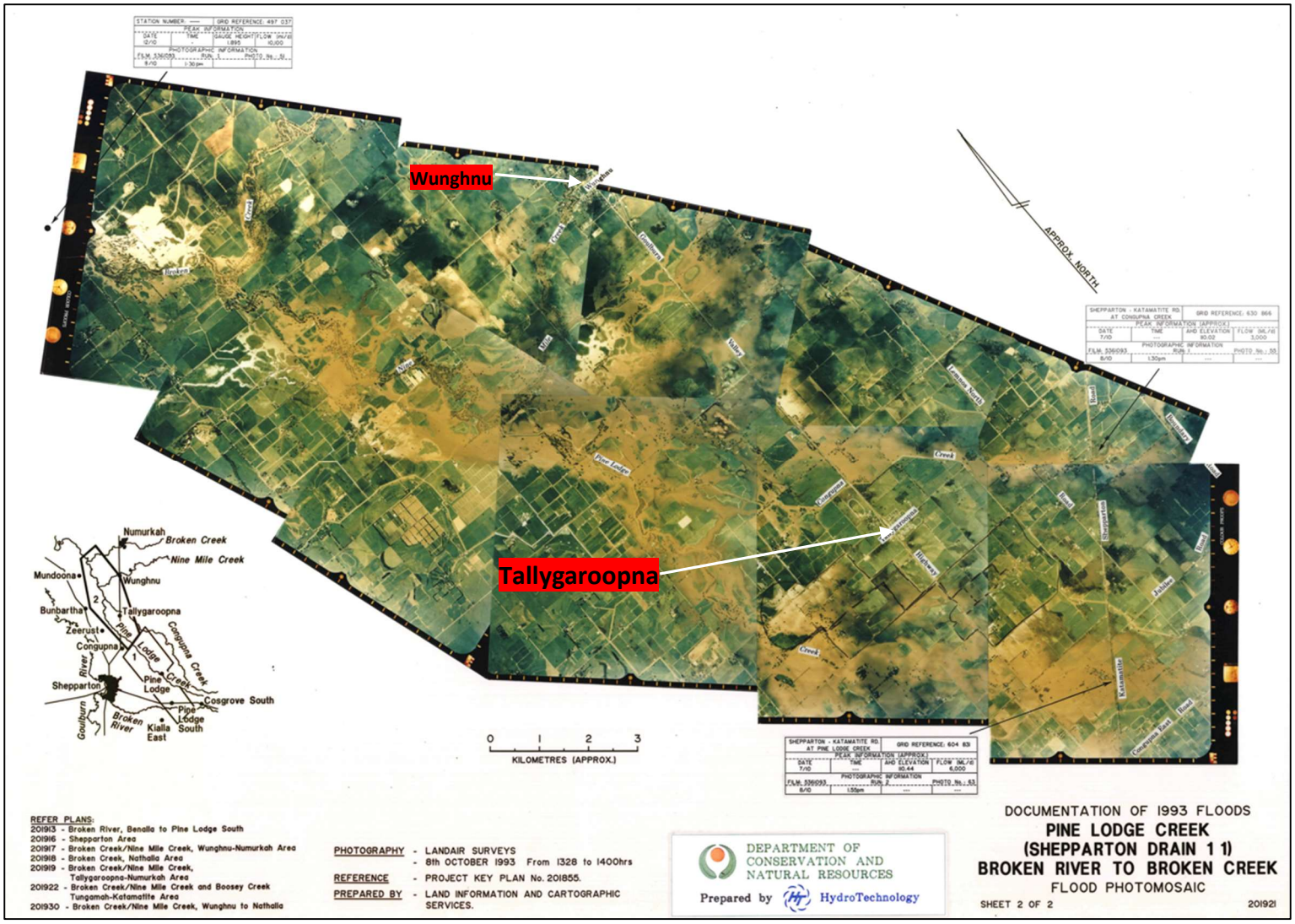


Figure 9 2012 Aerial Flood Photography – 5 March 2012

4.7 Drainage Infrastructure

4.7.1 Council Stormwater Drainage

Greater Shepparton City Council supplied data of their stormwater drainage infrastructure at Tallygaroopna. Stormwater drainage infrastructure is shown on Figure 3.

The stormwater plan and report data supplied by Council included:

- 2017 detailed design plans of a new stormwater pipe and swale cut-off drain across the northern boundary of the Recreation Reserve.
- 2014 Tallygaroopna Drainage Investigation – Concept Design Report (Heil Engineering Consultants). The 2014 report concludes:
    - The pipe network is in general undersized with capacity less than 5 year ARI (equivalent to approximately 20% AEP).
    - The existing township retarding basin cannot cater for a 5 year ARI storm. The basin requires an additional 11,400 m^3 of storage capacity in addition to the existing 5,100 m^3 (i.e. total storage required 16,500 m^3) to service the existing township area.
    - An additional 7,800 m^3 of storage is required to service the ultimate Woodlands (now Parklands) Estate development.
- 2014 SPINE 1 Network Drainage Upgrade Works detailed design drawings. These design drawings show a stormwater pipe drain upgrade between the northern end of Smith Street and the Railway reserve, south of the township retarding basin. The works are for a 675 mm diameter upgrade pipe, 420 m in length replacing the existing 375 and 450 mm diameter pipes.
- 2021 concept design plan for drainage infrastructure on the north side of Tallygaroopna (refer to Figure 10). The 2021 concept plan shows:
    - Retardation basin for the Stage 1 Parklands Estate located adjacent to the Railway reserve, located approximately 80 m north of the existing township retarding basin.
    - New stormwater pipe drain extending northwards down Fowler Street into the Parklands Estate and then discharging westwards to the estate retarding basin.
    - A future retarding basin located immediately north of the Parklands Estate. This basin is flagged as replacing the existing township basin to service the existing township, with expansion possible to also service Stages 2, 3 and 4 of the Parklands Estate.
    - Existing township basin is flagged to be abandoned and backfilled once the new township basin is established.
- Detailed design plans of the Parklands Estate Stage 1 (2016 plans) and Stages 2 to 4 (2022 plans).

The new Parklands Estate retarding basin is connected to the existing township basin by pipes ('balancing pipes').

Outflows from the town stormwater system continue to be pumped from the existing township retarding basin via a 400 mm diameter rising main to a large open channel drain which parallels the east side of the railway on route to Congupna Creek (Drain 2/11), 900 m north of the retarding basin (refer to Figure 4). Inflows to Congupna Creek are via a 450 mm pipe inlet. A second higher inlet in the form of a 1200 mm diameter half pipe is also present at the Congupna Creek inlet site.

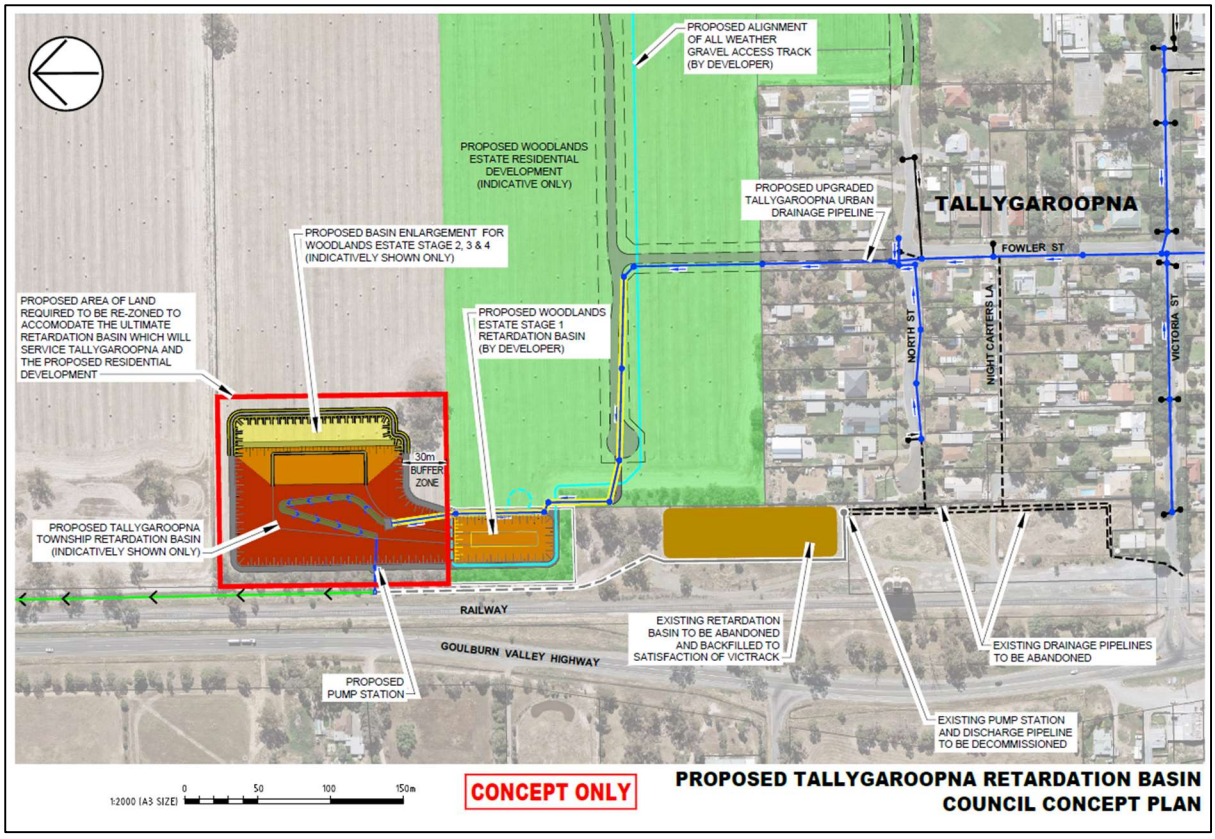


Figure 10 2021 Concept Plan for Township Stormwater Upgrades

4.7.2 Railway and Goulburn Valley Highway Drainage Infrastructure

Drainage culverts under the Tocumwal railway line are shown on Figure 4. Railway culverts are located as follows:

- 600 mm diameter culvert located 390 m south of Victoria Street, 100 m south of the town southern limit. This culvert discharges rural runoff to an open drain discharging northwards between the railway line and the highway.
- Twin 300 mm diameter culverts 40 m south of Victoria Street. This culvert discharges runoff from the road reserve to an open drain discharging northwards between the railway and highway.
- Four cell 375 mm diameter culverts located 870 m north of Victoria Street connecting the open drain on the east side of the railway to an adjoining culvert structure under the highway.

Drainage culverts under the Goulburn Valley Highway are shown on Figure 4. Highway culverts are located as follows:

- 1200 x 300 mm diameter box culvert located 20 m south of Bowey Road.
- Twin cell 1200 x 300 mm box culvert located 870 m north of Victoria Street adjacent to a railway culvert. Adjoins the four cell 375 mm diameter railway culvert.

The open drains present within the Goulburn Valley Highway and railway reserve opposite Tallygaroopna discharge to the corner of the Highway and Bowey Road. A flow split occurs at this point with some flow discharging northwards down the Highway to Congupna Creek and the remaining flow discharging westwards down Bowey Road to Pine Lodge Creek. The two routes are described as follows:

- Goulburn Valley Highway route
    - Length 1,000m
    - Indicative fall – 1 in 2,400
    - Culverts – three 300 mm diameter driveway access culverts and one 450 mm diameter access culvert
- Bowey Road route
    - Length 3,300m
    - Indicative fall – 1 in 6,000
    - Culverts – nine access culverts varying in size from as small as 300 mm in diameter.

Both routes have less than desirable fall and capacities which are limited by small access culverts. The GV Highway route is the shortest route with the most fall and is therefore expected to discharge the majority of the flow.

4.7.3 Rural Drainage Infrastructure

Tallygaroopna township is surrounded by rural land use properties. The natural fall at Tallgaroopna is in a north westerly direction (refer to Figure 1). Rural runoff therefore has the potential to discharge into the township from the west and south of the town.

The following drainage infrastructure is present to cater for rural runoff discharging towards the town:

- Drain in Slaughterhouse Road. This drain was upgraded after the 2012 flood. The drain collects runoff discharging westwards down Victoria Road. The drain effectively intercepts all runoff discharging westwards between Victoria Road and Congupna Creek. The drain discharges into Congupna Creek via a 450 mm diameter inlet.
- Drainage outlet near the south east corner of the township. A culvert is present under the supply channel leading to the raw water storage site in Church Street (refer to Figure 3). Rural runoff discharging towards the southern fringe of Tallygaroopna is intended to discharge to this culvert, subsequently bypassing the township via the railway and highway reserve drainage system. A low level bund around the township southern boundary assists this. For whatever reason (e.g. blockage of culvert, partial removal / lowering of bund at Smith Street), rural runoff flows have been observed in recent flood events to enter the township at Smith Street, opposite the netball courts.

Goulburn Valley Water (GVW) has advised that Council now use the water stored in the Church Street raw water storage to irrigate the oval at the Recreation Reserve. GVW have advised that maintenance of the drainage culvert under the supply channel leading to the raw water storage is either a GMW or Council responsibility. GMW have advised that the drainage culvert is not their responsibility. This leaves Council as arguably being responsible for the cross drainage culvert under the supply channel leading to the raw water storage.

Rural runoff also enters the township via the property on the south side of Victoria Road, on the eastern fringe of the town. Runoff discharges into the town down Victoria Road and along the Recreation Reserve boundary.

4.8 Review of March 2012 Flood Event

The March 2012 flood was a widespread event across northern and north eastern Victoria. It was particularly notable for having some of the highest ever recorded cumulative seven day rainfall totals of up to 300 mm.

Rainfall data from the nearest BOM daily read stations to Tallygaroopna are summarised in Table 10. The highest 24 hour totals occurred in the preceding 24 hours to 9am on the 28 February (between 92 and 124 mm) and the 24 hours to 9am on the 1 March (between 79 and 103 mm). No rainfall was recorded for the 24 hours to 9am on the 29 February (2012 being a leap year).

Tungamah located 42 km to the east of Tallygaroopna recorded a seven day cumulative total of 300 mm between the 27 February and the 4 March. This notably included 124 mm on the 28 February and 103 mm on the 1 March (to 9am on these days).

By comparison, Dookie Agricultural College located 28 km south-east of Tallygaroopna recorded 92 mm on the 28 February and 81 mm on the 1 March. Numurkah located 16 km north of Tallygaroopna recorded 100 mm on the 28 February and 79 mm on the 1 March. Shepparton Airport located 21 km south of Tallygaroopna recorded 41 mm on the 28 February and 72 mm on the 1 March.

Table 10 Rainfall Data – February / March 2012 Event

Source Station	Date	Rainfall to 9am (mm)
Numurkah	28.2.2012	100.0
	29.2.2012	0.0
	1.3.2012	79.0
	2.3.2012	0.0
Shepparton AWS	28.2.2012	41.6
	29.2.2012	0.0
	1.3.2012	72.6
	2.3.2012	0.0
Tungamah	28.2.2012	124.4
	29.2.2012	0.0
	1.3.2012	103.6
	2.3.2012	8.4
Dookie Agricultural College	28.2.2012	92.6
	29.2.2012	0.0
	1.3.2012	81.8
	2.3.2012	0.2

A comparison of the available 2012 rainfall event data with design IFD data (refer to Table 6) reveals the following:

- Assuming a 72 hour cumulative total of 180 mm at Tallygaroopna for the 2012 event, this is equivalent to in excess of a 1% AEP 72 hour duration design rainfall event.
- Assuming a 24 hour total of 100 mm at Tallygaroopna for the 2012 event, this is equivalent to a 2% AEP 24 hour duration design rainfall event.

Although rainfall for the 24 hours to 9am on the 1 March 2012 was not as high as that compared to the 24 hours to 9am on the 28 February, flooding at Tallygaroopna is expected to have been more severe on the 1 March due to the catchment being in a saturated condition prior to the rainfall. Media reports at the time would appear to support this. Shepparton News acquired aerial photographs taken just after 1pm on the 1 March 2012 show widespread inundation in parts of the town (refer to Figures 5 and 6). Anecdotal accounts would suggest that the aerial photography was taken close to the peak of flooding.

Recorded flood levels at Tallygaroopna for the 2012 event are on average 0.16 m higher than those recorded for the 1993 event. Flooding at Tallygaroopna in 2012 was therefore more severe in 2012 compared to 1993. The reason for this was the much higher rainfall in 2012 compared to 1993, which resulted in higher flood levels associated with local runoff flooding from the town area itself, and the rural areas to the east and south of the town.

The 2012 recorded flood heights at Tallygaroopna on the east side of the Tocumwal Railway vary from 107.05 to 107.32 m AHD, with the average height being 107.17 m AHD. The one recorded 2012 flood height on the downstream side of the Goulburn Valley Highway is 106.95 m AHD.

The top of the railway line at Tallygaroopna varies from 107.3 to 107.6 m AHD. The high point along the Goulburn Valley Highway varies from 107.4 to 107.5 m AHD. Flood levels at Tallygaroopna in 2012 did not therefore overtop either the railway or the highway directly opposite the township, peaking approximately 0.2 metres below the railway line and a similar height below the highway road crest.

4.9 Review of October 1993 Flood Event

The October 1993 flood was a widespread event in northern and north eastern Victoria. Flooding recorded for the Broken River was the most severe on record. Consequently there were record amounts of breakaway flows into the creek network north of the Broken River on the east side of Shepparton. This resulted in severe flooding along Pine Lodge Creek and Congupna Creek causing extensive rural flooding along these creek routes.

Rainfall data for the October 1993 event from the nearest BoM daily read stations is summarised in Table 11.

Regional data strongly suggests that the majority of rainfall in this event occurred in the 24 hours prior to 9am on the 4 October. Assuming a total of 100 mm at Tallygaroopna for this period (high end estimate), this would be equivalent to a 2% AEP 24 hour duration design rainfall event based on a comparison with the BoM design IFD data (refer to Table 6).

Table 11 Rainfall Data – October 1993 Event

Source Station	Date (rainfall to 9am on given date)	Rainfall (mm)
Tungamah	1.10.1993	4.0
	2.10.1993	18.8
	3.10.1993	3.6
	4.10.1993	60.8
Dookie Agricultural College	1.10.1993	5.4
	2.10.1993	11.6
	3 and 4.10.1993	111.4

4.10 Review of October 2022 Flood Event

A widespread flood occurred across large parts of Victoria in October 2022. Rainfall total recorded for the 48 hours to 9am on Friday 14 October 2022 were 76 mm at Shepparton AWS, 67 mm at Yarrawonga AWS and 72 mm at Numurkah.

Rainfall intensities for this event were generally only moderate. Based on the Shepparton AWS data, the maximum one hour rainfall was only 5 mm, occurring on the Thursday evening towards the later part of the event.

Significant rainfall ceased at about midnight on the Thursday. The majority of the rainfall therefore occurred during a 40 hour window. A comparison with BOM design IFD data (refer to Table 3) revealed the following equivalent rainfall severity for the event:

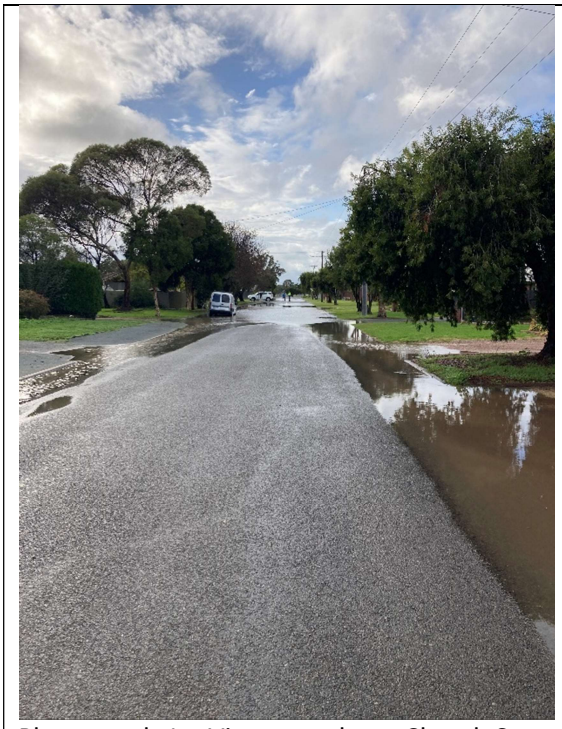
- 76 mm of rainfall in 40 hours is equivalent to a 15 % AEP design rainfall event (8 year ARI event)
- 57 mm of rainfall in 24 hours is equivalent to a 20% AEP design rainfall event (4.5 year ARI event)

4.11 Review of June 2023 Flood Event

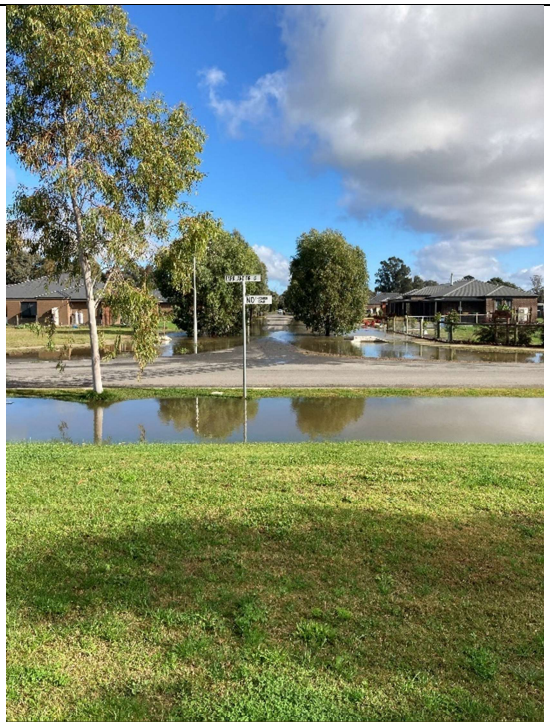
A significant rainfall event occurred in the 24 hours prior to 9.00am on Thursday 8 June 2023 during the early stages of the scoping study project. Three residents reported rainfall in private gauges within the town of 65 mm for the preceding 24 hours. This is equivalent to between 20 to 10% AEP design 24 hour duration rainfall.

An on-site inspection at Tallygaroopna between 9am and noon on the 8 June 2023 revealed the following (refer to Figure 11):

- Significant roadway flooding in Church Street
- Rural runoff inflows into the town system at Smith Street opposite the netball courts
- Rural runoff flows into the town system at the east boundary of the Recreation Reserve
- Flows in the open drains within the railway and highway corridor moving very slowly
- Extensive roadside flooding in Parklands Drive and the east end of North Street
- Parklands Estate basin full, township basin empty



Photograph 1 – View east down Church St towards Fowler St



Photograph 2 – View west across Parklands Drive down North Street

Photograph 3 – GV Highway roadside drain at Victoria Street, looking north

Photograph 4 – Council drain into Congupna Creek

Figure 11 Photographs – 8 June 2023 Flood Event

4.12 Review of Pre 1990 Events

Other flood years prior to 1993 which have been previously nominated as significant floods at Tallygaroopna are 1919, 1939, 1956 and 1974. These events are described as follows:

- **1919 Event.** A review of available BoM daily rainfall data for 1919 does not reveal any 24 hour rainfall totals over 50 mm. A total of 46 mm was recorded for the 24 hours to 9am on the 18 February at Invergordon.
- **1939 Event.** The nearby Katandra West BoM rainfall station was operating during 1939. The highest 24 hour total recorded in 1939 was 49 mm on the 14 April. Consecutive day totals of 42 mm and 45 mm were recorded on the 26 and 27 February.
- **1956 Event.** The nearby Katandra West rainfall station was operating during 1956. The highest 24 hour total recorded in 1956 was 60 mm on the 13 March. The next highest 24 hour total was 45 mm on the 16 May.
- **1974 Event.** The nearby Katandra West rainfall station was operating during 1974. The highest 24 hour total recorded in 1974 was 38 mm on the 15 May, following 30 mm the preceding day.

No further detailed accounts are available describing flooding conditions at Tallygaroopna for the above events. The above rainfall figures would however suggest that these events were considerably less severe in comparison to the 2012 event and to a lesser extent the 1993 event.

4.13 Post March 2012 - Council Tallygaroopna Flood Mitigation Project

Greater Shepparton City Council undertook a flooding and drainage improvement project following the March 2012 flood event at a number of towns including Tallygaroopna. Available documentation suggests that the project commenced with a community meeting at Tallygaroopna on the 2 May 2012, at which residents in attendance made suggestions and comments in relation to possible actions to alleviate flooding and drainage issues.

Council subsequently prepared a Tallygaroopna Mitigation Works plan documented on an undated plan (refer to Figure 12). Notable immediate priorities nominated by the plan are for:

- Upgrades to the town's stormwater drainage system including the pipe collector network, the retarding basin storage volume, the retarding basin pump facility and the outfall drain between the basin and Congupna Creek.
- Raising the height of the channel bank at GMW 5/17.
- Construction of a new culvert at Victoria Road / Slaughterhouse Road.
- Review of drainage arrangements where rural runoff enters the town.

Works which are understood to have been completed since 2012 include an upgrade of the Slaughterhouse Road drain, and raising of the GMW Channel 5/17 bank.

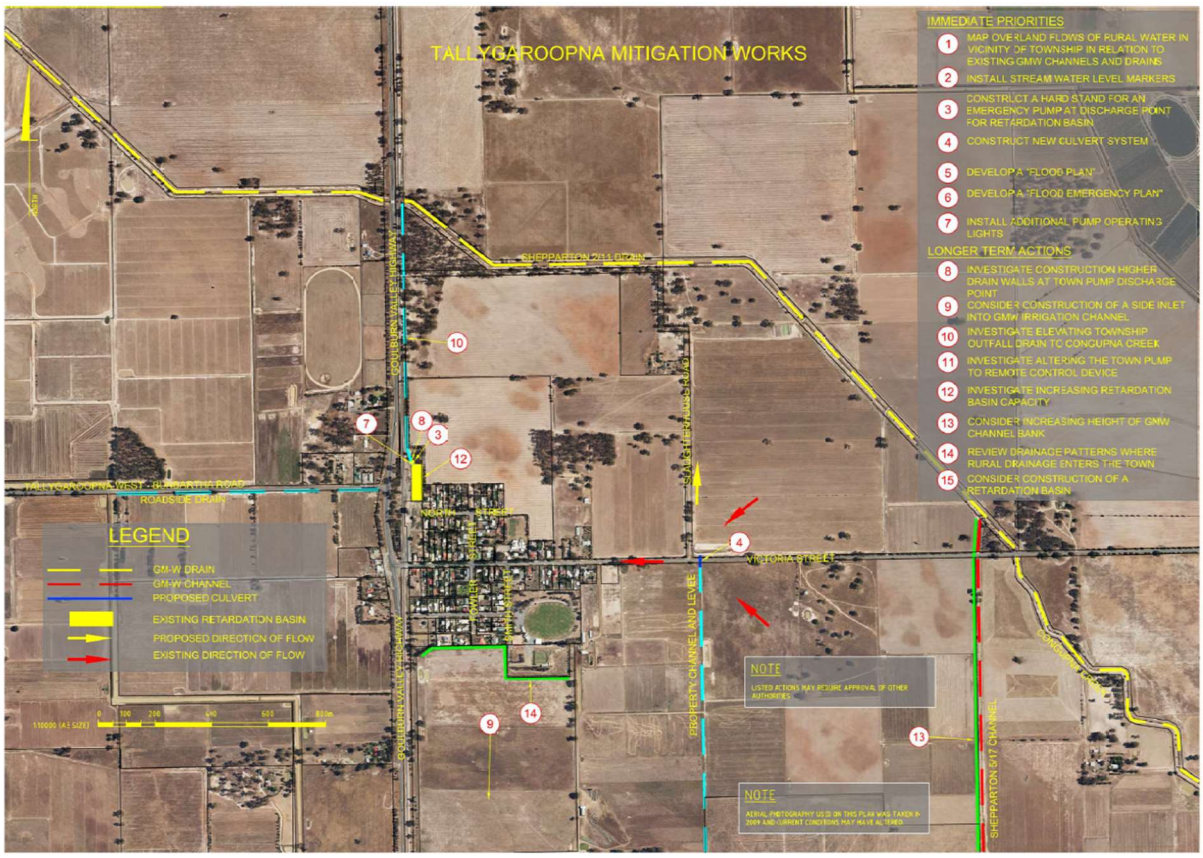


Figure 12 Tallgaroopna Drainage Improvement Plan – Post 2012 Event

4.13.1 GSCC - Flood Emergency Plan – A Sub-Plan of the MEMP (August 2018)

Appendix C4 of this 2018 document is specific to Tallygaroopna. It includes:

- Flood history focusing on March 2012 and October 1993 events. March 2012 described as a flash flood event. The other flood years nominated are 1919, 1939, 1956 and 1974.
- States that the highest flooding at Tallygaroopna occurred in 1993 (incorrect, as 2012 was higher).
- Extensive details provided in regards to the Broken River and the creek system flood height gauge network.

4.13.2 SES - Local Flood Guide – Tallygaroopna (2020)

This document includes:

- A description of flooding.
- Tallygaroopna rainfall thresholds and expected impacts:
    - 50 mm – described as not likely to cause any significant flooding in the area.
    - 75 mm – may cause water to reach the top of creek banks, come up through drains in streets, cover local roads, and inundate property grounds and out buildings.
    - 125 mm – may cause overbank flooding, threaten buildings, require evacuation in some areas and cover main roads.
    - 150 mm may threaten to flood houses and businesses, require many evacuations, result in isolation, disrupt major roads and transport routes.
    - 200 mm – likely to result in widespread flooding similar to 2012 event.
- Explanation of generic BOM and VICSES warnings / alerts.
- Generic guidelines for preparing for floods.

4.14 House Floor Level Elevation Data

At the Steering Committee meeting held on the 1 August 2023, it was decided that a floor level elevation survey would be undertaken for all existing 118 houses at Tallygaroopna township.

The floor level elevation survey was subsequently undertaken by Chris Smith & Associates in October 2023. Floor levels were obtained based on a vertical specification tolerance of +/- 0.03 m.

The only known houses not able to be surveyed / or not surveyed were:

- House at 4 North Street (not accessible)
- Front unit at 4 Church Street (rear main unit only surveyed)

5 Mapping

5.1 Approach

This scoping study project has not encompassed any hydraulic modelling. Modern flood studies use two dimensional hydraulic modelling techniques to simulate flooding conditions, producing a flood surface for a range of flow conditions. Outputs include the varying flood height, depth, velocity and extent within the model area.

The intent of this scoping study was to produce rudimentary flood mapping outputs with the available data, without going to the extent of undertaking hydrologic and hydraulic modelling as is the case for a full flood study.

One of the principal outputs of a flood study is the 1% AEP flood heights. The 1% AEP flood heights are commonly used for setting minimum floor level elevations for new development.

Given the absence of detailed historical flood data at Tallygaroopna, it is not possible to definitively assign the March 2012 event as equivalent to a specific AEP event. Based however on the available rainfall data for the 2012 event and the clear anecdotal accounts that indicate the event to be the most severe flooding that has occurred at Tallygaroopna in living memory, it is reasonable to conclude that the Tallygaroopna 2012 flood was equivalent to in the vicinity of a 1% AEP event. The rainfall data review of the 2012 event supports this assertion (refer to Section 4.8).

5.2 Point Flood Heights

Flood height data available at Tallygaroopna is limited to the following March 2012 data (refer to Section 4.4.1):

- Nine flood height marks originally surveyed in 2012 shortly after the flood event
- Six flood height marks identified and surveyed in July 2023 as part of the current project

The location of the above flood height marks is shown on Figure 7. The flood height mark elevations are listed in Table 9.

5.3 Local Catchment Area – Tallygaroopna Township

The LiDAR ground surface elevation data was used to identify the rural catchment area draining towards Tallygaroopna township. The indicative catchment area draining to Tallygaroopna is shown on Figure 13.

The general direction of natural fall at Tallygaroopna is in a north westerly direction. Rural runoff draining towards the town is therefore limited to areas south and east of the township.

5.3.1 Area North of Victoria Road

The Congupna Creek is effectively the eastern catchment boundary of rural catchment runoff impacting on Tallygaroopna. The area bounded by Congupna Creek, Victoria Road and Slaughterhouse Road (approximately 75 ha) drains westwards to the open drain aligned down Slaughterhouse Road. The Slaughterhouse Road drain discharges into Congupna Creek.

The intervening rural area between Slaughterhouse Road and the eastern edge of town drains into a farm reuse system. The area between the northern edge of town and Congupna Creek drains westwards to the township outfall drain on the east side of the railway line which in turn discharges into Congupna Creek at the 450 mm diameter drainage inlet on the upstream of the railway bridge.

The rural catchment area on the north side of Victoria Road draining into Tallygaroopna township is therefore minimal.

5.3.2 Area South of Victoria Road

The indicative rural catchment area on the south side of Victoria Road draining to Tallygaroopna is shown on Figure 13. The indicative catchment area is 250 hectares.

Features influencing the discharge of runoff towards Tallygaroopna include the natural terrain slope, GMW's drainage and supply channel network, farm supply and drainage channel infrastructure and the road network.

The runoff from 250 hectares in a severe event such as 2012 will be sufficient to overwhelm the town drainage system. The town drainage system has been designed to cater for runoff from approximately 40 hectares (increasing to 50 hectares after the Parklands Estate is completed).

Rural runoff from south of Channel 17 as it parallels Thompsons Road drains westwards towards the Goulburn Valley Highway. In large flood events, this runoff can then discharge northwards via the drain parallel with the railway line, thereby draining to Tallygaroopna. This can be prevented however by erecting a temporary levee bank within the opening between the railway embankment and Channel 17, as occurred in 2012.

At the time of this project, a local resident of Tallygaroopna was lobbying GMW to have a drainage inlet into Channel 17 reopened (SP805 – located 600m west of the Goulburn Valley Highway), to reduce the amount of rural runoff potentially draining northwards via the railway corridor into Tallygaroopna township during large flood events.

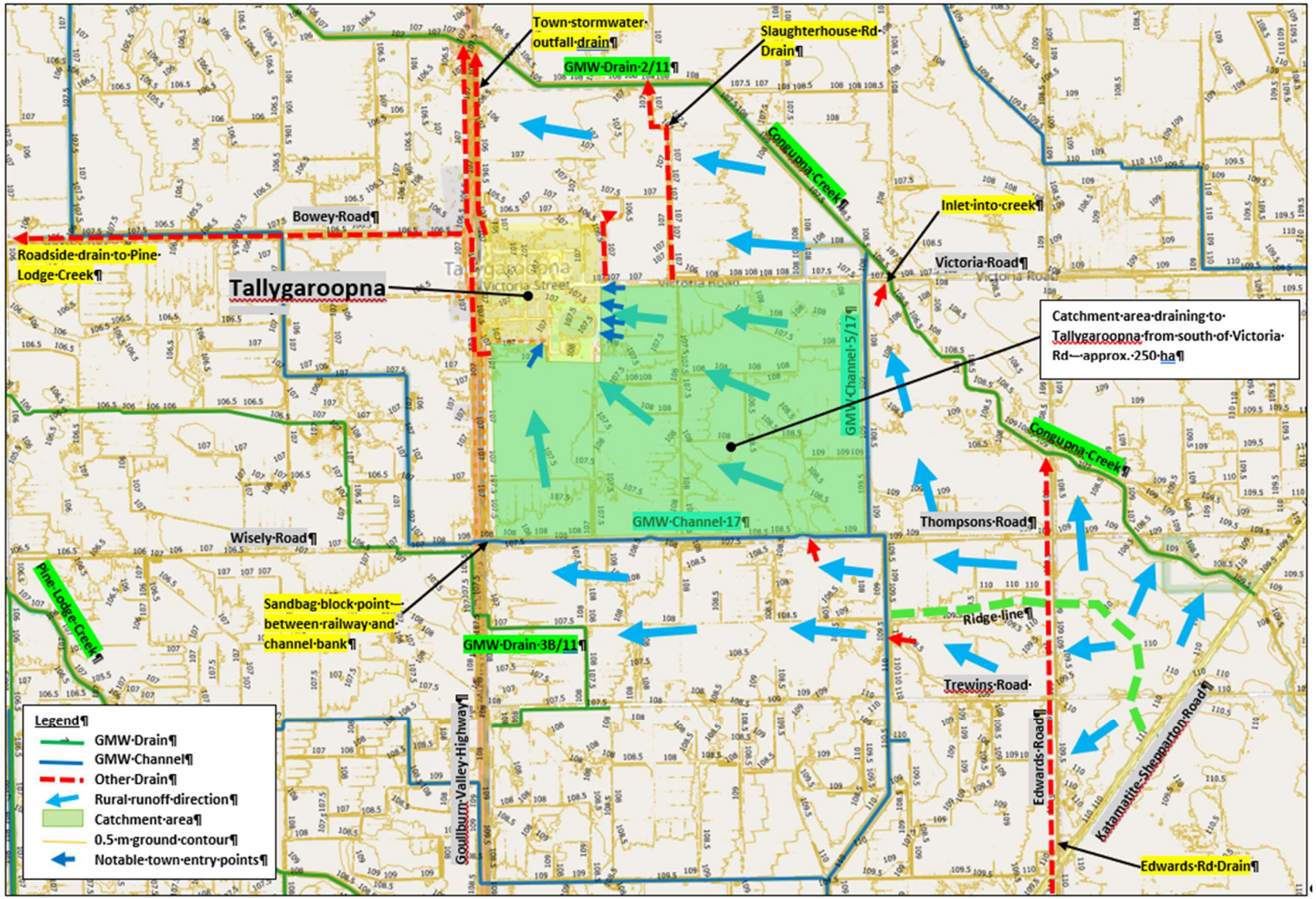


Figure 13 Tallygaroopna Township Catchment Plan

5.4 1% AEP Flood Height

The available 2012 event flood height data was used to inform the 1% AEP flood height at Tallygaroopna.

House floor level elevation data obtained for this study in combination with the questionnaire and interview data was also taken into account when considering what the 1% AEP flood height should be.

The 1% AEP flood height at Tallygaroopna has been 107.15 m AHD since it was adopted by the Goulburn Broken CMA in 2008 as part of a flood mapping project undertaken at that time. The height of 107.15 m AHD applies to all of the township area on the east side of the Railway.

Comments are provided below in relation to the township areas south of Victoria Street. The surveyed flood height marks referenced are detailed in Table 9 and shown on Figure 7:

- 17 Fowler Street (mark number FM20213-T2). At 107.32 m AHD, this is the highest recorded 2012 flood height mark at Tallygaroopna. The surveyed floor level of the house at this address is 107.36 m AHD. The owner / occupier in an interview advised that the house did not flood to above floor level in 2012, but was close to doing so. The flood height mark of 107.32 m AHD therefore fits with the owner's observations.
- 11 Church Street (mark number FM20213-T6). The owner / occupier of this property advised in an interview that the 2012 event peaked 1.5 bricks below the house floor level. The surveyed house floor level is 107.39 m AHD. One row of bricks is equivalent to 0.085 m. A flood height 1.5 bricks below floor level equates to 107.26 m AHD, which exactly matches the surveyed flood height mark at this property (FM2023-T6 – at a wall mark in the carport).
- 8 Church Street (mark number FM2023-T3). The 2012 surveyed flood height is 107.27 m AHD. This is well below the surveyed floor level at this address (107.51 m AHD) which agrees with the interview advice from the owner / occupier and also closely matches the flood level at nearby 11 Church Street (FM2023-T6).
- Smith Street opposite the netball court (mark number 21228). At 107.26 m AHD, this mark matches well with the other more recently surveyed marks in Fowler Street and Church Street.
- Corner of Fowler and Church Street (mark number 21226). At 107.15 m AHD, this mark is approximately 0.1 metre below FM2023-T3, FM2023-T6 and 21228. The accuracy of the mark was classified as medium. It is concluded that this mark is likely to be low based on the other available data.
- Church Street close to number 8 (mark number 21224). At 107.16 m AHD, this mark is approximately 0.1 m below the two nearby heights at 8 Church Street and 11 Church Street. It is concluded that this mark is likely to be low based on the available data.
- 25 Victoria Street. In a questionnaire response, this house was reported as being subject to above floor flooding in 2012. The surveyed house floor level is 107.23 m AHD, indicating a flood height slightly above this.
- Corner of Victoria Street and Fowler Street (mark number 21218). This mark (107.10 m AHD) would appear low if the nearby house at 25 Victoria Street was in fact flooded to above floor level (107.23 m AHD).

The balance of the above data supports a flood height of 107.2 to 107.3 m AHD for all of the area south of Victoria Street. A value of 107.25 m AHD is proposed, 0.10 m above the previous 1% AEP flood height.

Comments are provided below in relation to the township areas north of Victoria Street (surveyed flood height marks referenced are detailed in Table 9 and shown on Figure 7):

- 1 North Street (FM2023-T5). The owner / occupier advised in an interview that the house at this address was flooded above floor level to approximately 2 inches deep in 2012. The surveyed house floor level is 107.15 m AHD. This account places the flood level at 107.20 m AHD which is 0.06 m below the surveyed flood height mark located on a side fence at this property of 107.26 m AHD. This is considered to support a minimum flood height of 107.20 m AHD at this location.
- 11 North Street. The owner has advised that the 2012 flood peaked 0.02 m below the floor level of the house. If correct, this places the peak 2012 flood height at 107.19 m AHD (floor level 107.21 m AHD).
- 12 North Street (FM2023-T4). The owner / occupier advised that the flood height was at or marginally above the house floor height. The surveyed house floor level is 107.24 m AHD. This is a little higher than the surveyed flood height mark of 107.17 m AHD. This is considered to support a flood height mark of approximately 107.20 m AHD at this location.
- North Street. There are two 2012 recorded flood heights on the north side of North Street (mark number 21235 – 107.05 m AHD and mark number 21230 – 107.16 m AHD). These marks are considered to be low given the available 2012 flood height data at 1, 11 and 12 North Street.
- Victoria Street. The flood height mark at the Telstra property is 107.18 m AHD (mark number 212220). This would appear to be slightly on the low side compared to the marks to the south (Church Street) and to the north (North Street).
- Victoria Street on eastern side of town. The flood height mark west of Parklands Drive is 107.16 m AHD. Again, this appears to be on the low side compared to other 2012 heights, particularly those surveyed recently as part of the current project (2023-T4 and T5).

The balance of the above data supports a flood height of 107.15 to 107.25 m AHD for all of the area north of Victoria Street. A value of 107.20 m AHD is proposed, 0.05 m above the previous 1% AEP flood height.

On the west side of the Goulburn Valley Highway, the only recorded 2012 flood height mark is 106.95 m AHD at the service station site. The lowest house floor height on the west side of the Goulburn Valley Highway is 107.01 m AHD at number 1705, north of Bowey Road. A long time local resident advised that this house was not flooded to above floor level in 2012. On the basis of this account and the one available recorded 2012 flood height mark, a flood height of 107.00 m AHD is proposed for west of the Goulburn Valley Highway.

In summary the following 1% AEP flood heights are proposed for Tallygaroopna township:

- Township area south of Victoria Street – 107.25 m AHD (0.10 m higher than the previous height)
- Township area north of Victoria Street – 107.20 m AHD (0.05 m higher than the previous height)
- Township area west of Goulburn Valley Highway – 107.00 m AHD

5.5 1% AEP Flood Depth

Ground surface elevations are defined by the 2022 obtained LiDAR data.

Ground surface elevations within Tallygaroopna generally vary from 106.8 to 107.4 m AHD. Based on the adopted 1% AEP flood heights, flood depths are described in Table 12.

Table 12 1% AEP Flood Depths

Location / Street	Maximum depth of grounds flooding within adjoining properties (m)	Maximum depth of flooding above the lowest roadway gutter invert (m)
Church Street	0.25	0.45
Fowler Street	0.25	0.50
Smith Street	0.25	0.35
Victoria Street	0.25	0.35
Parklands Drive	0.20	0.60
North Street	0.40	0.60

Ground levels over the new Parklands Drive estate on the north side of town prior to the development (i.e. as per LIDAR) varied from 106.8 to 107.4 m AHD. The majority of the site pre-development was at 107.0 m AHD (i.e. 1% AEP flood depth 0.20 m).

There are relatively small areas of high ground above the 1% AEP flood height scattered around the town. Notable high ground locations are located at (refer to Figure 13):

- Recreation Reserve included the oval, bowling club areas (3.2 ha)
- High ground area extending either side of the Victoria Road high point (opposite 36 and 37 Victoria Road (1.6 ha)
- Water storage dam facility in Church Street (0.6 ha)
- East side of Parkland Drive (0.6 ha)
- Multiple other isolated high ground areas, all less than 0.6 ha in area

The railway line varies in height opposite the township from 107.3 to 107.6 m AHD. The railway opposite the township is not therefore overtopped in a 1% AEP flood.

The Goulburn Valley Highway road crown varies in height opposite the town from 107.4 to 107.5 m AHD. The Highway opposite the township is not therefore overtopped in a 1% AEP flood.

5.6 1% AEP Flood Hazard

The term 'flood hazard' refers to the velocity and depth of flooding.

Depths of 1% AEP flooding at Tallygaroopna are described in the preceding section above. The 1% AEP flood depth within the developed properties varies up to a maximum of 0.40 m, but is predominantly less than 0.25 m.

Roadway flooding, except for the open swale drain sections in Parkland Drive and the east end of North Street, is limited to a depth of 0.40m based on the maximum height above the gutter invert. Flood depths are predominantly less than 0.25 m within the road reserves.

Floodwater velocities are expected to be low. The reason for this is the extremely flat terrain present at Tallygaroopna. The natural north westerly gradient is 1 in 1,900. Velocities are further reduced by the presence of the raised Railway and the south side bank adjoining Congupna Creek. Indicative velocities and velocity depth products within the township are expected to be as follows:

- Flow depth 0.25 m, indicative expected velocity 0.30 m/s, velocity depth product 0.075 m^2/s
- Flow depth 0.45 m, indicative expected velocity 045 m/s, velocity depth product 0.20 m^2/s

The above hydraulic conditions coinciding with flood depths of up to 0.45 m are characteristic of low hazard conditions and LSIO type flooding conditions.

5.7 1% AEP Flood Height Contours

There are existing 1% AEP flood height contours defined for the flood prone areas surrounding Tallygaroopna. These heights are based on interpolation undertaken as part of a Goulburn Broken CMA project in 2008 using the then available historical event recorded flood height marks, primarily for the 1993 and 1974 events.

The 2008 defined 1% AEP flood heights / contours and the current study newly proposed 1% AEP flood heights / contours which take into account the recorded 2012 peak flood heights are provided in Table 13.

The 2012 recorded flood heights for Congupna Creek in the vicinity of the Goulburn Valley Highway have warranted a small increase in the 1% AEP flood height. At Victoria Road, the 2012 recorded flood heights have warranted a small decrease in the 1% AEP flood height at this location.

The 2008 work assigned 1% AEP flood height contours to the Daintons Creek flow path. The current study has determined that this flow path is no longer active. There is no longer a defined depression along the original flow path (refer to Section 5.10.8 for further discussion). Consequently it is recommended that the flood height contours along the Daintons Creek route be deleted.

Table 13 Proposed 1% AEP Flood Height / Contour Changes

Location	2008 Defined 1% AEP Flood Heights (m AHD)	Current study proposed 1% AEP flood heights (m AHD)
Tallygaroopna township – south of Victoria Street	107.15	107.25
Tallygaroopna township – north of Victoria Street	107.15	107.20
Tallygaroopna Township – west side of GV Highway	-	107.00
Congupna Creek – immediately downstream GV Highway	106.80	106.90
Congupna Creek – immediately upstream GV Highway	107.15	107.20
Congupna Creek – immediately downstream of Victoria Road (east of GMW Channel 5/17)	108.50	108.40

5.8 1% AEP Flood Extents

The areas inundated at Tallygaroopna township in a 1% AEP flood event are shown on Figure 14. The majority of the township is subject to shallow 1% AEP inundation. The aerial photography of the 2012 event reflects this.

The most notable high ground area is located at the Recreation Reserve.

The inundation map coverage is limited to the township area east of the railway. Both the railway and the Goulburn Valley Highway are not overtopped in a 1% AEP event.

Inundation areas on the west side of the Goulburn Valley Highway have not been mapped due to data limitations (i.e. there is only one flood height mark on the west side of the Highway which is considered of low reliability).

The current inundation mapping as depicted by the flood overlays (Floodway Overlay (FO) and Land Subject to Inundation Overlay (LSIO) around Tallygaroopna township is in need of updating. Specifically, the following is recommended:

- The floodway overlay extents in the vicinity of Congupna Creek to be adjusted such that it is positioned over the creek route.
- 1% AEP flood height contours over Congupna Creek to be adjusted as described in Section 5.4.5.
- 1% AEP flood height contour at Tallygaroopna township to be updated reflecting the 1% AEP flood heights nominated by this Scoping Study.
- LSIO extents at Tallygaroopna to be adjusted to reflect the inundation extents shown on Figure 14.
- The Daintons Creek floodway north of Thompsons Road to be deleted including the 1% AEP flood height contours along the floodway route.

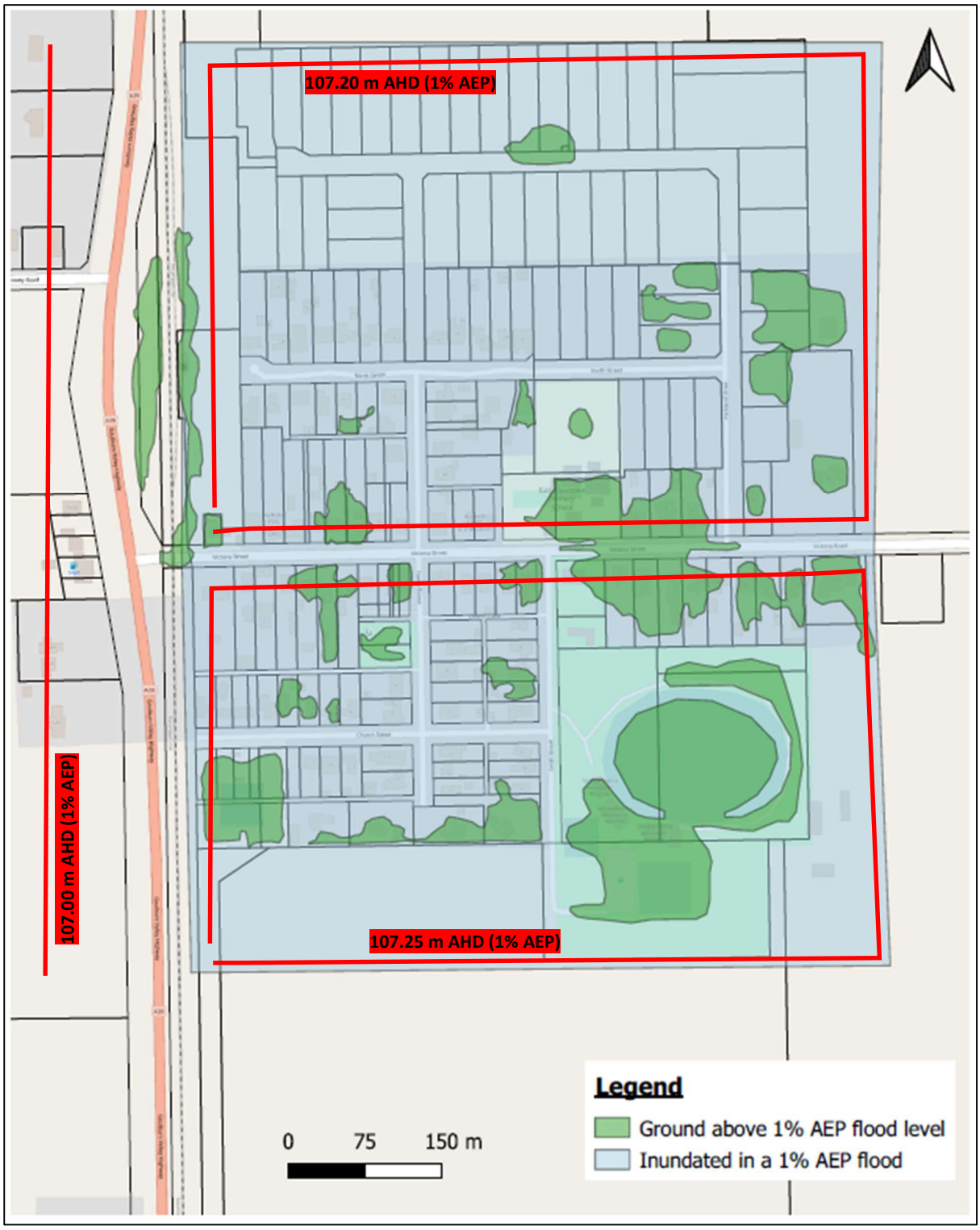


Figure 14 **Tallygaroopna Township – 1% AEP Flood Extents and Heights**

5.9 1% AEP Above Floor Flooding Impacts

House floor levels at Tallygaroopna were surveyed in October 2023. Above floor house flooding details are summarised in Table 14 based on the adopted 1% AEP flood levels.

- Five houses identified as being subject to 1% AEP above floor flooding.
- Four of the five houses subject to 1% AEP above floor flooding are located in North Street, west of Fowler Street.
- Maximum depth of 1% AEP above floor flooding is 0.05 m.
- The floor levels of a further 16 houses are located between 0.00 and 0.10 m above the 1% AEP flood level.

Table 14 Above Floor Flooding Data

Road / Street	Total number of houses	Number of properties flooded to above floor level	Number of other houses with freeboard less than 0.10 m
Church Street	13	0	1
Fowler Street	18	0	4
Smith Street	8	0	1
Victoria Street	36	1	4
Parkland Drive	6	0	0
North Street	27	4	5
GV Highway	7	0	1
Bowey Road	2	0	0
Total	117	5	16

The five houses identified as subject to 1% AEP above floor flooding are expected to flood infrequently. The reasons for this are:

- The lowest floor level of the houses surveyed at Tallygaroopna on the east side of the railway line has an elevation of 107.15 m AHD.
- The lowest house is located in North Street close to three nearby flood height marks from the October 1993 event, the second largest flood event at Tallygaroopna in at least the past 30 years. The three 1993 recorded heights are 106.95, 106.96 and 107.09 m AHD. The lowest house in Tallygaroopna will not therefore have been flooded to above floor level in 1993.

The floor levels of the houses on the west side of the Goulburn Valley Highway south of Bowey Road are all above 107.2 m AHD. The only 2012 recorded flood level on the west side of the Highway is 106.95 m AHD at the front of the Service Centre.

Of the five houses on the west side of the Goulburn Valley Highway north of Bowey Road, the lowest floor level is 107.01 m AHD. This house is reported to have been very close to flooding to above floor level in 2012. The other four house floor levels in this area are higher than 107.17 m AHD.

5.10 Discussion of Flooding Influences at Tallygaroopna

5.10.1 Limited Natural Fall

One of the most influential factors on flooding conditions at Tallygaroopna is the extremely flat natural fall present (1 in 1,900). This means it is inevitable that floodwater will drain slowly, reaching a higher height than would otherwise be the case if more fall was present. For example, if the natural fall was 1 in 700 as is the case at Katandra West, 10 km east of Tallygaroopna, a nominal flood depth of 0.25 m would reduce to 0.19 m due to higher velocities.

The actual flood gradient at Tallygaroopna is reduced further by the presence of the railway line and the Goulburn Valley Highway. Floodwater passing through Tallygaroopna is diverted northwards parallel to the railway line and the highway. The gradient present parallel with the railway and the highway is approximately 1 in 2,400.

5.10.2 GMW Channel Network

The GMW supply channel and drainage channel network impacts on flooding conditions at Tallygaroopna. Congupna Creek (Drain 2/11) intercepts all runoff from the east of the drain.

Supply Channel 5/17 east of Tallygaroopna diverts runoff northwards and into Congupna Creek. Supply Channel 17 at Thompsons Road diverts runoff westwards to the railway / highway corridor.

The Tallygaroopna stormwater system drains into Congupna Creek on the upstream side of the railway bridge. This can only occur whilst the Congupna Creek drain water level remains lower than the incoming town outfall drain water level. If the Congupna Creek water level exceeds the incoming drain water level, then the creek will commence to backflow out the drainage inlet until the creek water level recedes allowing gravity inflows to resume.

Residents at Tallygaroopna who are involved in flood response operations are aware of the need to close drainage inlets into Congupna Creek once the creek flood levels get sufficiently high to initiate backflows out of the creek.

5.10.3 Retarding Basin

The township stormwater system relies on a pump to discharge flows in the retarding basin to the outfall drain leading to Congupna Creek. The pump is understood to have not been operational during periods of the 2012 flood which will have exacerbated to some extent the flood impacts at Tallygaroopna. Council have advised that retarding basin pumps are now routinely inspected on-site the same day as soon as greater than 10 mm of rainfall is recorded within a 24 hour period.

Previous reports (e.g. 2014 – HEIL Engineering Consultants) have concluded that the township retarding basin volume is not sufficient to service the urban runoff from the township. The basin volume is 5,100 m^3. The 2014 report concluded that the basin requires an extra 11,400 m^3 to service the then town urban area.

5.10.4 Rural Runoff

Rural runoff from outside the town can have a significant impact on flooding conditions at Tallygaroopna. This is principally from the catchment area shown in Figure 13.

Runoff from east of the town can discharge into the town via Victoria Road and to the south of Victoria Road, notably through the eastern boundary of the Recreation Reserve.

Rural runoff can also discharge into the town from the south side of the town, notably at Smith Street opposite the netball courts.

The town is less susceptible to rural runoff inflows north of Victoria Road due to the presence of the Slaughterhouse Road diversion drain.

One structure potentially exacerbating flooding associated with rural inflows at Smith Street is a cross drainage culvert structure under a supply channel leading to the raw water storage facility in Church Street. This drainage pipe controls rural outflows to the open drain within the railway / highway corridor, enabling them to bypass the town. If this culvert structure is blocked or partially blocked, it will be forcing rural flows into the town system.

5.10.5 Railway and Highway Corridor

Open drains and culvert within the railway / freeway corridor are shown on Figures 3 and 4. The drains cater for runoff from the railway and highway corridor. The drains also received rural runoff inflows, including from the raw water storage supply channel cross drainage culvert.

The main drain route aligned within the railway/highway corridor opposite Tallygaroopna is described as follows:

- 600 mm diameter culvert under the railway immediately opposite the raw water storage supply channel cross drainage culvert.
- Open drain between the above railway culvert and the highway leading to a box culvert at Victoria Street (600 mm (wide) x 300 mm (high)).
- Open drain north of Victoria Road leading to a culvert under the highway (1200 mm (wide) x 300 mm (high)) on the south side of Bowey Road.
- Flow split at Bowey Road downstream of the above highway culvert. Flows discharge both northwards to Congupna Creek down the west side of the Highway and westwards to Pine Lodge Creek down the south side of Bowey Road.

The railway reserve also contains the town outfall drain discharging pumped outflows from the township retarding basin to twin inlets to Congupna Creek (450 mm inlet and a 1200 mm half pipe high level inlet).

Fall is minimal to the north being approximately 1 in 2,400. Drain capacities are therefore low. This capacity constraint within the railway / highway reserve will tend to force rural flows into the township system at Smith Street opposite the tennis courts.

5.10.6 Congupna Creek (Drain 2/11)

The stormwater drainage system at Tallygaroopna discharges into Congupna Creek on the north side of town, upstream of the railway bridge. Whilst creek levels are lower than the incoming town outfall drain water level, stormwater flows are able to gravity discharge into the creek via the 450 mm diameter drain inlet and a high level higher capacity half pipe inlet.

Once the flood level in the creek on the upstream side of the railway line rises above the water level in the stormwater outfall drain, it is no longer possible for stormwater flows to gravity drain into the creek. In these circumstances, the creek will backflow out the drain inlet unless the door is shut at the entry to the creek inlet. The closing of the inlet door and other inlet doors along the creek route when required is an important flood response action which local flood respondents are aware of.

In the 2012 flood event, the recorded peak flood heights in the vicinity of the town drainage inlet into Congupna Creek were as follows:

- Immediately downstream of Goulburn Valley Highway – 106.91 m AHD
- Between the highway and railway bridges – 107.13 m AHD

- In the town outfall drain, outside the creek – 107.21 m AHD

There is no recorded Congupna Creek flood level available on the upstream side of the railway bridge, but based on the nearby available heights it is reasonable to assume that it would have been close to 107.2 m AHD.

Given the above creek flood levels, it will not have been possible for flows within the outfall drain to gravity discharge into Congupna Creek whilst creek levels remained high.

The recorded peak 2012 flood heights within Tallygaroopna township varied from 107.05 to 107.32 m AHD (averaged 107.19 m AHD), just below the recorded flood height within the creek at the town drain outlet.

There is no permanent facility for pumping stormwater outflows from Tallygaroopna into Congupna Creek, when creek levels prevent gravity outflows. In the 1993 flood event, the recorded peak flood height within the creek immediately upstream of the railway bridge was 107.15 m AHD. The peak 1993 flood heights within Tallgaroopna township averaged close to 107.0 m AHD.

Congupna Creek can therefore have a significant influence on flooding at Tallygaroopna by preventing the gravity discharge of flow from the stormwater outfall drain into the creek, once creek flood levels exceed the drain flood levels. This will then lead to a build-up of flood levels backing back into the town. The railway cross drainage culvert structure located 400 m south of Congupna Creek (four cell 375 mm diameter culvert) does provide an outflow point which aids in limiting flood levels on the east side of the railway.

At Victoria Road, Channel 5/17 protects against any west side breakout flows from the Congupna Creek. The road height at the channel crossing is marginally higher than the recorded 2012 flood height of 108.43 m AHD immediately upstream of Victoria Road.

5.10.7 Pine Lodge Creek

Pine Lodge Creek is located 4 km south and 3 km west of Tallygaroopna.

Pine Lodge Creek does not impact on flooding conditions at Tallygaroopna. Impediments to floodwater discharging northwards from Pine Lodge Creek towards Tallygaroopna include GMW Drain 3B/11, Channel 3/17, Channel 17 and sandbagging at the Channel 17 siphon opening on the east side of the Goulburn Valley Highway.

5.10.8 Dainton's Creek

Dainton's Creek is a flow path feature shown on previously prepared flood mapping for the Tallgaroopna area (refer to Figure 15).

Examination of the available aerial flood imagery for the 2012 and 1993 floods showed that there was no concentrated, confined flow of floodwater to the east of Tallygaroopna within the Dainton's Creek flow path. The LiDAR terrain data also shows no natural depression feature present within or in the vicinity of the Dainton's Creek flow path, either east or north of the township.

The Dainton's Creek flow path would appear to have once been a designated flow path for floodwater to pass freely along with cross drainage structures provided at infrastructure crossings along the route including at the Goulburn Valley Highway, Tocumwal railway line, Victoria Road, GMW Channel 17 (twice), and at the Katamatite-Shepparton Road).

At some point in the past, the Dainton's Creek flow path became no longer active. This pre-dates the 1993 flood. A large drain is now present down Edwards Road, which diverts flows that previously discharged down the Dainton's Creek flow path when it was active. The Edwards Road drain discharges into Congupna Creek (refer to Figure 15).

The Victoria Road end of Slaughterhouse Road is located on the edge of the Dainton's Creek flow path. The further development of the drain down Slaughterhouse Road after the 2012 flood diverts any rural flow from the south and east which may once have drained to the Dainton's Creek flow path between Victoria Road and the Goulburn Valley Highway.

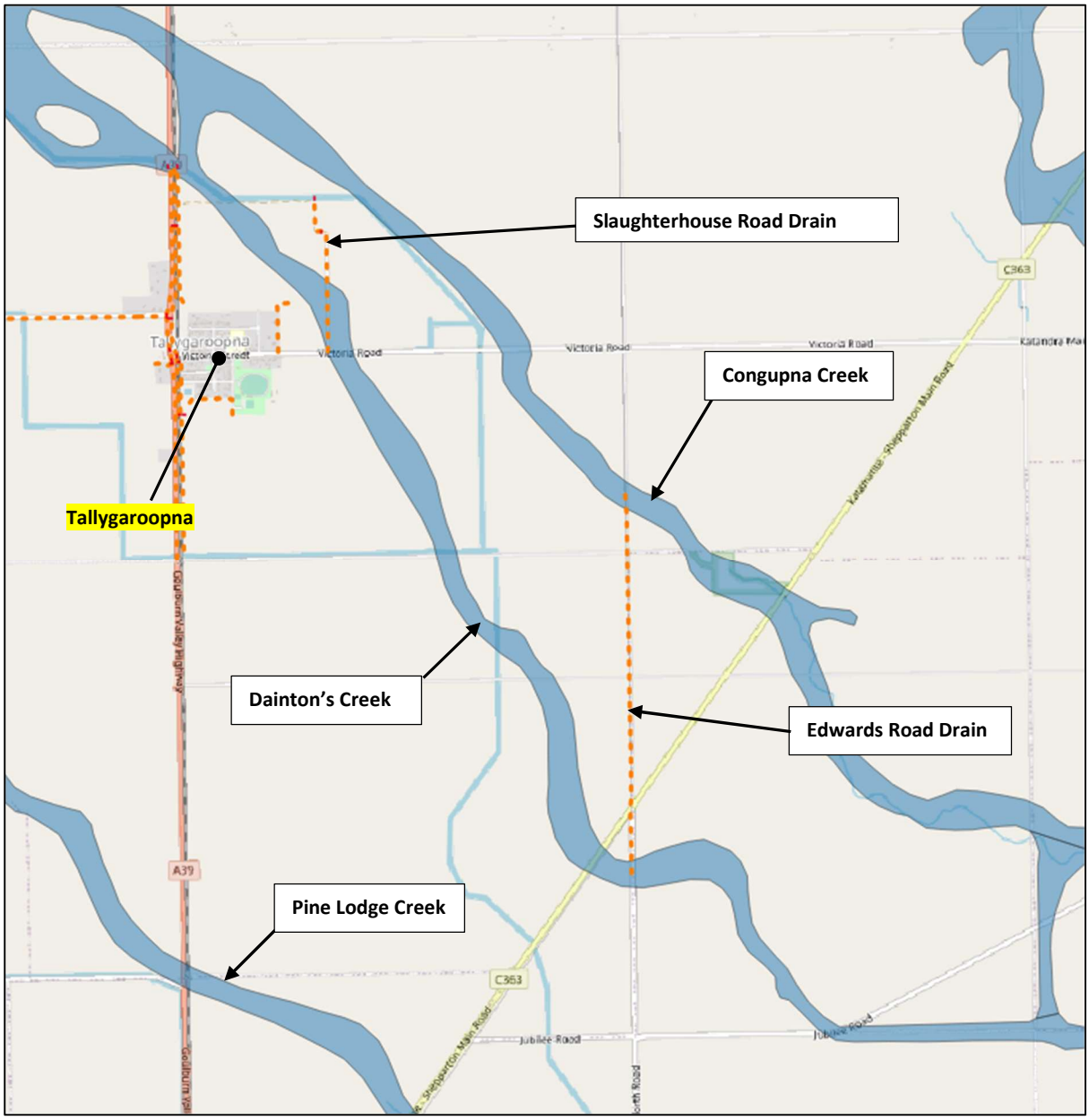


Figure 15 Dainton's Creek

6 Flood Mitigation

6.1 Need for a Flood Study / Floodplain Risk Management Study

This Scoping Study has been able to clearly define the expected impacts in a 1% AEP event at Tallygaroopna township.

Property flooding impacts in the second most severe flood event known to have occurred in the past 50 years at Tallygaroopna (October 1993) will have been relatively benign, restricted to shed, garage, carport and grounds flooding impacts. No houses are thought to have been flooded to above floor level in the 1993 event based on the available recorded flood heights and house floor level elevations.

In the most severe flood event (March 2012), five houses are assessed to have been subject to above floor flooding. The maximum depth of above floor flooding was only 0.05 m.

Flooding conditions do not represent a significant threat to public safety. Grounds flooding 1% AEP depths are typically up to 0.25 m. Flooding depths above roadside drain inverts are typically up to 0.45 m.

Flooding at Tallygaroopna is primarily due to runoff from the immediate township area and rural runoff inflows from the south and east. Riverine flooding will only occur if the Congupna Creek (Drain 2/11) is not able to confine its flows.

Given all of the above, a flood study followed by a floodplain risk management study utilising hydraulic modelling is considered to be a low priority for Tallygaroopna and not required in the short to medium term.

Continued efforts should however be made to mitigate the impact of future floods. These efforts should focus on the following:

- Maintenance of the local runoff drainage system with the aim of keeping the system relatively free of blockage and having mechanical elements in good working order (e.g. retarding basin pumps). Focus drainage system components include:
    - A key cross drainage culvert structure under the supply channel which fills the raw water storage dam in Church Street. Council would appear to be responsible for this structure based on advice from GMW and GVW.
    - The drains within the railway and highway reserves between the south side of the township and Congupna Creek. Maintenance of these drains is the responsibility of the state government rail and road infrastructure management agencies.
    - Stormwater drains catering for runoff from the immediate town area including the new infrastructure for the Parklands Drive Estate. Council is responsible for stormwater drainage infrastructure management.
- Implementation of measures to prevent rural runoff from the south and east of Tallygaroopna entering the township and overwhelming the town's stormwater infrastructure including:
    - Measures to ensure that surface water collecting at the southern boundary of the town bypasses the town stormwater system by discharging to the drains flowing northwards within the railway and highway reserves.
    - Measures to allow rural runoff on the south side of Victoria Road to discharge into the Slaughterhouse Road diversion drain.

6.2 Drain Upgrades

6.2.1 Southern Catchment Bypass Drain

Rural runoff to the south of Tallygaroopna drains to the southern edge of the township. Raised ground levels are located along the south side boundaries of 11 Church Street and 14, 23 and 25 Fowler Street.

Ideally the rural runoff flows should discharge to a town bypass drain within the railway and highway road reserves via a subway culvert under the raw water storage supply channel. The size and condition of this culvert structure is unknown.

Ultimately the bypass drain discharges into Congupna Creek at a 300 mm diameter inlet on the west side of the Goulburn Valley Highway. There are nine culvert structures on the drain route between the raw water storage supply channel culvert and the Congupna Creek inlet (refer to Figure 15). The culverts vary in size from as small as 300 mm diameter, to as large as a 1200 x 300 mm box culvert.

The following measures are nominated if Council wishes to upgrade the capacity of the bypass drain (refer to Figure 16):

- Size and condition of the raw water storage supply channel subway culvert to be field checked. Minimum 450 mm diameter size culvert is desirable. Also check condition of the adjoining 600 mm diameter railway culvert. Pump out may necessary to assist with inspections.
- Low level berm to be constructed to a height of 107.2 m AHD to prevent rural drainage flows entering the town stormwater system at Smith Street.
- Consider requesting an upgrade to the GMW drainage inlet into Congupna Creek (from existing 300 mm diameter inlet to a 375 or 450mm diameter).
- Upgrade various culverts along the drain route to match the upgraded drainage inlet at Congupna Creek (Drain 2/11).

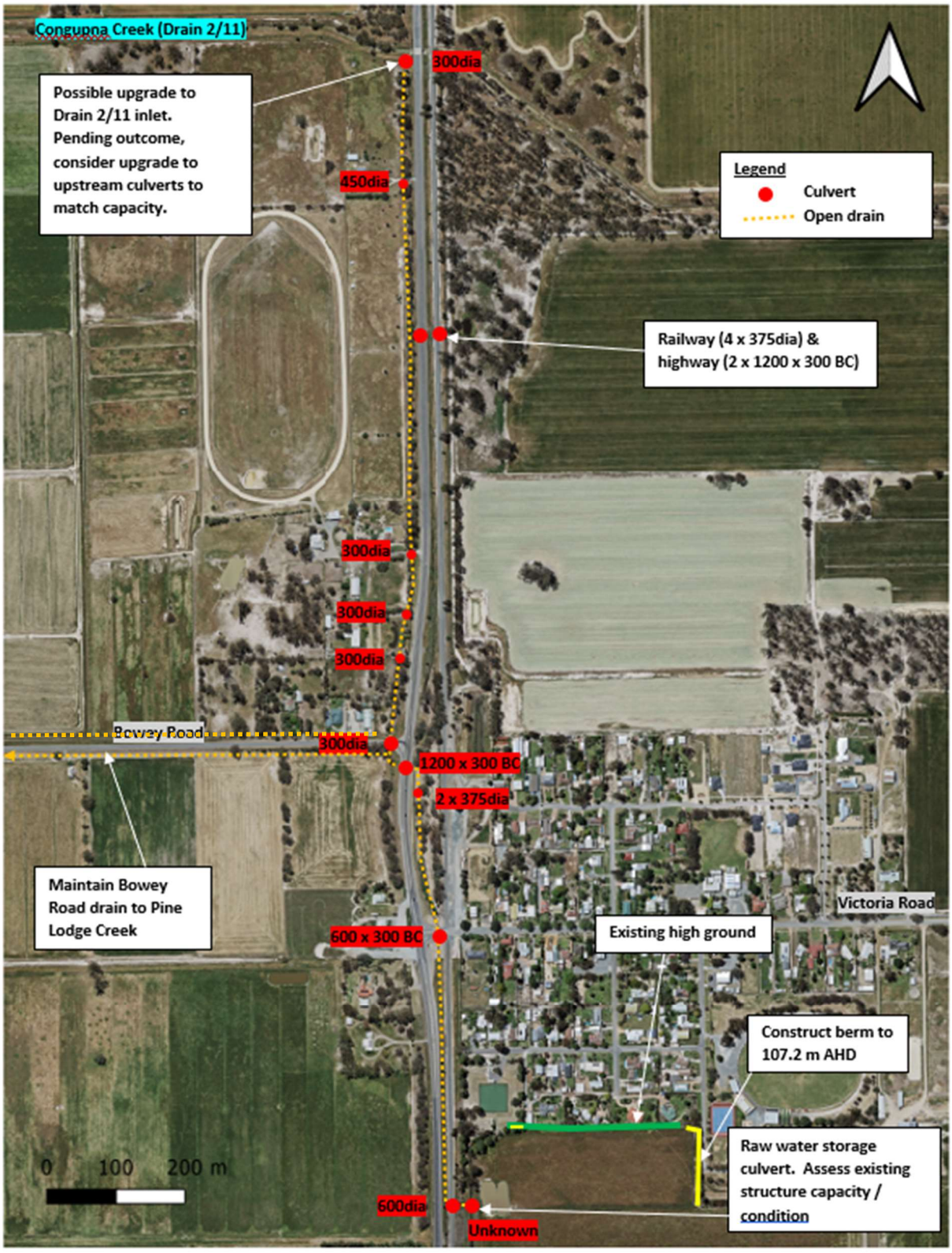


Figure 16 Diversion drain for south side rural runoff

6.2.2 Slaughterhouse Road Diversion Drain

The Slaughterhouse Road drain diverts runoff into Congupna Creek, away from Tallygaroopna township (refer to Figure 17). A 450 mm diameter culvert is present at the Congupna Creek inlet.

Culvert capacities along the drain route (1200 x 450 mm box culvert) are considered favourable.

No changes to the existing diversion drain are nominated. The drain could currently be better utilised if runoff from the property south of Victoria Road was able to access the drain.

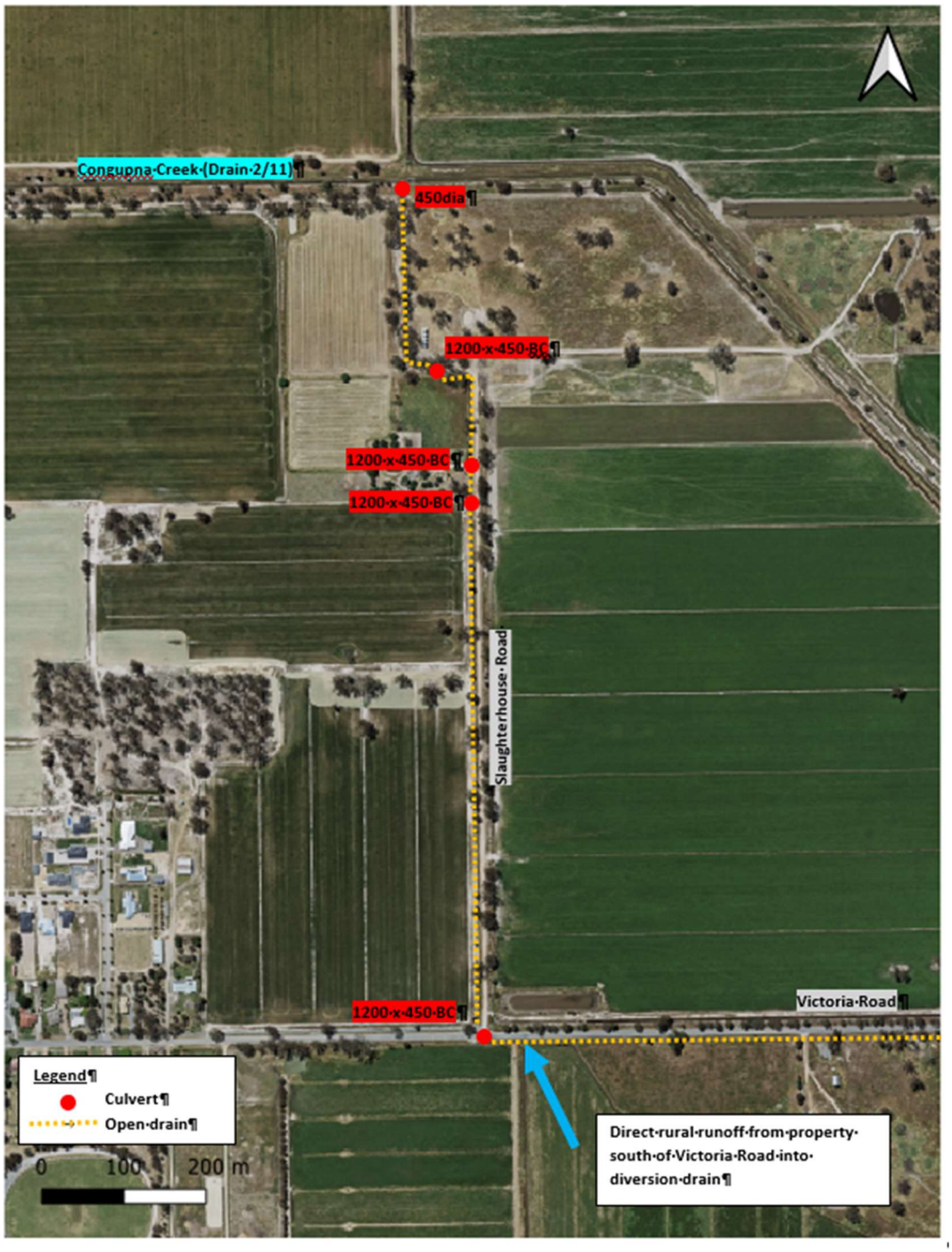


Figure 17 Slaughterhouse Road Diversion Drain

6.2.3 Railway Line

The southern most cross drainage structures is the 600 mm diameter culvert which forms part of the town bypass drain referred to in Section 6.2.1 (refer to Figure 16). Providing the 600 mm diameter culvert is not compromised by blockage, it is one of the higher capacity culvert structures along the bypass drain route, with consequently no recommendation to upgrade it.

The twin cell 300 mm diameter railway culvert located 40 m south of Victoria Street is also assessed as adequate. Local runoff from the surrounding area is better off discharging into the township stormwater pipe collector network.

The only other existing railway culvert is a four cell 375 mm diameter culvert located 870 m north of Victoria Road. This culvert is located opposite a twin cell 1200 x 300 culvert under the Goulburn Valley Highway. The railway culvert structure is undersized compared to the highway structure. The railway culvert could be upgraded to match the capacity of the adjoining highway culvert structure.

Consideration could be given to upgrading both the railway culvert and the Goulburn Valley Highway culvert structures located 870 m north of Victoria Road. This would provide the township with an improved flow release point, particularly during periods when Congupna Creek is too high to receive gravity inflows. Consideration of such upgrades would require an assessment on the impacts of higher release flows on properties downstream (west) of the Highway.

6.2.4 Goulburn Valley Highway

The highway crossing culvert located south of Bowey Road (1200 x 300 mm box culvert) is the highest capacity structure along the bypass drain route (refer to Section 6.1.1). There is therefore no cause to upgrade this structure.

Similarly the highway crossing culvert located 870 m north of Victoria Street exceeds the capacity of the adjoining railway culvert. There is therefore no cause to upgrade this structure, unless the intention is to upgrade both structures as canvassed in Section 6.2.3.

6.2.5 Channel 17 at Thompsons Road

Overland flows can discharge northwards at the syphon opening in Channel 17 on the east side of the railway line. These flows are better directed elsewhere. As such a temporary levee has been erected at the syphon opening in past floods including 2012. Options in regards to this issue are:

- Reopen drainage inlet SP805 into Channel 17, 6000 m east of the highway
- Continue to erect a temporary levee to block the syphon opening when required

6.2.6 Comments on Stormwater Drainage Infrastructure

Runoff from the township is conveyed by a collector pipe network to the retarding basin. The extremely flat terrain will result in low velocities within the pipe collector network which will tend to promote sedimentation induced blockages.

This scoping study has not assessed the adequacy of the stormwater infrastructure for servicing the township area. Council has commissioned other previous studies which have focused on stormwater discharge.

It is apparent that rural runoff from areas east and south of Tallygaroopna does discharge into the town stormwater system. Improvement measures nominated in the preceding sections focus on ways to reduce the extent to which rural runoff enters the town stormwater system. They include:

- Additional discharge of east side rural runoff to the Slaughterhouse Road Diversion Drain
- Works to more effectively divert south side runoff to the Southern Catchment Bypass Drain
- Maintenance of the above diversion drains (e.g. vegetation management, blockage clearing)

7 Other Issues

7.1 Minimum Floor Levels for New Development

It is important that minimum floor level controls are imposed on new development at Tallygaroopna.

This study has identified 1% AEP flood heights for the town area. A minimum floor height 300 mm above the 1% AEP flood height is recommended for new habitable development to adequately minimise the risk of above floor flooding.

7.2 Need for Flood Overlays at Tallygaroopna

The presence of flood overlays ensure that development proposals are referred to the CMA. Appropriate flood based development control conditions are then imposed by the CMA.

If flood overlays are not present, then this removes a mandatory trigger for referring development applications to the CMA.

Most of Tallygaroopna township is subject to 1% AEP inundation which is characteristic of the LSIO flooding conditions used in Victorian planning schemes..

None of the areas inundated at Tallygaroopna would be described as representative of Floodway overlay conditions, with the possible exception of the retarding basins and some of the open drains. Development is obviously already excluded from these areas.

Council and the Goulburn Broken CMA should consider adding the defined inundated areas shown on Figure 14 as new LSIO areas when the planning scheme overlays are next updated.

7.3 Flood Response Actions

This study has provided Council with knowledge of those houses which are at most risk of above floor flooding. There are five houses which have been assessed to flood to above floor level in a 1% AEP event to a maximum depth of 0.05 m. Any efforts to locally prevent above floor flooding (e.g. by sandbagging individual houses) should give priority to these five houses and to a lesser extent the other 16 houses whose flood levels have been identified to be less than 0.1 m above the 1% AEP flood level.

Council needs to ensure that its retarding basin pumps are working during a flood event through appropriate monitoring and maintenance.

The operation of the drainage inlets into Congupna Creek (Drain 2/11) requires human intervention during floods. The drainage inlets need to be open when it is possible to gravity drain into the creek. Once creek flood levels get too high to gravity drain, the drainage inlets need to be closed, to prevent backwater outflows. Flood response planning should clearly identify the location of the relevant Drain 2/11 drainage inlets, the height at which they should be closed to prevent surcharging and who is responsible for their operation.

The erection of a temporary sandbag levee at the Channel 17 syphon at Thompsons Road would appear to be a necessary task during a flood event. Flood response planning should clearly identify who is responsible for erecting the temporary levee.

7.4 Content for Future Updates to Flood Documents

Suggested content for adding to future updates of the following documents is provided in Appendix B:

- Local Flood Guide – Tallygaroopna (2020).
- Municipal Flood Emergency Plan – A Sub-Plan of the Municipal Emergency Management Plan (August 2018).

The content in Appendix B draws on the knowledge derived from this scoping study.

8 Summary and Recommendations

8.1 Description of Flooding

This scoping study has assessed flooding conditions within the Tallygaroopna township area. An assessment of flooding issues in the wider surrounding rural district was outside the scope of this project.

A review of the available data, including the additional flood height marks obtained during the scoping study revealed the following flooding conditions at Tallygaroopna township:

- LiDAR terrain data obtained in 2022 has confirmed that the predominant land fall at Tallgaroopna is in a north westerly direction at an average gradient of 1 in 1,900.
- The nearest waterway to Tallygaroopna is Congupna Creek (Drain 2/11) aligned to the east and north of the town (refer to Figure 1). Congupna Creek is a GMW engineered open drain with low height flow confinement banks and controlled drainage inlets. Congupna Creek is not expected to contribute directly to flooding at Tallygaroopna.
- Flooding at Tallygaroopna appears to be caused by local runoff from the immediate township area and runoff from the nearby rural areas on the east and south sides of the town (refer to Figure 13).
- The available rainfall data indicates that the March 2012 flood event appears to be the most severe historical flood at Tallygaroopna since at least the early 1900s. Based on the available recorded rainfall, the March 2012 event can be attributed as equivalent to a 1% AEP event.
- Much of the township is subject to inundation in a 1% AEP event (refer to Figure 14). Areas subject to 1% AEP flooding within the township are typically shallow (less than 0.25 m deep) and slow moving (velocities less than 0.3 m/s).
- Rural runoff flows entering the town stormwater system from the east and south exacerbate township flooding conditions.
- The town stormwater drainage system infrastructure and the receiving GMW drains have insufficient capacity to confine the volume of local runoff generated in an event as severe as the 2012 flood.
- Flooding inundation durations will vary markedly depending on the intensity and duration of the rainfall. The inundated areas within the township would typically be expected to recede within one to 48 hours after the main rainfall ceases. The 2012 rain event continued for multiple days with the resultant inundation extending over this same timeframe.
- Tallygaroopna adjoins the Goulburn Valley Highway. Access to outside the local district is available providing the highway remains open.

8.2 Flooding Influences

The dominant influences of flooding conditions at Tallygaroopna township are summarised as follows:

- Flat terrain. A natural gradient of 1 in 1,900 reduced further due to the road and railway network inhibits drainage.
- Rural runoff inflows into the town stormwater system.
- The limited capacity of the drainage system servicing the township which consists of the stormwater system infrastructure (pits, pipes, retarding basins, basin pumps) and the receiving GMW Drain 2/11 (refer to Figures 3 and 4).
- Inability to gravity discharge into Drain 2/11 once flood levels in the drain exceed the external flood levels.

- Any blockages or other factors compromising the drainage system (e.g. retarding basin pump not being operable as was the case in 2012).
- Limited discharge capacity of cross drainage structures at the railway line and the highway.

8.3 Flooding Impacts / Damages

A house floor level survey was undertaken during the scoping study project. A comparison of the surveyed floor heights with the 1% AEP flood heights revealed the following:

- No houses flooded to above floor level in the October 1993 flood event, second highest known flood.
- Five houses subject to 1% AEP above floor flooding up to a maximum depth of 0.05 m.
- Further 16 houses where the floor level is between 0.00 and 0.10 m above the 1% AEP flood level.

Most properties at Tallygaroopna are subject to grounds flooding in a 1% AEP flood. Those areas not expected to be inundated in a 1% AEP flood are shown on Figure 14.

Due to relatively shallow depths and low velocities, flooding is unlikely to cause structural damage associated with the force of the floodwater.

The risk to public safety should be low.

Given the above, the flood risk at Tallygaroopna is expected to be low.

8.4 Project Flood Data and Map Outputs

The Goulburn Broken CMA obtained nine flood height marks at Tallygaroopna in the immediate aftermath of the 2012 flood (e.g. peak flood marks on walls, fence posts, power poles etc). The CMA has largely relied on these marks since 2012 for issuing flood advice in response to requests.

As part of this scoping study project, a survey was undertaken of six newly identified flood height mark locations, as identified through returned questionnaires and interviews with residents.

Details for the above flood height marks are provided in Figure 7, Table 9 and Appendix A.

Some rudimentary flood mapping data was prepared utilising the available flood height marks and the LiDAR terrain data. Mapping outputs prepared consist of:

- 1% AEP flood heights adopted:
    - 107.25 m AHD for the township area south of Victoria Street
    - 107.20 m AHD for the township area north of Victoria Street
    - 107.00 m AHD for the township area west of the Goulburn Valley Highway
- 1% AEP flood extents within the township area as shown on Figure 14

The above interpreted flood data outputs will be useful for the following purposes:

- Provision of flood advice by the Goulburn Broken CMA for planning referrals and in response to requests for site flood information.
- Possible future inclusion of the extents as additions to the LSIO within Council's planning scheme maps.

8.5 Future Studies and Mitigation Measures

Flood studies and subsequent floodplain risk management studies are generally initiated by authorities as a result of serious flooding impacts being present (e.g. confirmed above floor flooding of habitable buildings).

This scoping study has confirmed that there is likely to be 1% AEP above floor flooding at Tallygaroopna. The flooding should however be relatively benign with 1% AEP depths and velocities generally limited to 0.25 m and 0.3 m/s respectively.

Given the findings of this Scoping Study, a flood study followed by a floodplain risk management study utilising hydraulic modelling is considered a low priority for Tallygaroopna and not required in the short to medium term.

Possible mitigation measures nominated by the Scoping Study are as follows:

- Implementation of improvement measures associated with the South Side Bypass Drain (refer to Section 6.2.1 and Figure 16) including drainage structure upgrades along the route and a berm to prevent rural runoff entering the stormwater system at Smith Street.
- Allowance for additional rural runoff from south of Victoria Road to discharge into the Slaughterhouse Road Diversion Drain.
- Upgrade to the existing railway and highway cross drainage structures located 870 m north of Victoria Road. This would allow for better drainage during periods when Drain 2/11 (Congupna Creek) is too high to receive gravity inflows.

8.6 Ongoing Flood / Drainage Management Activities

Activities for which Council are responsible for which assist with ensuring that flooding impacts are minimised are the maintenance of the stormwater system infrastructure (refer to Figures 3, 4, 16 and 17). This includes:

- Clearing of any blockages in the pit and pipe collector network. Repairs to any defects.
- Upkeep and monitoring of the operating condition of the pump at the retarding basin.
- Clearing of any blockages in the open channel drain and the pipe inlets between the retarding basin and Drain 2/11.

Activities for which GMW are responsible for which similarly assist in ensuring that flood impacts are minimised are the maintenance of Drain 2/11. This includes:

- Clearing of any excessive blockages in the open drain.
- Similarly keeping clear and repairing any defects for structures along the drain route including drainage inlets, road crossing culverts, property access culverts.

VicTrack are responsible for drain maintenance within the rail corridor reserve (Tocumwal railway line). Similarly, RRV are responsible for drain maintenance within the highway corridor road reserve. Both RRV and VicTrack are responsible for:

- Vegetation management within open drains in their respective reserves.
- Drain culvert maintenance including keeping culverts relatively free of blockage.

8.7 Other Outcomes

Current response arrangements include the closing of the drainage inlets into Congupna Creek (Drain 2/11) once creek flood levels get sufficiently high to cause surcharge flooding out o the creek via the inlets. Local respondents currently close the drainage inlet gates once they judge that this becomes necessary. It has been suggested that this process be more formalised with a trigger height identified using a newly installed creek flood height gauge or some other means. It is recommended that this be further investigated by Council and the Goulburn Broken CMA and any process adopted then be implemented and documented within the GSCC Municipal Flood Emergency Plan.

Included in Appendix B of this report is content which can be added to the 'Local Flood Guide – Tallygaroopna' when it is next scheduled to be updated.

Similarly in Appendix B of this report is content which can be added to the GSCC Municipal Flood Emergency Plan (which is a sub plan of the Municipal Emergency Management Plan) when it is next scheduled for update.

9 References

Goulburn Broken Catchment Management Authority (2018). Goulburn Broken Regional Floodplain Management Strategy 2018-2028.

Greater Shepparton City Council (updated August 2018 – version 2.4). Greater Shepparton City Council Flood Emergency Plan – A Sub-Plan of the Municipal Emergency Management Plan.

Heil Engineering Consultants (November 2014). Tallygaroopna Drainage Investigation – Concept Drainage Report. Prepared for Greater Shepparton City Council.

HydroTechnology (1995). Documentation and Review of 1993 Victorian Floods – Broken River Catchment Floods October 1993 – Volume 4. Prepared for the Department of Conservation and Natural Resources.

SES (2020). Local Flood Guide – Tallygaroopna.

APPENDIX A Flood Height Survey Data – 19 July 2023

Survey was undertaken on site at Tallygaroopna on the 19 July 2023. Surveyor – Chem Smith – SPIIRE Shepparton, Engineer – Trevor Clark – Confluence.

Vertical datum are derived from GNSS observations vide Congupna PM97 (RL106.744)
Horizontal datum are derived from GNSS Vicpos observations
Vicpos co-ordinates are grid co-ordinates on MGA2020

Point ID	Easting	Northing	Elevation	Date	Comments
NC1	359491.27	5988157.66	107.23	19/07/2023	Level on Netball Court
NC2	359504.31	5988155.54	107.34	19/07/2023	Level on Netball Court
NC3	359517.44	5988158.21	107.37	19/07/2023	Level on Netball Court
NC6	359517.90	5988134.41	107.35	19/07/2023	Level on Netball Court
NC5	359504.78	5988136.55	107.33	19/07/2023	Level on Netball Court
NC4	359491.75	5988133.92	107.24	19/07/2023	Level on Netball Court
P1	359488.70	5988070.39	107.51	19/07/2023	Level on Drainage Pit
P2	359489.16	5988076.71	107.53	19/07/2023	Level on Drainage Pit
P3	359481.81	5988083.20	107.41	19/07/2023	Level on Drainage Pit
P4	359478.92	5988252.97	107.03	19/07/2023	Level on Drainage Pit
P5	359468.77	5988254.59	107.05	19/07/2023	Level on Drainage Pit
P6	359478.13	5988305.99	106.99	19/07/2023	Level on Drainage Pit
P7	359469.99	5988306.86	107.12	19/07/2023	Level on Drainage Pit
P8	359390.74	5988251.43	106.86	19/07/2023	Level on Drainage Pit
FM2023-T1	359627.64	5988489.62	107.18	19/07/2023	Rear shed at 40 Victoria St
FM2023-T2	359388.96	5988235.88	107.32	19/07/2023	Garage door at 17 Fowler St
FM2023-T3	359169.28	5988262.19	107.27	19/07/2023	Level on top of step at 8 Church St
FM2023-T4	359300.00	5988631.44	107.17	19/07/2023	Level on house wall at 12 North St
FM2023-T5	359172.72	5988579.85	107.26	19/07/2023	Level on side fence at 1 North St
FM2023-T6	359224.51	5988157.22	107.26	19/07/2023	Level on garage wall at 11 Church St

2012 Flood Height Marks – Surveyed July 2023

Flood Mark No.	**FM2023 – T1**
Date of interview / Inspection	27 June 2023
Address	40 Victoria Street
Flood Description	2012 flood - where floodwaters got to on the concrete floor of this rear shed.
Reliability	Medium
Flood Level (m AHD)	107.18
MGA Zone 55 Coordinate - easting	359627
MGA Zone 55 Coordinate - northing	5988489

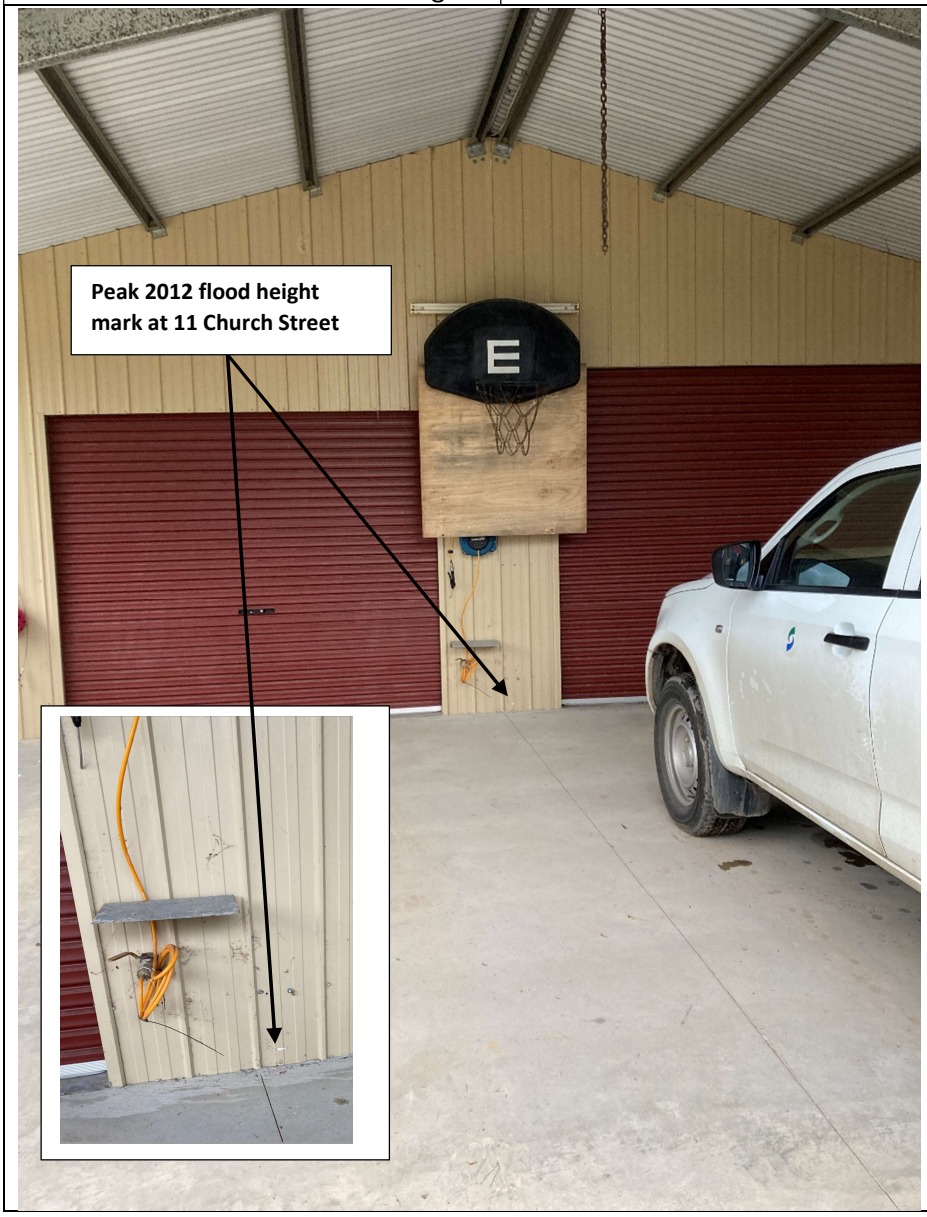
Flood Mark No.	**FM2023 – T2**
Date of interview / Inspection	27 June 2023
Address	17 Fowler Street
Flood Description	2012 flood – high water mark on the inside of this garage door – 0.25 m above concrete floor below.
Reliability	High
Flood Level (m AHD)	107.32
MGA Zone 55 Coordinate - easting	359388
MGA Zone 55 Coordinate - northing	5988235

Flood Mark No.	**FM2023 – T3**
Date of interview / Inspection	27 June 2023
Address	8 Church Street
Flood Description	Peak 2012 flood level equal to the top of the first step up the verandah leading to the house front door.
Reliability	Medium
Flood Level (m AHD)	359169
MGA Zone 55 Coordinate - easting	5988262
MGA Zone 55 Coordinate - northing	107.27

Flood Mark No.	**FM2023 – T4**
Date of interview / Inspection	30 June 2023
Address	12 North Street
Flood Description	Peak 2012 flood level. Flood level peaked just below the second horizontal brick mortar line above floor (10 cm above concrete floor) to left of the front door.
Reliability	High
Flood Level (m AHD)	107.17
MGA Zone 55 Coordinate - easting	359300
MGA Zone 55 Coordinate - northing	5988631

Flood Mark No.	**FM2023 – T5**
Date of interview / Inspection	12 July 2023
Address	1 North Street
Flood Description	Peak 2012 flood level. Ron recorded the peak at this mark on his side fence.
Reliability	High
Flood Level (m AHD)	107.26
MGA Zone 55 Coordinate - easting	359172
MGA Zone 55 Coordinate - northing	5988579

Flood Mark No.	**FM2023 – T6**
Date of interview / Inspection	12 September 2023
Address	11 Church Street
Flood Description	Peak 2012 flood level. Trent recorded this mark coinciding with the 2012 peak flood height on his garage wall.
Reliability	High
Flood Level (m AHD)	107.26
MGA Zone 55 Coordinate - easting	359224
MGA Zone 55 Coordinate - northing	5988157



APPENDIX B Content for Future Updates to Flood Information Documents

SES '*Local Flood Guide – Tallygaroopna*'

The 'Local Flood Guide – Tallygaroopna' is not specific to Tallygaroopna township. Its target audience is the broader area surrounding Tallygaroopna, parts of which are subject to riverine flooding from the Congupna Creek and the Pine Lodge Creek.

The following content could be inserted into the next update of the Local Flood Guide. The information below draws on the outcomes of this project.

Did you know?

Tallygaroopna's highest recorded flood level was in 2012. The town was also significantly impacted by flooding in 1993.

Leave the final three paragraphs of this section as they are.

Are you at risk of flood?

The Tallygaroopna district has experienced flooding in previous years including 1919, 1939, 1956, 1974, 1993, 2012, 2022 and 2023.

Flooding in October 2022 (75 mm in 40 hours) and June 2023 (65 mm in 24 hours) led to mainly nuisance level flooding within the Tallygaroopna township, including flooding of some local roads and property grounds.

Flooding in March 2012 (180 mm in 72 hours) led to more serious flooding within the township, with an estimated five houses flooded to above floor level. Which houses flood is generally dependant on the house floor height above ground. If the floor height is 300 mm above the ground, then above floor flooding will not occur. The closer the house floor height to ground level, the more you are at risk of above floor flooding.

Flooding within Tallygaroopna township is mainly due to local runoff from the town area itself and from nearby rural runoff originating from farmland to the east and south of town.

Flash flooding is possible at Tallygaroopna from high intensity rainfall generating high levels of runoff from within the town itself. Flash flooding can occur during or immediately after the flood inducing rainfall.

Flooding from local rural runoff to the east and south of the town will generally occur from between 30 minutes and 6 hours after the flood inducing rainfall.

Tallygaroopna township will generally not be affected by Congupna Creek unless backflows occur out of the creek. To avoid this happening, drainage inlets into the creek are closed once creek flood levels get too high. Banks either side of Congupna Creek are present to prevent creek overflows. Congupna Creek flood levels can take several days after the flood inducing rainfall to peak due to the time lapse for the Broken River to peak and breakaway flows to reach the creek system.

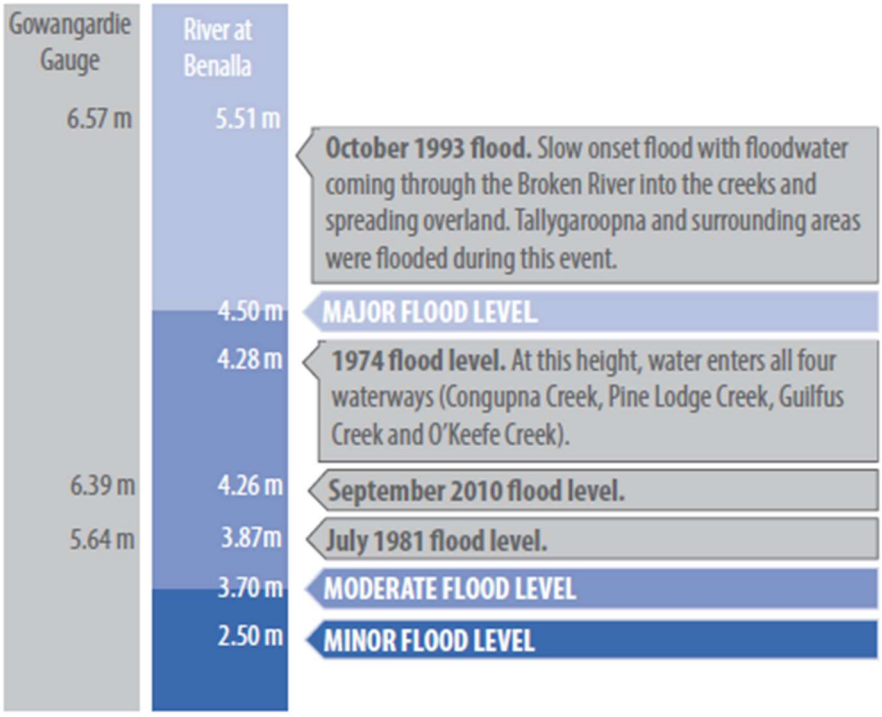
Tallygaroopna township is not affected by Pine Lodge Creek.

Local runoff flooding from the town area and the adjoining rural areas has in the past caused the town's drainage system to be overwhelmed by the sheer volume of floodwater. This resulted in much of the township being subject to shallow flooding in 2012. Flood depths of up to 0.25 m occurred across much of the town in 2012.

Planning for Flooding ***(to replace 'Broken River Flood levels at the Benalla Gauge and Gowangardie Weir Gauge')***

For those living within Tallygaroopna township, flooding will most likely result from local runoff. The severity will depend on the amount and intensity of rainfall. You should access local rainfall information to help you plan for flooding (e.g. via social media, the Bureau of Meteorology website at bom.gov.au/vic/flood, or your own personal rain gauge if you have one).

For those living in rural areas surrounding Tallygaroopna which may be impacted by creek flooding, there are river height gauges for the Broken River at Benalla and Gowangardie Weir which will provide an indication of possible impending flooding severity within the Congupna Creek and Pine Lodge Creek. You can compare the flood heights at Gowangardie Weir to the past flood heights listed below to help you plan for flooding.



Rainfall levels and flooding

The following tables provide an indication of what rainfall levels appear likely to cause flooding in the Tallygaroopna district. The impact of rainfall can vary significantly due to a number of factors including how wet the ground is prior to the rainfall and how quickly the rainfall falls.

Rainfall	Expected Impacts
50 millimetres	Not likely to cause any significant flooding in the area unless experienced as a high intensity storm event in which case flash flooding is possible
75 millimetres	May cause minor flooding impacts such as: ▪ Covering local roads, tracks and low level bridges ▪ Spreading across rural land and into out buildings on some farms ▪ Spreading onto the grounds of some properties within town ▪ Coming up through stormwater drains and partly flooding town streets
125 millimetres	May cause moderate to major flooding impacts such as: ▪ Creek banks spilling over and spreading across low-lying farmland areas ▪ Requiring evacuation in some rural farmland areas ▪ Covering main roads in addition to minor roads ▪ Possible above floor flooding of houses in low lying rural / farming areas ▪ Widespread flooding of town streets ▪ Extensive flooding of some sheds, carports and garages within Tallygaroopna
200 millimetres	Likely to result in widespread significant flooding such as occurred in 2012: ▪ Extensive protracted flooding of farmland and some township areas ▪ Above floor flooding of some houses in Tallygaroopna and the surrounding rural areas ▪ Evacuations of occupants in rural areas ▪ Disrupting major roads and transport routes ▪ Severe access restrictions to outside the district ▪ Widespread flooding of minor buildings in the township

GSCC 'Municipal *Flood Emergency Plan*'

The latest version of this Plan (GSCC Flood Emergency Plan – A Sub-Plan of the Municipal Emergency Management Plan) is dated August 2018. Appendix C4 of the plan is specific to Tallgaroopna.

The following content could be inserted into Appendix C4 when the Flood Emergency Plan is next updated. The information below draws on the outcomes of the Scoping Study project.

Overview of Flooding

The township of Tallygaroopna is located 16 km north of Shepparton. The township has a population of 260.

The township includes approximately 120 houses, a Recreation Reserve serving a number of different sports, a primary school, children's centre, Post Office, CFA facility, Soldier's Memorial Hall, Men's Shed and the service station on the Goulburn Valley Highway.

The town itself is located on the Goulburn Valley Highway at Victoria Street. The town is relatively compact occupying an area of approximately 40 hectares. The surrounding area is farmland located within the Goulburn-Murray Water Shepparton Irrigation Area.

The predominant land fall at Tallygaroopna is in a north westerly direction at an average grade of 1 in 1,900.

Flooding within Tallygaroopna township is mainly due to local runoff from the town area itself and from nearby rural runoff originating from farmland to the east and south of town.

The nearest significant waterway to Tallygaroopna is Congupna Creek located 700 m north of the township. Congupna Creek flooding will generally not impact on flooding within Tallygaroopna providing that drainage inlets into the creek are closed once creek levels get high. Confinement banks along the creek confine flood levels to the creek once creek flood levels rise above the adjoining ground levels.

Pine Lodge Creek is located 3 km west of Tallygaroopna. Pine Lodge Creek does not cause or influence flooding conditions at Tallygaroopna.

Flash flooding at Tallygaroopna is possible from high intensity rainfall generating high levels of runoff from within the town. Flash flooding can occur during or immediately after the flood inducing rainfall.

Runoff from the Tallygaroopna township discharges into Congupna Creek. Stormwater drainage infrastructure at Tallygaroopna managed by Greater Shepparton City Council includes:

- A pit and pipe collector network servicing for transferring runoff to the town retarding basin located at the north western corner of town.
- Outflows from the township retarding basin are pumped into an outfall drain leading to Congupna Creek, 900 m to the north.
- A second retarding basin was constructed in 2023 to service Stage 1 of the Parklands Drive estate under development.

Flood History

The Tallygaroopna district has experienced notable reported flooding in 1919, 1939, 1956, 1974, 1993, 2012 and to a lesser extent 2022 and 2023.

- Minor localised flooding was observed at Tallygaroopna in October 2022 (75 mm in 40 hours) and June 2023 (65 mm in 24 hours). Impacts were mainly in the form of nuisance level flooding of property grounds and local roads.
- Available data suggests that the March 2012 flood event would appear to have been the most severe historical flood in terms of impacts on the Tallygaroopna township. The 2012 flood resulted from approximately 180 mm of rainfall within a three day period. This resulted in widespread, generally shallow (less than 0.3 deep) inundation covering most of the town. Houses with floor levels close to ground level were subject to above floor flooding.
- The October 1993 flood event was largely influenced by breakaway flows from the Broken River into the creek system east of Shepparton. This led to severe flooding of farmland along the creek routes. Both Congupna Creek and Pine Lodge Creek flooded severely in 1993, impacting on rural properties surrounding the Tallygaroopna township, but not so much the township itself. Flooding from local runoff did occur within Tallygaroopna in 1993 but was not as severe as 2012.
- There is very little data associated with the earlier floods dating back to 1919. Rainfall data suggests that they were not as severe as the 2012 flood.

Flood Warning Time

The timing of flooding relative to the timing of the flood inducing rainfall within the Tallygaroopna district can vary significantly.

The term 'flash flooding' is associated with flooding caused by local runoff. Flooding within the township of Tallygaroopna is due to local runoff flooding. The runoff is generated from within the town itself, and the rural areas on the east and south side of the township which falls north westwards towards the town.

Flash flooding at the township can therefore commence as soon as sufficient runoff is generated, which can be during the actual rain event. Flooding at Tallygaroopna township can therefore commence during, immediately after and for a few hours after the flood inducing rainfall, and would be expected to peak within a period of between 30 minutes and 6 hours once the main rainfall ceases.

The time for flooding of Congupna Creek and Pine Lodge Creek to peak is far more protracted than local runoff flooding. In 1993, peak flooding in these creeks did not occur until approximately two days after the lower Broken River peaked. The creeks can also flood due to inflows from their local catchments, in which case they would be expected to peak within 24 hours of the flood inducing rainfall.

Flood Warnings – Flash Flooding / Local Runoff

The BoM will issue warnings in relation to potential flash flooding (i.e. for those areas where high intensity rainfall is predicted). Flash flooding is often caused by high intensity, short duration, localised thunderstorms. Where and when thunderstorms occur is not easily predicted, hence residents should not expect any definitive warnings that relate to impending flash flooding from thunderstorm events at Tallygaroopna.

The March 2012 event was associated with the highest ever seven day cumulative rainfall totals in parts of northern and north eastern Victoria. The flooding at Tallygaroopna was towards the end of this seven day period. The BoM issued numerous flood warnings during the 2012 event for all towns in the region impacted by the widespread protracted and severe rainfall, including Tallygaroopna.

Flood Warnings – Creek / Riverine Flooding

The BoM issues flood warnings associated with riverine flooding.

Depending on the forecast severity of flooding for the Broken River, warnings may be issued for the creek system east of Shepparton, which includes the Congupna and Pine Lodge Creeks. These Broken River related warnings will be issued days in advance of floodwater peaking in the creeks.

There are multiple river height gauges on the Broken River including gauges located at:

- Benalla
- Gowangardie

Flood warnings issued for the Broken River at Benalla and Gowangardie will give an indication of the possibility and potential size of breakaway flows into the creek system which includes Congupna and Pine Lodge Creeks. The 1993 Broken River flood was the most severe flood for that river since at least 1870 by a considerable margin.

Historic Flood Levels

Flood levels at the Tallygaroopna township based on a survey of identified flood height marks in the aftermath of the March 2012 event are documented in the Tallygaroopna Flood Scoping Study report (Confluence Group, 2023).