Tatura Structure Plan

Future Strategic Residential Growth Corridor

Traffic Impact Assessment Report

Client:

Greater Shepparton Council

Project No. 190877

FINAL Report – 17/12/2020

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EXECUTIVE SUMMARY

Trafficworks has been engaged by Greater Shepparton City Council (the Council) to undertake a traffic impact assessment to assist Council with the development of the Tatura Structure Plan. This report will help inform the road layout of each of the precincts for the next level of design and forms part of the initial design / investigation work for the future strategic residential growth corridors to the north, northeast and east of Tatura.

This traffic impact assessment was carried out to:

- estimate traffic generation and distribution associated with the proposed development
- determine the suitability of the proposed access location onto the adjacent road network
- determine the likely traffic impacts on the existing road network
- identify any necessary mitigating works.

A summary is shown below

Address	Tatura Structure Plan Study Area (refer Figure 1)

Zoning	• Farming zone
	  ○ schedule 1
	  ○ schedule 2
	• Rural living zone
	• Low density residential zone
	• Industrial 1 zone

Proposed development	Approximately 3,748 residential dwellings
Road network	Midland Highway (state arterial road – A300) Tatura-Undera Road (state arterial road – C357) Dhurringile Road Pyke Road Ferguson Road Bayunga Road Murton Road
Traffic generation	33,742 vehicles per day (vpd) 2,868 vehicles per hour (vph) peak hour traffic

Recommendations	It is recommended that: • **Recommendation 1:** Council undertake a review of the speed zones within the Tatura Structure Plan study area and the adjoining road network to provide consistency • **Recommendation 2:** the development of the study area includes sealing of the unsealed roads that are relied upon for access for the newly developed residential dwellings • **Recommendation 3:** a review of the Midland Highway / Dhurringile Road intersection is undertaken to consider if improvements are required to maintain satisfactory operation of the intersection • **Recommendation 4:** ensure all intersections provide the required turn lane treatments in accordance with AGRD4 • **Recommendation 5:** SIDRA analysis be undertaken of the Intersection G to confirm if a cross intersection will operate satisfactorily • **Recommendation 6:** a new intersection be provided to Dhurringile Road from precinct B with sufficient offset to the rail crossing • **Recommendation 7:** ensure all proposed intersections are located to ensure that turn lane lengths do not conflict with any existing or future turn lanes associated with existing intersections and that the location of the access does not conflict with any access to surrounding land • **Recommendation 8:** ensure all intersections are checked against the AGRD4A sight distance requirements at the detailed design phase to ensure compliance • **Recommendation 9:** ALCAM assessments are undertaken for the level crossings at Tatura-Undera Road, Hogan Street, Dhurringile Road and Bayunga Road, based on current operating conditions

Referenced documents

References used in the preparation of this report include the following:

- RTA Guide to Traffic Generating Developments, Version 2.2, October 2002 for traffic generation predictions and parking requirements
- Austroads Guide to
    - Road Design
        - Part 4 (AGRD4)
        - Part 4A (AGRD4a)
- Austroads Guide to Traffic Management
    - Part 3 (AGTM3)
    - Part 6 (AGTM6)
- Greater Shepparton City Council Planning Scheme

  Local Government Infrastructure Design Association's Infrastructure Design Manual (IDM), Version 5.20 released March 2019.

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1 INTRODUCTION

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This traffic impact assessment was carried out to:

- estimate traffic generation and distribution associated with the proposed development
- determine the suitability of the proposed access location onto the adjacent road network
- determine the likely traffic impacts on the existing road network
- identify any necessary mitigating works.

2 BACKGROUND

2.1 Tatura structure plan

Greater Shepparton City Council (Council) is commencing design and investigation work for a future strategic residential growth corridor for Tatura. Trafficworks has been engaged by Council to undertake a traffic impact assessment of the study area to identify the transport infrastructure works that will be required as a result of the growth area.

The Tatura Structure Plan study area comprises approximately 760 hectares to the north, north east and east of the Tatura township, which is currently zoned (but not limited to) Farming zone – schedule 1 and 2 (FZ1, FZ2), Rural living zone (RLZ), Low density residential zone (LDRZ) and Industrial 1 zone (IN1Z).

The Tatura Structure Plan study area, precincts and the surrounding road network is shown in Figure 1 and the zoning map of the area is shown in Figure 2.

Figure 1: Location Plan (reproduced with permission from Melway Publishing Pty Ltd)

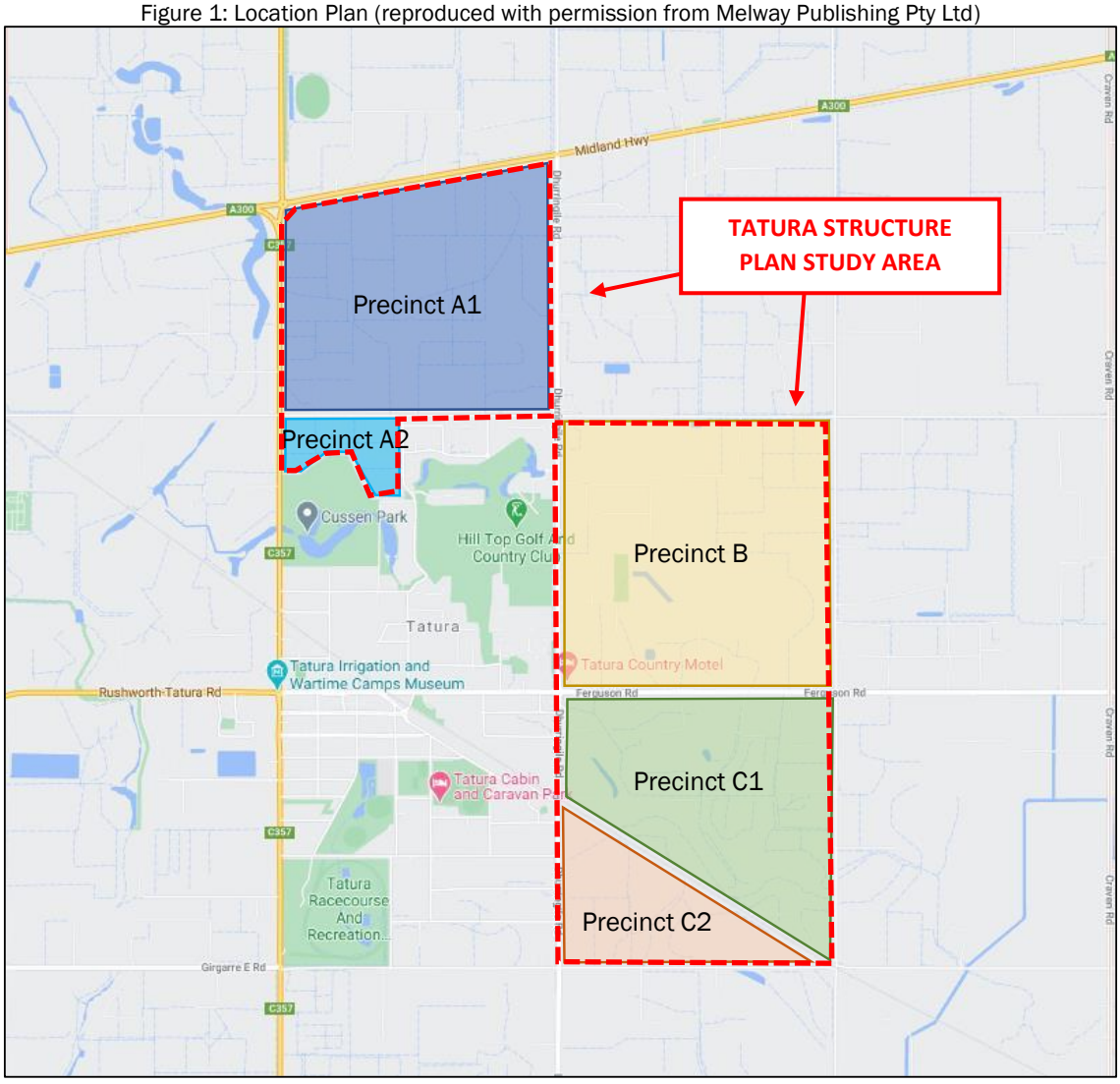
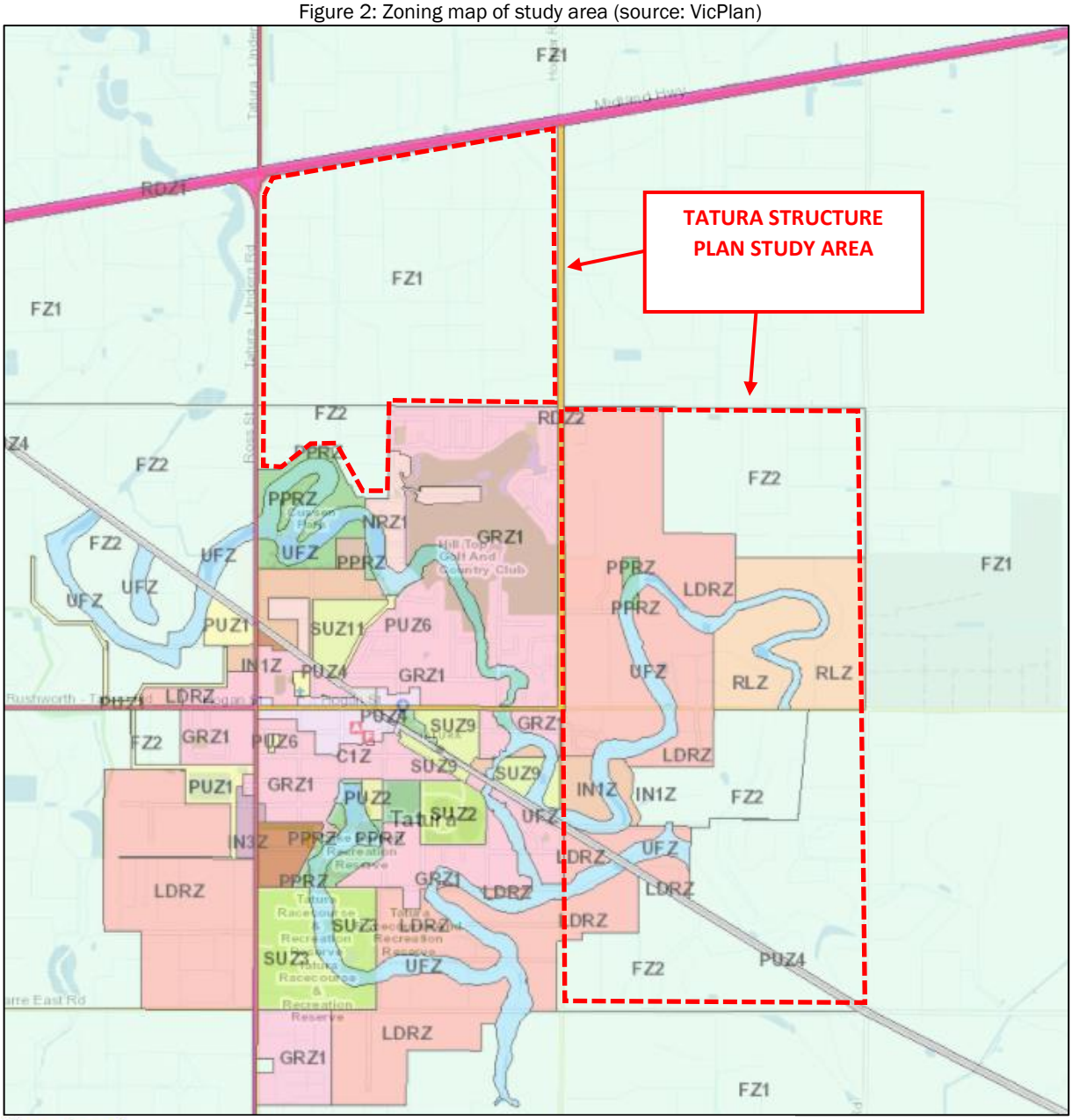


Figure 2: Zoning map of study area (source: VicPlan)



2.2 Road network

2.2.1 Midland Highway

The Midland Highway (A300) is a state arterial road under the management of Regional Roads Victoria (RRV[1]). It is aligned generally in an east-west direction and provides a connection between Benalla to the east and Bendigo to the south-west. Near the study area, the Midland Highway forms a two-lane, two-way road (2 x 3.5 m traffic lanes) divided by centreline wire rope safety barrier with 2.5 m – 3.5 m sealed shoulders on each side (refer to Photos 1 and 2).

The Midland Highway is subject to a posted speed limit of 100 km/h.

Photo 1: The Midland Highway intersection with the Tatura-Undera Road, looking west

Photo 2: Typical cross section of the centreline wire rope safety barrier on the Midland Highway, looking east

[1] RRV is part of the Department of Transport (DoT)

2.2.2 Tatura-Undera Road

The Tatura-Undera Road (C357) (also known locally as Ross Street) is a state arterial road under the management of RRV. It is aligned in a north-south direction and provides a connection between Undera to the north and Murchison (via the Murchison-Tatura Road, also the C357) to the south. Near the study area, Tatura-Undera Road forms a two-lane, two-way (2 x 3.4 m traffic lanes) undivided road with 1.3 m sealed shoulders on each side (refer Photos 3 and 4).

Photo 3: typical urban area cross section of the Tatura-Undera Road, looking north

Photo 4: typical rural area cross section of the Tatura-Undera Road, looking south

Tatura-Undera Road is subject to a posted speed limit of 100 km/h. A reduced speed limit of 60 km/h applies to Tatura-Undera Road through the town centre, between approximately 650 m south of Pyke Road and Murton Street (to the south of the Tatura Racecourse).

2.2.3 Pyke Road

Pyke Road is a local road under the management of Council. It is aligned in an east to west direction and provides connection between Mahoney Track to the east and Winter Road to the west. Near the study area, Pyke Road between Charter Street and Bayunga Road is a two-lane, two-way sealed road with a carriageway width of approximately 6.2 m (refer Photo 5). Between Tatura-Undera Road and Charter Street and to the west of Bayunga Road, Pyke Road is a two-way gravel (refer Photo 6).

Photo 5: Pyke Road, looking west, at the intersection with Charter Street, the unsealed section in the background

Photo 6: the unsealed section of Pyke Road, looking west near to the intersection with the Tatura-Undera Road

Pyke Road is subject to a rural default speed limit of 100 km/h which reduces to 60 km/h between Charter Street and Dhurringile Road.

2.2.4 Ferguson Road

Ferguson Road is a local road under the management of Council. It is aligned in an east to west direction and provides connection between Turnbull Road to the east and Hogan Street to the west. Near the study area, Ferguson Road is a two-lane, two-way undivided road with 2.1 m sealed shoulders on each side. On-road bicycle lanes are provided along Ferguson Road adjacent to the new residential development at 65 Ferguson Road (refer Photos 7 and 8).

Photo 7: typical urban area cross section of Ferguson Road, looking east

Photo 8: typical rural area cross section of Ferguson Road, looking east

The following speed limits apply to Ferguson Road in the vicinity of the study area:

- posted speed limit of 60 km/h applies east of Dhurringile Road for approximately 660 m

- posted speed limit of 80 km/h applies from approximately 660 m east of Dhurringile Road for approximately 160 m
- posted speed limit of 100 km/h applies approximately 830 m east of Dhurringile Road.

2.2.5 Murton Road

Murton Road is a local road under the management of Council. It is aligned in an east to west direction and provides connection between Downer Road to the east and Tatura-Undera Road to the west. Near the study area, Murton Road is a two-way undivided road with a sealed carriageway width of approximately 4.6 m (refer Photos 9 and 10).

Photo 9: typical rural residential area cross section of Murton Road, looking east

Photo 10: typical rural area cross section of Murton Road, looking east

Murton Road is subject to a posted speed limit of 80 km/h from Dhurringile Road and increases to 100 km/h approximately 200 m east of Dhurringile Road.

2.2.6 Dhurringile Road

Dhurringile Road is a local road under the management of Council. It is aligned in a north to south direction and provides connection between the Midland Highway to the north and Hammond Road to the south. Near the study area, Dhurringile Road is a two-lane, two-way undivided road with 0.5 m sealed shoulders on each side (refer Photos 11 and 12).

Photo 11: typical rural cross section of Dhurringile Road, looking south

Photo 12: typical rural residential cross section of Dhurringile Road, looking north

The following speed limits apply to Dhurringile Road in the vicinity of the study area:

- posted speed limit of 60 km/h applies approximately 660 m north of Ferguson Road to Hampton Street
- posted speed limit of 80 km/h applies from:
    - approximately 500 m south of Pyke Street for approximately 320 m
    - Hampton Street to approximately 80 m south of Murton Street
- posted speed limit of 100 km/h applies from south of the Midland Highway to approximately 500 m south of Pyke Street and to the south of Murton Road.

2.2.7 Bayunga Road

Bayunga Road is a local road under the management of Council. It is aligned in a north to south direction and provides connection between the Midland Highway to the north and Hammond Road to the south. Near the study area, Bayunga Road is a two-way unsealed (with some sealed sections near residences and on approach to intersections) road with a carriageway width of approximately 4.0 m (refer Photos 13 and 14).

Photo 13: typical sealed cross section of Bayunga Road, looking south

Bayunga Road is subject to a rural default speed limit of 100 km/h which reduces to 80 km/h approximately 500 m north of Murton Road.

Conclusion 1: the assessment revealed that there are several different speed zones within the Tatura Structure Plan study area. Consideration should be given to reviewing the current speed zones to provide consistency throughout the study area and the adjoining road network for Tatura.

Recommendation 1: Council undertake a review of the speed zones within the Tatura Structure Plan study area and the adjoining road network to provide consistency.

Conclusion 2: the assessment revealed that there are sections of roads within the study area that are unsealed and will need to be sealed as part of the development of the study area.

Recommendation 2: the development of the study area includes sealing of the unsealed roads that are relied upon for access for the newly developed residential dwellings.

Photo 14: typical unsealed cross section of Bayunga Road, looking south

2.3 Existing intersection

2.3.1 Major road intersections

The existing intersections in Tatura are subject to give-way, roundabout or staggered intersection as summarised in Figure 3, overleaf.

2.3.2 Internal road intersections

Existing internal road connections that could be upgraded to provide access into the future development areas are discussed as follows and are shown in Figure 4:

- Johnstone Road is an existing local access road that intersects with Dhurringile Road approximately 500 m north of Ferguson Road which provides access into precinct B
- Mako Drive is new local road that intersects with Ferguson Road is in the process of being constructed which provides access into precinct B. This intersection provides a CHR and an AUL turn treatments
- Doller Court is an existing local access road that intersects with Ferguson Road which provides access into precinct B and is located approximately opposite Mako Drive (refer to Figure 4). This intersection provides a CHR(s) turn treatment.

Gowrie Park Road is an existing local access road that intersections Dhurringile Road approximately 10 m north of the rail crossing which provides access into Precinct C1

Figure 3: Existing intersection treatments

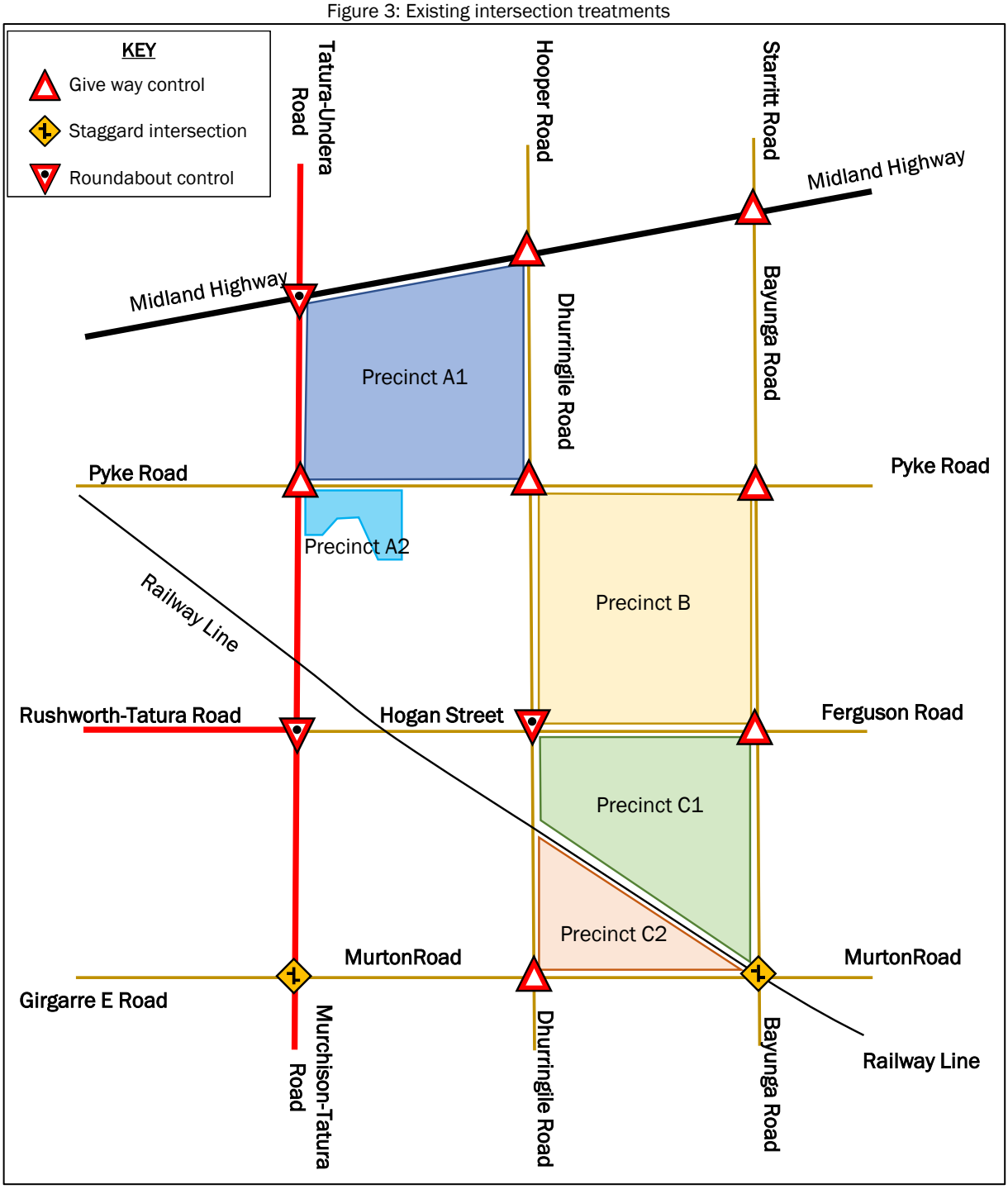
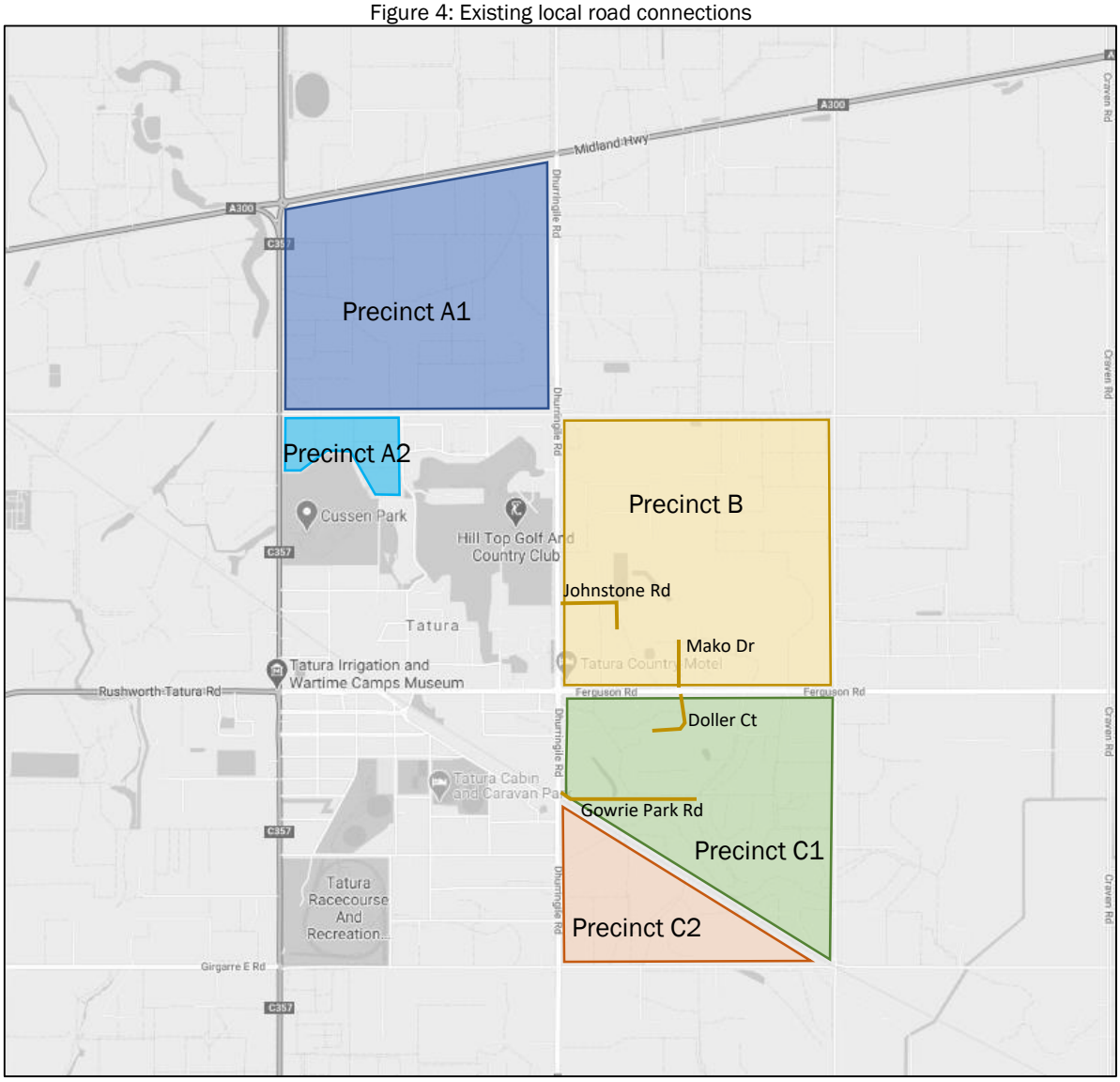


Figure 4: Existing local road connections



2.4 Traffic volumes

Council provided the most recent 24-hour vehicle classification survey data that was available for the following roads in the vicinity of the study area:

1. Pyke Road between Tatura-Undera Road and Charters Street (January 2017)
2. Pyke Road between Gleneagles Drive and Dhurringile Road (February 2016)
3. Dhurringile Road between Midland Highway and Pyke Road (February 2016)
4. Dhurringile Road between Pyke Road and Sunningdale Boulevard (August 2019)
5. Dhurringile Road between Mactier Street and Gowrie Park Road (August 2014)
6. Bayunga Road - 400 m north of Ferguson Road (December 2019)
7. Ferguson Road between Doller Court and Bayunga Road (November 2013)
8. Murton Road between Ross Street and Maskell Lane (January 2018)
9. Tatura-Undera Road between Hunter Street and Hogan Street (November 2018).

The locations of the surveys are shown in Figure 5 and the traffic volumes are summarised in Table 1.

Figure 5: Location of traffic surveys

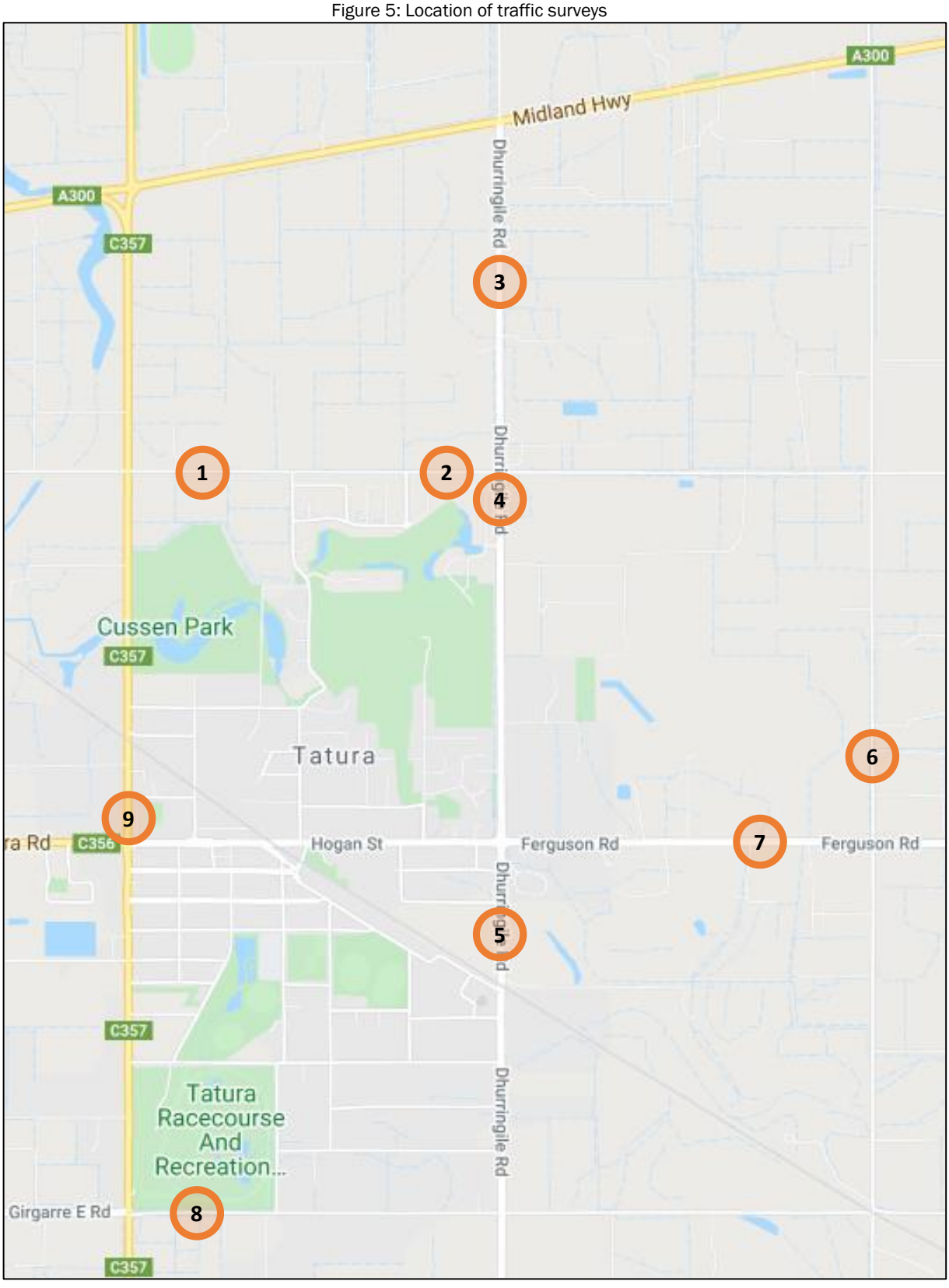


Table 1: Traffic survey results

Ref	Location	Date	Peak Period	Volumes		
				Direction 1[2]	Direction 2[3]	Two-Way
1	Pyke Road Tatura-Undera Road to Charters Street	01/17	8.00 - 9.00 am	10	1	11
			5.00 - 6.00 pm	8	13	21
			24-hour volume	79	69	148
2	Pyke Road Gleneagles Drive to Dhurringile Road	02/16	8.00 - 9.00 am	6	3	9
			5.00 - 6.00 pm	7	4	11
			24-hour volume	80	69	149
3	Dhurringile Road Midland Highway to Pyke Road	02/16	8.00 - 9.00 am	204	151	355
			5.00 - 6.00 pm	137	176	313
			24-hour volume	2,086	1,954	4,040
4	Dhurringile Road Pyke Road to Sunningdale Boulevard	08/19	8.00 - 9.00 am	98	106	204
			5.00 - 6.00 pm	97	87	184
			24-hour volume	1,128	1,137	2,265
5	Dhurringile Road Mactier Street to Gowrie Park Road	08/14	8.00 - 9.00 am	79	33	112
			5.00 - 6.00 pm	46	92	138
			24-hour volume	732	702	1,434
6	Bayunga Road 400 m north of Ferguson Road	12/19	8.00 - 9.00 am	5	1	6
			5.00 - 6.00 pm	4	1	5
			24-hour volume	23	18	41
7	Ferguson Road Doller Court to Bayunga Road	11/13	8.00 - 9.00 am	54	108	162
			5.00 - 6.00 pm	133	104	237
			24-hour volume	1,062	1,162	2,224
8	Murton Road Ross Street to Maskell Lane	01/18	8.00 - 9.00 am	9	6	15
			5.00 - 6.00 pm	17	8	25
			24-hour volume	160	146	306
9	Tatura-Undera Road Hunter Street to Hogan Street	11/18	8.00 - 9.00 am	133	142	275
			5.00 - 6.00 pm	140	113	253
			24-hour volume	1,663	1,557	3,220

[2] Northbound or Eastbound
[3] Southbound or Westbound

2.5 Crash history

The Department of Transport (DoT) *Crashstats* database details all injury crashes on roads throughout Victoria. Scrutiny of these records indicates that five casualty crashes have occurred in the vicinity of the Tatura Structure Plan study area in the last five years of available data:

Tatura-Undera Road / Pyke Road intersection

- one 'right rear' type collision (DCA 132) occurred on Tuesday 7 April 2015 at 9.30 am resulting in an 'other' injury

Midland Highway / Dhurringile Road intersection

- two 'left near' type collision (DCA 116) occurred on:
    - Thursday 22 February 2018 at 5.15 pm resulting in an 'other' injury
    - Friday 1 December 2018 at 12.30 pm resulting in an 'other' injury

Ferguson Road / Dhurringile Road intersection

- one 'cross traffic' type collision (DCA 110) occurred on Monday 23 May 2016 at 9.10 am resulting in a serious injury

Mactier Street / Dhurringile Road intersection

- one 'right through' type collision (DCA 121) occurred on Wednesday 16 January 2019 at 12.30 pm resulting in an 'other' injury

No trends in crashes have been observed, hence it can be concluded that the roads near the Tatura Structure Plan study area do not have a traffic safety problem that requires urgent remedial action.

Conclusion 3: No trends in crashes were observed within the vicinity of the Tatura Structure Plan study area in the last five years of available data, hence there are no traffic safety problems that require urgent remedial action.

2.6 Pedestrians and cyclists

There is currently no shared path network connecting the study area with the Tatura town centre, although pedestrians and cyclists were observed travelling within and adjacent to the existing rural living access roads.

2.7 Public transport

Tatura is located on a V-Line regional coach service that operates between:

- Barmah to Melbourne (via Shepparton or Heathcote)
- Moama – Echuca – Melbourne (via Seymour and Murchison East)

Buses on this route stop in Fraser Street in the centre of town. There is no known town bus service that caters for local trips within Tatura.

2.8 Community consultation

On behalf of Trafficworks, Council contacted the Tatura community plan group to request information regarding local residents' travel patterns to different destinations within and around Tatura and the wider area.

The responses provided indicated that local residents typically travel to/from the town centre or to Shepparton and Mooroopna (to the east), with a small number of trips to/from the wider area to the north and west.

In addition, the responses indicated that recent upgrades to the Midland Highway / Dhurringile Road intersection has created a number of safety concerns for local residents including poor visibility, short turning lanes and limited overtaking opportunities. As a result of these safety concerns, local residents advised they avoided this intersection all together and utilised Ferguson Road as an alternative route to the east.

Conclusion 4: Council to consider advocating for RRV to undertake a review of the safety implications of the upgrades to the Midland Highway / Dhurringile Road intersection.

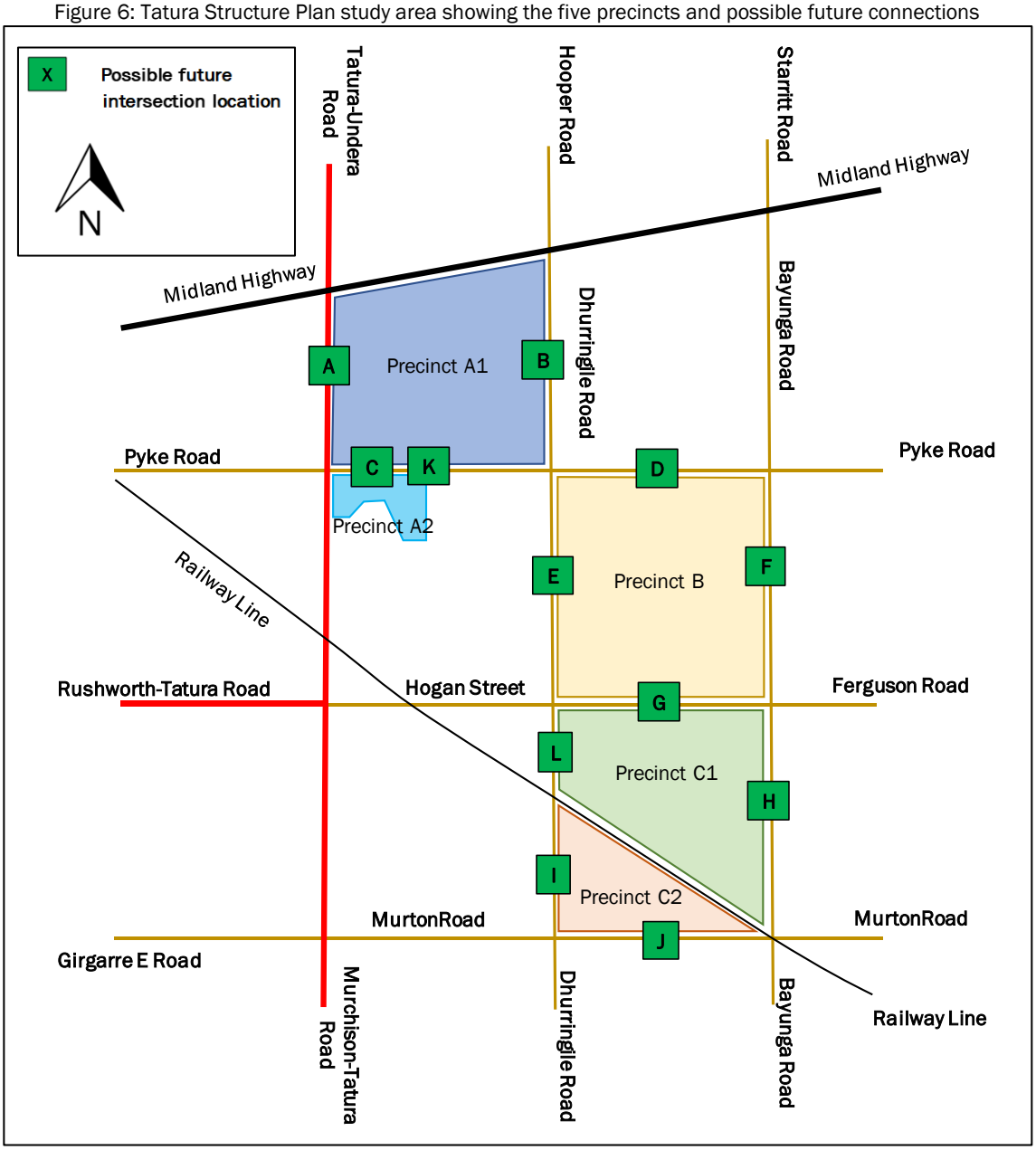
Some of the responses indicated that local trips to / from the town centre were being undertaken by bicycle and 'dooring' was an issue, particularly on Hogan Street.

3 PROPOSED DEVELOPMENT

3.1 Proposed development summary

For the purpose of this assessment, the Tatura Structure Plan study area was divided into precincts as highlighted in Figure 6.

Figure 6: Tatura Structure Plan study area showing the five precincts and possible future connections



Based on the residential subdivision outlined in the Tatura Framework Plan, the number of dwellings for the Tatura Structure Plan study area was determined based on the approximate land area of each precinct (based on the dwelling densities identified in the Tatura Framework Plan) and the average lot sizes. It was conservatively assumed that 10% of each precinct would be set aside for roads and drainage services.

Therefore, it is anticipated that at full development the Tatura Structure Plan study area will yield approximately 3,748 residential dwellings, as follows:

- Precinct A1 1,440 dwellings
- Precinct A2 275 dwellings
- Precinct B 1,154 dwellings
- Precinct C1 421 dwellings
- Precinct C2 84 dwellings

It has been assumed that RRV would not support any new connections from precinct A1 to the Midland Highway.

For the purpose of this assessment, the connections shown to each abutting road are theoretical and will be used to determine the number of road connections required to service the development area. The intersection locations are indicative only to represent the traffic that could gain access onto each abutting road. The suitability of the existing internal road connections is considered further in Section 4.5 of this report.

The location of each theoretical road connection is indicatively shown in Figure 6.

3.2 Applicable IDM cross sections

The *Infrastructure Design Manual* (IDM) includes a series of standard road cross sections that are applicable to the Tatura Structure Plan study area.

The design criteria for roads applicable to the Tatura Structure Plan study area, are summarised in the following subsections.

3.2.1 Connector Street (Level 2)

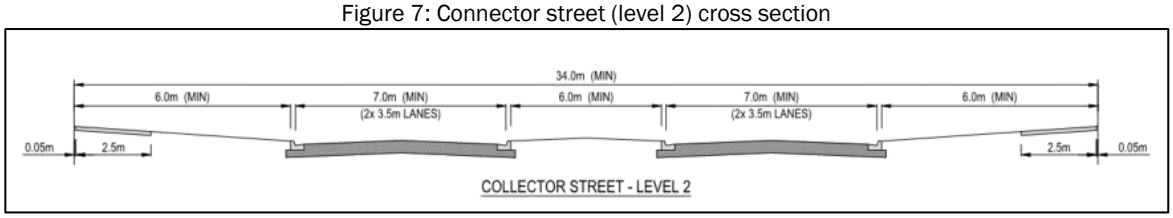
Connector streets (level 2) carry higher volumes of traffic and connect access places and access streets through and between neighbourhoods. A summary of the design criteria for this type of road is:

- traffic volumes up to 6,000 – 12,000 vpd[4]
- 2 x 7.0 m carriageway widths with indented on-street parallel parking on both sides
- 6.0 m wide central median
- verge width of 6.0 m to accommodate services
- pedestrian paths should be provided on both sides of the road
- shared paths should be provided on both sides of the road
- road reserve width of 34.0 m.

Refer to Figure 7 for the Connector street (level 2) cross section.

[4] Vpd = vehicles per day

Figure 7: Connector street (level 2) cross section



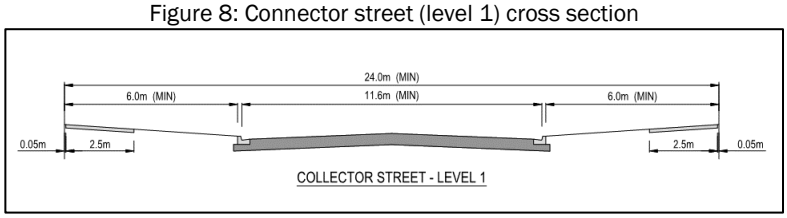
3.2.2 Connector Street (Level 1)

Connector streets (level 1) carry higher volumes of traffic and connects access places and access streets through and between neighbourhoods. A summary of the design criteria for this type of road is:

- traffic volumes up to 2,500 – 6,000 vpd
- 11.6 m carriageway width with idented on-street parallel parking on both sides
- verge width of 6.0 m to accommodate services
- shared paths should be provided on both sides of the road
- road reserve width of 24.0 m.

Refer to Figure 8 for the Connector street (level 1) cross section.

Figure 8: Connector street (level 1) cross section



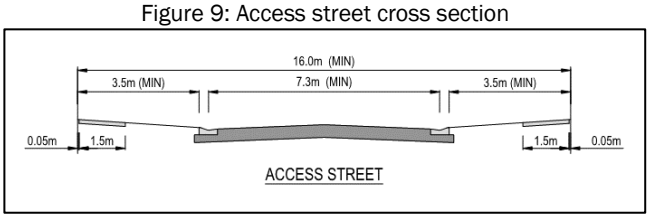
3.2.3 Access Street

Access street provides local residential access where traffic is subservient, speed and traffic volumes are low and pedestrian movements are facilitated. A summary of the design criteria for this type of road is:

- traffic volumes up to 1,000 – 2,500 vpd
- 7.3 m carriageway width with on-street parallel parking on both sides
- verge width of 6.0 m to accommodate services
- pedestrian paths should be provided on both sides of the road
- road reserve width of 16.0 m.

Refer to Figure 9 for the access street cross section.

Figure 9: Access street cross section



3.3 Theoretical Road Capacity

It is noted that the traffic volume range provided for the IDM cross sections are related to the provision of an intended level of amenity along the roadway, rather than providing an indication of the actual road capacity.

Austroads Guide to Traffic Management Part 3 (AGTM3) specifies a one-way mid-block capacity for urban arterial roads with interrupted flows is shown in Table 5.1 of AGTM3 and ranges between 600 vph and 900 vph for undivided roads. This road capacity range is based on factors including the road environment, side road access, property access and on-street parking.

Hence, if the directional splits are 50:50 and assuming 10% of daily traffic occurs within the peak hours, the theoretical capacity of an undivided two-lane, two-way is between 12,000 to 18,000 vpd.

4 ASSESSMENT

4.1 Trip generation and distribution

4.1.1 Traffic generation

Traffic generation for new developments is typically estimated using the traffic generation rates provided in the *RTA Guide to Traffic Generating Developments* (2002) or the rates provided in the *Infrastructure Design Manual* (IDM). As per the RTA Guide, the traffic generation rates applicable to the residential development are:

- 9 vehicle trips per dwelling per day
- 0.85 vehicle trips per dwelling per hour (during the peak hour).

The IDM the traffic generation rate applicable to the residential development is 10 vehicle trips per dwelling per day.

For this assessment, a daily traffic generation rate of 10 vehicle trips per dwelling per day and 0.85 vehicle trips per dwelling per hour was adopted to determine the anticipated traffic generation to / from the Tatura Structure Plan study area.

Refer to Table 2 for a summary of the traffic generation for the Tatura Structure Plan study area.

Table 2: Development traffic volumes

Precinct	Lots	RTA Guide / IDM Traffic Generation Rate		Study area Traffic Generation	
		Hourly	Daily	Hourly	Daily
A1	1,440	0.85	10	1,224	14,402
A2	275	0.85	10	234	2,748
B	1,154	0.85	10	981	11,540
C1	421	0.85	10	358	4,215
C2	84	0.85	10	71	837
			TOTAL	2,868	33,742

Conclusion 5: The overall Tatura Structure Plan study area is likely to generate 33,742 vpd with a peak hour traffic volume of 2,868 vph (vehicles per hour).

4.1.2 Traffic distribution

Full development of the Tatura Structure Plan study area is likely to occur within the next 30-year period; however, it is difficult to forecast the annual compounded growth rate for the underlying traffic volumes beyond a 10-year period.

Therefore, for this traffic assessment it has been assumed that the full development will occur within the next 10 or 30-year period. An annual compounded growth rate of 1%[5] annual compounded growth rate on all roads to project the existing traffic volumes to 2030 traffic volumes.

Furthermore, it is assumed that 85% of the development traffic is likely to travel to / from Tatura town centre (local trips) and the remaining traffic is likely to travel to:

- 10% to the east
- 1% to the north
- 2% to the south
- 2% to the west

As discussed in Section 2.7, consultation with local residents indicated that many residents travelling to/from the east are avoiding the Midland Highway / Dhurringile Road intersection due to various safety concerns and are utilising Ferguson Road as an alternative route. Therefore, this distribution has assumed that the majority of the traffic travelling to/from the east will utilise Ferguson Road.

The percentage of traffic that is anticipated to generate to each road connection is summarised in Table 3. It is noted that it is assumed that 60% of precinct A2 will generate to/from Charter Street which is an established local road that provides access to existing dwellings to the east of precinct A2.

Table 3: Intersection splits

Intersection	Precinct				
	A1	A2	B	C1	C2
A	35%				
B	40%				
C		40%			
D			25%		
E			30%		
F			15%		
G			30%	60%	
H				20%	
I					60%
J					40%
K	25%				
L				20%	
existing[6]		60%			

[5] RRV data for both the Midland Highway and the Tatura-Undera Road indicate a growth rate of 1%
[6] Existing access to precinct A2 via Charter Street

The splits for the AM and PM peak hour at each intersection based on existing traffic patterns are shown in Figure 10. It is noted that the traffic distribution and operation of the intersections to the major roads will need to be re-evaluated during the next design stage (once the internal road network is established.

4.1.3 Anticipated traffic volumes

The anticipated 2030 traffic volumes, assuming full development of the Tatura Structure Plan study area is shown in Figure 11.

4.2 Existing road network ultimate cross section

The anticipated post-development traffic volumes on the existing road network impacted by the development of the Tatura Structure Plan study area are summarised in Table 4 and the post development IDM road classification is shown graphically in Figure 12.

Based on the anticipated post-development traffic volumes, Ferguson Road, Dhurringile Road and Tatura-Undera Road are to be designed as a connector street (level 2) due to the existing travel patterns. It is noted that these roads are constrained by dwellings and the existing road reservation widths are not sufficient to provide the cross-section for a connector street (level 2).

As discussed in Section 3.3, the theoretical road capacity of a two-lane, two-way road is between 12,000 to 18,000 vpd and is sufficient to accommodate the anticipated post development traffic volumes. In addition, the above analysis considers the existing travel patterns of local residents and as the land is developed, these travel patterns may change as the surrounding roads are upgraded to provide safer and more convenient travel routes. If travel patterns change, the higher order road cross-section may not be required.

Conclusion 6: The theoretical capacity of a two-lane, two-way road (i.e. Connector Road level 1) is sufficient to accommodate the anticipated post-development traffic volumes of Ferguson Road, Dhurringile Road and Tatura-Undera Road.

It is noted that traffic volumes along Dhurringile Road are currently high to the south of intersection B due to local residents avoiding the Midland Highway / Dhurringile Road intersection. As traffic volumes along Dhurringile Road increase, as the future residential development within the study area grows, it is recommended that a review of the Midland Highway / Dhurringile Road intersection is undertaken to consider if improvements are required to maintain satisfactory operation of the intersection.

Recommendation 3: a review of the Midland Highway / Dhurringile Road intersection is undertaken to consider if improvements are required to maintain satisfactory operation of the intersection.

Figure 10: Anticipated intersection splits

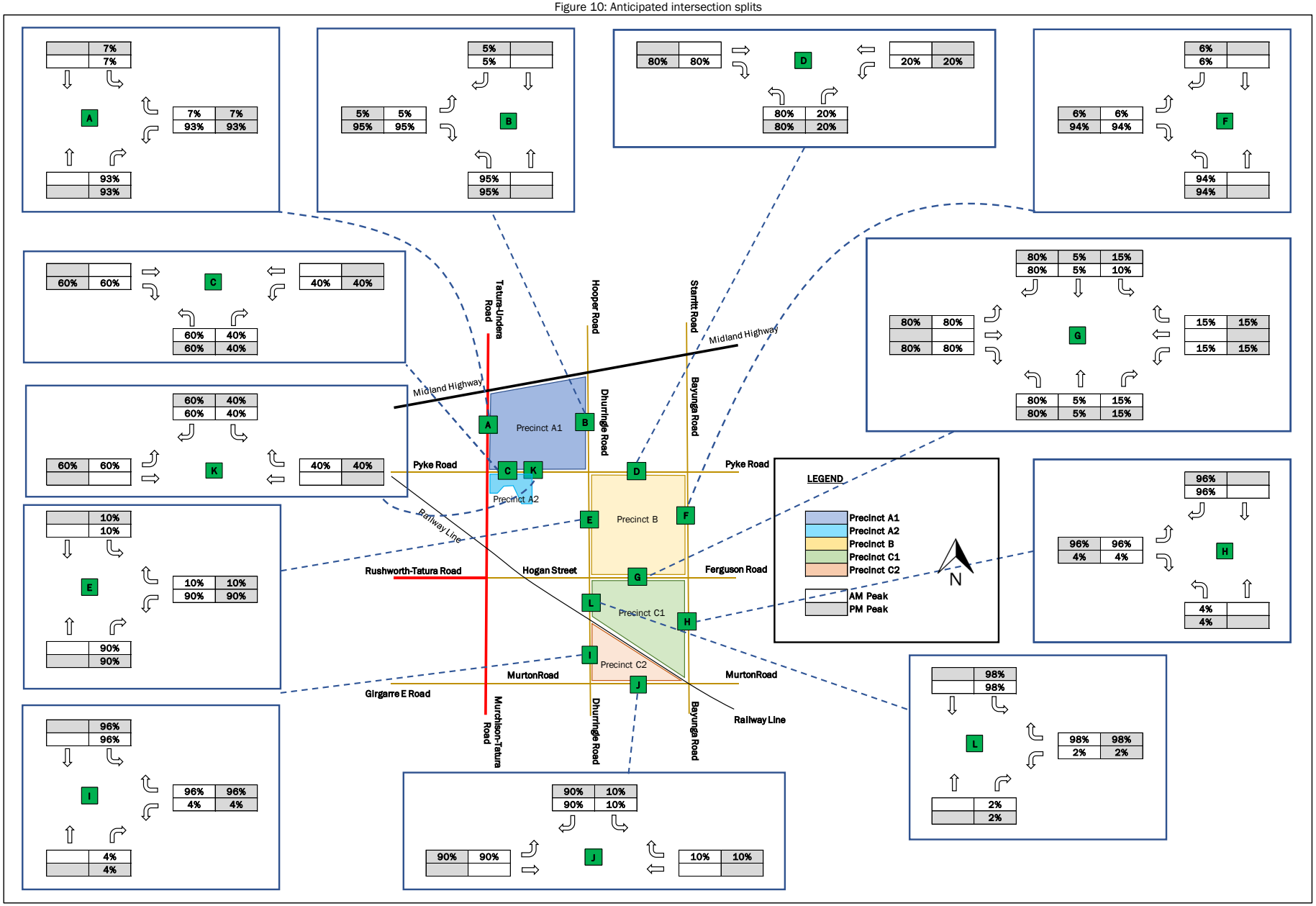


Figure 11: Anticipated peak hour traffic volumes

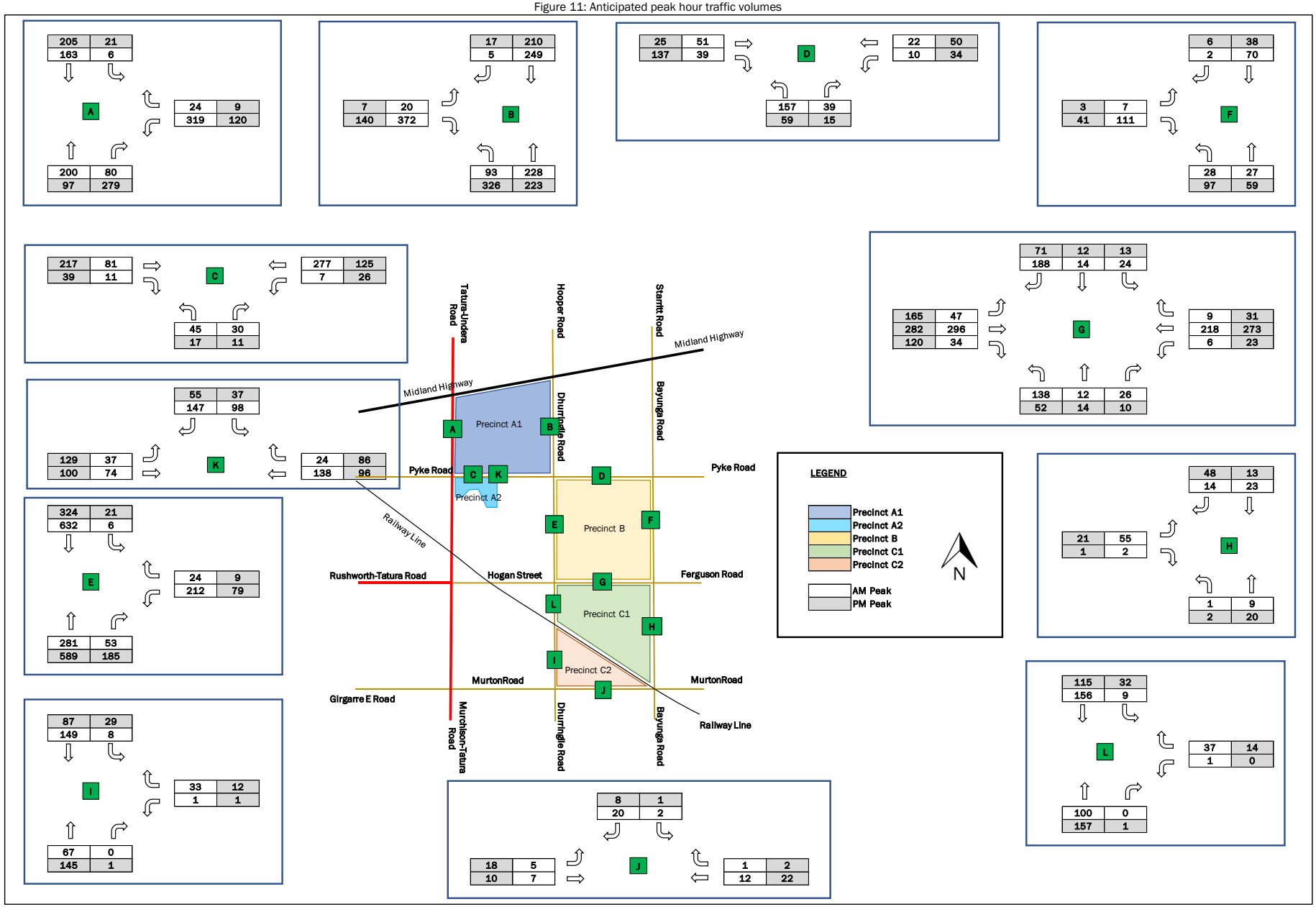
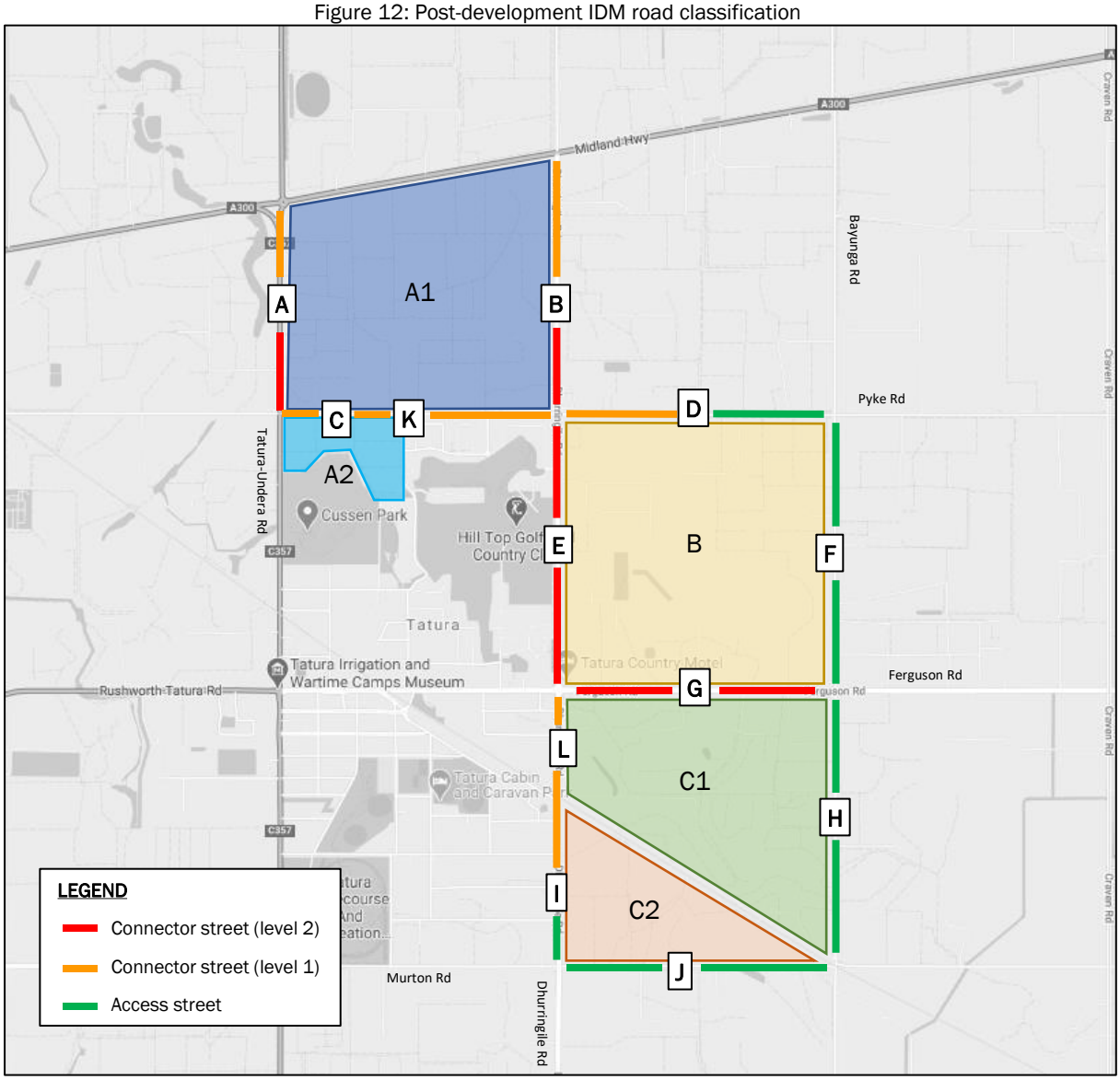


Table 4: Anticipated post-development two-way daily traffic volumes

Road	Intersection	Location	Daily two-way volume	IDM Road Classification
Tatura-Undera Road	A	North	3,929	Connector Street – Level 1
		South	7,614	Connector Street – Level 2
Dhurringile Road	B	North	5,019	Connector Street – Level 1
		South	9,427	Connector Street – Level 2
	E	North	9,427	Connector Street – Level 2
		South	11,782	Connector Street – Level 2
	L	North	3,176	Connector Street – Level 1
		South	2,727	Connector Street – Level 1
	I	North	2,727	Connector Street – Level 1
		South	2,335	Access Street
Ferguson Road	G	East	6,311	Connector Street – Level 2
		West	9,621	Connector Street – Level 2
Pyke Road	C	East	3,959	Connector Street – Level 1
		West	4,146	Connector Street – Level 1
	D	East	1,239	Access Street
		West	2,710	Connector Street – Level 1
	K	East	3,347	Connector Street – Level 1
		West	3,959	Connector Street – Level 1
Bayunga Road	F	North	1,056	Access Street
		South	2,351	Access Street
	H	North	1,027	Access Street
		South	368	Access Street
Murton Road	J	East	348	Access Street
		West	576	Access Street

Figure 12: Post-development IDM road classification



Conclusion 7: Based on the anticipated post-development traffic volumes, Pyke Road is to be designed as a connector street (level 1).

Conclusion 8: Based on the anticipated post-development traffic volumes, Bayunga Road is to be designed as an access street.

4.3 Major road intersections

The traffic generated post-development of the study area will increase traffic volumes at the existing major road intersections. As discussed in Section 2.3, cross-intersections which are subject to sign control will require upgrade to a roundabout to improve safety and capacity, including the following intersections:

- Dhurringile Road / Pyke Road intersection
- Dhurringile Road / Murton Road intersection

- Ferguson Road / Bayunga Road intersection
- Bayunga Road / Pyke Road intersection

Given the increase in traffic volumes, it is considered unlikely that any intersections will require signalisation. However, the operation of the major road intersections could be evaluated during the next design stage once the internal road layout is determined.

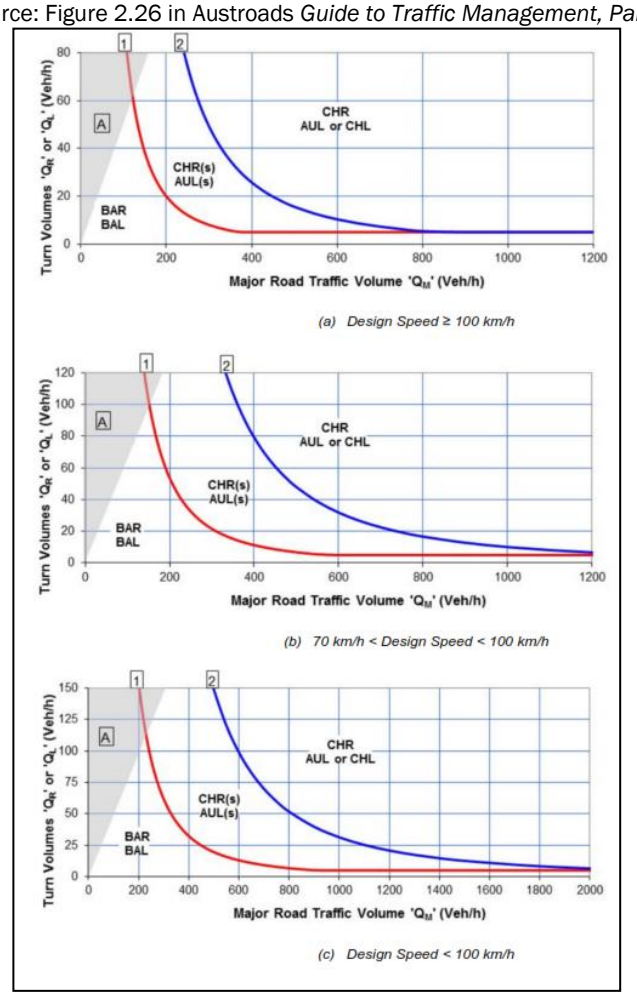
4.4 Turn provisions

Separate turn lanes are normally provided to avoid congestion and/or delays to through traffic and to improve safety for traffic movements at intersections and significant access points

The type of turn treatment is determined based on speed environment and the combination of through and turning traffic volumes. Figure 2.26 of the Austroads *Guide to Traffic Management – Part 6 (AGTM6)* (reproduced in Figure 11) is used for the selection of intersection treatments.

Using Figure A11 from the Austroads *Guide to Road Design– Part 4* (AGRD4) the major road traffic parameters Q_M can be established and applied to the graph in Figure 13 to determine the turn treatments required at each intersection.

Figure 13: Warrant for turn treatments on the major road at unsignalised intersections
(Source: Figure 2.26 in Austroads *Guide to Traffic Management, Part 6*)



Note 1: For Figure 2.26(a) Austroads has advised that the applicable design speed is ≤70km/h

Based on the posted speed limit at each road intersection and the graphs above, the turn warrants for each access road intersection is summarised in Table 5.

Table 5: Turn lane treatments at local road intersections

Intersection	Peak Period	Right Turn Treatment		Right Turn Warrant	Left Turn Treatment		Left Turn Warrant
		QM	QR		QM	QL	
Intersection A	AM	342	80	CHR	158	6	BAL
	PM	296	279	CHR	186	21	BAL
Intersection B	AM	565	5	BAR	224	93	AUL(S)
	PM	738	17	CHR	222	326	AUL(S)
Intersection C	AM	295	9	CHR(S)	212	9	BAL
	PM	325	33	CHR(S)	100	33	BAL
Intersection D	AM	89	39	BAR	23	10	BAL
	PM	116	137	CHR(S)	55	34	BAL
Intersection E	AM	979	55	CHR	691	4	BAL
	PM	965	194	CHR	344	12	BAL
Intersection F	AM	131	2	BAR	28	28	BAL
	PM	199	6	BAR	64	97	BAL
Intersection G North – Precinct B	AM	573	6	CHR(S)	304	50	AUL(S)
	PM	746	21	CHR	284	175	AUL(S)
Intersection G South – Precinct C1	AM	527	37	CHR(S)	218	4	BAL
	PM	586	128	CHR	286	15	BAL
Intersection H	AM	31	14	BAR	8	1	BAL
	PM	33	48	BAR	19	2	BAL
Intersection I	AM	228	0	BAR	152	8	BAL
	PM	264	1	BAR	88	29	BAL
Intersection J	AM	25	1	BAR	7	5	BAL
	PM	50	2	BAR	10	18	BAL
Intersection K	AM	210	31	CHR(S)	81	31	BAL
	PM	293	107	CHR	99	80	BAL
Intersection L	AM	270	0	BAR	161	9	BAL
	PM	308	1	BAR	117	32	BAL

Based on the above, the access road intersections warrant various turn treatments based on the anticipated traffic volumes.

Recommendation 4: ensure all intersections provide the required turn lane treatments in accordance with AGRD4.

4.5 Precinct local road connections

Section 4.1 indicates that one access to each abutting road (excluding the Midland Highway) will sufficiently service each of the precincts based on the anticipated post-development traffic volumes.

As the internal road layout is not known at this stage, possible locations for the local road connections to each precinct are discussed below. Once the internal road network is determined, the operation of the intersections to the major roads will need to be re-evaluated.

4.5.1 Precinct A1

The intersections to precinct A1 are shown in Figure 14 and discussed below. It is noted that there are no existing local road accesses to the abutting roads and therefore new road connections will be required.

Figure 14: Local road connections to precinct A1

Intersection A

Intersection A has been indicatively shown to be approximately mid-block between the Midland Highway and Pyke Road. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. CHR and BAL turn treatments) do not conflict with any existing or future turning lanes along Tatura-Undera Road.

Intersection B

Intersection B has been indicatively shown to be approximately mid-block between the Midland Highway and Pyke Road. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. CHR and AUL(s) turn treatments) do not conflict with any existing or future turning lanes along Dhurringile Road.

Intersection K

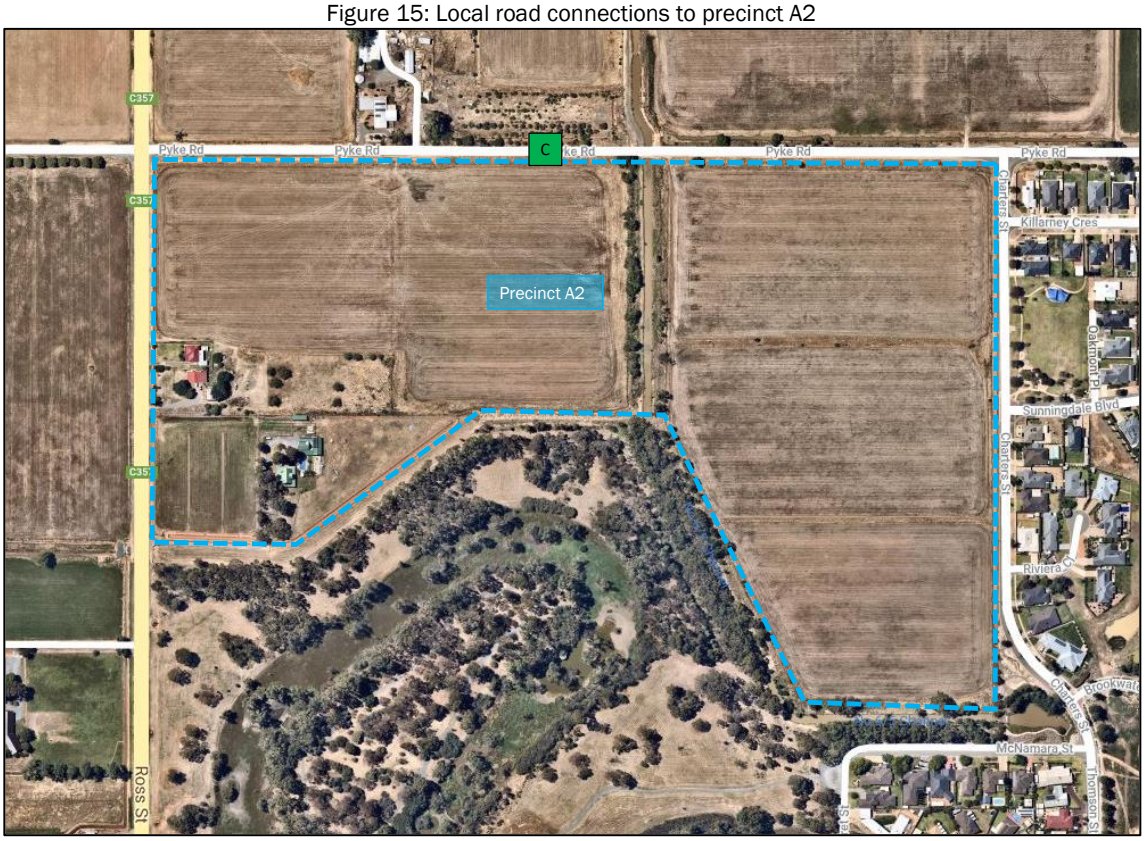
Intersection K has been indicatively shown to be approximately mid-block between the Dhurringile Road and Bayunga Road. It is recommended that this intersection be located within the existing 60 km/h speed zone on Pyke Road (between Charter Street and Dhurringile Road) and should be located to ensure that the turn lane requirements (i.e. CHR and BAL turn treatments) do not conflict with any existing or future turning lanes associated with Charter Street or Dhurringile Road. In addition, it should be ensured that the location of the access does not conflict with any access to the southern side of Pyke Road.

It is recommended that Intersection K be located a minimum of 15 m east of Charter Street to form a staggered intersection.

4.5.2 Precinct A2

The intersections to precinct A2 are shown in Figure 15 and discussed below. It is noted that it is anticipated that a proportion of precinct A2 will utilise Charter Street.

Figure 15: Local road connections to precinct A2



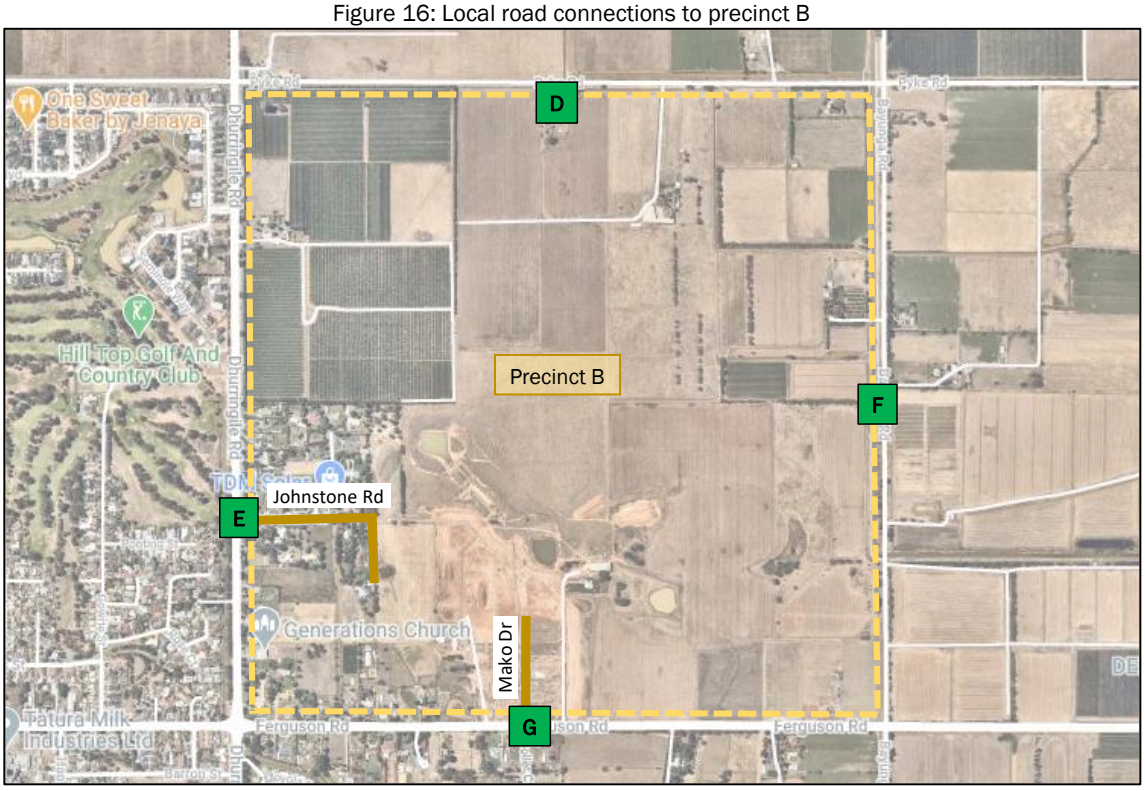
Intersection C

Intersection C has been indicatively shown to be approximately mid-block along Precinct A2's frontage. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. CHR(s) and BAL turn treatments) do not conflict with any existing or future turning lanes associated with the intersection of Charter Street with Pyke Road.

4.5.3 Precinct B

The intersections to precinct B are shown in Figure 16 and discussed below. It is noted that precinct B has an existing local road connection to Dhurringile Road (Johnstone Road) and an existing connection to Ferguson Road (Mako Drive) which may be appropriate to provide access into precinct B.

Figure 16: Local road connections to precinct B



Intersection D

Intersection D has been indicatively shown to be approximately mid-block between Dhurringile Road and Bayunga Road. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. CHR(s) and BAL turn treatments) do not conflict with any existing or future turning lanes associated with Dhurringile Road or Bayunga Road. In addition, it should be ensured that the location of the access does not form a cross intersection with any future access to the northern side of Pyke Road.

Intersection E

Johnstone Road is an existing local access road to Dhurringile Road approximately 500 m north of Ferguson Road that provides access from precinct B (refer to Figure 17). The location and sightlines of Johnstone Street would make this local road appropriate for access from precinct B

to Dhurringile Road (Intersection E), subject to the provision of required upgrade works (i.e. CHR and BAL turn treatments).

Figure 17: Johnstone Road / Dhurringile Road intersection (source: Nearmap Aerial Photography)

As Johnstone Road is located close to Ferguson Road, an additional local access to Dhurringile Road may be considered to the north, depending on the ultimate layout of the internal road network.

Conclusion 9: the existing Johnstone Road intersection with Dhurringile Road would provide appropriate access from precinct B, subject to the provision of required upgrade works (i.e. CHR and BAL turn treatments).

Intersection F

Intersection F has been indicatively shown to be approximately mid-block between Pyke Road and Ferguson Road. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. BAR and BAL turn treatments) do not conflict with any existing or future turning lanes associated with Pyke Road or Ferguson Road. In addition, it should be ensured that the location of the access does not create a conflict by forming a cross intersection with any future access to the eastern side of Bayunga Road.

Intersection G (north)

Intersection G has been shown as a cross intersection to demonstrate the worst case scenario, however, it is recommended that a staggered t-intersection be provided to reduce the likelihood of collision and for improved operation/performance.

Mako Drive is an existing local access to Ferguson Road which provides access into precinct B (refer to Figure 18). This intersection provides a CHR and an AUL turn treatments. The location, sightlines and turn treatments at this intersection would provide safe and convenient access to precinct B from Ferguson Road.

Conclusion 10: the Mako Drive intersection with Ferguson Road would provide appropriate access from precinct B.

Figure 18: Mako Drive / Doller Court / Ferguson Road intersection (source: Nearmap Aerial Photography)

4.5.4 Precinct C1

The intersections to precinct C1 are shown in Figure 19 and discussed below. It is noted that precinct C1 has an existing local road connection to Ferguson Road (Doller Court) and an existing connection to Dhurringile Road (Gowrie Park Road) which may be appropriate to provide access into precinct C1.

Precinct C1 is divided by a creek that may have implications for the access arrangements to each abutting road.

Intersection G (south)

Due to the location of the Doller Court opposite Mako Drive (refer Figure 18), this approach may not be appropriate for Intersection G. SIDRA analysis should be undertaken of the Intersection G to confirm if a cross intersection will operate satisfactorily.

Conclusion 11: the existing Doller Court approach to Ferguson Road may not be appropriate to provide access from precinct C1 due to the intersection being opposite Mako intersection on the northern side of Ferguson Road.

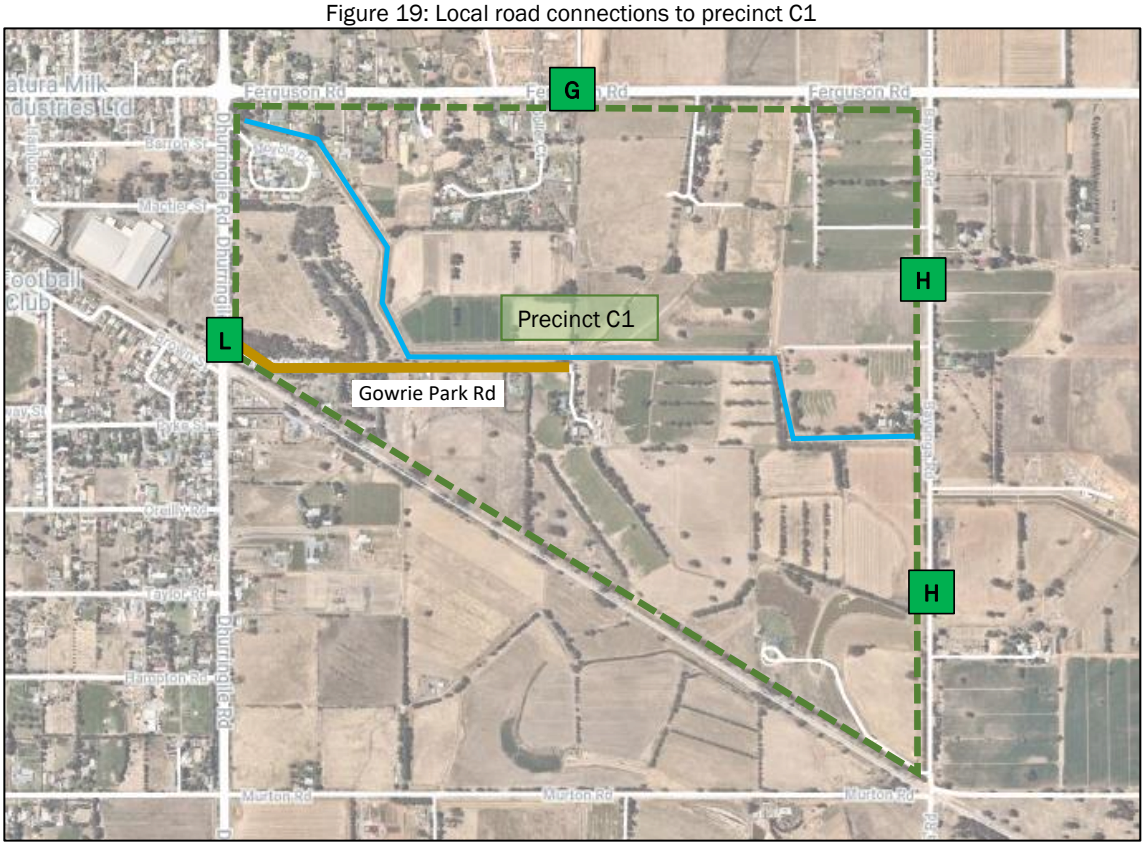
Recommendation 5: SIDRA analysis be undertaken of the Intersection G to confirm if a cross intersection will operate satisfactorily.

Intersection H

Intersection H has been indicatively shown to be approximately mid-block between Ferguson Road and Murton Road. It is noted that from a capacity perspective only one access is required from precinct C1 to Bayunga Road, however due to the alignment of the creek, an additional access to Bayunga Road may be required.

It is recommended that these intersections be located to ensure that the turn lane requirements (i.e. CHR(s) and BAL turn treatments) do not conflict with any existing or future turning lanes associated with Pyke Road or Ferguson Road. In addition, it should be ensured that the location of the access does not conflict with any access to the eastern side of Bayunga Road.

Figure 19: Local road connections to precinct C1



Intersection L

Gowrie Park Road is an existing local access road intersection from precinct C1 to Dhurringile Road and is located approximately 10 m north of the rail crossing (refer to Figure 20). Although turning movements to/from Intersection L are low, Gowrie Park Road is located close to the rail crossing and may result in queues extending across the railway level crossing.

Conclusion 12: the existing Gowrie Park Road intersection with Dhurringile Road may not be appropriate to provide access from precinct C1.

Due to the level crossing, consideration should be given to providing a new intersection approximately mid-block between Ferguson Road and the level crossing and ensure that it does not form a cross intersection with any access to the western side of Dhurringile Road.

Recommendation 6: a new intersection be provided to Dhurringile Road from precinct B approximately mid-block between Ferguson Road and the level crossing.

4.5.5 Precinct C2

The intersections to precinct C2 are shown in Figure 21 and discussed below. It is noted that there are no existing local road accesses to the abutting roads and therefore new road connections will be required.

Figure 20: Gowrie Park Road / Dhurringile Road intersection (source: Nearmap Aerial Photography)

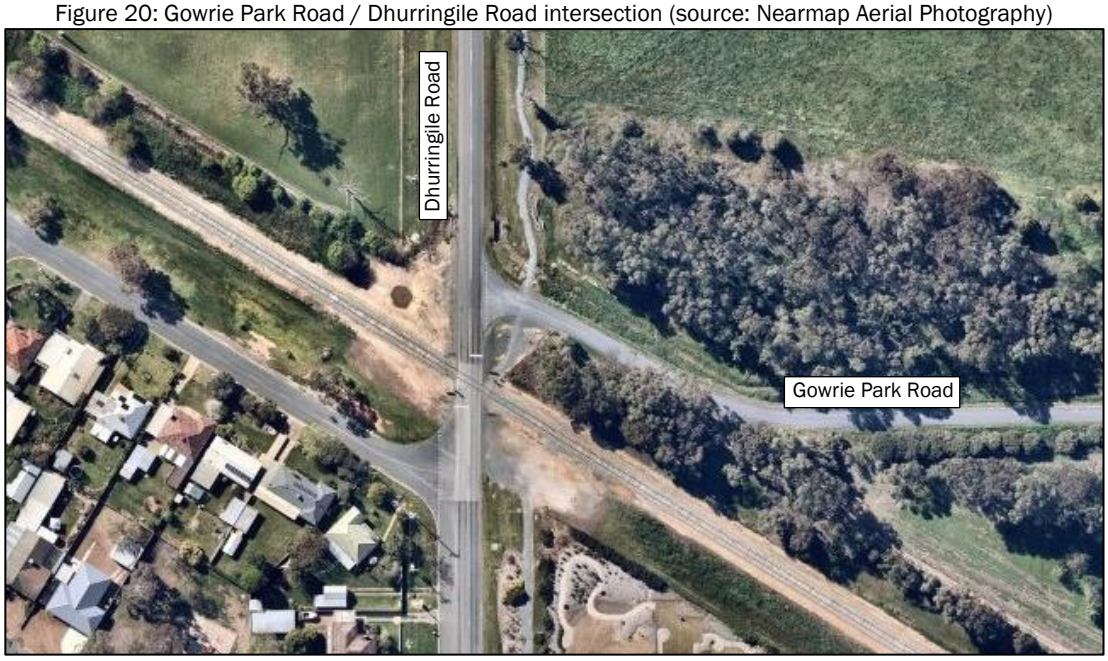
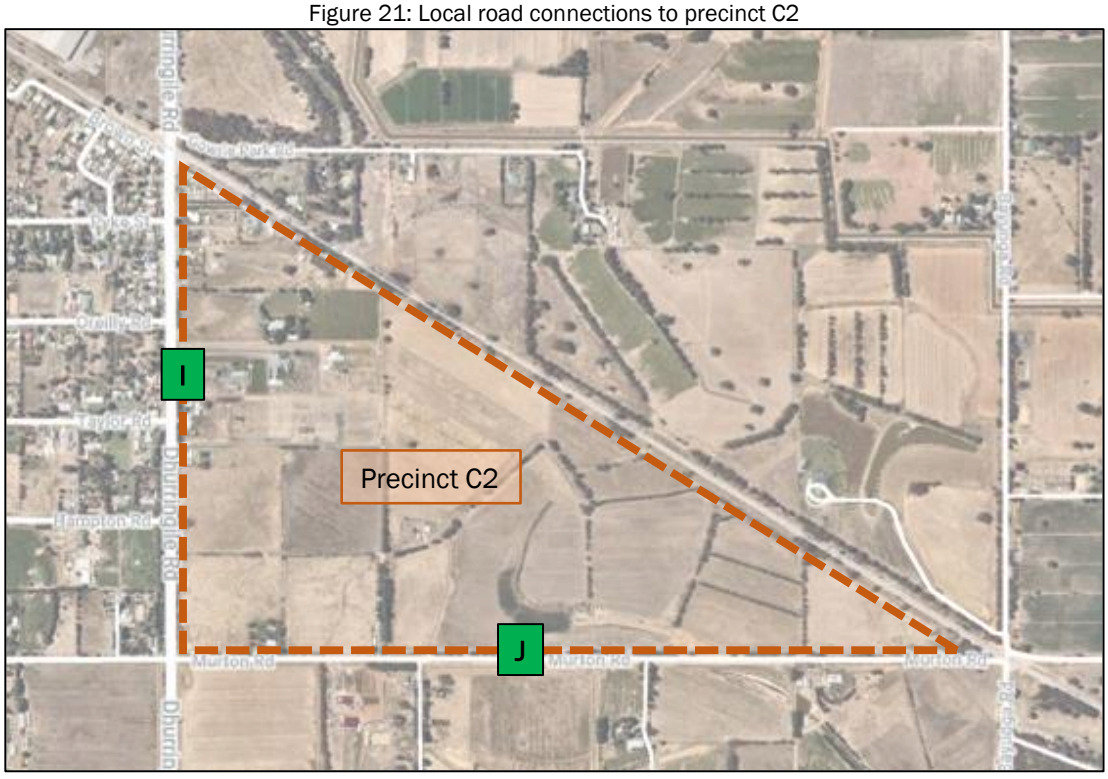


Figure 21: Local road connections to precinct C2



Intersection I

Intersection I has been indicatively shown to be approximately mid-block between the level crossing and Murton Road. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. BAR and BAL turn treatments) do not conflict with any existing or future turning lanes associated with Murton Road. In addition, it should be ensured that the location of the access does not conflict with the railway level crossing or any existing access to the western side of Dhurringile Road.

Intersection J

Intersection J has been indicatively shown to be approximately mid-block between the Dhurringile Road and Bayunga Road. It is recommended that this intersection be located to ensure that the turn lane requirements (i.e. BAR and BAL turn treatments) do not conflict with any existing or future turning lanes associated with Dhurringile Road or Bayunga Road. In addition, it should be ensured that the location of the access does not conflict with any access to the southern side of Murton Road.

Recommendation 7: ensure all proposed intersections are located to ensure that turn lane lengths do not conflict with any existing or future turn lanes associated with existing intersections and that the location of the access does not conflict with any access to surrounding land.

Conclusion 13: Once the internal road network is determined, the operation of the intersections to the major roads will need to be re-evaluated.

4.6 Sight distance

The visibility criterion normally applied to intersections is Safe Intersection Sight Distance (SISD). This is nominated in the Austroads Guide to Road Design, Part 4A (AGRD4) as the minimum distance which should be provided on the major road at any intersection (refer to Section 3.2.2 in AGRD4A) and provides sufficient distance for a driver of a vehicle on the major road to observe a vehicle from the minor access approach moving into a collision situation (e.g. in the worst case, stalling across the traffic lanes) and to decelerate to a stop before reaching the collision point (refer Figure 22).

The minimum SISD criterion specified in Table 3.2 of the Austroads Guide requires clear visibility for a desirable minimum distance of:

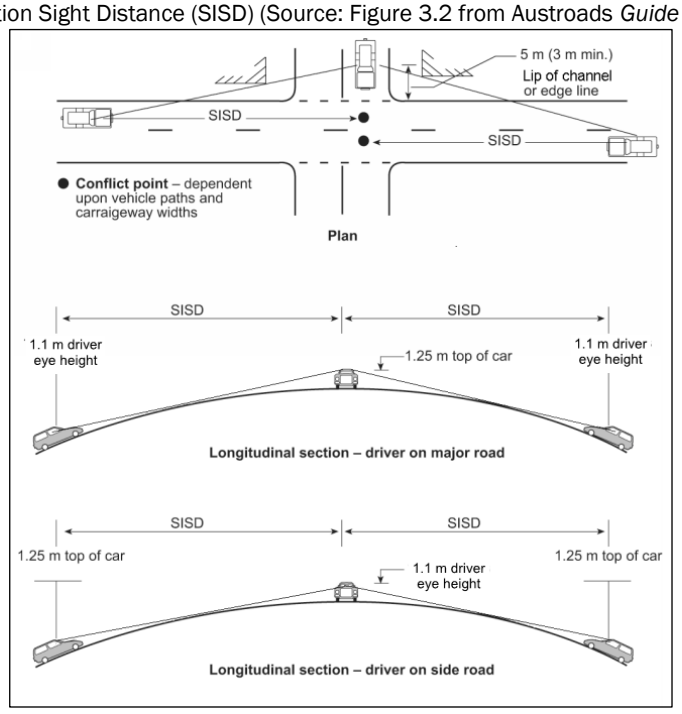
- 123 m relating to a 60 km/h design speed[7], applicable to:
    - any access road connecting to Ferguson Road (depending on the ultimate location of the intersection)
    - any access road connecting to Dhurringile Road (depending on the ultimate location of the intersection)

[7] Design speed is equivalent to posted speed limit (for 60 km/h and less)

- 214 m relating to a 90 km/h design speed[8], applicable to:
    - any access road connecting to Ferguson Road (depending on the ultimate location of the intersection)
    - any access road connecting to Dhurringile Road (depending on the ultimate location of the intersection)
- 285 m relating to a 110 km/h design speed[10], this is applicable to:
    - any access roads connecting onto Tatura-Undera Road / Ross Street
    - any access road connecting to Ferguson Road (depending on the ultimate location of the intersection)
    - any access road connecting to Dhurringile Road (depending on the ultimate location of the intersection)
    - any access roads connecting onto Pyke Road
    - any access roads connecting onto Murton Road
    - any access roads connecting onto Bayunga Road

All intersections within the proposed development and the surrounding road network should be designed to meet the AGRD4A sight distance requirements as mentioned above.

Figure 22: Safe Intersection Sight Distance (SISD) (Source: Figure 3.2 from Austroads *Guide to Road Design Part 4A*)



At the detailed design stage for each sub-precinct all intersections impacted by the associated development traffic should be checked for compliance with the AGRD4A sight distance requirements.

Recommendation 8: ensure all intersections are checked against the AGRD4A sight distance requirements at the detailed design phase to ensure compliance.

[8] Design speed is equivalent to posted speed limit plus 10 km/h (for 70 km/h and more)

4.7 Rail Crossing Upgrades

Active control level crossings are present at the following locations:

- Tatura-Undera Road approximately 430 m north of Hogan Street (refer to Photo 15)

Photo 15: Tatura-Undera Road rail crossing

- Hogan Street approximately 600 m east of Tatura Under Road (refer to Photo 16)

Photo 16: Hogan Road rail crossing

Passive sign-controlled level crossings are present at the following locations:

- Dhurringile Road approximately 10 m south of Gowrie Park Road (refer to Photo 17)

Photo 17: Dhurringile Road rail crossing

- Bayunga Road / Murton Road intersection (refer to Photo 18)

Photo 18: Bayunga Road rail crossing

The Australian Level Crossing Assessment Model (ALCAM) is an assessment tool used to identify key potential risks at level crossings and to assist in the prioritisation of crossings for upgrades. The risk model is used to support a decision-making process for both road and pedestrian level crossings and to help determine the most cost-effective treatments.

Therefore, the relevant authority should undertake a new ALCAM assessment to determine if the existing level crossings are appropriate or whether these require upgrading.

Conclusion 14: an ALCAM assessment should be undertaken for the level crossings at Tatura-Undera Road, Hogan Street, Dhurringile Road and Bayunga Road to determine if any upgrades are required to the current level crossings.

Recommendation 9: ALCAM assessments are undertaken for the level crossings at Tatura-Undera Road, Hogan Street, Dhurringile Road and Bayunga Road, based on current operating conditions

4.8 Public Transport / Peds / Cyclists

The development of the Tatura Structure Plan should consider the future provision of public transport, pedestrians and cyclists' facilities, including:

- seek to improve access and connectivity of all relevant transport modes within Tatura and where possible connect to other towns both now and into the future
- provision of direct cycling paths, including off road paths, to link the town centre with residential developments and schools
- the need for pedestrian and bicycle crossings where appropriate

Conclusion 15: the Tatura Structure Plan road network should consider the future provision of public transport, pedestrians and cyclists' facilities.

4.9 Internal network set up

The design and road safety considerations made to ensure the layout of the Tatura Structure Plan is compliant with the relevant reference documents in determining the road network for the structure plan are detailed below.

Clause 56.06 – Access and Mobility Management

Clause 56.06 sets out the access and mobility requirements with regard to walking, cycling, public transport, street network and lot access that must be met for residential subdivision proposals in an urban area within Victoria. The objectives of Clause 56.06 describe the outcomes to be achieved in a new residential subdivision. The associated standards contain the requirements or measures that meet the objectives.

The requirements of Clause 56.06 apply to an application to subdivide land in a Residential 1, Residential 2, Residential 3, Mixed Use and Township Zone and any Comprehensive Development Zone or Priority Development Zone that provides for residential development.

Clause 56.06 includes:

- 56.06-1 – Integrated mobility objectives
    - Planning for walking, cycling, public transport and other motor vehicles should occur in an integrated manner.

- 56.06-2 – Walking and cycling network objectives
    - Provide safe, direct travel paths through and between neighbourhoods to encourage daily walking and cycling.
- 56.06-3 – Public transport network objectives
    - Provide an arterial road and neighbourhood street network designed to encourage maximum use of public transport and provide for direct, safe, energy-efficient public transport operations.
- 56.06-4 – Neighbourhood street network objective
    - Provide safe and easy connections through and between neighbourhoods for pedestrians, cyclists, public transport and other vehicles.
- 56.06-5 – Walking and cycling network detail objectives
    - Ensure the detailed design and construction of footpaths, shared paths and bicycle paths are safe, comfortable and accessible for all users including users of wheelchairs, scooters and prams.
- 56.06-6 – Public transport network detail objectives
    - Ensure that public transport runs safely and efficiently and is comfortable and convenient for passengers, including people with disabilities, to use.
- 56.06-7 – Neighbourhood street network detail objective
    - Ensure the detailed design of carriageways and verges so that street geometry and traffic speeds provide an accessible and safe neighbourhood street system for pedestrians (footpath-bound vehicles), cyclists, public transport and other motor vehicles.
- 56.06-8 – Lot access objective
    - Provide safe access between lots and roads.

The key clauses for the task of determining the extent of a suitable key local road network for the development plan area are specifically Clauses 56.06-4 and Clause 56.06-6. For each of the sub clauses there is an associated standard that contains the requirements or measures that meet the objects.

56.06-4 – Neighbourhood street network objective

Clause 56.06-4 sets out the neighbourhood street network objective. Standard C17 is applicable to Clause 56.06-4 and the objectives of the clause are met when:

- proposed roads and streets connect with the existing network of arterial roads and neighbourhood streets, footpaths, shared paths, cycle paths and public transport routes
- the design of arterial roads and neighbourhood street types are clearly distinguished
- access to arterial roads from neighbourhood streets and lots abutting arterial roads is in accordance with VicRoads' Arterial Road Access Management[9] policies
- provision is made for safe and:

[9] Although the VicRoads Arterial Road Access Management Policies were never formerly published, many components have been adopted in Austroads Guide to Traffic Management Part 5: Link Management.

- efficient access to activity centres by commercial and freight vehicles
- easy pedestrian and cyclist movements
- easy access to public transport.

- local service vehicles such as refuse trucks and emergency vehicles can safely move throughout the network. A well-connected street system minimises the number of cul-de-sacs and the associated need for large vehicles to make complicated turning or reversing manoeuvres. This can help manage associated risks for small children
- necessary traffic control measures are provided in the layout of the street network. The layout of streets and street types should manage pedestrian, cyclist, public transport and other motor vehicle volumes and movement needs. Pedestrian, cyclist, and public transport movements should come first when planning the neighbourhood street network.

The design of neighbourhood street networks should have the following characteristics:

- that the transport strategy, plan or policy for the area set out in the local planning scheme is implemented
- arterial roads are approximately 1.6 kilometres apart with connector streets halfway between arterial roads at around 800 metres separation. This mobility framework broadly provides walkable distances to public transport, and neighbourhood centres that are located on arterial roads and connector streets
- connector streets should line-up between neighbourhoods so that pedestrian, cyclist and bus movements are direct without turning movements at intersections. Planning for public transport should come before planning for motor vehicles
- the network of access lanes, access places and access streets, connector streets and arterial roads is well designed to appropriately disperse traffic within and between neighbourhoods
- provide a speed environment that is appropriate to the street type
- user movement demand within the neighbourhood street network as a whole is appropriately managed for all users – pedestrians, cyclists, public transport and other motor vehicles
- road reservation widths will need to accommodate footpath, shared path and bicycle lane configurations as suited to expected user demand and encourage safe user behaviour. For example, provide sufficient space for pedestrian movements and appropriate integration or separation of the different modes of movement according to traffic volumes and speed
- safe sharing of access lanes and access places (with less than 5 dwellings served) where footpaths are not required by the provisions.

56.06-7 – Neighbourhood street network detail objective

Clause 56.06-7 sets out the neighbourhood street network detail objective. Standard C20 is applicable to Clause 56.06-7 and the design of the streets and road should:

- meet the requirements of Table C1[10], design of roads and neighbourhood streets. Where the widths of access lanes, access places, and access streets do not comply with the

[10] Table C1 is detailed in Clause 56-06-8, Lot access objective, as part of Standard C21

requirements of Table C1, the requirements of the relevant fire authority[11] and roads authority[12] must be met

- provide street blocks that are generally between 120 metres and 240 metres in length and generally between 60 metres to 120 metres in width to facilitate pedestrian movement and control traffic speed
- have verges of sufficient width to accommodate footpaths, shared paths, cycle paths, integrated water management, street tree planting, lighting and utility needs
- have street geometry appropriate to the street type and function, the physical land characteristics and achieve a safe environment for all users
- provide a low-speed environment while allowing all road users to proceed without unreasonable inconvenience or delay
- provide a safe environment for all street users applying speed control measures where appropriate
- ensure intersection layouts clearly indicate the travel path and priority of movement for pedestrians, cyclists and vehicles
- provide a minimum 5 metre by 5 metre corner splays at junctions with arterial roads and a minimum 3 metre by 3 metre corner splays at other junctions unless site conditions justify a variation to achieve safe sight lines across corners
- ensure carriageways of:
    - planned arterial roads are designed to the requirements of the relevant road authority
    - neighbourhood streets are designed for a minimum 20 year life span.
- provide pavement edges, kerbs, channel and crossover details designed to:
    - delineate the edge of the carriageway for all street users.
    - provide efficient and comfortable access to abutting lots at appropriate locations.

A street detail plan should be prepared that shows, as appropriate:

- the street hierarchy and typical cross-sections for all street types
- location of carriageway pavement, parking, bus stops, kerbs, crossovers, footpaths, tactile surface indicators, cycle paths and speed control and traffic management devices
- any relevant details for the design and location of street furniture, lighting, seats, bus stops, telephone boxes and mailboxes.

Conclusion 16: the Tatura Structure Plan road network should comply with the objectives and standards as set out in Clause 56.06 of the Councils Planning Scheme.

Conclusion 17: where the Tatura Structure Plan road network does not comply with the requirements of Clause 56.06, the requirements of the relevant fire authority[13] and roads authority[14] must be met.

[11] for the CFA, this is their Access Requirements document
[12] for Council, this is the Infrastructure Design Manual (IDM)

Infrastructure Design Manual

The Infrastructure Design Manual (the IDM) was originally prepared by the Cities of Greater Bendigo and Greater Shepparton and the Shire of Campaspe. Since the preparation of the IDM many other Councils have adopted the IDM. These Councils have formed the Local Government Infrastructure Design Association (LGIDA) which now owns and maintains the IDM.

The objectives of the IDM are:

- clearly document Council's requirements for the design and development of Infrastructure that is or will become Council's Infrastructure
- standardise development criteria as much as possible and thus expedite Council's engineering reviews
- ensure that minimum design criteria are met regarding the design and construction of Infrastructure within the municipalities regardless of whether it is constructed by Council or a developer
- recognise and deal with the various issues currently impacting on the land development industry, in particular sustainability, integrated water cycle management, timeliness and affordability.

The key clause for the task of determining the extent of a suitable road network for the development plan area Clause 12, Design of Roads.

Clause 12 – Design of Roads

Clause 12 sets out the standard design criteria for road works. For items not specifically referred to in the IDM, they should be generally in accordance with the following documents:

- the road cross sections included in any applicable Precinct Structure Plan (PSP)
- Austroads: Guide to Road Design
- the Standard Drawings associated with the IDM.

Proposed lot sizes up to 2,000 m^2 are considered to be urban in character, and sub Clause 12.3 (Urban Roads) is applicable. Included in the section that contains Clause 12 is Table 2, Urban Road/Street Characteristics, that contains relevant infrastructure details for each street type, including:

- Access
    - Lane (0 – 300 vpd)
    - Place (0 – 300 vpd)
    - Street (0 – 2,500 vpd)
- Collector/Connector Street
    - Level 1 (2,500 – 6,000 vpd)
    - Level 2 (6,000 – 12,000 vpd)
- Commercial Street
- Industrial Street

- Court Bowl
    - Residential (10.0 m radius)
    - Industrial (15.0 m radius)

Guide to Road Safety

The Guide to Road Safety provides guidance on road safety related responsibilities of road designers based on Safe System principles. Of the nine parts that make up the Guide to Road Safety, the following part is key when considering the layout for the Tatura Structure Plan road network, as follows:

- Part 3: Speed Limits and Speed Management provides an overview of speed limits and their application as a speed management tool. The use of appropriate speed limits forms an integral part of a safe road system.

Guide to Traffic Management

The Guide to Traffic Management provides traffic management guidance on traffic engineering, road design and road safety. Of the 13 parts that make up the Guide to Traffic Management, the following parts are key when considering the layout for the Tatura Structure Plan road network, as follows:

- Part 5: Link Management provides guidance on how to manage road corridor links (i.e. sections between intersections)
- Part 6: Intersections, Interchanges and Crossings Management provides guidance on how to manage intersections, interchanges and crossings and covers the selection of intersection type, roundabouts, signalised and unsignalised intersections and pedestrian and cyclist crossings
- Part 8: Local Street Management provide guidance on how to manage local streets through implementation of local area transport management (LATM) and is focussed on the calming of motorised general vehicular traffic within local streets.

Some of the key considerations when developing the road network for a new development area includes:

- location of intersections
- intersection treatments
- management of vehicle speeds.

Location of intersections

In urban situations, the location of the intersection is usually limited by the layout of the existing streets and the constraints of property boundaries. The location and spacing of intersections and property access can affect the safety and operation of a road. The road authority may determine the appropriate degree of access according to a roads classification based on access management categories (as per the earlier reference to the VicRoads Arterial Road Access Management Policies and Part 5 of the Austroads Guide to Traffic Management).

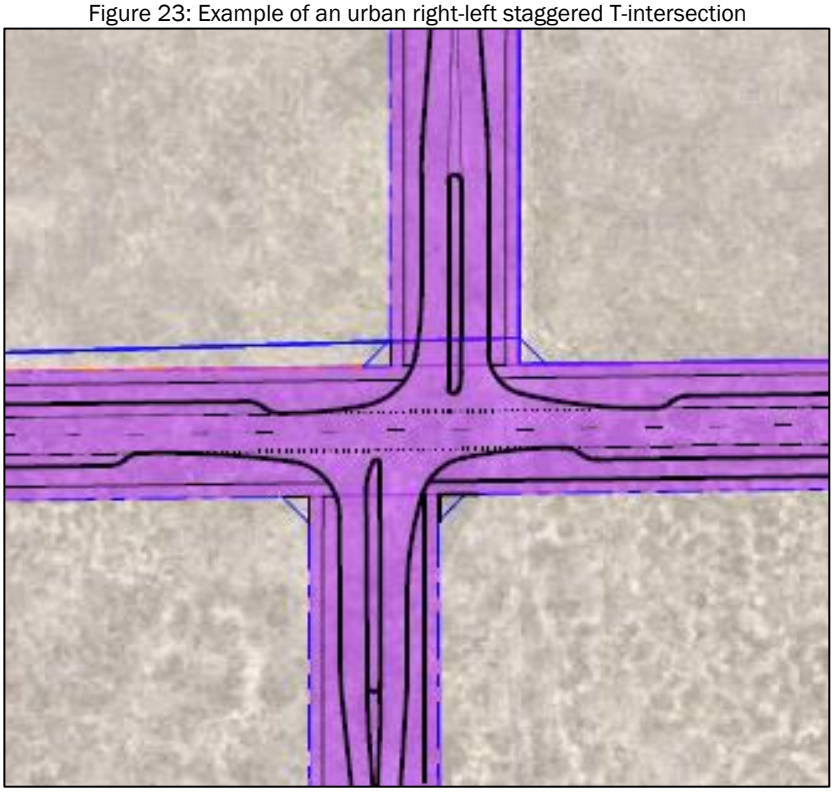
Intersection treatments

Generally, sign controlled (Give Way or Stop) T- intersections within residential developments will operate satisfactorily, however, where higher volumes are present (for instance at collector/collector road intersections) roundabouts or traffic signal controlled intersections may be required.

Good practice is to avoid where possible sign controlled cross road intersections, although these can be managed (safety and operational) through the implementation of roundabouts or traffic signals (traffic intersection analysis may be required, using SIRDA analysis).

If two side roads are unable to be aligned to meet at the same point when connecting to a higher order through road (i.e. to facilitate a roundabout) a right-left stagger should be introduced (similar to the image shown in Figure 23).

Figure 23: Example of an urban right-left staggered T-intersection



The right-left treatment has some relative advantages for safety due to the reduced number of conflict points when compared to a cross intersection (effectively providing two separate T-intersections).

The right-left treatment allows a right turning vehicle entering the through road to make an unopposed left turn into the second side road. The left-right treatment will need turn lanes/manoeuvring space for the right turning vehicle waiting in the through road to enter the second side road. The distance between the two side roads should be a minimum of 15.0 m and where the traffic volume between the two side roads is likely to be high, splitter islands should be installed to ensure better compliance and lane discipline.

Management of vehicle speeds

Local Area Traffic Management (LATM) schemes can be introduced to manage vehicle operating speeds within residential developments. LATM devices come in many forms, however there are four main treatments, which are (including examples):

- vertical deflection devices
    - road humps
    - raised pavements at intersections
- horizontal deflection devices
    - lane narrowing
    - slow points
- diversion devices
    - left in/left out treatments at intersections
    - partial road closures (for a single direction)
- signs, linemarking and other treatments
    - speed limits / shared zones
    - threshold linemarking treatments.

Conclusion 18: the Tatura Structure Plan road network should satisfy the relevant Austroads guides with respect to the selection of the location/type of intersections.

Conclusion 19: the Tatura Structure Plan road network should satisfy the relevant Austroads guides with respect to introduction of LATM to manage vehicle operating speeds.

5 CONCLUSIONS

A traffic impact assessment was undertaken for the proposed residential development at the Tatura Structure Plan study area. The key findings from this assessment are summarised below:

- the assessment revealed that there are several different speed zones within the Tatura Structure Plan study area. Consideration should be given to reviewing the current speed zones to provide consistency throughout the study area and the adjoining road network for Tatura
- the assessment revealed that there are sections of roads within the study area that are unsealed and will need to be sealed as part of the development of the study area
- no trends in crashes were observed within the vicinity of the Tatura Structure Plan study area in the last five years of available data, hence there are no traffic safety problems that require urgent remedial action
- Council to consider advocating for RRV to undertake a review of the safety implications of the upgrades to the Midland Highway / Dhurringile Road intersection
- the overall Tatura Structure Plan study area is likely to generate 33,742 vpd with a peak hour traffic volume of 2,868 vph
- the theoretical capacity of a two-lane, two-way road (i.e. Connector Road level 1) is sufficient to accommodate the anticipated post-development traffic volumes of Ferguson Road, Dhurringile Road and Tatura-Undera Road
- based on the anticipated post-development traffic volumes, Pyke Road is to be designed as a connector street (level 1)
- based on the anticipated post-development traffic volumes, Bayunga Road is to be designed as an access street
- the existing Johnstone Road intersection with Dhurringile Road would provide appropriate access from precinct B, subject to the provision of required upgrade works (i.e. CHR and BAL turn treatments)
- the Mako Drive intersection with Ferguson Road would provide appropriate access from precinct B
- the existing Doller Court intersection with Ferguson Road may not be appropriate to provide access from precinct C1 due to the intersection being opposite Mako intersection on the northern side of Ferguson Road
- the existing Gowrie Park Road intersection with Dhurringile Road may not be appropriate to provide access from precinct B.
- once the internal road network is determined, the operation of the intersections to the major roads will need to be re-evaluated.
- an ALCAM assessment should be undertaken for the level crossings at Tatura-Undera Road, Hogan Street, Dhurringile Road and Bayunga Road to determine if any upgrades are required to the current level crossings
- the Tatura Structure Plan road network should consider the future provision of public transport, pedestrians and cyclists' facilities
- the Tatura Structure Plan road network should comply with the objectives and standards as set out in Clause 56.06 of the Councils Planning Scheme

- where the Tatura Structure Plan road network does not comply with the requirements of Clause 56.06, the requirements of the relevant fire authority and roads authority must be met
- the Tatura Structure Plan road network should satisfy the relevant Austroads guides with respect to the selection of the location/type of intersections
- the Tatura Structure Plan road network should satisfy the relevant Austroads guides with respect to introduction of LATM to manage vehicle operating speeds.

The key recommendations from this assessment are summarised below:

- **Recommendation 1**: Council undertake a review of the speed zones within the Tatura Structure Plan study area and the adjoining road network to provide consistency
- **Recommendation 2**: the development of the study area includes sealing of the unsealed roads that are relied upon for access for the newly developed residential dwellings
- **Recommendation 3:** a review of the Midland Highway / Dhurringile Road intersection is undertaken to consider if improvements are required to maintain satisfactory operation of the intersection
- **Recommendation 4**: ensure all intersections provide the required turn lane treatments in accordance with AGRD4
- **Recommendation 5:** SIDRA analysis be undertaken of the Intersection G to confirm if a cross intersection will operate satisfactorily
- **Recommendation 6:** a new intersection be provided to Dhurringile Road from precinct B with sufficient offset to the rail crossing
- **Recommendation 7**: ensure all proposed intersections are located to ensure that turn lane lengths do not conflict with any existing or future turn lanes associated with existing intersections and that the location of the access does not conflict with any access to surrounding land
- **Recommendation 8**: ensure all intersections are checked against the AGRD4A sight distance requirements at the detailed design phase to ensure compliance
- **Recommendation 9**: ALCAM assessments are undertaken for the level crossings at Tatura-Undera Road, Hogan Street, Dhurringile Road and Bayunga Road, based on current operating conditions.

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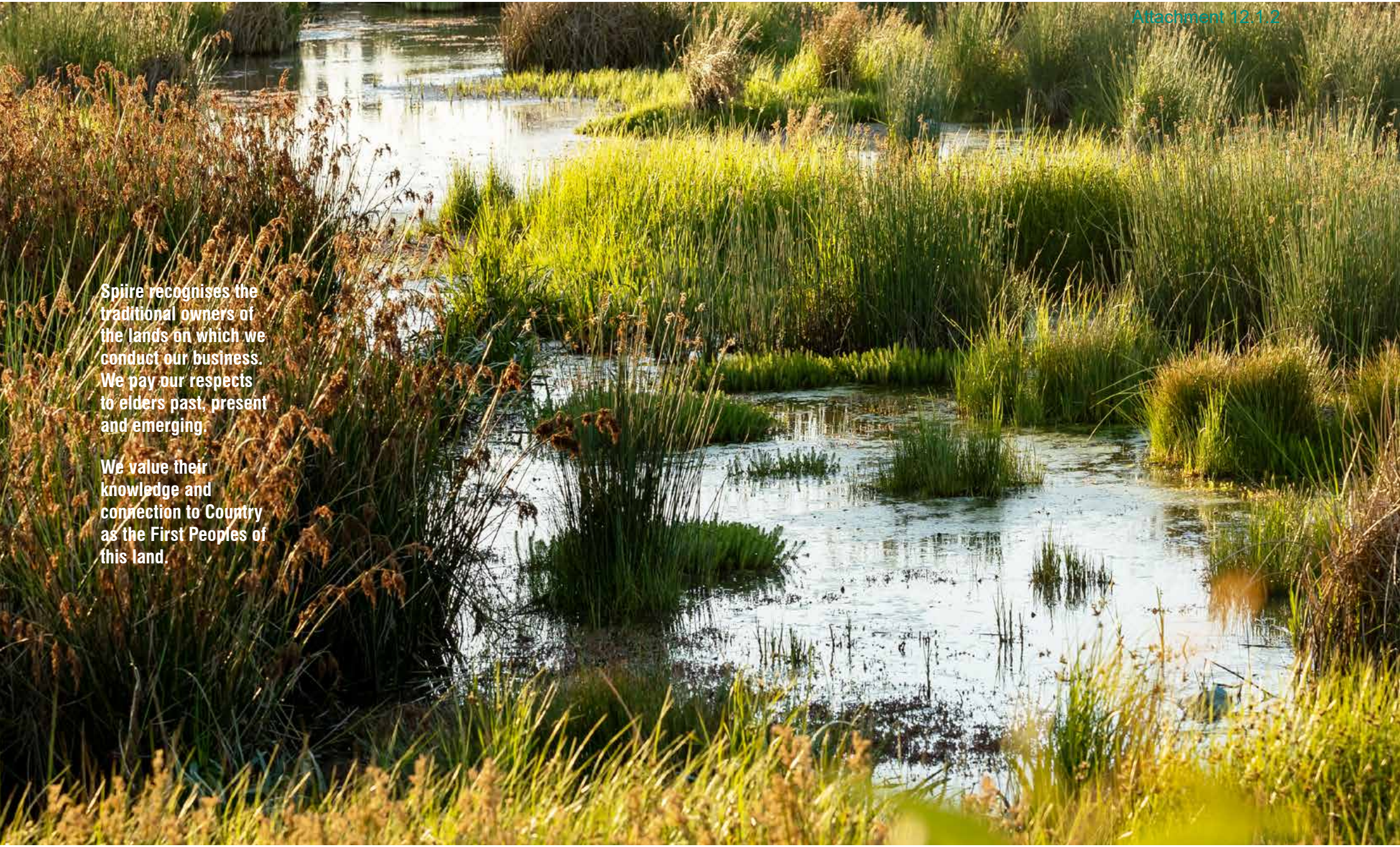
spiire

Tatura Integrated Water Management Strategy

Prepared for Greater Shepparton City Council

Reference number: 307990
1 April 2021



Spiire recognises the traditional owners of the lands on which we conduct our business. We pay our respects to elders past, present and emerging.

We value their knowledge and connection to Country as the First Peoples of this land.

Contents

Image Caption

Issue Date	Rev No	Authors	Checked	Approved
02/12/2020	Draft	J.Carroll	J. Espagne	M.Yule
30/03/2021	Final for Council Approval	J.Carroll	J.Espagne	M.Yule

Introduction

Spiire Australia has been engaged by Greater Shepparton City Council to develop an Integrated Water Management Strategy (IWMS) and investigate opportunities to implement integrated water management (IWM) within proposed Tatura growth areas to the north and east of the township.

Tatura was listed as high priority township within the Greater Shepparton Townships Framework Plan Review 2019 and Council seeks to encourage the growth of the town by developing a structure plan for the area. This IWMS has been developed with the vision to inform the future Council Structure Plan, as well as identify innovative opportunities for the conservation and utilisation of water within the township.

A range of IWM measures have been investigated including:

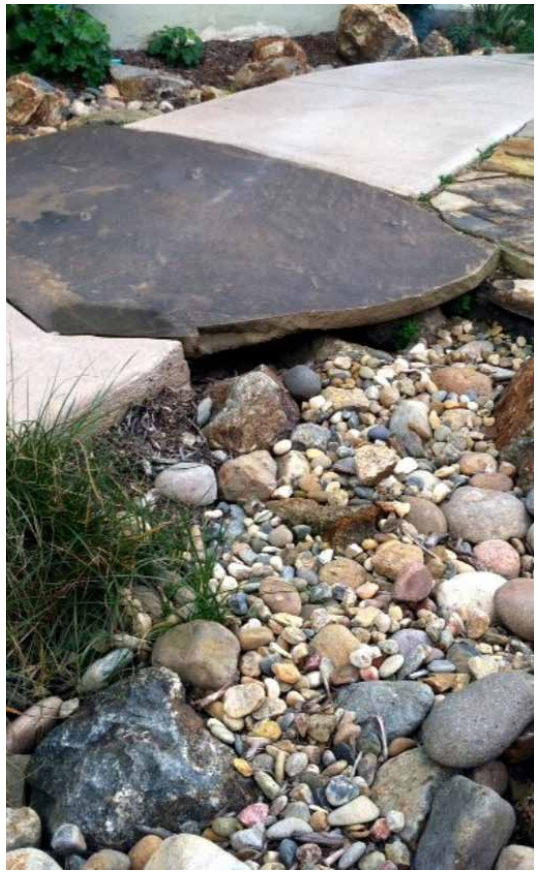
- Drainage infrastructure
- Stormwater harvesting
- Rainwater tanks
- Demand management
- Water Sensitive Urban Design (WSUD)
- Onsite water management
- Increased vegetation and biodiversity connections
- Education and policy programs.

The IWM options presented in this report provide realistic and feasible options for integration in the community, considering existing topography, infrastructure, and landscape.

This report has been developed with the intention to provide a high-level framework for drainage and IWM options that could be incorporated into the Structure Plan. Detailed assessments of the sub-catchments will be required as a part of further studies to produce a sustainable integrated water management plan for the proposed development in Tatura. This Strategy includes:

- Identification of opportunities to assist with management (and/or treatment) of stormwater runoff prior to entry into watercourses, with the intention of mitigating peak flow and reducing/ mitigating pollution associated with this runoff
- Identification of feasible opportunities for water retention, treatment and irrigation of green spaces within the township of Tatura
- Identification of feasible opportunities to use alternative water for non-drinking purposes within Tatura
- Incorporation of WSUD principles into future works, design and implementation programs

The intent of this report is to not to provide one solution but rather a number of alternatives to allow Council and the community to decide what best suits their needs.



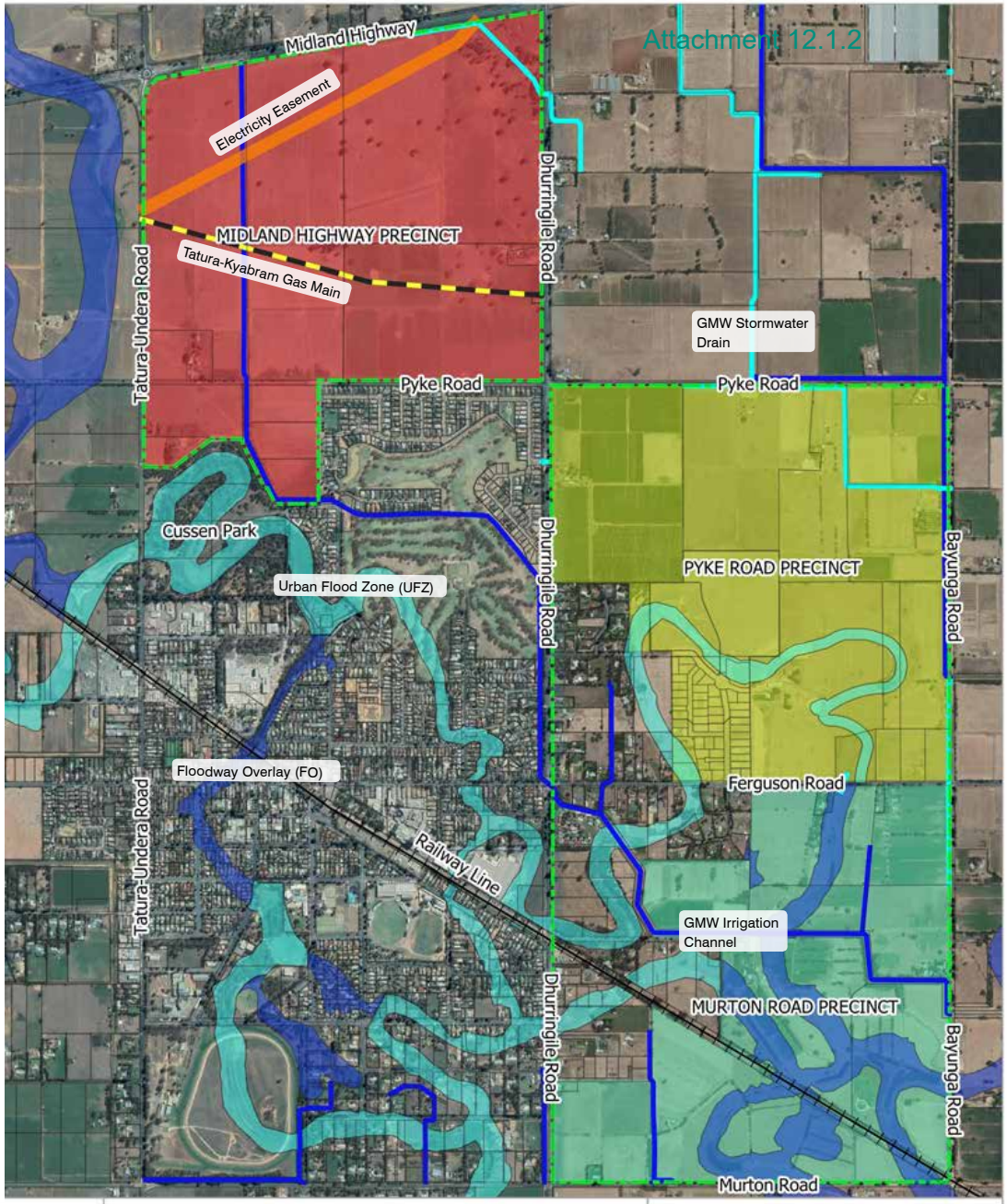
Study Area

Tatura is a township located approximately 17km southwest of Shepparton in the Greater Shepparton City Council. Due to growth in the region, the City of Greater Shepparton is investigating two areas for rezoning outside the current township.

The first investigation area is located to the north of the township and is bounded by the Midland Highway to the north, Dhurringile Rd to the east, Pyke Rd and Cussen Park to the south and Tatura-Undera Rd to the West. Due to its proximity to the Midland Highway it has been referred to as the Midland Highway Precinct. The Midland Highway Precinct is characterised by two main catchments which have been created due to a GMW irrigation channel. The irrigation channel runs from south to north and splits catchment in two with approximately 75% area being allocated to the east and 25% to the west. The eastern catchment is a homogeneous catchment that generally slopes to the northeast corner of the investigation area. The western catchment consists of two sub-catchments which are divided by the Tatura-Kyabram gas main that traverses the site. The northern sub-catchment drains towards the north whist the southern sub-catchment drains to a culvert under Tatura-Undera Rd which connects to a formalised drain to the west.

The second investigation area is located to the east of the township and is bounded by Pyke Rd to the north, Bayunga Rd to the east, Murton Rd to the south and Dhurringile Rd to the west. The eastern investigation area is much more complex in regards to catchment delineation than the northern investigation area. This is due to the large depressions that meander across the area, a GMW irrigation channel that runs from east to west which divides the southern third of the site from the northern portion, and a railway line which traverses the southern third of the site diagonally from the southeast corner of the investigation area. As a result the eastern investigation area is divided into two main precincts the Pyke Rd Precinct in the north and the Murton Rd Precinct in the South. It is also heavily fragmented with a number of sub-catchments that drain to the large depressions which traverse the site.

The total area of the investigation is 767ha, with the Midland Highway Precinct comprising of approximately 245ha, Pyke Rd Precinct 223ha and the Murton Rd Precinct 189ha. The Midland Highway Precinct is currently zoned entirely Farm Zone whilst the Pyke Rd Precinct and Murton Rd Precinct are a mixture of zones which include Rural Living, Low Density Residential, Industrial, Farm Zone and Urban Flood Zone. These areas have been broken down further later in the report, into local catchments which have been created based on the topography of the land and natural drainage areas.



NOTATIONS

File Ref: 307990
Plan: W GIS 307990
Rev: B
Date: 26.03.2021

Designed: J.Carroll
Checked: M.Yule
Authorised: J.Espagne

LEGEND

- INVESTIGATION AREA
- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- ELECTRICITY EASEMENT
- GAS MAIN
- RAILWAY LINE
- URBAN FLOOD ZONE
- FLOODWAY OVERLAY
- MIDLAND HIGHWAY PRECINCT
- MURTON ROAD PRECINCT
- PYKE ROAD PRECINCT

205 0 205 410 615 m

1:20,000

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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Topography & Existing Water Cycle

The topography of the study area is illustrated by the adjacent map. The map is based on LIDAR of the study area and demonstrates the 'lay of the land', with the higher areas being shaded in a red/brown colour whilst the lower areas are characterised by a shade of green. As described on the previous page, the Midland Highway Precinct generally slopes towards the north and west, whilst the eastern precincts, Pyke Rd Precinct and Murton Rd Precinct, are more complex and the vast majority of the area drains towards the existing depressions that traverse the area. The proposed retarding basins which are discussed later in the report have been included to demonstrate that they are generally located in the lower lying areas of the catchment. This is to ensure that the terrain does not have to be modified excessively to capture additional runoff due to development.

As the investigation area is predominantly zoned as either farm zone or low density residential, it means that the runoff from the land will generally follow the natural topography and flow to the north in the northern investigation area and flow towards the natural depressions in the eastern study area. Further confirmation of the natural flow paths is evident by the Urban Flood Zone and Floodway Overlay illustrated on the previous page.

Another characteristic of the current conditions is that presently there is less runoff than what will occur after development of the region. This is due to more water being infiltrated and evaporated into natural surrounds. A water balance has been undertaken to understand the current conditions and how stormwater is distributed across the investigation area. This can be seen in Figure 1 and Table 1.

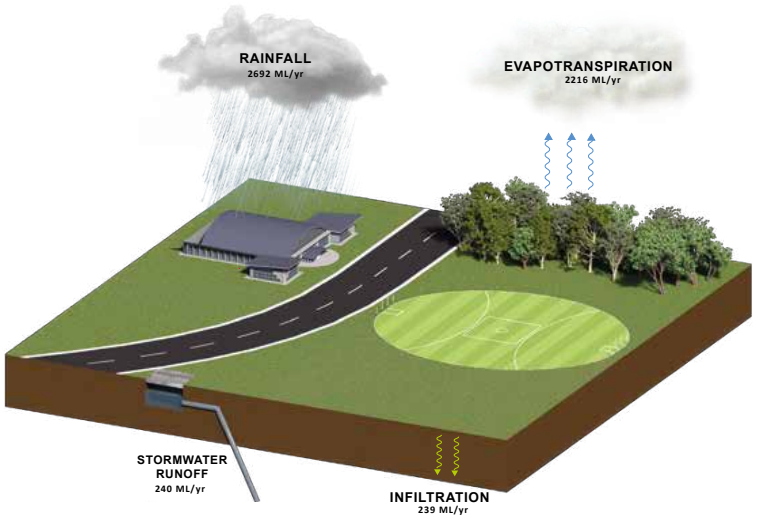
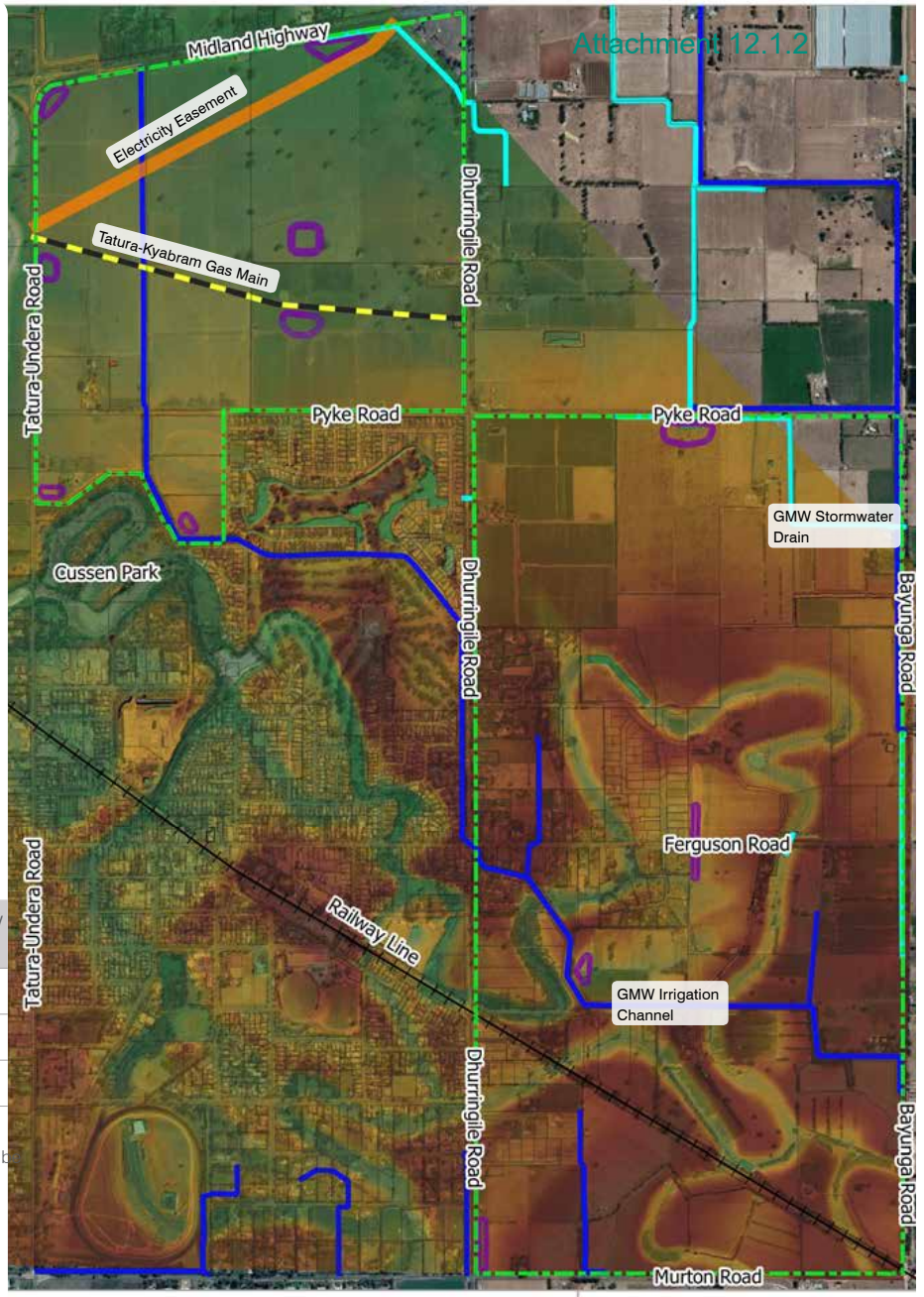


Figure 1: Visual Water Balance - Existing Conditions

Table 1: Catchment Water Balance - Existing Conditions

Catchment	Catchment Area (ha)	Rain (ML/yr)	Evapotransipiration (ML/yr)	Infiltration (ML/yr)	Runoff (ML/yr)
Northern	234	1049	870	94	86
Eastern	363	1643	1346	145	154
Total	**597**	**2692**	**2215**	**239**	**240**

Note: Totals do not equal rainfall due to soil storage factors and the catchment areas refer to the areas currently proposed to be rezoned, not the total investigation area. Refer to page for areas to b rezoned.



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LEGEND

- INVESTIGATION AREA
- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- ELECTRICITY EASEMENT
- GAS MAIN
- RAILWAY LINE
- RETARDING BASIN

TERRAIN ELEVATION m (AHD)

109.5	112	114.5
110	112.5	115
110.5	113	115.5
111	113.5	116

205 0 205 410 615 m

1:20,000

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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Integrated Water Management in Tatura

What is IWM?

Integrated water management (IWM) is a holistic approach to managing water and addresses all components of the water cycle in order provide benefits to the community and environment. The adjacent diagram illustrates how IWM can be broken-down into its key components starting from the inside of the diagram and moving outward.

Why IWM in Tatura?

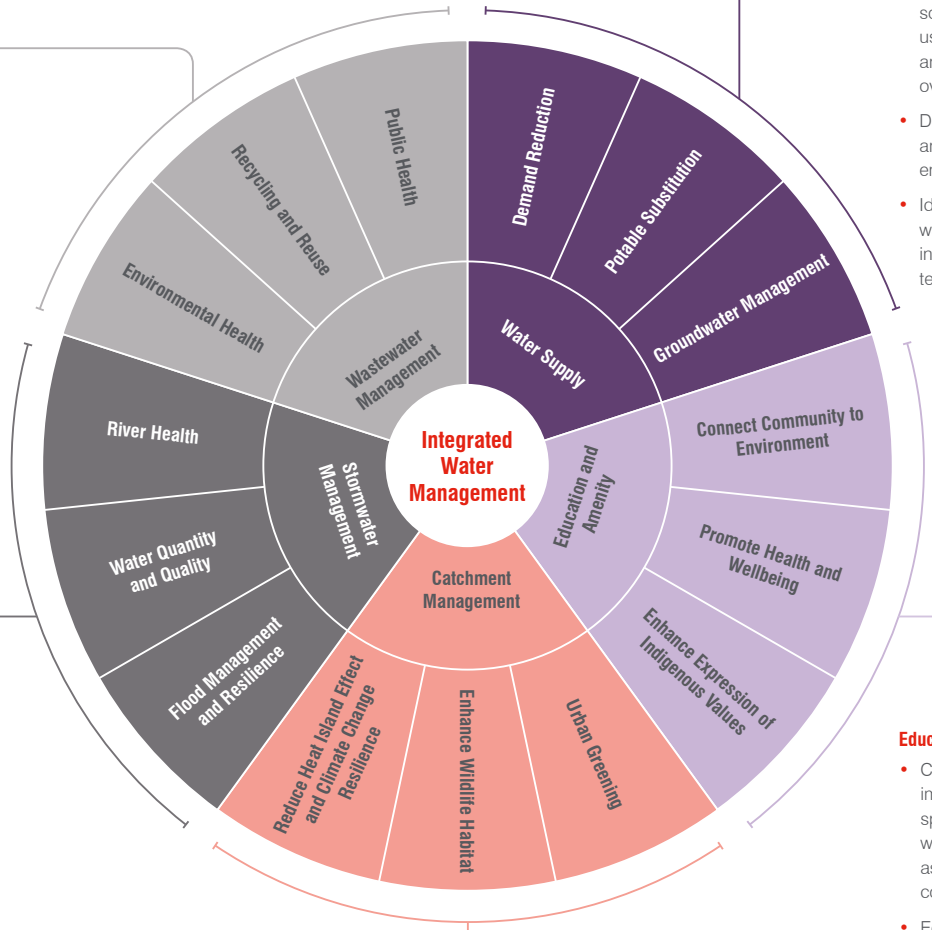
Due to increased uncertainty around water supply caused by climate change, IWM seeks to diversify and decentralise water systems so that more resilient systems can be created. Climate change is significant threat to water resources due to its impact on rainfall, which in general is either causing a lack of rainfall, or conversely too much of it at once. Both of these scenarios are risk to water resources since a lack of rain reduces and threatens water supply whilst too much rainfall can devastative property, crops, as well as contaminate water supplies.

IWM can mitigate these risks by reducing reliance on a single water source and utilising water more effectively through the implementation of innovative technologies, such as rainwater tanks, stormwater harvesting, and tree pits.

As the township of Tatura is expanding, it is an ideal time to implement IWM infrastructure in order to future-proof its water supply and provide preventive measures to protect the environment from significant variations in water supply. Finally, installing IWM in greenfield areas is the most economical option for the community.

How can IWM be applied Tatura?

There are multiple ways that IWM can be applied to Tatura. The text around the diagram provides examples of how the key components of IWM can be approached when developing the growth areas of Tatura.



Wastewater Management Examples

- Standard sewerage systems will be provided to new premises, which is preferred over septic systems.
- The Tatura Wastewater Treatment Plant currently provides treatment of wastewater which is reused by irrigators such as woodlots and crop growers.

Water Supply Examples

- Identifying and developing alternative water solutions to reduce the potable water usage, i.e. rainwater harvesting for houses and stormwater harvesting for schools and ovals.
- Demand management including 5 star water and energy appliances to reduce water and energy use in households.
- Identifying and developing alternative water solutions featuring all forms of water, including rainwater harvesting and smart technology.

Stormwater Management Examples

- Implementation of retarding basins with pumps to prevent the new urban areas causing flood impacts to neighbouring properties.
- Large and small scale Water Sensitive Urban Design within existing streetscapes to provide localised stormwater quality treatment.
- Integrating flood management and stormwater harvesting opportunities, to reduce downstream flooding whilst providing a source of water, e.g. stormwater harvesting for oval irrigation.

Catchment Management Examples

- Promoting Healthy Streetscapes through urban greening by prioritising pedestrians, trees and WSUD in streetscape upgrade. Provides opportunities to reduce urban heat island effect from the developing areas.
- Using linear retarding basins to create biolinks, wildlife corridors and urban greening for development.

Education and Amenity Examples

- Connecting communities and water through implementing water assets in community spaces, e.g. providing Cussen Park with more water and integrating WSUD assets such as wetlands to make them a community focal point.
- Education through multiple facets, such as partnering with schools to provide water education and providing interpretive signage on all assets
- Increased neighbourhood amenity through greener community spaces that encourage shade, active water play and connections for biodiversity.

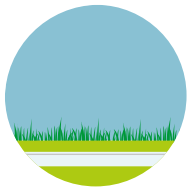
Integrated Water Management in Tatura

Objectives

The intent of this IWM strategy is to address the key components of IWM outlined on the previous page in order to achieve the following objectives.

Integrate and Promote Strategic Water Use

- A diverse range of water supplies and sources
- Manage water efficiency and demand
- Safe & secure water supply
- Educating the residents, businesses and organisations around Tatura about water use
- Implement policy promoting environmental controls prior to discharge to creeks



Effective and Affordable Wastewater Systems

- Meet public health and environmental standards
- Reduce wastewater generated
- Effective wastewater systems to meet current and future regulations
- Maximise waste-to-resource opportunities (fit for purpose alternate water) in balance with maintaining waterway flows

Effective Stormwater Management That Protects Our Waterways

- Flows to Cussen Park are improved to protect important riparian ecosystems
- Appropriate levels of flood protection in new development
- Community and property resilient to local flood risk
- Improve water quality in watercourses

Create Cool, Green and Water Sensitive Urban Landscapes

- Diverse urban landscapes that reflect local conditions and community values
- Waterways accessible as valuable open space
- Aboriginal cultural values associated with waterways are protected
- A united, empowered and engaged community co-operating to enact IWM opportunities
- Street tree selection that balances shade, water efficiency, fire risk and amenity values

Climate Change Resilient Systems

- Safe conveyance of flows
- Improve water quality
- Reduce the peak magnitude and volume of post-development stormwater flows
- Alternate water sources
- Protection from extended droughts, heat and intense rainfall events

IWM Aspect

In order to meet the objectives the following aspects will be incorporated into the Tatura IWM Strategy.

- Waterways and Flood Plains - Protecting existing watercourses and flood plains against increased runoff from development.
- Major Drainage - Providing adequate infrastructure to ensure that flooding does not occur in the new urban areas.
- Catchment Management and Land Use - Designing assets that provide multiple benefits such as drainage and community amenity
- WSUD - Ensuring that runoff from new development is having a minimal impact on the environment whilst providing assets for community enjoyment.
- Drinking Water - Reducing a reliance on potable water consumption and finding alternative water sources.
- Sewerage - Reduce wastewater in a safe and environmentally friendly manner.
- Alternative Water - Providing additional water sources to supplement potable water supply.

Stakeholder Engagement

Several levels of stakeholder engagement have occurred in order to help inform this IWMS. Prior to commencing this report Council consulted with DELWP, Goulburn Valley Water, Goulburn Murray Water, and landowners within the area to obtain their input. Some of the key comments/concerns raised were:

- Runoff from the rezoned area will drain to undeveloped areas and the increased runoff may impact existing property owners.
- Consideration should be given to any stormwater drainage which may be required to outfall to Goulburn Murray Water assets
- Open channels should be converted to pipes when appropriate.
- Parks and public areas should extend along waterways with native vegetation.
- Drainage lines should follow existing natural drain paths
- Drainage should be directed through Cussen Park to enhance the wetlands in that environment.
- The IWMS should take into consideration the impacts of climate change
- Any development should maintain natural flows through the mosquito depression.

In addition to the above, Spiire has been consulting with Council in order to ensure that the asset proposed are practical options for Council.

IWM Implementation Strategy in Tatura

It is envisioned that this report will provide a framework for the future drainage needs of the area and options of IWM initiatives that can be implemented within the future Tatura Structure Plan. Once preferable options have been identified these options will be refined further following the implementation of the Tatura Structure Plan, which identifies land uses. Below are the most suitable options proposed for the Tatura growth area.

IWM Aspect	Objectives	Base Case IWM Options		Aspirational IWM Options	Rationale
Waterways & Flood Plains	• Flows to Cussen Park are improved to protect important riparian ecosystems • Improve water quality in watercourses	Above ground detention for each catchment	Linear retarding basins to create biolinks	Smart rainwater tanks with storage provision for detention purposes	Above ground detention is to be utilised as its more cost effective and has the benefit of contributing to a 'green corridor'.
Major Drainage	• Appropriate levels of flood protection in new development • Community and property resilient to local flood risk	Conventional stormwater drainage, utilising pipes and roads	Linear streetscape swales and piped drainage system	Infiltration of stormwater for use by local vegetation	Piped drainage required for flood protection for new developments, however, swales to be used where practical to provide stormwater treatment and grade control.
Catchment Management & Land Use	• Diverse urban landscapes that reflect local conditions and community values • Street tree selection that balances shade, water efficiency, fire risk and amenity values	Conventional street trees and paths within reserves	Conventional street trees and paths within reserves interfacing assets	Diverse vegetation, pathways interfacing assets and wayfinding	The intent is to have the community interacting with water assets to allow for increased amenity, urban greening, and education opportunities.
WSUD	• Improve water quality in watercourses • Waterways accessible as valuable open space	End of the line WSUD assets or distributed treatment	Combination of distributed and end of the line assets	Treatment of stormwater through WSUD assets and supply to supplement water in GMW irrigation	A combination of both assets is favoured as higher levels of treatment is achieved at a reasonable cost.
Drinking Water	• A diverse range of water supplies and sources • Safe & secure water supply	Connect to conventional potable networks	Supply of water from alternative water sources, such as ground water.	Implementation of lot scale tanks and efficient appliances to offset drinking water demand	Required for health and regulatory purposes.
Sewerage	• Meet public health and environmental standards • Reduce wastewater generated	Connect to conventional sewerage network	Third pipe supply supply from Tatura WWTP	Onsite decentralised sewerage treatment for reuse.	Required for health and regulatory purposes.
Alternative Water	• Maximise waste-to-resource opportunities (fit for purpose alternate water) in balance with maintaining waterway flows	No alternative water considered	Passive street tree water, rainwater tanks, and stormwater harvesting	Recycled water	Reduces a reliance on potable water, reduced sewerage treatment, uses water which is fit for purpose.

Selected as an option for Tatura

Potential alternative options for Tatura

IWM Implementation Strategy and Objectives

The table below builds on the previous pages to demonstrate how the selected IWM measures relate to the objectives of IWM.

The measures selected aim to address the key components of IWM whilst also being appropriate for the site conditions and context. The selected measures were:

- Waterway and Flood plains - Above ground onsite detention or linear retarding basins to create biolinks.
- Major Drainage - Swales and piped drainage
- Catchment Management and Land use - Diverse vegetation, pathways interfacing assets and wayfinding
- WSUD Assets - Wetlands and tree pits
- Potable Water - Standard system, with rainwater tanks and demand management to offset drinking water demand
- Sewerage - Utilise existing recycling systems
- Alternative Water - Stormwater and rainwater harvesting
- Education and Policy Programs

It is acknowledged, that further IWM opportunities are available for Tatura, however, the opportunities analysed in this report were selected in consultation with Council, as best aligning with the IWM vision and stakeholder priorities.

Table 2: IWM options assessment for Tatura

	IWM Objectives	EFFECTIVE STORMWATER MANAGEMENT THAT PROTECTS OUR WATERWAYS	INTEGRATE AND PROMOTE STRATEGIC WATER USE	EFFECTIVE AND AFFORDABLE WASTEWATER SYSTEMS	COOL, GREEN AND WATER SENSITIVE URBAN LANDSCAPES	CLIMATE CHANGE RESILIENT SYSTEMS
	OPTIONS					
1	Waterways and Flood Plains - Above ground onsite detention	✓			✓	✓
2	Major Drainage - Swales and piped drainage system	✓				✓
3	Catchment Management and Land Use - Diverse vegetation, pathways interfacing assets and wayfinding	✓			✓	✓
4	WSUD - Wetlands and tree pits	✓	✓			✓
5	Potable Water and Demand Management		✓	✓		✓
6	Sewerage - Utilise existing water recycling			✓		
7	Alternative Water - Stormwater and rainwater harvesting	✓	✓	✓	✓	✓
8	Education and Policy Programs		✓		✓	✓

IWM Opportunities

Above Ground Retarding Basins

In order to prevent new properties and existing properties from flooding, above ground retarding basins are an effective option. Although generally considered standard drainage infrastructure, the have the following benefits:

- They control flood flows and provide a constant outflow rate
- Cost effective compared to the underground basins
- Their space can be utilised to add to community amenity

In terms of their implementation in Tatura, due the flat terrain, it means that the retarding basins will require pumped outlets and as a result flows to downstream areas and properties are controlled. Also, their open space can be combined with other stormwater assets such as wetlands, or community assets such as parks and ovals to provide increased amenity to the community.

Above ground retarding basins were selected over underground retarding basins, due to the high costs associated with underground basins. As the basin areas can be over a hectare, this would require significant costs to create a structurally integral asset which may not be financially viable for landowners in the area. Furthermore, on going maintenance costs could be much higher because if repairs are required on an underground asset the work would be much more complex and labour intensive.

An alternative option for Tatura is to implement linear retarding basins to create biolinks and open spaces corridors for pedestrians and cyclists, and to enhance to the community amenity of the new urban areas.

Swales and Piped Drainage

In order to convey stormwater to the retarding basins, assets such as swales and pipes will be required. Whilst both assets are considered standard drainage assets, they both provide benefits and contribute to IWM by managing stormwater. The main benefits that the assets provide are as follows:

- Pipes primary function is that they prevent flooding by conveying stormwater below the ground, which adds capacity to the drainage system.
- Swales on the other hand also provide some flood prevention benefits by channelising flows, however they also treat the water through their vegetation and capture sediment prior to discharging into waterways

It is envisioned that both these assets will be utilised in the Tatura growth area due to their respective benefits

Swales were also included to be utilised as opposed to just pipes because they can be more appropriate for low density areas, they can help in situations where there is limited grade and they also provide stormwater treatment, as mentioned above.

Catchment Management and Land Use

IWM is not just about water assets it is also about how communities interact with water. In this context, the planning of new growth areas provides opportunities to utilise the water assets in the area for other purposes such as amenity and urban greening.

Allowing community to interact with water assets, such as waterways and wetlands, provides more liveable communities, as they provide a place of gathering, recreation and relaxation. In addition to this they also allow for:

- Increased cooling and mitigation of the urban heat island effect;
- Improved air quality
- Create wildlife habitat
- Intercept stormwater runoff
- Assist and help to prevent soil erosion
- Enhance climate resiliency

In the Tatura growth areas, it is proposed that diverse vegetation and pathways that interface with water assets are implemented, as opposed to the conventional paths that don't interact with water infrastrucutre so that a greater public amenity is achieved and the community engage with, as well as appreciate, water assets.

IWM Opportunities

Water Sensitive Urban Design

WSUD assets contribute to reducing pollutant loads entering watercourses. There is potential to design WSUD assets, such as wetlands, raingardens and tree pits in the green spaces in the new growth areas Tatura. These assets would help to improve amenity and create an opportunity to educate residents about the water cycle.

WSUD has the following benefits:

- Reduce pollutant loads of stormwater entering waterways
- Bring water to the surface to enable the community's visual connection to the water cycle
- Slowing down of water and promoting infiltration
- Urban greening
- Improve amenity

A combination of distributed assets and end of the line WSUD assets was selected due to the benefits the combination brings, as opposed to only selecting distributed assets or end of the line assets. Only having distributed assets is more costly as economies of scale are not achieved and there are significant on going maintenance costs, whereas end of the line assets are not necessarily effective as distributed assets, however their value for money is higher and they are easier to maintain. By combining both options, cost savings can be achieved from the end of the line assets whilst the distributed assets enhance the overall treatment of the catchment.

Potable Water

Standard potable water systems will be in place to service the new growth areas of Tatura as this a requirement by the regional water authority and cannot be modified due to health and regulatory reasons. However, although standard potable water systems will be in place, its consumption and reliance on it can be reduced through the use of, alternative water systems.

Alternative water systems utilise other sources of water, besides potable water, in a manner that is fit for purpose. For example, whilst stormwater may not be fit for drinking purposes, it can be utilised to supply water for other activities where water quality requirements are not as strict, such as watering ovals or industrial wash-down purposes. As a result, by using alternative water, potable water demand is reduced which in-turn mitigates threats to water supply

In addition, potable water consumption is proposed to be reduced in Tatura through the implementation of rainwater tanks on new lots and demand management initiatives, such as water efficient appliances and water education.

Wastewater

The wastewater strategy for the new growth areas of Tatura will be to provide standard sewerage connections to premises and utilise the existing water recycling system at the Tatura Wastewater Facility. The Tatura Wastewater facility currently treats water so that it can be reused by irrigators in the area for industries such as crops, dairy and woodlots. As these irrigators utilise large amounts of water, the wastewater created from the new developable areas are certain to have an end user and the treated wastewater will be utilised effectively within the broader community.

It was investigated if wastewater could be treated to Class A recycled water so that the recycled water cold be reused within the new development area via a purple pipe system, however, there are currently no provisions for this level of treatment within the Tatura region and installing the required infrastructure would be prohibitively expensive unless funded at a state level, which is currently not proposed.

IWM Opportunities

Alternative Water Options

Two potential alternative water sources for Tatura are stormwater and rainwater harvesting. Stormwater and rainwater harvesting provides opportunity to reduce excess stormwater runoff entering watercourses around Tatura. Some examples of how harvested stormwater can be utilised are:

- Commercial sites using stormwater for non-potable reuse
- Irrigators complimenting their water demands with stormwater

For rainwater harvesting, rainwater tanks can be fitted in the new residential and commercial areas. Harvested rainwater can be used for non-potable water usage on site such as toilets and irrigation.

Stormwater and rainwater harvesting provides the following benefits:

- Reduce demand on potable water supply
- Help control and manage peak stormwater flows
- Rainwater tanks can be retrofitted on existing buildings and have a relatively low capital cost
- A highly visible technology, which can be used for education

In addition to water harvesting, technologies such as tree pits also allow for runoff to be utilised as an alternative water source which can subsequently contribute other aspects of IWM such as urban greening by creating vibrate green spaces and streetscapes.

Another alternative water source investigated was recycled water, however, as mentioned on the previous page, Tatura currently lacks the required infrastructure to provide Class A recycled water and installing such infrastructure would be prohibitively expensive.

Education and Policy

Education programs are a great way to involve the community in the integrated water space. These programs provide the community with information around the water cycle, its interaction with Tatura and how the communities actions directly influence it.

Several educational initiatives are proposed for the purpose of spreading awareness could be:

- The water cycle
- Water consumption in Tatura
- Cultural and heritage values of water and landscape
- Maintenance and operation
- Construction sediment management and control.

Benefits of education and policy include:

- Connect the community to the landscape, cultural values and biodiversity
- Bring water to the forefront of the community awareness
- Promote health and well-being connecting with the environment
- Support the broader community awareness and appreciation about where our water comes from and its impacts on the environment
- Reduce potable water consumption
- Make contractors and developers accountable for the impact they have on waterways and the surrounding environment
- Assist in providing guidelines or a framework for future development, construction and maintenance activities

Strategy Intent: Areas and Zonings

The Tatura Framework Plan proposes to rezone approximately 767ha of land of varying zone types. The predominant zoning is Farm Zone; however, within the framework area other zone types include Low Density Residential, Rural Living, Industrial, Urban Flood Zone and Public Park and Recreation Zone. It is currently understood that the investigation area will be rezoned into two main types of zoning; residential, which includes low density residential, and Rural Living. However, to account for potential changes in future zoning, any areas with minimum lot sizes of 2000m^2 or below have been assumed to be zoned residential.

Since the two zone types of produce significantly different amounts of runoff, due to the impervious area associated with each zone type, two different approaches are required. The approaches for each zone type will be as follows:

Rural Living Zoning

Rural Living Zone (20,000m^2 lots and above) results in the creation of a small impervious area compared to the broader property. As a result, the increase in runoff from the pre-developed conditions is minimal, and therefore the works required to cater for the additional runoff is minor in nature and can be undertaken by the property owner. Furthermore, due the large minimum lot size there is ample space on each property to capture stormwater and reuse it on the property.

Owing to the factors above its proposed that development within the Rural Living zone implement their own water sensitive urban design and/or IWM measures and not be included in the regional infrastructure. There are two main reasons for this:

- Property owners are able to implement measures which are fit for purpose. For example, they may decide to install rainwater tanks for reuse within the house, construct a dam for watering the vegetation, or any other suitable alternative.
- The contributions to regional infrastructure is generally more expensive than cost of onsite measures. As a result, it would likely be disadvantageous to the property owner to pay contributions to regional measures when they could provide adequate stormwater treatment or reuse on site.

It is recommended that Council set the minimum requirements for these properties with respect to stormwater management.

Finally the Victorian Planning Provisions state under Section 53.18 that low density subdivisions should be:

- Designed and managed in accordance with the requirements and to the satisfaction of the relevant drainage authority.
- Designed and managed in accordance with the requirements and to the satisfaction of the water authority where reuse of stormwater is proposed.
- Designed to meet the current best practice performance objectives for stormwater quality as contained in the Urban Stormwater - Best Practice Environmental Management Guidelines (Victorian Stormwater Committee, 1999).
- Designed to ensure that flows downstream of the subdivision site are restricted to pre-development levels unless increased flows are approved by the relevant drainage authority and there are no detrimental downstream impacts.
- Designed to contribute to cooling, improving local habitat and providing attractive and enjoyable spaces.

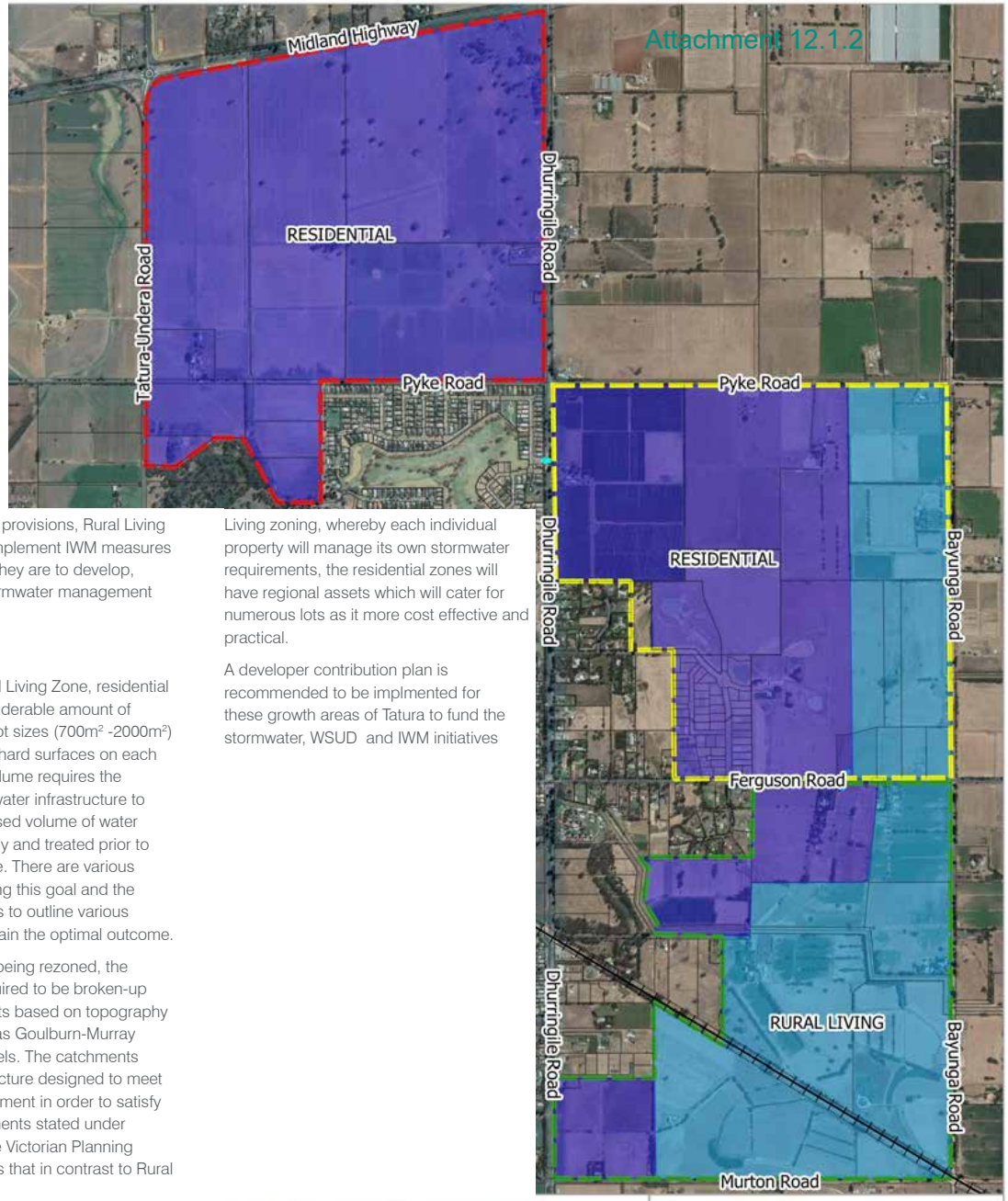
Therefore under these provisions, Rural Living sites are required to implement IWM measures on a lot sized scale if they are to develop, which compliment stormwater management requirements.

Residential Zoning

In contrast to the Rural Living Zone, residential zoning creates a considerable amount of runoff due to smaller lot sizes (700m^2 -2000m^2) and larger portions of hard surfaces on each lot. This increase in volume requires the construction of stormwater infrastructure to ensure that the increased volume of water can be conveyed safely and treated prior to entering a watercourse. There are various methods for a achieving this goal and the intent of this strategy is to outline various options in order to obtain the optimal outcome.

Due to the large area being rezoned, the residential area is required to be broken-up into smaller catchments based on topography and constraints such as Goulburn-Murray Water irrigation channels. The catchments will then have infrastructure designed to meet the needs of the catchment in order to satisfy development requirements stated under Clause 56.07-04 of the Victorian Planning Provisions. This means that in contrast to Rural Living zoning, whereby each individual property will manage its own stormwater requirements, the residential zones will have regional assets which will cater for numerous lots as it more cost effective and practical.

A developer contribution plan is recommended to be implmented for these growth areas of Tatura to fund the stormwater, WSUD and IWM initiatives



NOTATIONS

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Date: 26.03.2021

Designed: J.Carroll
Checked: M.Yule
Authorised: J.Espagne

LEGEND

- RESIDENTIAL
- RURAL LIVING
- MIDLAND HIGHWAY PRECINCT
- MURTON ROAD PRECINCT
- PYKE ROAD PRECINCT
- RAILWAY LINE

205 0 205 410 615 m

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Coordinate System: GDA 1994 MGA Zone 55
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Drainage Infrastructure

The intent of this report is to provide options on stormwater infrastructure which may best service the needs of each catchment. In order to do this, the infrastructure will be broken down into two main components drainage infrastructure and IWM infrastructure. Drainage infrastructure refers to the standard infrastructure required to manage runoff and includes assets such as underground pipes and retarding basins, whilst IWM infrastructure is in relation to the treatment, reduction and reuse of urban runoff and includes infrastructure such as stormwater harvesting, soakage pits, WSUD assets etc.

Drainage Infrastructure

In order to allow development to occur to the north and east of Tatura, drainage infrastructure is required to ensure that the new properties do not flood and neighbouring or downstream properties are not affected by the increased runoff created by the new development. Some typical types of drainage infrastructure options include retarding basins, underground pipelines, waterways, culverts.

Retarding basins for each catchment have been investigated and preliminary sized. These are a critical piece of infrastructure to prevent flooding of neighbouring properties, they provide an outfall for underground pipes, and they have large footprints which is important to understand for creating the future urban Structure Plan. A summary of the retarding basin key characteristics can be found in Table 3 below, with the location of each retarding basin shown on the following pages.

As mentioned in the Strategy Intent section, the retarding basins have been sized based on the assumption that higher densities may occur in future, i.e. lot sizes 2000m^2 and below will eventually be zoned residential.

This conservative approach allows for easier refinement of the assets once the zoning types are finalised. Furthermore, only the new retarding basins have been shown. There is proposed excavation of the urban flood zone to provide additional storage for sites draining to this area, however, as it is not expected to take any additional land, it has not been included in the retarding basin locations. Finally the retarding basin foot prints have been sized assuming 1 in 5 batters. This is for safety and maintenance purposes and also to allow for community use during dry weather periods.

It should be noted that, pipelines and other asset types were not investigated as they are subject to being designed in accordance with road layouts which are currently not available.

Table 3: Catchments and Retarding Basins

Catchment	Catchment Area (ha)	RB Name	Area (m^2)	Storage (m^3)
A	11.5	A	5,353	11,164
B	23.4	B	9,094	25,450
C	25.0	C	9,363	23,681
D	11.2	D	5,053	10,736
E	48.4	E	15,022	45,980
F	53.7	F1	17,017	53,645
F	56.8	F2	16,559	56,257
H	61.5	H	18,960	60,085
N	8.4	N	5,160	7,973
Q	6.5	Q	4,304	6,234
R	16.0	R	6,644	15,672
V	16.6	V	9,033	16,226

Drainage Infrastructure

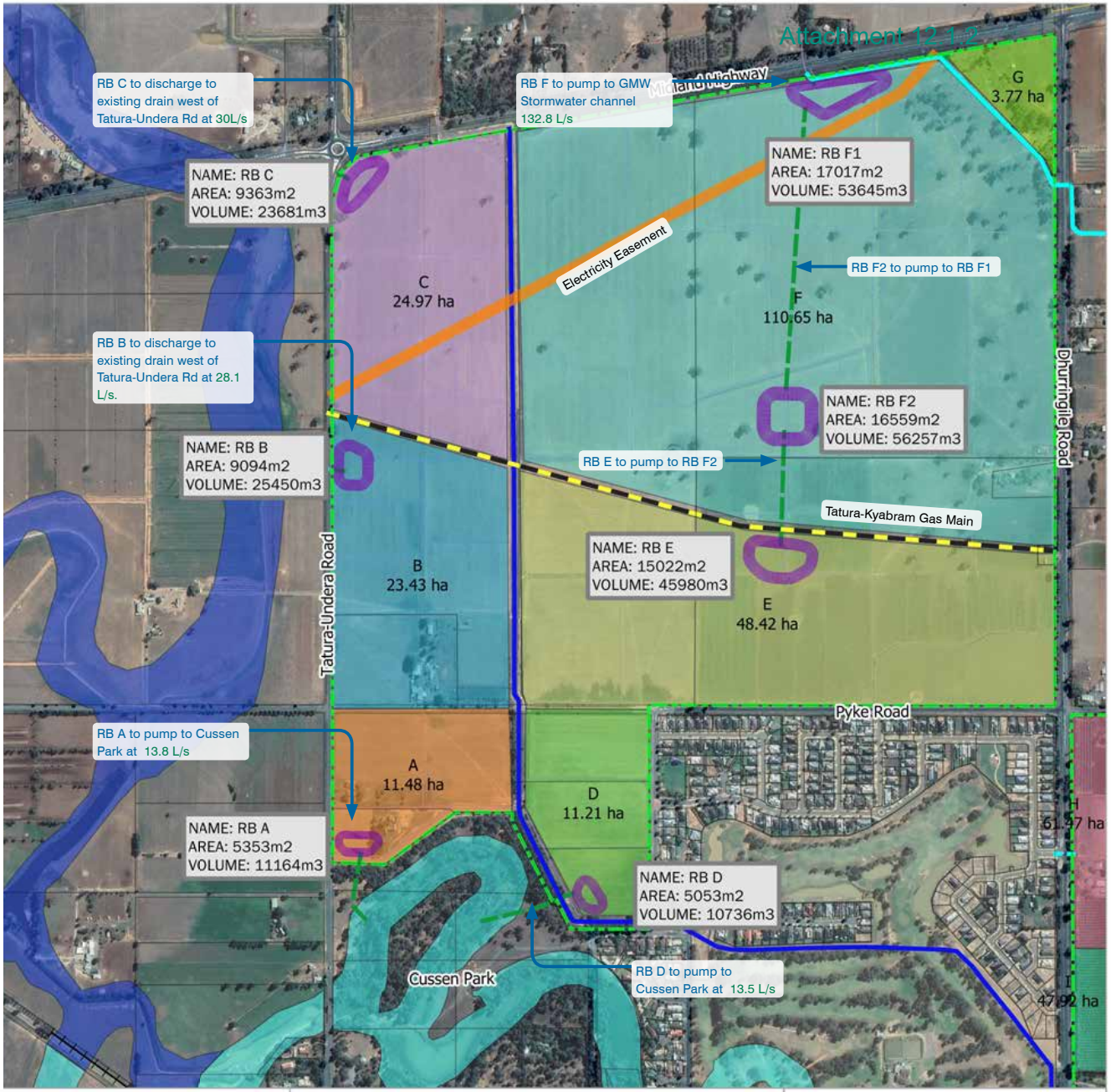
Midland Highway Precinct

The Midland Highway precinct comprises of the sub-catchments A-G which generally slope from the south to the north. There are several significant constraints within this area, including a GMW irrigation channel running south to north, the Tatura-Kyabram Gas main which runs from east to west and a major electrical easement which runs from the west of the site to the north-east.

The drainage infrastructure in this area has been designed generally in accordance with the natural contours with retarding basins being located in the natural low points and draining to existing drainage lines or watercourses. The exception being catchments A and D, which have been design to drain southwards towards Cussen Park in order provide the park with an alternative water source as requested in the in community and stakeholder consultation.

The retarding basins also address one of the other stakeholder concerns around the impact on flooding of downstream properties. The intent of the basins will be to capture runoff and discharge it at steady rate so that the increased runoff from development won't increase existing flood levels.

It should also be noted that a retarding hasn't been located on Catchment G, this is because it is a small catchment and can be determined at the development stage.



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LEGEND

- INVESTIGATION AREA
- CULVERTS
- GMW IRRIGATION CHANNEL
- GMW STORMWATER DRAIN
- ELECTRICITY EASEMENT
- GAS MAIN
- RETARDING BASIN
- URBAN FLOOD ZONE (UFZ)
- FLOODWAY OVERLAY (FO)

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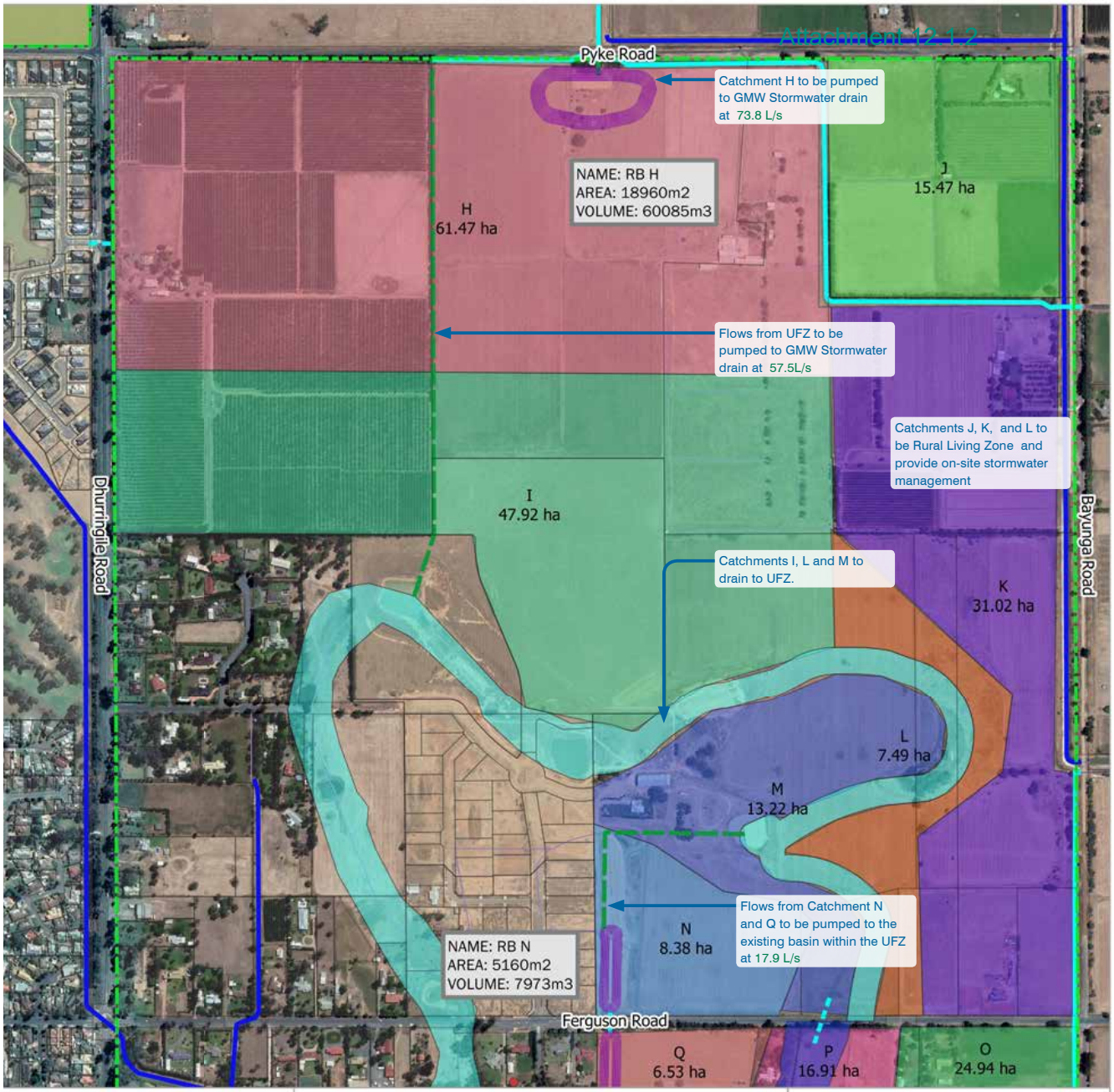
Drainage Infrastructure

Pyke Road Precinct

Pyke Road Precinct comprises of the sub-catchments H-N which, similar to the Midland Highway Precinct, generally slope from the south to the north. A significant feature of this area is a large depression which meanders through the southern portion of the region. This depression is flood prone and zoned as Urban Flood Zone (UFZ). Approximately half of the area to be rezoned will drain to this depression whilst the rest will drain to the north.

As this region is defined by a large depression zoned UFZ, the intent of this strategy was to utilise this area for drainage and amenity purposes. Catchments I-N will drain to this location, where it will be excavated and utilised as retarding basin and then pumped to the GMW drain located along the northern boundary.

The drainage strategy is similar to the endorsed development plan for Tatura Waters, with the exception of Catchment H which is proposed to drain to the north because of the natural topography. This results in an additional retarding basin on the development site, however, as the development plan has been endorsed, this retarding basin is for consideration purposes only, as it may be more cost effective and practical to provide an additional retarding basin in the north than modify the site so that it all drains to the depression. Furthermore, it should be noted that the Tatura Waters development plan is based on low development densities such as farm zone and low density residential, whilst this strategy has assumed that catchments, I, J, M, N will eventually be zoned residential.



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LEGEND

- INVESTIGATION AREA
- RETARDING BASIN
- CULVERTS
- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- SW RISING MAIN
- URBAN FLOOD ZONE (UFZ)
- FLOODWAY OVERLAY (FO)

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Drainage Infrastructure

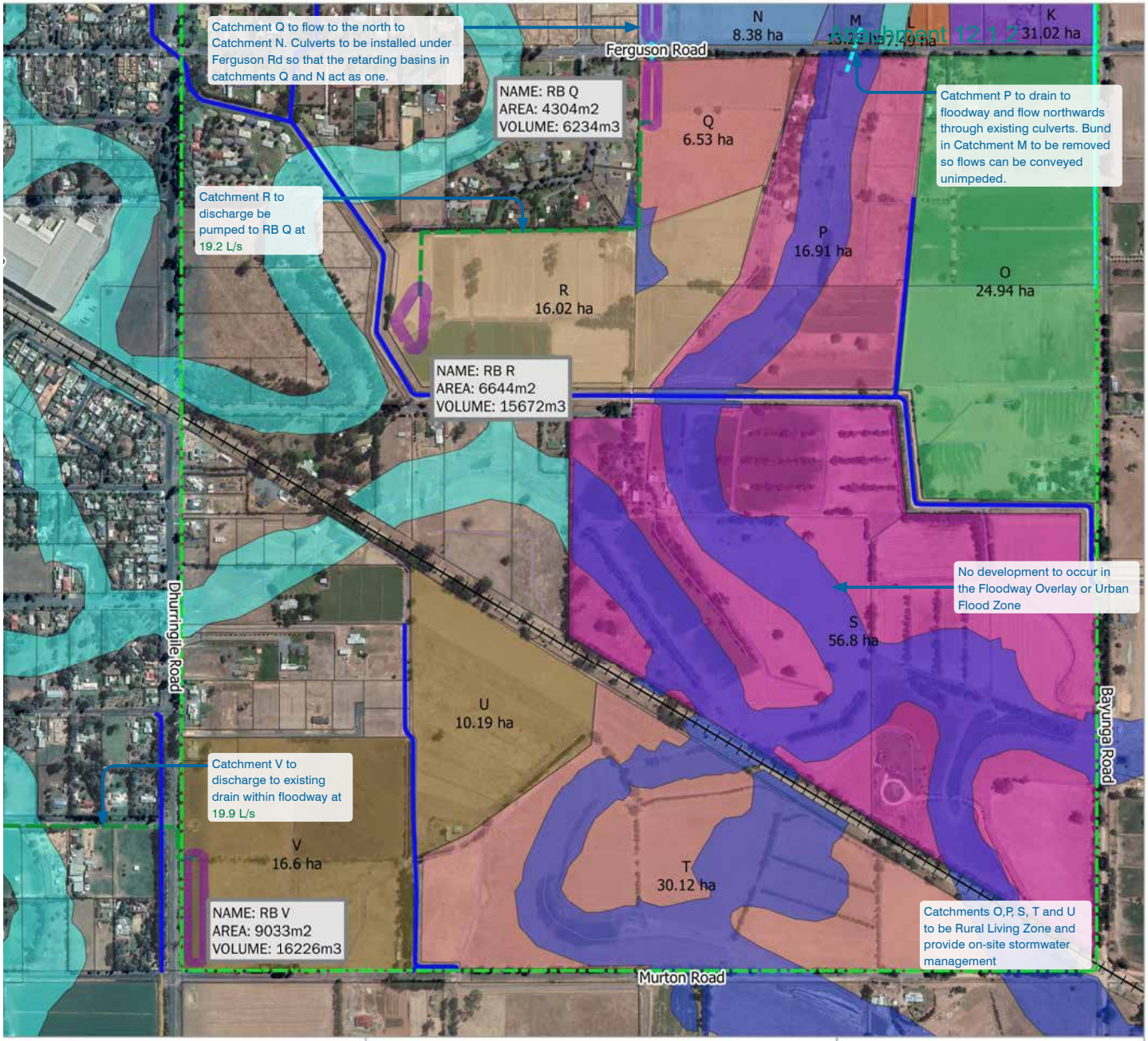
Murton Road Precinct

Murton Road Precinct is characterised by the by numerous depressions which meander across the precinct and as a result the land is to be zoned predominantly Rural Living since higher densities would not be feasible. The catchments P, Q, R and T are planned to be zoned residential and therefore only these catchments require regional drainage infrastructure installed as the Rural Living areas will provide their own stormwater infrastructure.

For Catchment P to drain effectively it is proposed that the bund on located on the north side of Ferguson Rd be removed as it is blocking the natural flow of drainage within the depression. Under normal circumstances Catchment P would flow to one of the retarding basins north of Ferguson Rd where it would be able to be pumped up to the GMW drain north of the development area. It was investigated if Catchment P could drain to west, either to Catchment Q or R, however, because of the topography of the natural terrain the water level in Catchment P would put properties in those catchments at risk if since the high water level in flood events may cause the drains in catchments Q or R to overflow.

In order to drain Catchment R, it is proposed to place a retarding basin at the western end of the catchment and then pump flows up to RB Q. This outlet was determined to be the most feasible option given the constraints of the GMW irrigation channel and access to existing drainage networks.

Catchment V is proposed to outlet to the existing Council drainage in Hampton Rd.



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Flood Results:
Data:

LEGEND

- INVESTIGATION AREA
- RETARDING BASIN
- CULVERTS
- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- SW RISING MAIN
- RAILWAY
- URBAN FLOOD ZONE (UFZ)
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Water Balance and IWM Infrastructure

In order to understand the volumes of water likely to be produced by the rezoning of new areas around Tatura, a conceptual water cycle model was developed in MUSIC, using 10 years worth of rainfall data. The model estimated the volumes of runoff that would be generated in each catchment on an annual basis. Table 4 states the runoff generated from each catchment and were it goes, i.e. evaporates, infiltrates etc.

Whilst the increased runoff needs to be managed in order prevent flooding, it can also be seen as a resource. Table 5 indicates that up to 743ML/yr of additional runoff will be available to be utilised for non-potable purposes. Some of the options provided in this report, utilise runoff as a resource. The main example is the implementation of rainwater tanks, which if installed on each property, would reduce runoff by 170ML/yr whilst simultaneously reducing potable water demand by the same amount. Other examples are, tree pits, which utilise the increased runoff to help trees grow, which intern provides various benefits to the community such as urban cooling, increased amenity, and increased biodiversity. Stormwater reuse, can also be captured and reused to water green areas, such as ovals or gardens, this has the benefit of not only decreasing potable water usage for irrigation but also improving public amenity and community spaces. Options for the reuse of the additional stormwater are outlined in the following pages.

Note: The calculations for the mains water, sewer and rainwater tanks are based on households of 2.4 people per household (2016 Census), with each household using 481L/day. The rainwater tanks are assumed to provide water for toilets, laundry and the garden, and can use up to 250L/day. To confirm the supply of rainwater to the tanks, the stormwater program MUSIC was utilised. An assumption of 10 lots per hectare was made for residential areas, until such time that a structure plan is formalised.

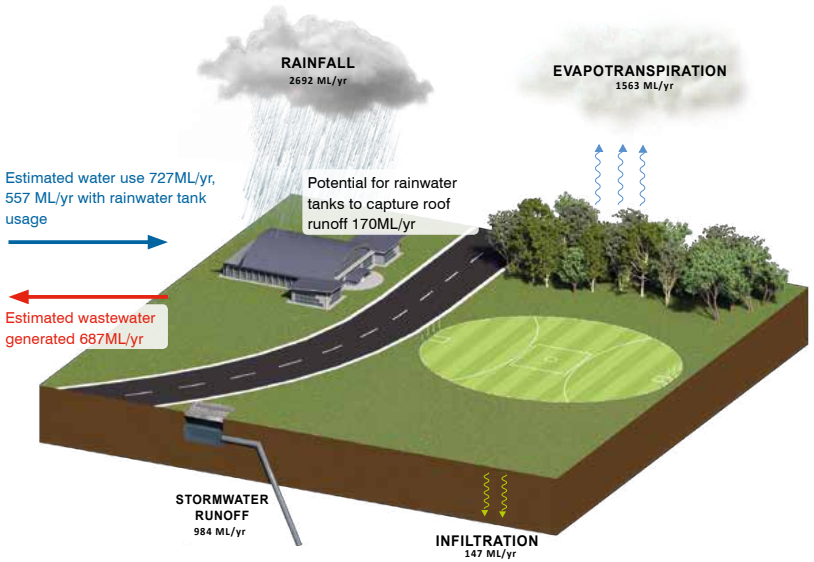


Figure 3: Visual Water Balance - Developed Conditions

Table 5: Differences in Water Balance Scenarios

	Catchment Area (ha)	Rain (ML/yr)	Evapotransipiration (ML/yr)	Infiltration (ML/yr)	Runoff (ML/yr)
Pre-developed	597	2692	2216	239	240
Developed	597	2692	1563	147	984
Difference	0	0	-653	-92	+743

Table 4: Catchment Water Balance

Catchment	Catchment Area (ha)	Rain (ML/yr)	Evapotransipiration (ML/yr)	Infiltration (ML/yr)	Runoff/ Potential reuse (ML/yr)
A	11	51	24	2	25
B	23	109	53	2	54
C	25	111	52	4	55
D	11	50	23	2	25
E	48	216	101	9	107
F	111	494	231	20	244
G	4	17	8	1	8
H	61	274	128	11	135
I	48	214	100	9	106
J	15	69	57	6	6
K	31	138	115	12	11
L	7	33	28	3	3
M	13	59	28	2	29
N	8	37	17	1	18
O	25	134	111	12	11
P	17	75	46	5	25
Q	7	29	14	1	14
R	16	72	33	3	35
S	57	254	210	23	21
T	30	134	112	12	11
U	10	45	38	4	4
V	17	74	35	3	37
Total	597	2692	1563	147	984

Note: Totals do not equal rainfall due to soil storage factors

IWM Infrastructure

Midland Highway Precinct

As catchments A and D are proposed to drain to Council land at Cussen Park, treatment measures such as swale or wetland could be implemented within this area. This would have the benefit of providing approximately 50ML treated water per year to Cussen Park, which was a recommendation by DELWP in the stakeholder consultation process.

An alternative IWM option explored for the A and D catchments was to treat the water via a WSUD asset such as wetland and then pump into the GMW irrigation channel, however, this option was deemed infeasible by GMW and therefore not explored further.

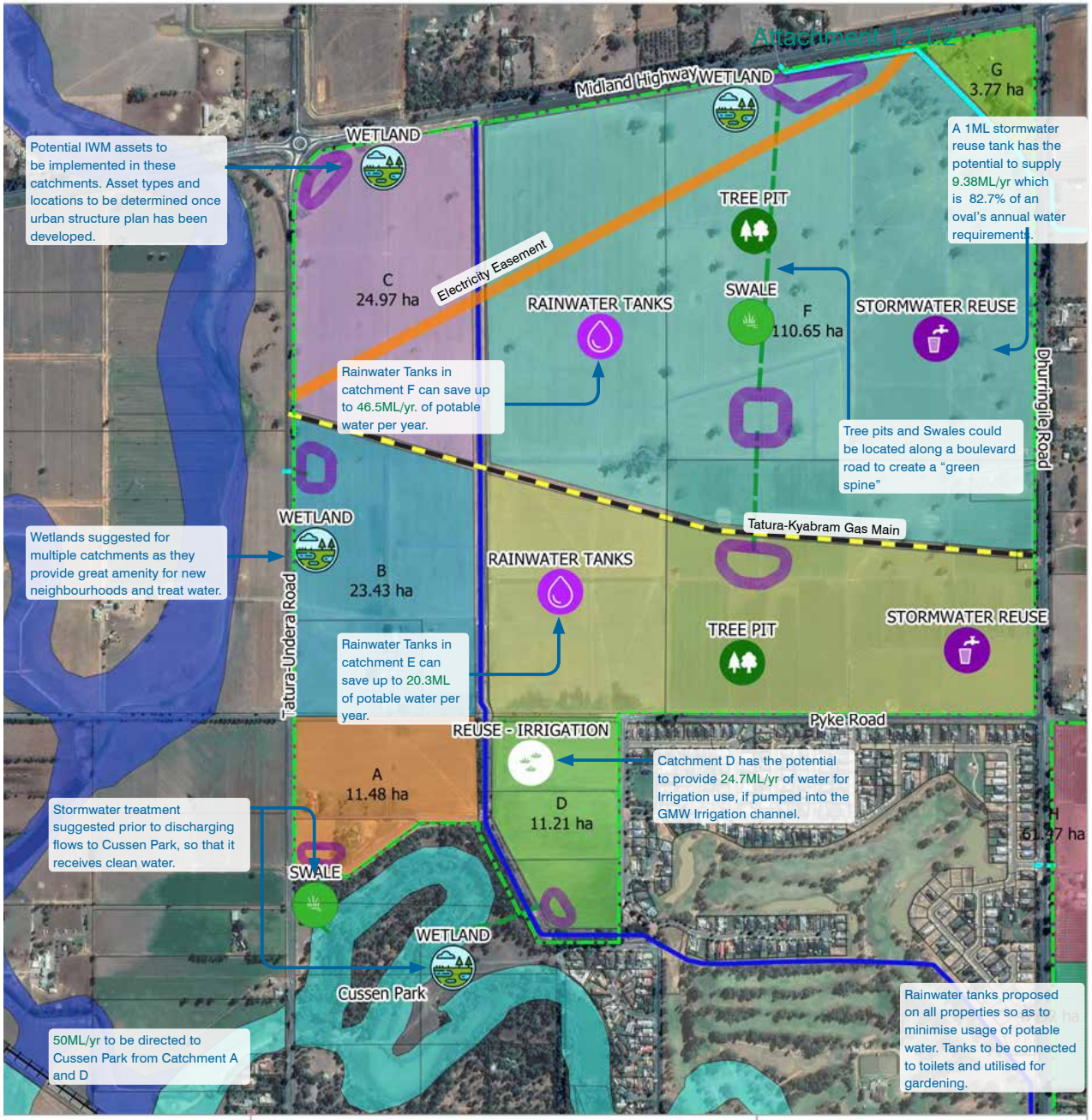
For the remaining catchments, due to the large area being rezoned and the structure plan still in progress there are numerous possibilities for the implementation of IWM infrastructure in this area. For example, if there were schools and ovals proposed within this area, stormwater reuse would be favourable option. To provide an example of the benefit that stormwater reuse can provide, an analysis was undertaken of installing a 1 megalitre (ML) tank in catchment F. If a reuse tank was installed for an AFL oval, it could provide approximately 83% of the water usage required for that oval (refer to Table 4 for calculations),

It has been assumed that combination of IWM measures will be implemented in each catchment. For instance, for Catchment F, it could be that tree pits, stormwater reuse, swales and wetlands are implemented in this catchment, with the space between the electricity easement and the highway being an ideal opportunity to co-located assets such as wetlands and retarding basin, whilst catchment E, may only implement tree pits and a wetland.

The adjacent plans shows some of the possibilities, however the feasibility and practicality of these options will have to be refined once a structure plan is finalised and land uses have been determined.

Table 4: Analysis of a 1ML Stormwater Harvesting System in Catchment F

	Value	Comment
Evapotranspiration - Grass	659.12mm	0.55 of all evapotranspiration for warm season (1198.4mm)
Effective Rainfall	127.85mm	50% of Warm season rainfall (Oct - April)
Water demand - Grass	531.27mm	Difference in evapotranspiration of grass and effective rainfall
Water demand considering sprinkler efficiency	708.36mm	Assumed 0.75 efficiency when watering grass
Oval Area	16,000m²	Average AFL oval
Annual water demand of oval	11.34ML	(708.36*16000/100000)
1ML Stormwater reuse tank supply per annum	9.38ML	Calculated for catchment F in MUSIC
Annual water demand of Oval demand met	82.7%	



NOTATIONS

File Ref: 307990
Plan: W GIS 307990
Rev: B
Date: 26.03.2021

Designed: J.Carroll
Checked: M.Yule
Authorised: J.Espagne

LEGEND

- INVESTIGATION AREA
- CULVERTS
- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- ELECTRICITY EASEMENT
- GAS MAIN
- URBAN FLOOD ZONE (UFZ)
- FLOODWAY OVERLAY (FO)

102 0 102 204 306 m

1:10,000

Coordinate System: GDA 1994 MGA Zone 55
Paper size A3 Landscape

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IWM Infrastructure

Pyke Road Precinct

Approximately half of the Pyke Road Precinct is zoned is low density and therefore IWM options will be provided on a lot scale and subject to the future owners preferences.

The situation for the residential catchments is similar to the Midland Highway Precinct, it has large catchments where multiple IWM possibilities are available and are dependent on the land use. Once a preliminary structure plan has been developed, the preferred IWM options can be defined. In general the intent would be to locate assets near or within the Urban Flood Zone and Council Reserve, such as tree infiltration trenches and wetlands in order to minimise the impact of developable land. It would also have the added benefit of creating a green corridor along the existing depression.

For areas where there is minimal land available for WSUD/IWM assets it is recommended smaller, more localised assets be constructed such as street tree pits and rainwater tanks to increase local vegetation cover and reduce potable water demand.

As mentioned in the drainage infrastructure section, this area already has an endorsed development plan and these IWM options could potentially be integrated into development.

Prior to development, it is recommended that a drinking water and sewerage strategy is undertaken which can further investigate ways to incorporate IWM into the precinct.

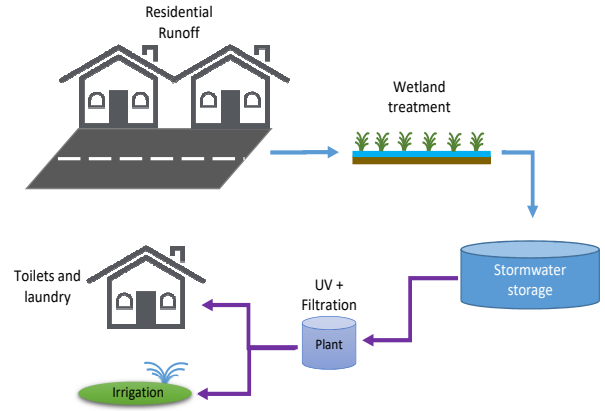
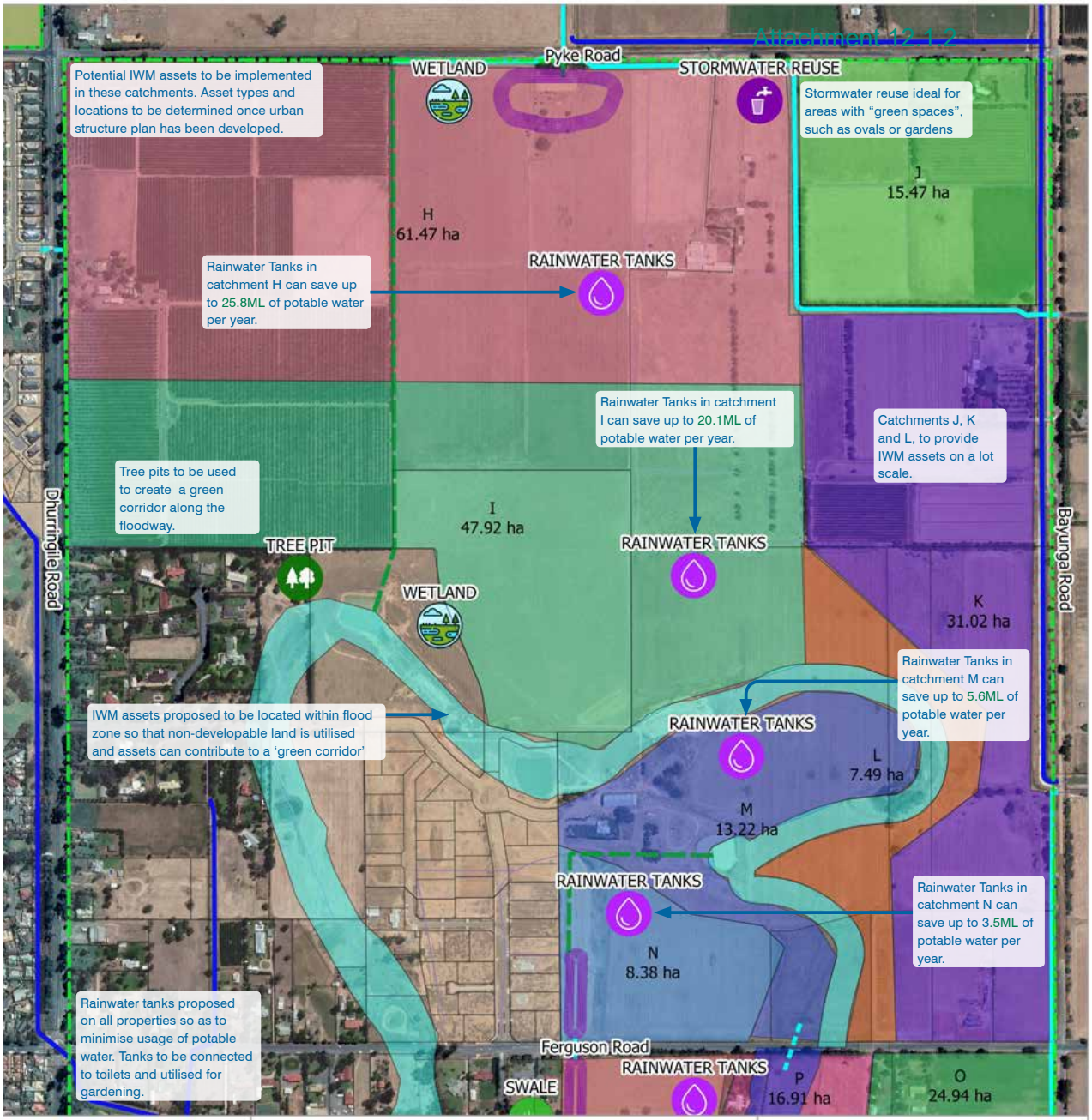


Figure 3: Stormwater Harvesting Process Example



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LEGEND

- INVESTIGATION AREA
- CULVERTS
- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- URBAN FLOOD ZONE (UFZ)
- FLOODWAY OVERLAY (FO)

76 0 76 152 228 m

1:7,500

Coordinate System: GDA 1994 MGA Zone 55
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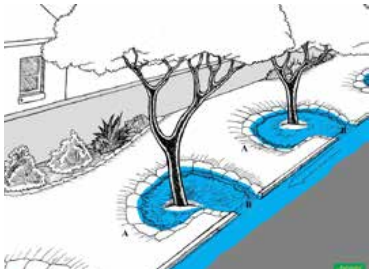
IWM Infrastructure

Murton Road Precinct

A large portion of the Murton Road Precinct is zoned low density residential, as a result these areas will be providing onsite IWM solutions. For the areas which are zoned residential, the following options were explored:

- For Catchment Q, a swale drain as proposed to be constructed along the existing drainage line to the UFZ to the west, through the 56 Ferguson Rd property, however this would require an easement over private property which would be acquired by Council. After discussions with Council this was not a preferred option and Catchment Q will be directed to the north.
- Similar to Midland Highway Precinct, in Catchment R reuse for irrigation was explored by treating runoff through a WSUD asset and then pumping back into a GMW irrigation drain, however, after discussions with GMW, they advised that this option would not be acceptable to GMW.
- Rainwater tanks implemented at a lot level.

It is also recommended that prior to development occuring that a drinking water and sewerage strategy is undertaken which can further investigate ways to incorporate IWM into the precinct.



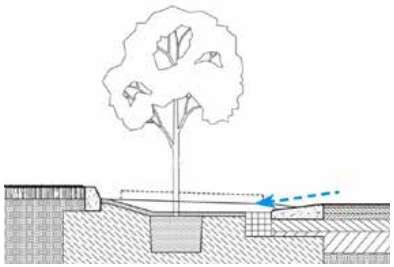
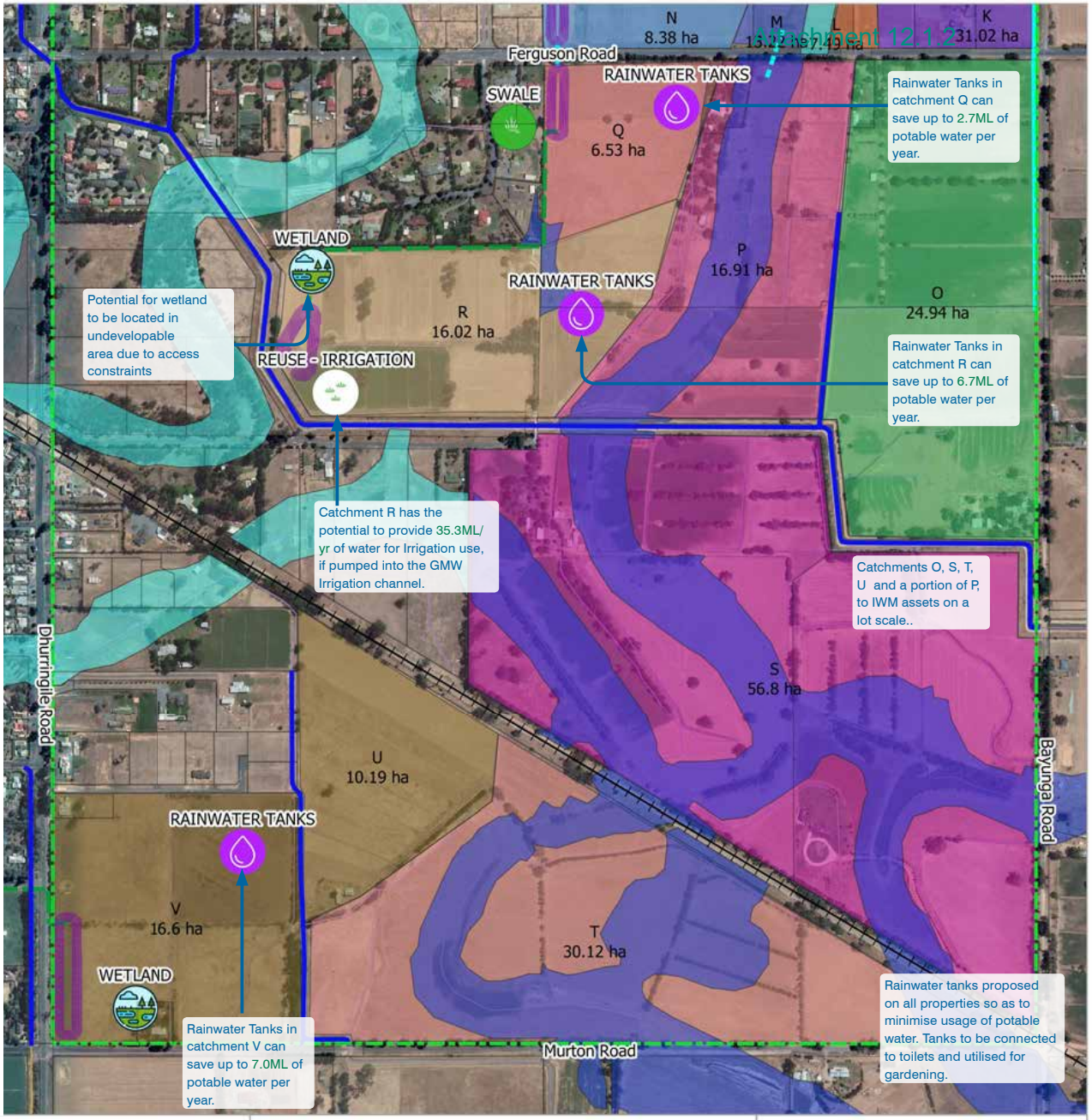


Figure 4: Examples Of How Street Trees function



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LEGEND

- INVESTIGATION AREA
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- GMW IRRIGATION CHANNELS
- GMW STORMWATER DRAINS
- URBAN FLOOD ZONE (UFZ)
- FLOODWAY OVERLAY (FO)
- RAILWAY

76 0 76 152 228 m

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Alternative Options

In addition to the scenarios presented in this report, alternative designs and options were investigated for consideration by Council. The main options investigated were:

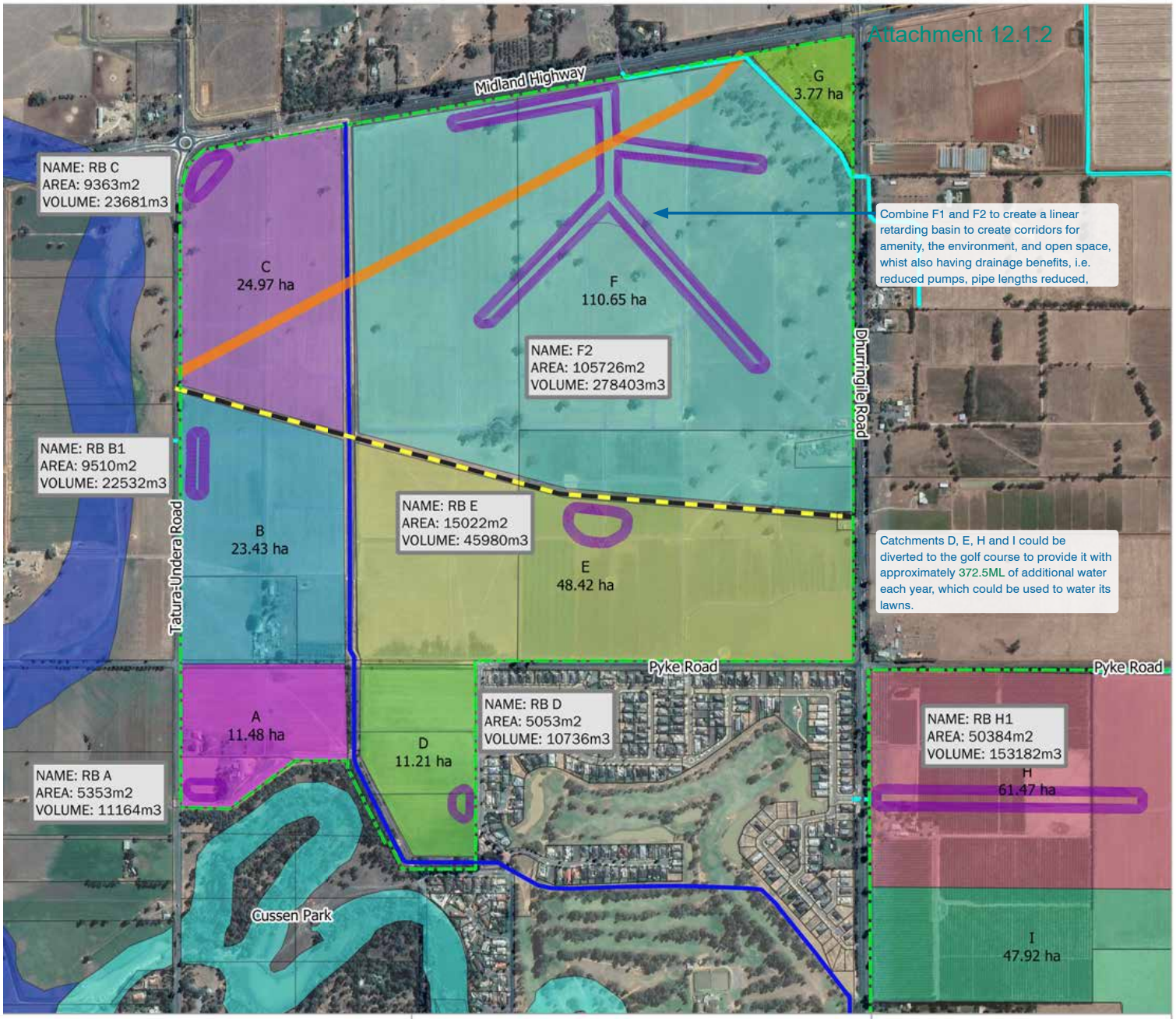
- Linear retarding basins
- Stormwater reuse within Tatura.

These concepts are outlined on the following pages.

Linear retarding basins

The intent of these retarding basins was to provide an alternative to the standard form of constructing retarding basins within the Shepparton area by creating linear drainage reserves which would mimic a constructed waterway. These retarding basins can provide various benefits for the new developments, the main benefit being providing amenity to the new development area. Waterbodies can be located in the bottom of basins and the elongated retarding basins would create long linear open spaces which could incorporate footpaths and parks making them features of the new development. They would also allow for the creation of a green corridor where trees could be planted to promote urban greening and biolinks in the new estates. These trees would have several advantages for the new the estates, they have the potential to reduce the temperature of the surrounding areas through increasing shade and minimising the use of impervious surfaces which store and radiate heat, as well as allow for the implementation of WSUD structures, such as tree infiltration pits, to be included within reserves, which reduce urban runoff loads.

These linear retarding basins would also allow for a reduction in the number of retarding basins and pumps, particularly in Catchment F, which is a large catchment where multiple RBs would be required. However, these linear retarding basins are larger in size than the traditional retarding basins and as result would require a larger reserve area than a standard retarding basin.



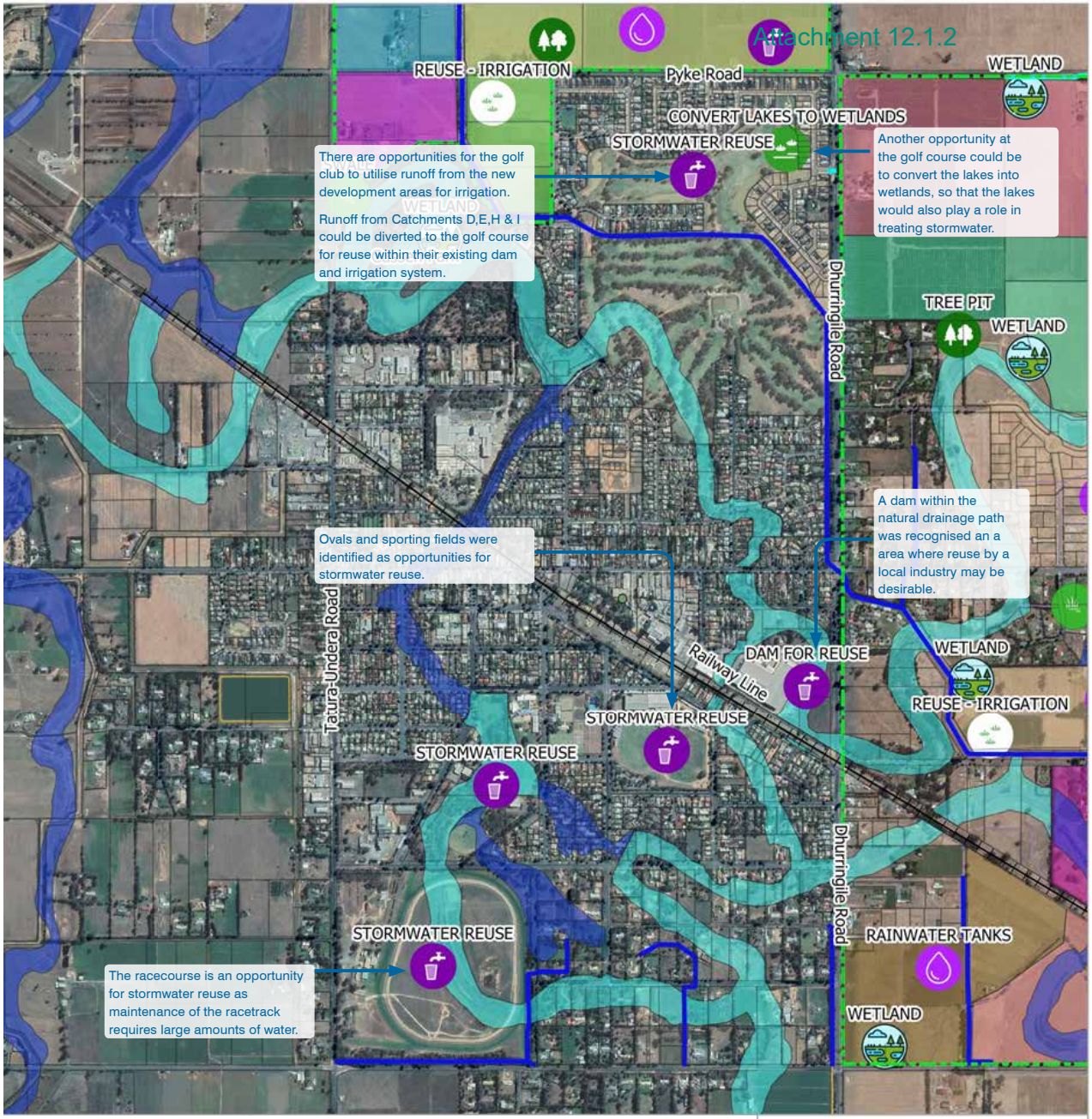
Alternative Options

Stormwater reuse in township

As discussed the development of Tatura will generate approximately 743ML of additional stormwater a year. This stormwater has the ability to provide a water resource to the development as well as the broader community. Potential projects can be brought online in Tatura as the development occurs to offset the potable water use within the township. These projects are identified on the map on the right.

The biggest potential for reuse was the golf course, as golf courses require significant amounts of water in order to maintain the lawns and there were already ponds which could be utilised. This strategy investigated diverting several catchments (D, E, H and I) from the new development areas to the golf course. This option would divert runoff from approximately 170ha of land to the golf course which could be used for irrigating the lawns.

In addition to the golf course other areas were identified, including the racecourse, show grounds, ovals and recreation areas, amongst others. These options for stormwater reuse were discussed with Council, however were not pursued further at this stage due to the uncertainty of formalising agreements with private entities. Further feasibility and design would be required by Council to implment these projects.



Summary and Next Steps

Tatura is a high priority township within the Greater Shepparton Townships Framework Plan Review 2019 and Council is facilitating the growth of the town and is developing an structure plan for the area. This document has been developed to inform the Council Structure Plan, and to incorporate innovative opportunities for the conservation and utilisation of water within the township, prevent the increasing of flood conditions and provide infrastructure that will contribute to more vibrant and liveable communities. To achieve this an Integrated Water Management (IWM) approach was identified by Council as a key step in implementing a sustainable development framework for Tatura.

As a result of consultation with council and stakeholders the key objectives of this IWM are to:

- Integrate and promote strategic water use.
- Provide effective and affordable wastewater systems
- Provide effective stormwater management that protects our waterways.
- Create cool, green and water sensitive landscapes.
- Create climate change resistant systems.

A range of IWM measures have been investigated and adopted in this plan aim to address the key components of IWM whilst also being appropriate for the site conditions and context. The selected measures are:

- Waterway and Flood plains - Above ground onsite detention or linear retarding basins to create biolinks.
- Major Drainage - Swales and piped drainage
- Catchment Management and Land use - Diverse vegetation, pathways interfacing assets and wayfinding
- WSUD Assets - Wetlands and tree pits
- Potable Water - Standard system, with rainwater tanks and demand management to offset drinking water demand
- Sewerage - Utilise existing recycling systems
- Alternative Water - Stormwater and rainwater harvesting
- Education and policy programs

It is acknowledged, that further IWM opportunities are available for Tatura, however, the opportunities analysed in this report were selected in consultation with Council, as best aligning with the IWM vision and stakeholder priorities.

The investigation found that through the development of Tatura, the town would use up to 727ML of additional potable water per year and generate 687ML of sewerage per year, increasing the demand on existing water and wastewater infrastructure in Tatura. Further to this, the development will generate an additional 743 ML of stormwater a year, which is available for reuse within the development and the community. One way that this additional stormwater can be utilised is through the use of rainwater tanks which if installed on every property, can provide up to 170ML per year as an alternative water source for activities such as toilet flushing and laundry.

The options provided in this report, focus on utilising this runoff as a resource, whilst implementing ways to decrease water consumption and wastewater generation. For example, implementing stormwater harvesting for irrigation of ovals and community reserves, has the benefit of not only decreasing potable water usage but also improving public amenity and community spaces. These IWM opportunities can also be developed with supporting options, such as wetlands to treat stormwater, swales along connected roads and tree pits to create biolinks through the community. The location of these opportunities can be further developed, as the Structure Plan is finalised.

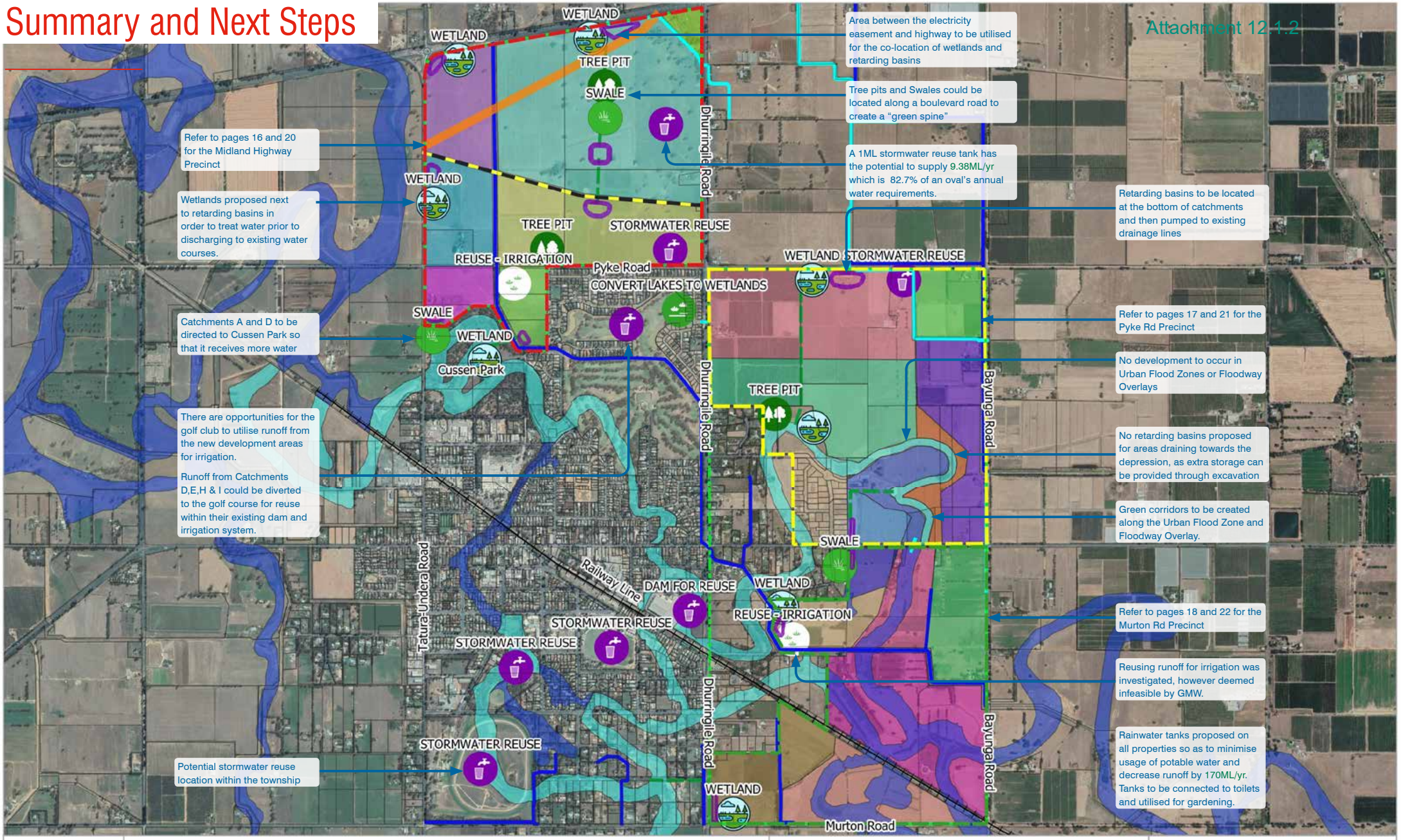
Complimenting these options for utilising the runoff as a resource, other opportunities focusing on water consumption are recommended, such as the implementation of rainwater tanks on all properties for non-potable water uses within the household. Along with these rainwater tanks, a minimum energy and water efficiency is proposed for development to decrease water consumption with households.

Decreasing water consumption will help to decrease the sewerage generated in the new developments. It is noted that the Tatura Wastewater Treatment Plant currently treats the sewerage for irrigation purposes only. This is recommended to continue for the sewerage generated from the development area too.

Following the development of this report, the next steps are:

- To formalise a Structure Plan for the Tatura Growth area.
- Council to decide on the preferred IWM options for Tatura.
- Further investigations to be undertaken to refine the stormwater and IWM Infrastrcuture within the Tatura growth area based on the structure plan.
- Council to develop polices to ensure that new developments incorporate new WSUD and IWM asseets into their develoments.

Summary and Next Steps



ecology & heritage partners

Final Report

Ecological Investigations for the Proposed Tatura Structure Plan, Tatura, Victoria

Prepared for

Greater Shepparton City Council

March 2021

Ecology and Heritage Partners Pty Ltd

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Report reviewer	Aaron Organ (Director/Principal Ecologist)
Other EHP staff	Jack Pascoe (Consultant Botanist), Linda Parker (Consultant Ecologist)
Mapping	Petra Sorensen (GIS Coordinator)
File name	14382_EHP_TaturaSP_EA_Final_22032021
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Bioregion	Victorian Riverina
Catchment Management Authority	Goulburn Broken
Council	Greater Shepparton City Council

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Report versions	Comments	Comments made by:	Date submitted
Draft	Report sent to the client for review	JM	05/02/2021
Final	Response to client comments.	LP, JM	22/03/2021

CONTENTS

1 INTRODUCTION

1.1 Background

Ecology and Heritage Partners Pty Ltd was commissioned by Greater Shepparton City Council to undertake ecological investigations for the proposed Tatura Structure Plan, Tatura, Victoria.

We understand that Greater Shepparton City Council has identified the precinct as a future residential growth area with the potential to support urban expansion in this area. The structure plan will guide the future development of all land yet-to-be-rezoned for residential purposes, including the extent of infrastructure required to support this growth.

The purpose of this assessment was to identify the extent and type of native vegetation present within the study area to help inform the future residential re-zonings in the north, north-east and east of Tatura. This report presents the results of the assessment and discusses the potential ecological and legislative implications associated with the proposed action.

1.2 Study Area

The study area is located immediately north and east of the Tatura township, approximately 155 kilometres north of Melbourne's CBD (Figure 1) and covers approximately 785 hectares.

The study area is currently used for agricultural purposes. It is generally flat, with no ridges, crests or waterways within or immediately adjacent to the site. However, there are several irrigation channels currently in use within the study area east of Tatura.

According to the Department of Environment, Land, Water and Planning (DELWP) NatureKit Map (DELWP 2021a), the study area is located within the Victorian Riverina bioregion, Goulburn Broken Catchment Management Authority (CMA) and Greater Shepparton City Council.

2 METHODS

2.1 Desktop Assessment

Relevant literature, online-resources and databases were reviewed to provide an assessment of flora and fauna values associated with the study area. The following information sources were reviewed:

- The DELWP NatureKit Map (DELWP 2021a) and Native Vegetation Information Management (NVIM) Tool (DELWP 2021b) for:
    - Modelled data for location risk, native vegetation patches, scattered trees and habitat for rare or threatened species; and,
    - The extent of historic and current Ecological Vegetation Classes (EVCs).
- EVC benchmarks (DELWP 2021c) for descriptions of EVCs within the relevant bioregion;
- The Victorian Biodiversity Atlas (VBA) for previously documented flora and fauna records within the project locality (DELWP 2020);
- The Illustrated Flora Information System of Victoria (IFLISV) (Gullan 2017) and Atlas of Living Australia (ALA) (ALA 2021) for assistance with the distribution and identification of flora species;
- Birdlife Australia (2021) for detailed descriptions and distributions of birds (both native and exotic);
- The Commonwealth Department of Agriculture, Water and the Environment (DAWE) Protected Matters Search Tool (PMST) for matters of National Environmental Significance (NES) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DAWE 2021);
- Relevant listings under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act), including the latest Threatened (DELWP 2019a) and Protected (DELWP 2019b) lists;
- The online VicPlan Map (DELWP 2021d) to ascertain current zoning and environmental overlays in the study area; and
- Aerial photography of the study area.

2.2 Field Assessment

A field assessment was undertaken between 16 and 17 December 2020 to obtain information on flora and fauna values within the study area. The field surveys focussed on areas potentially supporting ecological values, with small residential lots and developed and/or cropped land excluded from the assessment. Select properties were walked and driven, with commonly observed vascular flora and fauna species recorded, and significant records mapped, and the overall condition of vegetation and habitats noted. Ecological Vegetation Classes (EVCs) were determined with reference to DELWP pre-1750 and extant EVC mapping (DELWP 2021a) and their published descriptions (DELWP 2021c).

2.2.1 *Vegetation Assessment*

Native vegetation (as defined in Table 1) is assessed using two key parameters: extent (in hectares) and condition. For the purposes of this assessment, both condition and extent were determined as part of the habitat hectare assessment.

Table 1. Determination of a patch of native vegetation (DELWP 2017).

Category	Definition	Extent	Condition
Patch of native vegetation	An area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native; OR An area with three or more native canopy trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy; OR any mapped wetland included in the *Current Wetlands map*, available in DELWP systems and tools.	Measured in hectares. Based on hectare area of the native patch.	Vegetation Quality Assessment Manual (DSE 2004). Modelled condition for *Current Wetlands*.
Scattered tree	A native canopy tree that does not form part of a native patch.	Measured in hectares. Each Large scattered tree is assigned an extent of 0.071 hectares (15m radius). Each Small scattered tree is assigned a default extent of 0.031 hectares (10 metre radius).	Scattered trees are assigned a default condition score of 0.2 (outside a patch).

Notes: Native vegetation is defined in the Victoria Planning Provisions as 'plants that are indigenous to Victoria, including trees, shrubs, herbs and grasses'.

2.3 Assessment Qualifications and Limitations

This report has been written based on the quality and extent of the ecological values and habitat considered to be present or absent at the time of the desktop and/or field assessments being undertaken.

Not all properties within the study area were assessed. Properties identified during the desktop assessment as having potential to hold ecological values were prioritised, with ecological values within sites not accessed mapped from adjacent properties or the road reserve.

The 'snapshot' nature of a rapid ecological assessment, meant that migratory, transitory or uncommon fauna species may have been absent from typically occupied habitats at the time of the field assessment. In addition, annual or cryptic flora species such as those that persist via underground tubers may also be absent.

A comprehensive list of all terrestrial flora and fauna present within the study area was not undertaken as this was not the objective of the assessment. Rather a list of commonly observed species was recorded to assist in determining the broader biodiversity values present within the study area.

Ecological values identified within the study area were recorded using a hand-held GPS or tablet with an accuracy of +/-5 metres. This level of accuracy is considered to provide an accurate assessment of the

ecological values present within the study area; however, this data should not be used for detailed surveying purposes.

The terrestrial flora and fauna data collected during the field assessment and information obtained from relevant desktop sources is considered to adequately inform the assessment of the broad ecological values present within the study area.

3 EXISTING ENVIRONMENT

3.1 Vegetation Condition

The study area is representative of many areas within the Victorian Riverina, with large areas of improved pastures and derived native grasslands, scattered patches of remnant vegetation and regrowth from past clearing. The majority (>90%) of the study area was highly modified due to historic and current agricultural practices.

Given that much of the indigenous shrub and tree layer has been cleared throughout the study area, and there are extensive areas of planted indigenous and non-indigenous trees, it is difficult to determine whether patches of indigenous understorey species are representative of Plains Woodland or another similar EVC. In most cases, the decision for classifying patches was guided by the modelled pre-1750s native vegetation mapping (DELWP 2020c), with native flora in the study area best represented by one EVC: Plains Woodland (EVC 803).

Native vegetation mapping completed as part of this identified 60.05 hectares of native vegetation representative of Plains Woodland (Figure 2), including:

- 41.60 hectares of 'treed' Plains Woodland;
- 10.79 hectares of 'treeless' Plains Woodland (derived native grassland);
- 7.66 hectares of revegetation that is representative of Plains Woodland; and
- 151 Scattered Trees.

The remaining assessed portions of the study area were identified as being either developed or supporting non-remnant vegetation (i.e. planted indigenous and non-indigenous species, grassland/ pasture dominated by introduced species or crops).

Specific details relating to the observed EVCs and other vegetation/ habitat types are provided below.

3.1.1 Patches of Native Vegetation

Native vegetation in the study area is representative of Plains Woodland (EVC 803). The presence of this EVC is generally consistent with the modelled pre-1750s native vegetation mapping (DELWP 2021c). Specific details relating to the observed EVC are provided below.

Plains Woodland

Plains Woodland is characterised as a eucalypt woodland to 15 metres tall, with an understorey of comprised of a diversity of grassy and herbaceous flora species. Plains Woodland occurs on a range of geologies, occupying fertile clays and clay loam soils on flat or gently undulating plains at low elevations in areas with an average annual rainfall of less than 600 millimetres.

Plains Woodland patches within the study area generally consisted of small, isolated patches and isolated strips within the road reserve, predominately present as canopy trees over an exotic understorey dominated by pasture grasses (Plate 1 and Plate 2). Several patches of revegetation were also identified as being broadly consistent with the Plains Woodland EVC (Plate 3).

One large patch of remnant Plains Grassland recorded in the north-east of the study area, immediately south of the Midland Highway, consisted of a predominantly native understorey dominated by Wallaby Grasses *Rytidosperma* spp., with a canopy of large eucalypts, dominated by Grey Box *Eucalyptus macrocarpa* (Plate 4).

Plate 1. Treeless Plains Woodland (derived native grassland) under planted vegetation within the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

Plate 2. A patch of Plains Woodland along the road reserve within the study area (Ecology and Heritage Partners Pty Ltd 17/12/2020).

Plate 3. A patch of revegetation consistent with Plains Woodland EVC within the study area. (Ecology and Heritage Partners Pty Ltd 17/12/2020).

Plate 4. A patch of high-quality Plains Woodland in the north-east of the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

3.1.2 Scattered Trees

A total of 151 scattered trees (River Red-gum, Grey Box and Yellow Box) were recorded within the study area, which consisted of 141 large and 10 small scattered trees (Figure 2; Appendix 1.3). These trees would have once formed part of the Plains Woodland EVC; however, the understorey vegetation contained predominantly introduced species (mainly exotic pasture grasses) and the trees no longer formed a patch of native vegetation (Plate 5 and 6).

Plate 5. Scattered trees within the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

Plate 6. A large Grey Box within the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

3.1.3 Introduced and Planted Vegetation

Areas not supporting native vegetation had a high cover (>90%) of exotic grass species, many of which were direct-seeded for use as pasture. Scattered native grasses were generally present in these areas, however they did not have the required 25% relative cover to be considered a patch. Native and introduced trees and shrubs were also planted for ornamental purposes within the study area, primarily around existing dwellings and sheds and in windrows (Plate 7).

Non-native areas were dominated by pasture grasses and environmental weeds such as Toowoomba Canary-grass *Phalaris aquatica*, Barley *Hordeum* spp., Rye-grass *Lolium* spp., Couch *Cynodon dactylon* var. *dactylon* and Wild Oat *Avena fatua* (Plate 8 and Plate 9).

Noxious weeds, as defined under the CaLP Act, were present within the study area, with Chilean Needle-grass *Nassella neesiana*, Bathurst Burr *Xanthium spinosum* and African Boxthorn *Lycium ferocissimum* observed throughout the study area (Plate 10). Chilean Needle-grass and African Boxthorn are also Weeds of National Significance (WoNS).

Plate 7. A row of planted trees within the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

Plate 8. Cereal crop stubble within the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

Plate 9. Exotic pasture grasses dominate most of the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

Plate 10. Chilean Needle-grass within the study area (Ecology and Heritage Partners Pty Ltd 16/12/2020).

3.2 Fauna Habitat

Plains Woodland derived grasslands within the study area provides potential habitat for a diversity of fauna species. This habitat type is likely to support a range of native and introduced birds (including a diversity of raptors), mammals (e.g. Eastern Grey Kangaroo *Macropus giganteus* and Red Fox *Vulpes Vulpes*), reptiles (e.g. Eastern Brown Snake *Pseudonaja textilis*) and frogs (e.g. Spotted Marsh Frog *Limnodynastes tasmaniensis*).

Plains Woodland, including revegetated areas, within the study area provides suitable habitat for a variety of fauna guilds including arboreal mammals, microbats, birds and reptiles. During the current survey, a variety of birds were observed foraging amongst trees and shrubs in these areas. Hollows and fissures within mature eucalypts and stags (dead trees) provide roosting, nesting and sheltering habitat for hollow-dependent birds and mammals. Microbats are also likely to roost within hollows in these areas and forage within, over and around canopy vegetation. While the ground layer and mid-storey within this vegetation is relatively open, several patches support a low-moderate cover of woody ground debris, likely to be inhabited and used by a range of reptile species.

The large areas of exotic grassland within the study are likely to be utilised by common mammal and bird species. Several bird species common to modified, grassy or open habitats were recorded during the current assessment. Diurnal and nocturnal raptors are likely to forage over these areas.

Irrigation channels and farm dams (when inundated) within the study area are likely to support a range of common fauna species. The modified (irrigation channel) and ephemeral (farm dams) nature of the waterbodies, and the site's proximity to areas of high-quality habitat provided by the extensive Goulburn River system to the east, minimises the likelihood of migratory/ threatened waterbird species making significant use of these resources.

3.3 Significance Assessment

3.3.1 Flora

The VBA contains records of 13 State significant flora species previously recorded within 10 kilometres of the study area (DELWP 2020) (Figure 3). The PMST nominated an additional seven nationally significant species which have not been previously recorded but have the potential to occur in the locality (DAWE 2021) (Figure 3; Appendix 1.3).

Of these species, there is suitable habitat within the study area for Buloke *Allocasuarina luehmannii.*

3.3.2 Fauna

The VBA contains records of 10 nationally significant and 27 State significant fauna species previously recorded within 10 kilometres of the study area (DELWP 2020) (Figure 4). The PMST nominated an additional nine nationally significant species which have not been previously recorded but have the potential to occur in the locality (DAWE 2021) (Figure 4; Appendix 2.1).

Based on the modified nature of the study area, landscape context and the proximity of previous records, significant fauna species are considered unlikely to rely on habitat within the study area for foraging or breeding purposes due to the lack of suitable and/or important habitat features.

3.3.3 Ecological Communities

Five nationally listed ecological communities are predicted to occur within 10 kilometres of the study area (DAWE 2021):

- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions;
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia;
- Natural Grasslands of the Murray Valley Plains;
- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains; and
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland;

Plains Woodland vegetation in the north-east of the study area was consistent with the description of the nationally significant (EPBC Act-listed) Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia ecological community.

One FFG Act-listed ecological community is present in the study area, being Grey Box - Buloke Grassy Woodland Community. This community corresponds to areas of Plains Woodland EVC mapped in the study area and meet the relevant description and characteristics described for this community (DELWP 2019c). Plains Woodland vegetation in the north-east of the study area contained potential habitat for woodland birds associated with the FFG Act-listed Victorian Temperate Woodland Bird Community.

4 SUMMARY OF ECOLOGICAL VALUES

The desktop review and field survey identified the following key ecological values within the study area:

- Remnant patches of native vegetation and native scattered trees:
    - 41.60 hectares of 'treed' Plains Woodland;
    - 10.79 hectares of 'treeless' Plains Woodland (derived native grassland);
    - 7.66 hectares of revegetation that is representative of Plains Woodland; and
    - 151 Scattered Trees.
- 34.59 hectares of 'high' ecological value Plains Woodland in the north-east of the study area consistent with the description of the nationally significant Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia ecological community.
- 34.59 hectares of 'high' ecological value Plains Woodland in the north-east of the study area providing potential habitat for woodland birds associated State-significant Victorian Temperate Woodland Bird Community.
- 41.60 hectares of the State-significant Grey Box - Buloke Grassy Woodland Community.
- Potential habitat for flora species of State (Buloke and Buloke Mistletoe) conservation significance.

5 IMPLICATIONS FOR FUTURE DEVELOPMENT

Further requirements associated with development of the study area, as well as additional studies or reporting that may be required, are provided in Table 2.

Table 2. Further requirements associated with development of the study area.

Relevant Legislation	Implications
Environment Protection and Biodiversity Conservation Act 1999	The EPBC Act establishes a Commonwealth process for the assessment of proposed actions likely to have a significant impact on matters of NES, or those that are undertaken on Commonwealth Land. An action, unless otherwise exempt, requires approval from the Commonwealth Minister for the Environment if it is likely to have an impact on any of the following matters of NES: World Heritage properties, National Heritage places, Ramsar wetlands of international significance, nationally listed threatened species and ecological communities, Migratory species protected under international agreements, Commonwealth marine areas, the Great Barrier Reef Marine Park, nuclear actions and water resources (for coal seam gas and large coal mining projects). Key ecological constraints associated with the EPBC Act relate to the known or potential presence of threatened species of flora and fauna and ecological communities (Section 4). Any action that is likely to significantly impact upon these values or any other matter of NES would need to be referred to DAWE for assessment and approval. Referrals are assessed over a period of 20 working days, including a ten-day public comment period. A referred action will subsequently be classed as one of the following: • *Not a controlled action* – approval is not required if the action is undertaken in accordance with the referral. • *Not a controlled Action 'particular manner'* – approval is not required if the action is undertaken in accordance with the manner specified. • *Controlled action* – the action is subject to the assessment and approval process under the EPBC Act. Should matters of NES be identified within the study area following a detailed ecological assessment (eg. Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia ecological community), a referral to the Commonwealth via an EPBC Act referral may be required. The Minister will decide whether the proposed action is a 'controlled action' and, if so, will require further assessment to determine whether approval will be granted under the EPBC Act. However, if the impact area avoids all known matters of NES, then it is considered unlikely that the proposed development will be a 'controlled action'.

Relevant Legislation	Implications
Environment Effects Act 1978	The *Environment Effects Act 1978* (EE Act) provides for an assessment of proposed activities that are capable of having a significant impact on the environment at a State level. The Act allows the Victorian Minister for planning to decide whether an Environment Effects Statement (EES) is required to be completed. The "*Ministerial Guidelines for Assessment of Environmental Effects under the Environment Effects Act 1978*" provides triggers for which an EES is required, such as the removal of 10 or more hectares of native vegetation or potential impacts on remaining habitat or populations of threatened species. Any action that is likely to have a significant impact on State matters, as defined under the relevant guidelines, would need to be referred under the EE Act. Actions undertaken in accordance with a prescribed Precinct Structure Plan (PSP) are exempt from the requirements of the EE Act.
Flora and Fauna Guarantee Act 1988	The FFG Act is the primary legislation dealing with biodiversity conservation and the sustainable use of native flora and fauna in Victoria. The provisions of the FFG Act bind all public agencies, public landowners and land managers. The Act contains lists of threatened flora and fauna species, 'protected flora species' and threatened vegetation communities, as well as action statements to protect the long-term viability of these values. The Act applies to the removal of listed threatened species and communities, as well as protected flora species. Protected flora species include any of the Asteraceae (Daisies) family, all orchids, ferns (excluding *Pteridium esculentum*) and Acacia species (excluding *Acacia dealbata, Acacia decurrens, Acacia implexa, Acacia melanoxylon* and *Acacia paradoxa*); in addition to any taxa that forms a component of a listed FFG Act vegetation community. A species may be both listed and protected. Proponents are required to apply for an FFG Act permit to 'take' listed and/or protected flora species and listed vegetation communities in areas of public land (i.e. within road reserves). An FFG Act permit is generally not required for removal of listed and/or protected flora species and communities on private land. There are currently no requirements for proponents to apply for a permit under the FFG Act where a proposed activity requires the removal of habitat for a listed terrestrial fauna species. The Act does however regulate the removal, salvage, temporary holding, translocation, taking, trading and keeping of FFG Act-listed fish species, and as such, an FFG Act permit is required if listed fish species are likely to be affected by a proposed activity. Key ecological constraints within the study area associated with the FFG Act are likely to include threatened ecological communities (e.g. Grey Box - Buloke Grassy Woodland Community and Victorian Temperate Woodland Bird community) and species of flora and fauna. The majority of land within the study area is privately owned and therefore exempt from most provisions under the FFG Act including the requirement to obtain a permit for the removal or disturbance of listed/ protected plants, ecological communities and fish species. Any such action on public land affecting these values would require a permit from DELWP.

Relevant Legislation	Implications
Planning and Environment Act 1987	The *Planning and Environment Act 1987* outlines the legislative framework for planning in Victoria and for the development and administration of planning schemes. All planning schemes contain native vegetation provisions at Clause 52.17 which require a planning permit from the relevant local Council to remove, destroy or lop native vegetation on a site of more than 0.4 hectares, unless an exemption clause under 52.17-6 of the Victorian Planning Schemes applies, or if the proposed clearing is in accordance with a Native Vegetation Precinct Plan (NVPP) (Clause 52.16) that has been incorporated into the Planning Scheme. Permitting requirements associated with the removal of native vegetation will be dependent on the future planning process.
Guidelines for the removal, destruction or lopping of native vegetation (the Guidelines)	The assessment process for the clearing of vegetation follows the '*Guidelines for the removal, destruction or lopping of native vegetation*' (the Guidelines) (DELWP 2017). The '*Assessor's handbook: Applications to remove, destroy or lop native vegetation*' (Assessor's handbook) (DELWP 2018) provides clarification regarding the application of the Guidelines (DELWP 2017). Any permitted clearing of native vegetation within the study area would be offset in accordance with the Guidelines.
Catchment and Land Protection Act 1994	The *Catchment and Land Protection Act 1994* (CaLP Act) contains provisions relating to catchment planning, land management, noxious weeds and pest animals. The Act also provides a legislative framework for the management of private and public land and sets out the responsibilities of land managers, stating that they must take all reasonable steps to: • Avoid causing or contributing to land degradation which causes or may cause damage to land of another land owner; • Protect water resources; • Conserve soil; • Eradicate regionally prohibited weeds; • Prevent the growth and spread of regionally controlled weeds; and, • Prevent the spread of, and as far as possible eradicate, established pest animals. A number of weeds listed as noxious under the CaLP Act are known occur throughout the study area (Section 3). Similarly, it is likely that the region is occupied by several pest fauna species listed under the Act. Landowners are responsible for the control of any infestation of noxious weeds and pest fauna species. To meet CaLP Act requirements listed noxious weeds and pests should be appropriately controlled during any development activity to minimise their spread and impact on ecological values within the study area.
Wildlife Act 1975 and Wildlife Regulations 2013	The *Wildlife Act 1975* (and associated Wildlife Regulations 2013) is the primary legislation in Victoria providing for protection and management of wildlife. Authorisation for habitat removal may be obtained under the *Wildlife Act 1975* through a licence granted under the *Forests Act 1958*, or under any other Act such as the *Planning and Environment Act 1987*. Any persons engaged to remove, salvage, hold or relocate native fauna during construction must hold a current Management Authorisation under the *Wildlife Act 1975*, issued by DELWP.

Relevant Legislation	Implications
Water Act 1989	A 'works on waterways' permit is likely to be required from the Goulburn Broken CMA where any action impacts on waterways within the study area.

6 CONCLUSION

The Tatura Structure Plan area ('study area') has been identified as a significant growth area with the potential to support population growth. The structure plan will guide the future development of all land yet-to-be-rezoned for residential purposes and it will identify all infrastructure required to support the future development of the land.

The purpose of this Ecological Assessment report was to provide a high-level assessment of the ecological values within the study area to inform the early stage of the precinct planning process. Therefore, it is recommended that detailed ecological assessments be undertaken prior to the commencement of any development within the study area.

Desktop-based assessments and field surveys were undertaken to broadly assess the biodiversity value of the study area and inform early stage of the precinct planning process. The findings of the assessment confirmed that the majority (>90%) of the study area supports non-native vegetation and is highly disturbed. Despite its modified nature, the study area supports a diversity of natural assets (Section 3), which are subject to the natural and anthropogenic pressures commonly associated with developed and fringing landscapes. Given the potential for future development within the study area to intensify existing pressures and threaten the overall viability of retained ecological values (particularly scattered trees), a precinct-wide approach is required to ensure all known values are accounted for and that management responses are consistent and implemented on a landscape-scale.

Based on the findings of this Ecological Assessment Report, it is considered that the study area can accommodate the medium and longer term growth of Tatura whilst maintaining and enhancing the key ecological values present.

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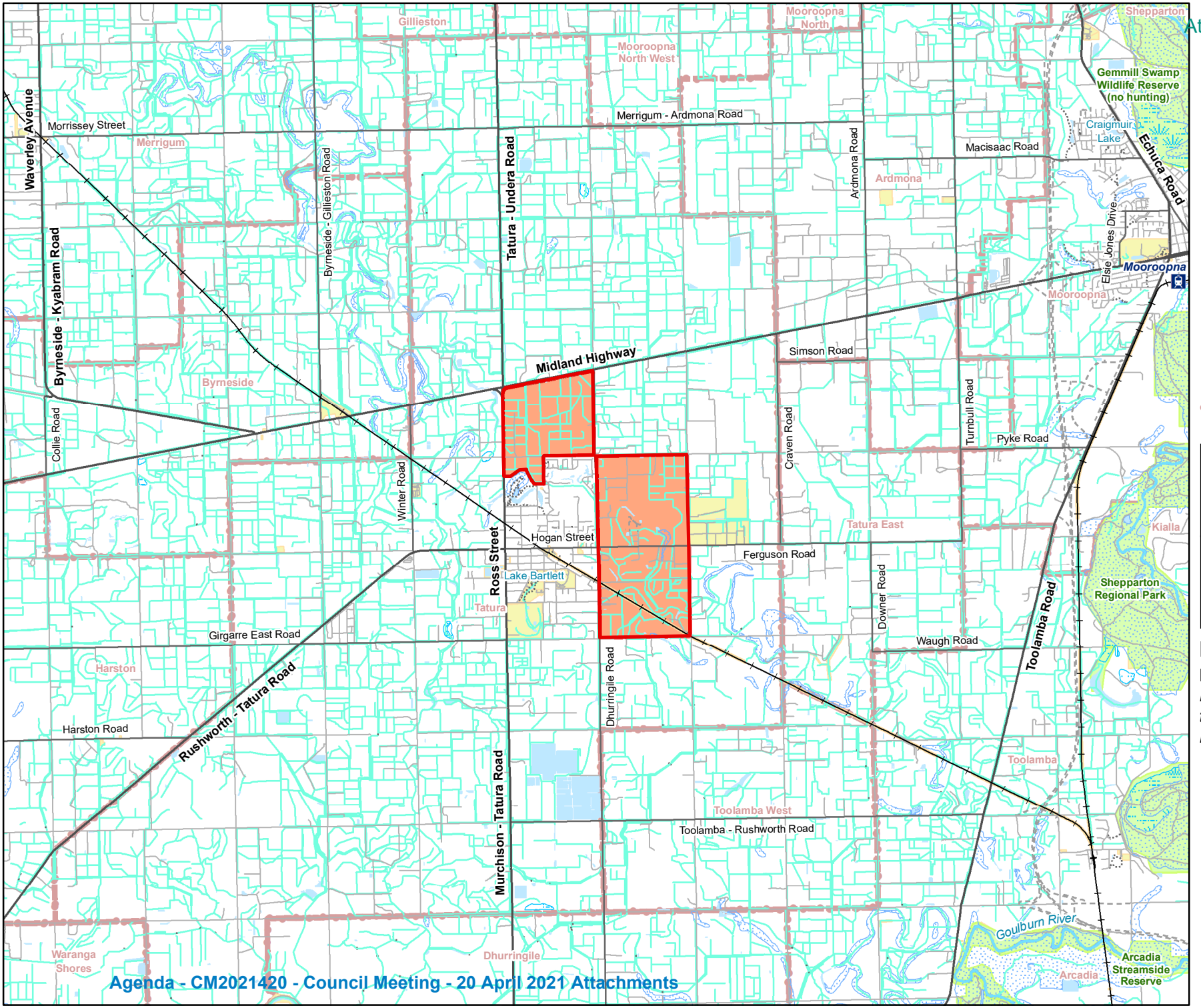


Legend

- Study Area
- Railway
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Walking Track
- Minor Watercourse
- Major Watercourse
- Permanent Waterbody
- Land Subject to Inundation
- Wetland/Swamp
- Parks and Reserves
- Crown Land
- Localities

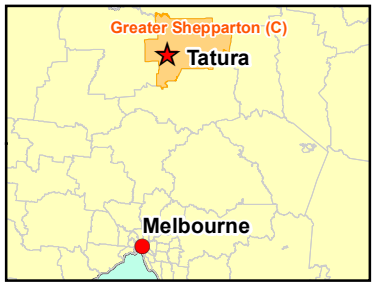


Figure 1

Location of the study area

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

0 1,000 2,000
Metres

Map Scale: 1:90,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

14382_Fig01_StudyArea_G20 15/01/2021 psorensen

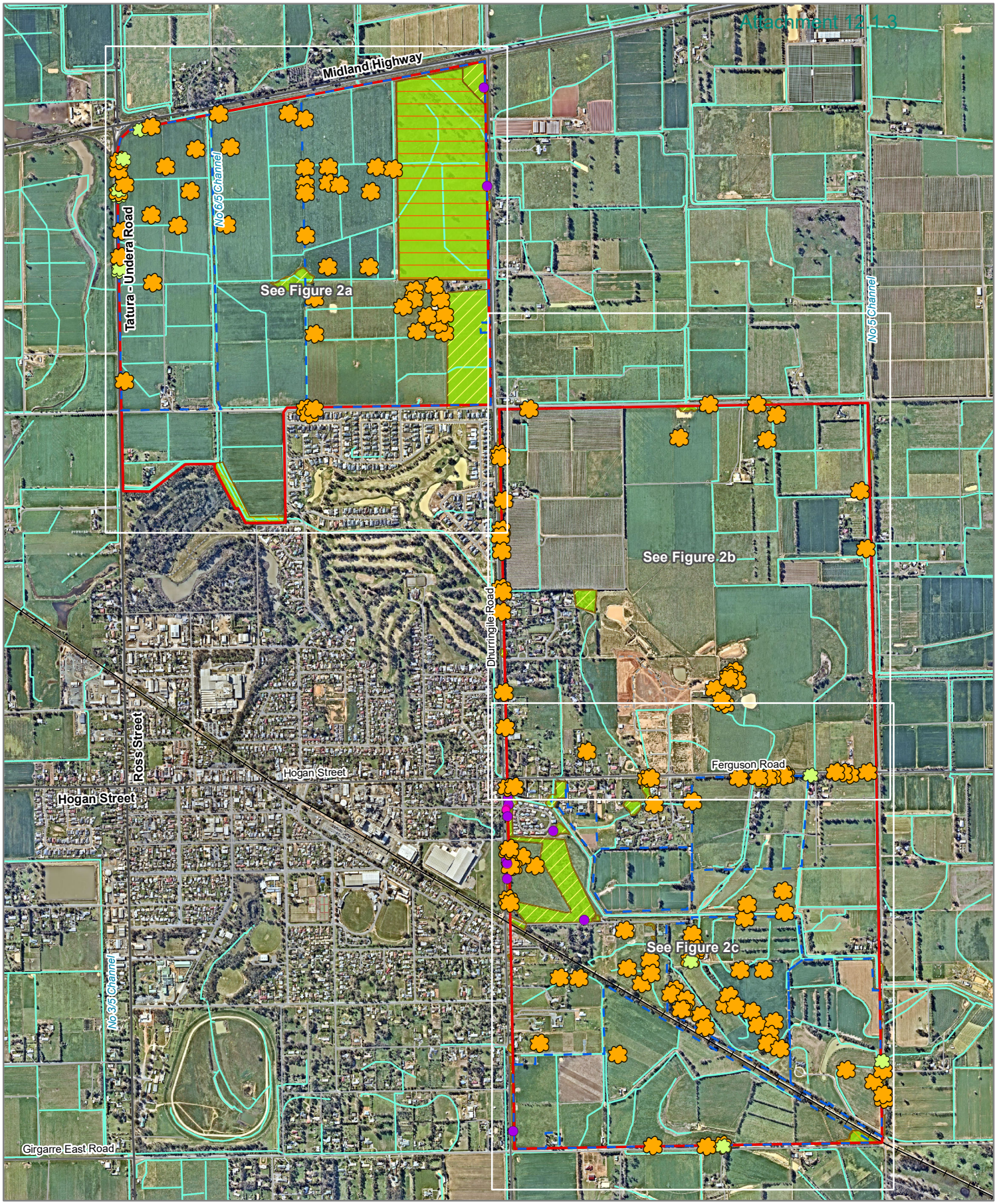


Figure 2 Overview

Ecological features

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

Legend

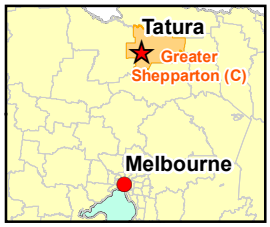
- Study Area
- Properties accessed
- Scattered Large Tree
- Scattered Small Tree
- Large Tree in patch
- Small Tree in patch

Vegetation quality

- High
- Moderate
- Low

Ecological Vegetation Class

- Plains Woodland



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Metres

Map Scale: 1:22,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

14382_Fig02_EcolFeat_PMB_G20 18/03/2021 melsley

Aerial source: Nearmap 2020

Figure 2a

Ecological features

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

Legend

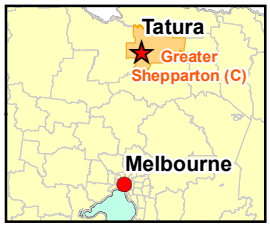
- Study Area
- Properties accessed
- Scattered Large Tree
- Scattered Small Tree
- Large Tree in patch

Vegetation quality

- High
- Moderate
- Low

Ecological Vegetation Class

- Plains Woodland



0 80 160

Metres

Map Scale: 1:9,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

14382_Fig02_EcolFeat_PMB_G20 18/03/2021 melsley

Aerial source: Nearmap 2020

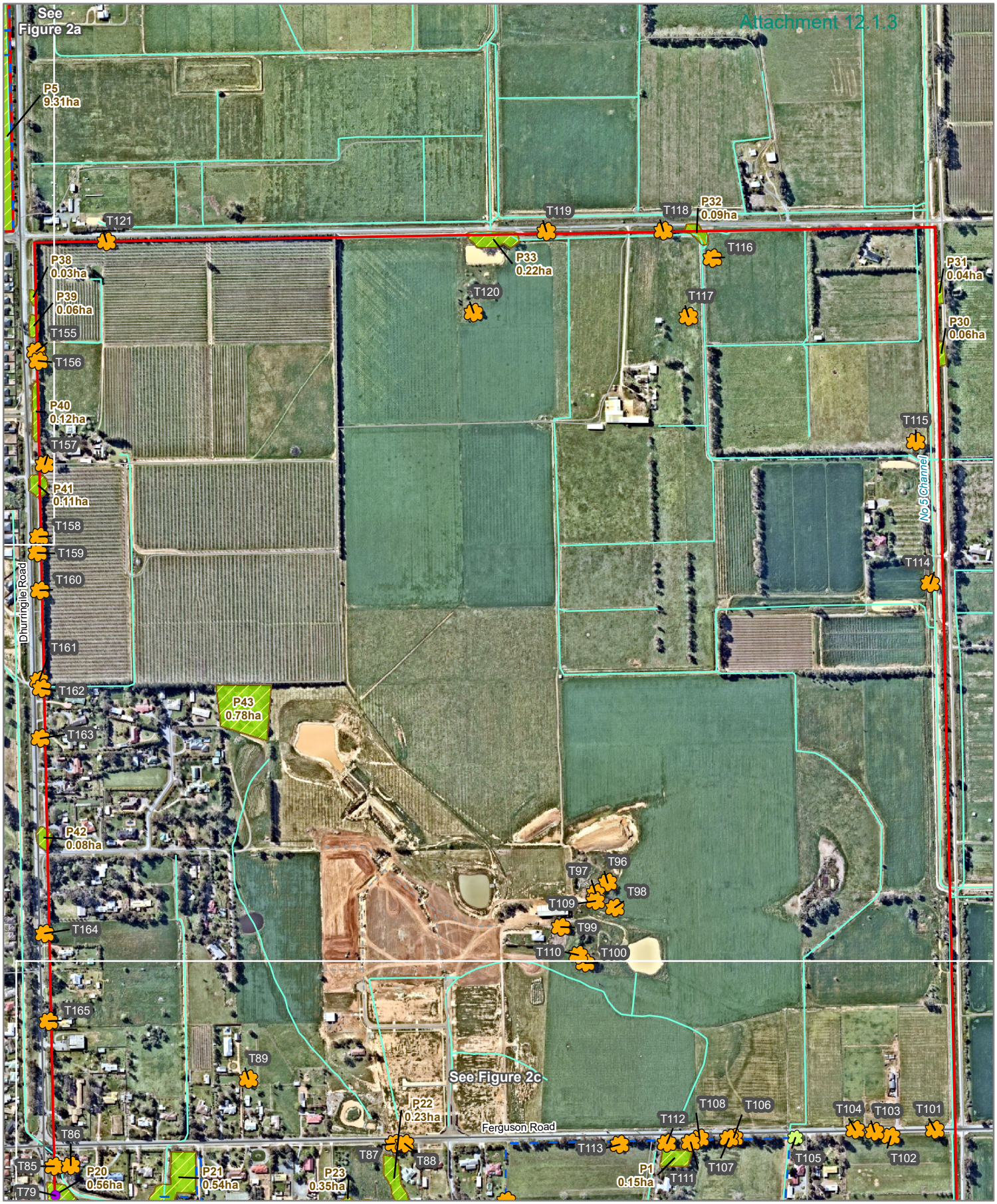


Figure 2b

Ecological features

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

Legend

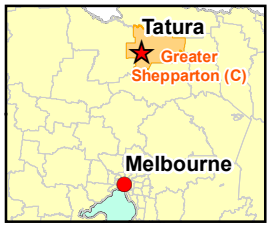
- Study Area
- Properties accessed
- Scattered Large Tree
- Scattered Small Tree
- Large Tree in patch

Vegetation quality

- Moderate
- Low

Ecological Vegetation Class

- Plains Woodland



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Map Scale: 1:9,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

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Aerial source: Nearmap 2020

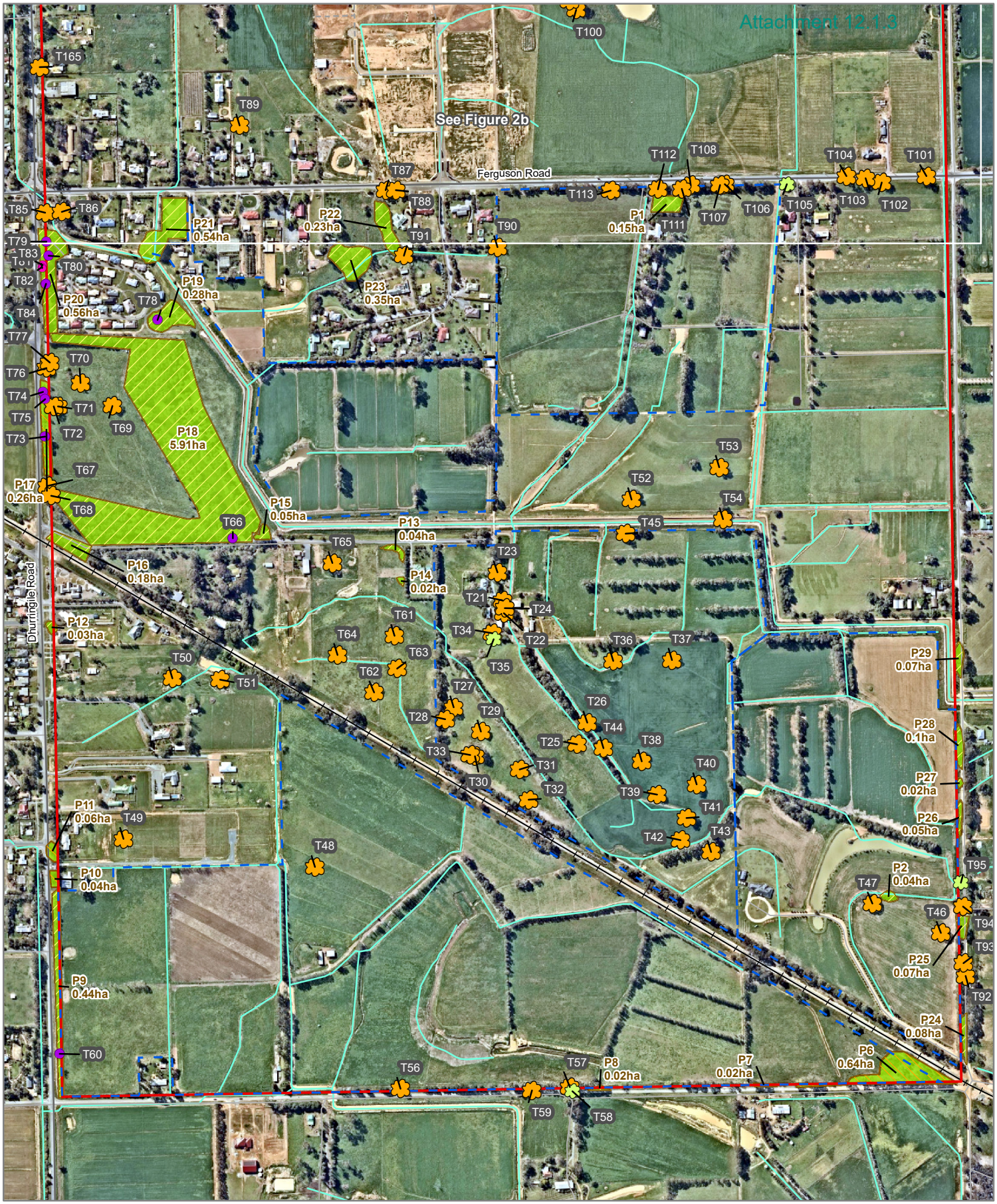


Figure 2c

Ecological features

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

Legend

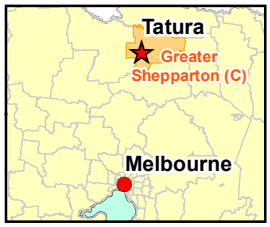
- Study Area
- Properties accessed
- Scattered Large Tree
- Scattered Small Tree
- Large Tree in patch
- Small Tree in patch

Vegetation quality

- Moderate
- Low

Ecological Vegetation Class

- Plains Woodland



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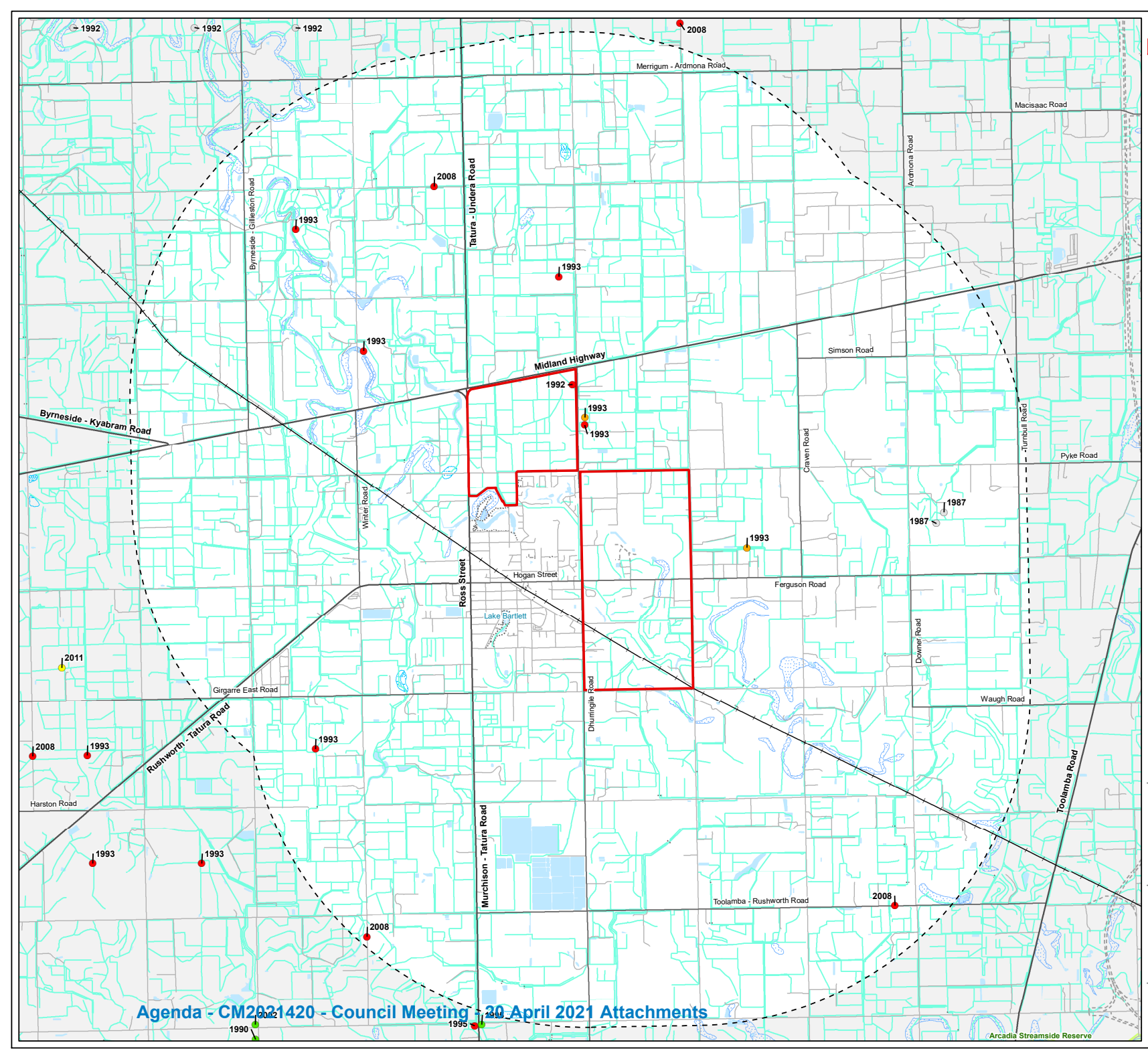


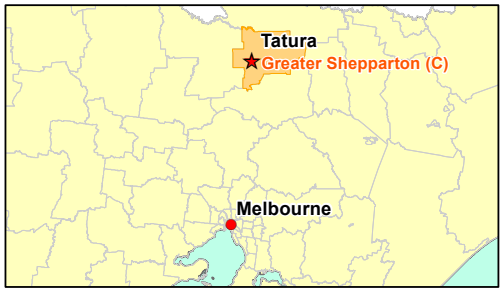


Figure 3

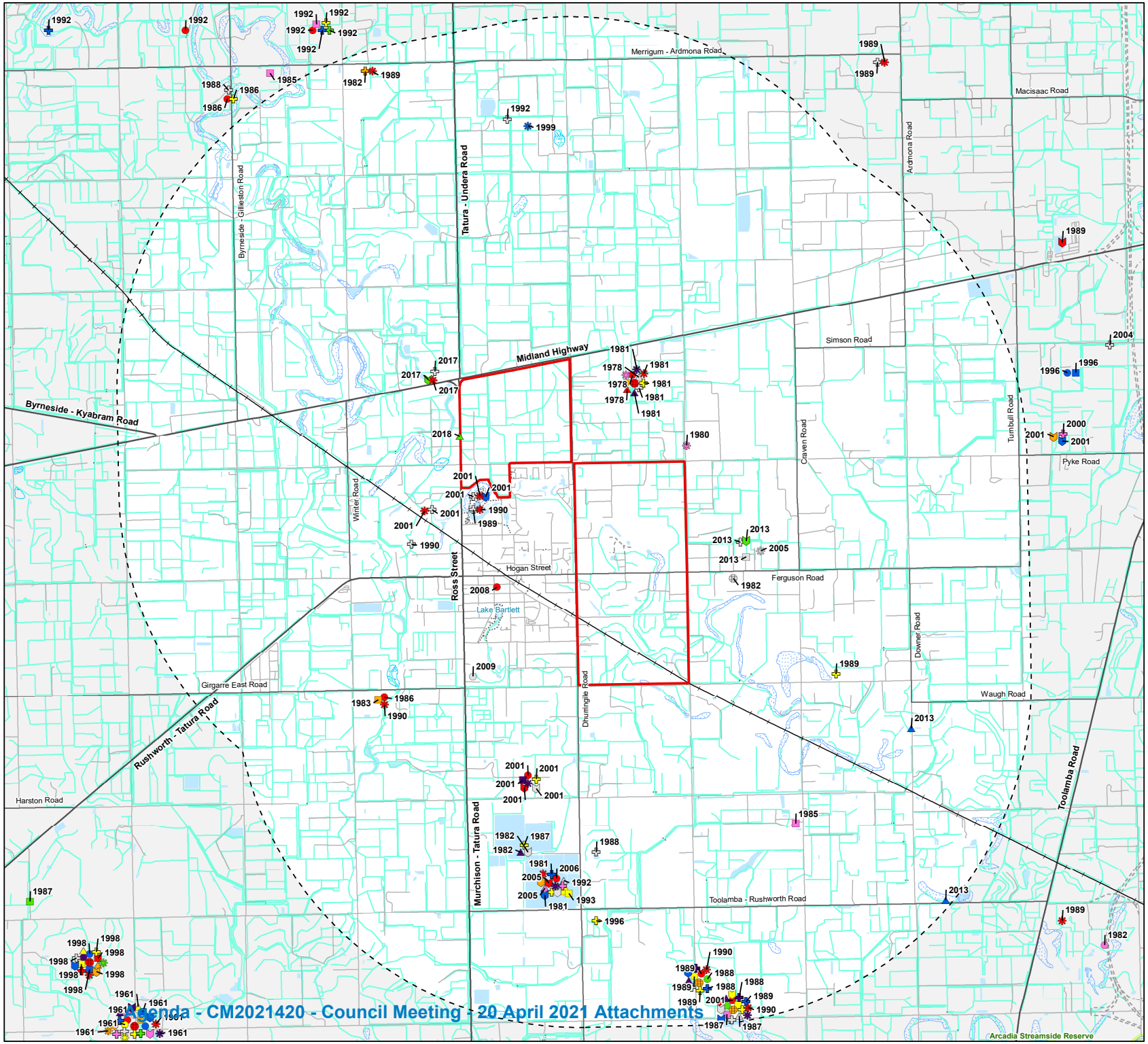
Previously documented significant flora within 5km of the study area

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

Map Scale: 1:53,000 @ A3
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

14382_Fig03_SigFlora_G20 18/01/2021 psorensen



Legend

- Study Area
- Great Egret

Significant fauna

- Australasian Bittern
- Australasian Shoveler
- Australian Gull-billed Tern
- Australian Little Bittern
- Australian Painted-snipe
- Azure Kingfisher
- Baillon's Crake
- Barking Owl
- Black Falcon
- Black-eared Cuckoo
- Black-tailed Godwit
- Blue-billed Duck
- Brolga
- Brown Treecreeper
- Bush Stone-curlew
- Caspian Tern
- Common Greenshank
- Curlew Sandpiper
- Diamond Dove
- Diamond Firetail
- Eastern Great Egret
- Eastern Snake-necked Turtle
- Freckled Duck
- Glossy Ibis
- Grey-crowned Babbler
- Growling Grass Frog
- Hardhead
- Hooded Robin
- Latham's Snipe
- Little Egret
- Long-toed Stint
- Marsh Sandpiper
- Musk Duck
- Nankeen Night Heron
- Pacific Golden Plover
- Pied Cormorant
- Plumed Egret
- Red-backed Kingfisher
- Regent Honeyeater
- Regent Parrot
- Royal Spoonbill
- Speckled Warbler
- Spotted Harrier
- Spotted Quail-thrush
- Square-tailed Kite
- Turquoise Parrot
- Whiskered Tern
- White-bellied Sea-Eagle
- White-throated Needletail
- Wood Sandpiper

Figure 4

Previously documented significant fauna within 5km of the study area

Ecological Assessments for the Proposed Tatura Structure Plan, Tatura

N

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Kilometres

Map Scale: 1:53,000 @ A3
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

APPENDIX 1. - FLORA

Appendix 1.1 - Flora Results

Legend:

L Listed as threatened under the FFG Act (DELWP 2019a);
I Protected under the FFG Act (DELWP 2019b);
e Listed as endangered in Victoria under the Advisory List of Rare or Threatened Plants in Victoria (DEPI 2014);
***** Listed as a noxious weed under the CaLP Act;
w Weed of National Significance;
****** Planted indigenous species in the study area;
+ Planted indigenous species that also occur in native vegetation in the study area;
# Planted Victorian and non-Victorian species.

Table A1.1. Flora within the study area.

Scientific Name	Common Name	Notes
INDIGENOUS SPECIES		
Austrostipa spp.	Spear Grass	-
Bursaria spinosa	Sweet Bursaria	**
Chrysocephalum apiculatum s.l.	Common Everlasting	**
Clematis microphylla s.l.	Small-leaved Clematis	**
Dianella revoluta s.l.	Black-anther Flax-lily	+
Dodonaea viscosa	Sticky Hop-bush	**
Eucalyptus camaldulensis	River Red-gum	+
Eucalyptus leucoxylon	Yellow Gum	-
Eucalyptus melliodora	Yellow Box	-
Eucalyptus microcarpa	Grey Box	-
Rytidosperma spp.	Wallaby Grass	-
Xerochrysum viscosum	Shiny Everlasting	I **
NON-INDIGENOUS OR INTRODUCED SPECIES		
Acacia pendula	Weeping Myall	# L e
Avena barbata	Bearded Oat	-
Avena fatua	Wild Oat	-
Avena spp.	Oat	-
Cenchrus clandestinus	Kikuyu	-
Cichorium intybus	Chicory	-
Dactylis glomerata	Cocksfoot	-

Scientific Name	Common Name	Notes
Fraxinus spp.	Ash	#
Hordeum (monospecific)	Barley	-
Lactuca serriola	Prickly Lettuce	-
Lolium spp.	Rye Grass	-
Lycium ferocissimum	African Box-thorn	W *
Melia azedarach	White Cedar	#
Nassella neesiana	Chilean Needle-grass	W *
Opuntia spp.	Prickly pear	-
Phalaris aquatica	Toowoomba Canary-grass	-
Plantago lanceolata	Ribwort	-
Polygonum arenastrum	Wireweed	-
Schinus molle	Pepper Tree	#
Xanthium spinosum	Bathurst Burr	*

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Appendix 1.2. - Tree Data

Table A1.2. Trees recorded within the study area.

Tree ID	Species	Common Name	Size Class	Scattered/Patch	Notes
1	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
2	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
3	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
4	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
5	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
6	*Eucalyptus* sp.	Stag	Large	Scattered	-
7	*Eucalyptus* sp.	Stag	Small	Scattered	-
8	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
9	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
10	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	Hollows
11	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
12	*Eucalyptus melliodora*	Yellow Box	Small	Scattered	-
13	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
14	*Eucalyptus* sp.	Stag	Large	Scattered	Hollows
15	*Eucalyptus* sp.	Stag	Large	Scattered	-
16	*Eucalyptus* sp.	Stag	Large	Scattered	-
17	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
18	*Eucalyptus* sp.	Stag	Large	Scattered	-
19	*Eucalyptus* sp.	Stag	Large	Scattered	-
20	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
21	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
22	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
23	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
24	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
25	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
26	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
27	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
28	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
29	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
30	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
31	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
32	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
33	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-

Tree ID	Species	Common Name	Size Class	Scattered/Patch	Notes
34	*Eucalyptus* sp.	Stag	Large	Scattered	-
35	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
36	*Eucalyptus melliodora*	Yellow Box	Large	Scattered	Hollows
37	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	Hollows
38	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
39	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
40	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
41	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
42	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
43	*Eucalyptus* sp.	Stag	Large	Scattered	Hollows
44	*Eucalyptus* sp.	Stag	Large	Scattered	-
45	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
46	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
47	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
48	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
49	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
50	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
51	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
52	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
53	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
54	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
55	*Eucalyptus microcarpa*	Grey Box	Large	Patch	-
56	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
57	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
58	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
59	*Eucalyptus* sp.	Stag	Large	Scattered	-
60	*Eucalyptus microcarpa*	Grey Box	Large	Patch	-
61	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
62	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
63	*Eucalyptus* sp.	Stag	Large	Scattered	-
64	*Eucalyptus* sp.	Stag	Large	Scattered	-
65	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
66	*Eucalyptus* sp.	Stag	Large	Patch	Hollows
67	*Eucalyptus* sp.	Stag	Large	Scattered	Hollows/bees
68	*Eucalyptus* sp.	Stag	Large	Scattered	Hollows
69	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
70	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-

Tree ID	Species	Common Name	Size Class	Scattered/Patch	Notes
71	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
72	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
73	*Eucalyptus microcarpa*	Grey Box	Large	Patch	-
74	*Eucalyptus microcarpa*	Grey Box	Large	Patch	-
75	*Eucalyptus microcarpa*	Grey Box	Large	Patch	-
76	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
77	*Eucalyptus* sp.	Stag	Large	Scattered	Hollows/bees
78	*Eucalyptus* sp.	Stag	Large	Patch	Hollows
79	*Eucalyptus melliodora*	Yellow Box	Large	Patch	-
80	*Eucalyptus melliodora*	Yellow Box	Large	Patch	Hollow/bees
81	*Eucalyptus melliodora*	Yellow Box	Small	Patch	-
82	*Eucalyptus melliodora*	Yellow Box	Small	Patch	-
83	*Eucalyptus melliodora*	Yellow Box	Small	Patch	-
84	*Eucalyptus microcarpa*	Grey Box	Large	Patch	Hollows/bees
85	*Eucalyptus camaldulensis*	River Red-gum	Large	Scattered	-
86	*Eucalyptus* sp.	Stag	Large	Scattered	-
87	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
88	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
89	*Eucalyptus melliodora*	Yellow Box	Large	Scattered	-
90	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
91	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
92	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
93	*Eucalyptus* sp.	Stag	Large	Scattered	-
94	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
95	*Eucalyptus melliodora*	Yellow Box	Small	Scattered	-
96	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
97	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
98	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
99	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
100	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
101	*Eucalyptus melliodora*	Yellow Box	Large	Scattered	-
102	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	Hollows/bees
103	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
104	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
105	*Eucalyptus microcarpa*	Grey Box	Small	Scattered	-
106	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
107	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-

Tree ID	Species	Common Name	Size Class	Scattered/Patch	Notes
108	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
109	*Eucalyptus* sp.	Stag	Large	Scattered	-
110	*Eucalyptus* sp.	Stag	Large	Scattered	-
111	*Eucalyptus melliodora*	Yellow Box	Large	Scattered	-
112	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
113	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
114	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
115	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
116	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
117	*Eucalyptus* sp.	Stag	Large	Scattered	-
118	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
119	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
120	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
121	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
122	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
123	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
124	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
125	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
126	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
127	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
128	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
129	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
130	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
131	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
132	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
133	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
134	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
135	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
136	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
137	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
138	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
139	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
140	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
141	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
142	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
143	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
144	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-

Tree ID	Species	Common Name	Size Class	Scattered/Patch	Notes
145	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
146	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
147	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
148	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
149	*Eucalyptus* sp.	Stag	Large	Patch	-
150	*Eucalyptus* sp.	Stag	Large	Scattered	-
151	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
152	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
153	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
154	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
155	*Eucalyptus* sp.	Stag	Large	Scattered	-
156	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
157	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
158	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
159	*Eucalyptus* sp.	Stag	Large	Scattered	-
160	*Eucalyptus camaldulensis*	River Red-gum	Large	Scattered	-
161	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
162	*Eucalyptus microcarpa*	Grey Box	Large	Scattered	-
163	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
164	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-
165	*Eucalyptus* sp.	Eucalypt	Large	Scattered	-

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Appendix 1.3. - Patch Data

Table A1.3. Patches of native vegetation recorded within the study area.

Unique ID	Patch ID	EVC	Quality of Patch	Patch size (ha)
P1	PW2	Plains Woodland	Low	0.155
P2	PW1	Plains Woodland	Low	0.044
P3	PW1	Plains Woodland	High	34.587
P4	PW2	Plains Woodland	Low	1.271
P5	PW2	Plains Woodland	Low	9.306
P6	PW1	Plains Woodland	Moderate	0.641
P7	PW1	Plains Woodland	Moderate	0.020
P8	PW1	Plains Woodland	Low	0.021
P9	Reveg	Plains Woodland	Low	0.436
P10	PW1	Plains Woodland	Moderate	0.043
P11	PW1	Plains Woodland	Moderate	0.058
P12	PW1	Plains Woodland	Low	0.034
P13	PW2	Plains Woodland	Low	0.045
P14	PW2	Plains Woodland	Low	0.016
P15	PW1	Plains Woodland	Low	0.054
P16	PW1	Plains Woodland	Low	0.185
P17	Reveg	Plains Woodland	Moderate	0.262
P18	Reveg	Plains Woodland	Low	5.906
P19	Reveg	Plains Woodland	Low	0.279
P20	Reveg	Plains Woodland	Low	0.563
P21	PW1	Plains Woodland	Low	0.535
P22	PW1	Plains Woodland	Low	0.233
P23	PW1	Plains Woodland	Low	0.348
P24	PW1	Plains Woodland	Low	0.078
P25	PW1	Plains Woodland	Low	0.072
P26	PW1	Plains Woodland	Low	0.047
P27	PW1	Plains Woodland	Low	0.016
P28	PW1	Plains Woodland	Low	0.097
P29	PW1	Plains Woodland	Low	0.073
P30	PW1	Plains Woodland	Low	0.059
P31	PW1	Plains Woodland	Low	0.041
P32	PW1	Plains Woodland	Moderate	0.089
P33	PW1	Plains Woodland	Low	0.215
P34	PW1	Plains Woodland	Low	1.059

Unique ID	Patch ID	EVC	Quality of Patch	Patch size (ha)
P35	PW1	Plains Woodland	Low	0.100
P36	Reveg	Plains Woodland	Low	0.209
P37	PW1	Plains Woodland	Moderate	1.655
P38	PW1	Plains Woodland	Low	0.033
P39	PW1	Plains Woodland	Low	0.061
P40	PW1	Plains Woodland	Low	0.119
P41	PW1	Plains Woodland	Low	0.115
P42	PW1	Plains Woodland	Low	0.085
P43	PW1	Plains Woodland	Low	0.783

Appendix 1.4. - Significant Flora Species

Significant flora within 10 kilometres of the study area is provided in the Table A1.4.3 at the end of this section, with Tables A1.4.1 and A1.4.2 below providing the background context for the values in Table 1.4.3.

Table A1.3.1 Conservation status of each species for each Act/policy. The values in this table correspond to Columns 5 to 7 in Table A1.4.3.

EPBC (*Environment Protection and Biodiversity Conservation Act 1999*):		FFG (*Flora and Fauna Guarantee Act 1988*):		DELWP (Advisory List of Rare or Threatened Plants in Victoria [DEPI 2014]):	
EX	Extinct	L	Listed as threatened	x	Presumed extinct in Victoria
CR	Critically endangered	N	Nominated for listing as threatened	e	Endangered in Victoria
EN	Endangered	D	Delisted as threatened	v	Vulnerable in Victoria
VU	Vulnerable	I	Rejected for listing as threatened; taxon invalid	r	Rare in Victoria
#	Listed on the Protected Matters Search Tool	X	Rejected for listing as threatened; taxon ineligible	k	Poorly known in Victoria

Table A1.4.2 Likelihood of occurrence rankings: Habitat characteristics assessment of significant flora species previously recorded within 10 kilometres of the study area, or that may potentially occur within the study area to determine their likelihood of occurrence. The values in this table correspond to Column 8 in Table A1.4.3.

1	Known Occurrence	• Recorded within the study area recently (i.e. within ten years).
2	High Likelihood	• Previous records of the species in the local vicinity; and/or, • The study area contains areas of high-quality habitat.
3	Moderate Likelihood	• Limited previous records of the species in the local vicinity; and/or • The study area contains poor or limited habitat.
4	Low Likelihood	• Poor or limited habitat for the species, however other evidence (such as lack of records or environmental factors) indicates there is a very low likelihood of presence.
5	Unlikely	• No suitable habitat and/or outside the species range.

Table A1.4.3 Significant flora recorded within 10 kilometres of the study area.

Scientific name	Common name	Total # of documented records	Last documented record	EPBC	FFG	DELWP	Likelihood of occurrence in study area	Rationale for likelihood of occurrence
NATIONAL SIGNIFICANCE								
Amphibromus fluitans #	River Swamp Wallaby-grass	-	-	VU	-	-	4	Potential habitat, but very unlikely due to agricultural disturbance
Brachyscome muelleroides #	Mueller Daisy	-	-	VU	L	e	5	No suitable habitat
Glycine latrobeana #	Clover Glycine	-	-	VU	L	v	4	Potential habitat, but very unlikely due to agricultural disturbance and no previous records within 10km of the study area
Pimelea spinescens subsp. *spinescens #*	Spiny Rice-flower	-	-	CR	L	e	4	Potential habitat, but very unlikely due to agricultural disturbance and no previous records within 10km of the study area
Senecio psilocarpus #	Swamp Fireweed	-	-	VU	-	v	5	Outside distribution range
Sclerolaena napiformis #	Turnip Copperburr	-	-	EN	L	e	4	Potential habitat, but very unlikely due to agricultural disturbance
Swainsona murrayana #	Slender Darling-pea	-	-	VU	L	e	4	Potential habitat, but very unlikely due to agricultural disturbance and no previous records within 10km of the study area
STATE SIGNIFICANCE								
Acacia howittii	Sticky Wattle	1	2014	-	-	r	5	Outside distribution range

Scientific name	Common name	Total # of documented records	Last documented record	EPBC	FFG	DELWP	Likelihood of occurrence in study area	Rationale for likelihood of occurrence
Allocasuarina luehmannii	Buloke	35	2008	-	L	e	2	Study area contains suitable habitat
Alternanthera sp. 1 (Plains)	Plains Joyweed	3	2011	-	-	k	5	Potential habitat, but very unlikely due to agricultural disturbance
Anthosachne kingiana subsp. *multiflora*	Short-awned Wheat-grass	2	2011	-	-	k	4	Potential habitat, but very unlikely due to agricultural disturbance
Cardamine moirensis	Riverina Bitter-cress	2	2014	-	-	r	5	Potential habitat, but very unlikely due to agricultural disturbance
Cullen parvum	Small Scurf-pea	1	1995	-	L	e	4	Potential habitat, but very unlikely due to agricultural disturbance
Dianella tarda	Late-flower Flax-lily	2	2011	-	-	v	5	Poor and very limited habitat within the study area.
Diplachne fusca subsp. *fusca*	Brown Beetle-grass	6	1992	-	-	r	4	No suitable habitat
Eleocharis pallens	Pale Spike-sedge	1	2011	-	-	k	5	No suitable habitat
Fimbristylis velata	Veiled Fringe-sedge	1	2000	-	-	r	5	Poor and very limited habitat within the study area.
Geranium sp. 6	Delicate Crane's-bill	1	2011	-	-	v	5	No suitable habitat
Cyperus leptocarpus	Button Rush	5	1993	-	-	v	4	No suitable habitat
Myoporum montanum	Waterbush	4	2002	-	-	r	4	Poor and very limited habitat within the study area.

Data Sources: Victorian Biodiversity Atlas (DELWP 2020); Protected Matters Search Tool (DAWE 2021)

APPENDIX 2 - FAUNA

Appendix 2.1. - Significant Fauna Species

Significant fauna within 10 kilometres of the study area is provided in the Table A2.1.3 at the end of this section, with Tables A2.1.1 and A2.1.2 below providing the background context for the values in Table 2.1.3.

Table A2.1.1 Conservation status of each species for each Act/policy. The values in this table correspond to Columns 5 to 8 in Table A2.1.3.

EPBC (*Environment Protection and Biodiversity Conservation Act 1999*):	FFG (*Flora and Fauna Guarantee Act 1988*):
EX Extinct	L Listed as threatened
CR Critically endangered	N Nominated for listing as threatened
EN Endangered	D Delisted as threatened
VU Vulnerable	I Rejected for listing as threatened; taxon invalid or ineligible
CD Conservation dependent	
# Listed on the Protected Matters Search Tool	
DELWP (Advisory List of Threatened Vertebrate Fauna in Victoria [DSE 2013]; Advisory List of Threatened Invertebrate Fauna in Victoria [DSE 2009]):	NAP (National Action Plans for several Australian species [Cogger *et al.* 1993; Duncan *et al.* 1999; Garnet *et al.* 2011; Sands and New 2002; Tyler 1997: Woinarski *et al.* 2014)):
EX Extinct in Victoria	EX Extinct
RX Regionally extinct in Victoria	CR Critically endangered
EW Extinct in the wild in Victoria	EN Endangered
CR Critically endangered in Victoria	VU Vulnerable
EN Endangered in Victoria	NT Near threatened
VU Vulnerable in Victoria	CD Conservation dependent
NT Near threatened in Victoria	DD Data deficient (insufficient or poorly known)
DD Data deficient (insufficient or poorly known)	LC Least concern

Table A2.1.2. Likelihood of occurrence rankings: Habitat characteristics assessment of significant fauna species previously recorded within 10 kilometres of the study area, or that may potentially occur within the study area to determine their likelihood of occurrence. The values in this table correspond to Column 9 in Table A2.1.3.

1	High Likelihood	• Known resident in the study area based on site observations, database records, or expert advice; and/or, • Recent records (i.e. within five years) of the species in the local area (DELWP 2018); and/or, • The study area contains the species' preferred habitat.
2	Moderate Likelihood	• The species is likely to visit the study area regularly (i.e. at least seasonally); and/or, • Previous records of the species in the local area (DELWP 2018); and/or, • The study area contains some characteristics of the species' preferred habitat.
3	Low Likelihood	• The species is likely to visit the study area occasionally or opportunistically whilst en route to more suitable sites; and/or, • There are only limited or historical records of the species in the local area (i.e. more than 20 years old); and/or, • The study area contains few or no characteristics of the species' preferred habitat.
4	Unlikely	• No previous records of the species in the local area; and/or, • The species may fly over the study area when moving between areas of more suitable habitat; and/or, • Out of the species' range; and/or, • No suitable habitat present.

Table A2.1.3. Significant fauna within 10 kilometres of the study area.

Common Name	Scientific Name	Last Documented Record (VBA)	# Records (VBA)	EPBC Act	FFG ACT	DSE (2013)	Likelihood of occurrence in the study area	Rationale for likelihood of occurrence
NATIONAL SIGNIFICANCE								
Grey-headed Flying-fox	*Pteropus poliocephalus*	-	1	VU	L	VU	4	May visit the study area en route to more suitable habitat.
Australasian Bittern	*Botaurus poiciloptilus*	-	2	EN	L	EN	4	No suitable habitat.
Plains-wanderer	*Pedionomus torquatus*	#	1	CR	L	CR	4	No suitable habitat.
Australian Painted Snipe	*Rostratula australis*	1988	3	VU	L	CR	4	No suitable habitat.
Eastern Curlew	*Numenius madagascariensis*	#	-	CR	-	VU	4	No suitable habitat
Curlew Sandpiper	*Calidris ferruginea*	1978	1	CR	-	EN	4	No suitable habitat.
Superb Parrot	*Polytelis swainsonii*	#	-	VU	L	EN	4	No suitable habitat, edge of species range.
Swift Parrot	*Lathamus discolor*	1982	1	CR	L	EN	3	May visit the study area occasionally or on an opportunistic basis.
Regent Honeyeater	*Anthochaera phrygia*	1958	1	CR	L	CR	4	Outside species range.
Painted Honeyeater	*Grantiella picta*	2013	2	VU	L	VU	3	Some suitable habitat; may visit the area occasionally or opportunistically.
Grey Falcon	*Falco hypoleucos*	#	-	VU	L	EN	3	May visit the study area occasionally or on an opportunistic basis.
Growling Grass Frog	*Litoria raniformis*	1788	1	VU	L	EN	3	Some suitable habitat but no recent records in the area.
Flat-headed Galaxias	*Galaxias rostratus*	1980	2	CR	-	VU	4	No suitable habitat.
Bluenose Cod (Trout Cod)	*Maccullochella macquariensis*	2015	3	EN	L	CR	4	No suitable habitat.

Common Name	Scientific Name	Last Documented Record (VBA)	# Records (VBA)	EPBC Act	FFG ACT	DSE (2013)	Likelihood of occurrence in the study area	Rationale for likelihood of occurrence
Murray Cod	*Maccullochella peelii*	2015	13	VU	L	VU	4	No suitable habitat.
Macquarie Perch	*Macquaria australasica*	#	-	EN	L	EN	4	No suitable habitat, outside species range.
Golden Sun Moth	*Synemon plana*	#	-	CR	L	CR	4	Potential presence within the high-quality Plains Woodland remnant within the study area. However, the nearest documented records of the species near Nagambie (several kilometres to the south west of the study area). However, there are no locally confirms records and it is outside of the species distributional range based on DEWHA (2008)
STATE SIGNIFICANCE								
Brush-tailed Phascogale	*Phascogale tapoatafa*	1995	1	-	L	VU	4	No suitable habitat
Squirrel Glider	*Petaurus norfolcensis*	2010	8	-	L	EN	4	Low quality habitat in the form of Plains Woodland. An extant population is not likely to occur within the study area and the nearest confirmed records are to the east of the study area along the Goulburn River.
Musk Duck	*Biziura lobata*	2005	37	-	-	VU	4	No suitable habitat. May fly over en route to more suitable habitat.
Freckled Duck	*Stictonetta naevosa*	2005	10	-	L	EN	3	May visit the study area en route to more suitable habitat.

Common Name	Scientific Name	Last Documented Record (VBA)	# Records (VBA)	EPBC Act	FFG ACT	DSE (2013)	Likelihood of occurrence in the study area	Rationale for likelihood of occurrence
Hardhead	*Aythya australis*	2006	64	-	-	VU	4	No suitable habitat. May fly over en route to more suitable habitat.
Blue-billed Duck	*Oxyura australis*	2001	12	-	L	EN	4	No suitable habitat. May fly over en route to more suitable habitat.
Diamond Dove	*Geopelia cuneata*	1991	1	-	L	NT	4	No suitable habitat.
White-throated Needletail	*Hirundapus caudacutus*	1991	4	-	-	VU	3	May visit the study area occasionally or on an opportunistic basis.
Square-tailed Kite	*Lophoictinia isura*	1999	1	-	L	VU	4	No suitable habitat. May fly over en route to more suitable habitat.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	1982	1	-	L	VU	4	No suitable habitat.
Black Falcon	*Falco subniger*	2013	1	-	L	VU	3	May visit the study area occasionally or on an opportunistic basis.
Bush Stone-curlew	*Burhinus grallarius*	1993	8	-	L	EN	3	Potential habitat, although very unlikely due to agricultural disturbance.
Pacific Golden Plover	*Pluvialis fulva*	1987	2	-	-	VU	4	Outside of species range; no suitable habitat.
Black-tailed Godwit	*Limosa limosa*	1983	1	-	-	VU	3	No suitable habitat. May fly over en route to more suitable habitat.
Common Greenshank	*Tringa nebularia*	1992	3	-	-	VU	3	No suitable habitat. May fly over en route to more suitable habitat.
Marsh Sandpiper	*Tringa stagnatilis*	2001	5	-	-	VU	3	No suitable habitat. May fly over en route to more suitable habitat.

Common Name	Scientific Name	Last Documented Record (VBA)	# Records (VBA)	EPBC Act	FFG ACT	DSE (2013)	Likelihood of occurrence in the study area	Rationale for likelihood of occurrence
Wood Sandpiper	*Tringa glareola*	1989	10	-	-	VU	3	No suitable habitat. May fly over en route to more suitable habitat.
Caspian Tern	*Hydroprogne caspia*	2001	1	-	L	NT	3	No suitable habitat. May fly over en route to more suitable habitat.
Turquoise Parrot	*Neophema pulchella*	1980	2	-	L	NT	3	May visit the study area occasionally or on an opportunistic basis.
Powerful Owl	*Ninox strenua*	2010	1	-	L	VU	4	No suitable habitat.
Diamond Firetail	*Stagonopleura guttata*	1991	2	-	L	NT	4	Potential habitat although unlikely due to agricultural disturbance.
Murray Short-necked Turtle	*Emydura macquarii*	1982	1	-	-	VU	4	Outside of species range.
Lace Goanna	*Varanus varius*	1985	1	-	-	EN	4	No suitable habitat.
Giant Bullfrog	*Limnodynastes interioris*	2002	1	-	L	CR	4	Outside of species range, no suitable habitat.
Crimson-spotted Rainbowfish	*Melanotaenia fluviatilis*	2015	24	-	L	VU	4	Outside of species range, no suitable habitat.
Silver Perch	*Bidyanus bidyanus*	2015	5	-	L	VU	4	Outside of species range, no suitable habitat.
REGIONAL SIGNIFICANCE								
Pied Cormorant	*Phalacrocorax varius*	2017	2	-	-	NT	4	No suitable habitat.
Glossy Ibis	*Plegadis falcinellus*	1993	9	-	-	NT	4	No suitable habitat.
Royal Spoonbill	*Platalea regia*	2017	39	-	-	NT	3	May pass through study area en route to more suitable habitat.

Common Name	Scientific Name	Last Documented Record (VBA)	# Records (VBA)	EPBC Act	FFG ACT	DSE (2013)	Likelihood of occurrence in the study area	Rationale for likelihood of occurrence
Spotted Harrier	*Circus assimilis*	1958	1	-	-	NT	3	Some suitable habitat, but on edge of species range.
Latham's Snipe	*Gallinago hardwickii*	2001	13	-	-	NT	2	Likely to visit the study area seasonally. Recent records nearby.
Long-toed Stint	*Calidris subminuta*	1989	3	-	-	NT	3	May visit the study area occasionally or on an opportunistic basis.
Black-eared Cuckoo	*Chrysococcyx osculans*	1991	1	-	-	NT	3	No suitable habitat. Records are also not recent.
Spotted Quail-thrush	*Cinclosoma punctatum*	1991	1	-	-	NT	3	On edge of species range, no suitable habitat.
Golden Perch	*Macquaria ambigua*	2015	19	-	-	NT	4	Outside of species range.

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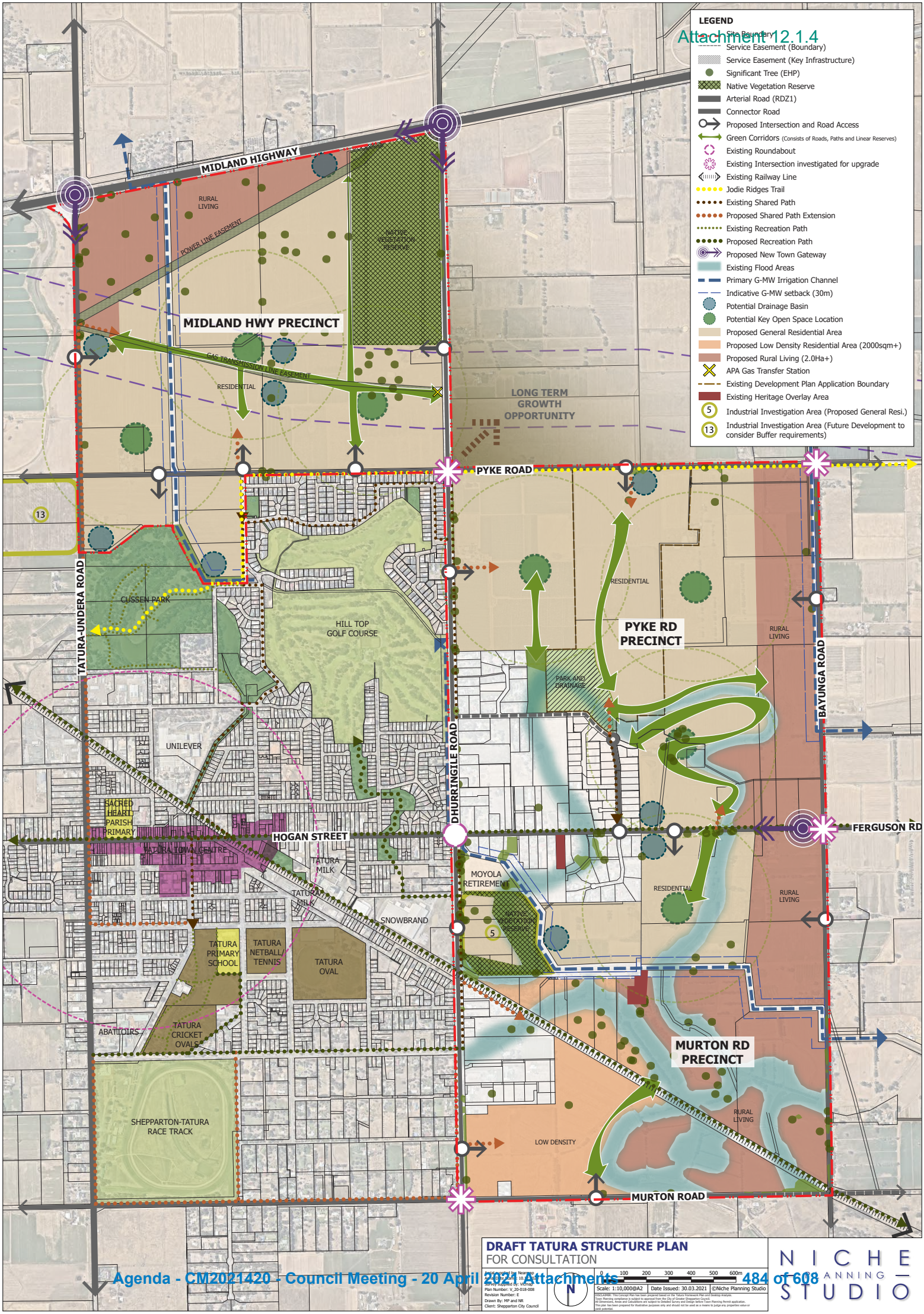
LEGEND
Site Boundary
Service Easement (Boundary)
Service Easement (Key Infrastructure)
Significant Tree (EHP)
Native Vegetation Reserve
Arterial Road (RDZ1)
Connector Road
Proposed Intersection and Road Access
Green Corridors (Consists of Roads, Paths and Linear Reserves)
Existing Roundabout
Existing Intersection investigated for upgrade
Existing Railway Line
Jodie Ridges Trail
Existing Shared Path
Proposed Shared Path Extension
Existing Recreation Path
Proposed Recreation Path
Proposed New Town Gateway
Existing Flood Areas
Primary G-MW Irrigation Channel
Indicative G-MW setback (30m)
Potential Drainage Basin
Potential Key Open Space Location
Proposed General Residential Area
Proposed Low Density Residential Area (2000sqm+)
Proposed Rural Living (2.0Ha+)
APA Gas Transfer Station
Existing Development Plan Application Boundary
Existing Heritage Overlay Area
5 Industrial Investigation Area (Proposed General Resi.)
13 Industrial Investigation Area (Future Development to consider Buffer requirements)
MIDLAND HIGHWAY
RURAL LIVING
POWER LINE EASEMENT
NATIVE VEGETATION RESERVE
MIDLAND HWY PRECINCT
GAS TRANSMISSION LINE EASEMENT
RESIDENTIAL
LONG TERM GROWTH OPPORTUNITY
PYKE ROAD
13
TATURA-UNDERA ROAD
CUSSEN PARK
HILL TOP GOLF COURSE
RESIDENTIAL
PYKE RD PRECINCT
RURAL LIVING
PARK AND DRAINAGE
BAYUNGA ROAD
DHURRINGILE ROAD
UNILEVER
SACRED HEART PARISH PRIMARY
HOGAN STREET
FERGUSON RD
TATURA TOWN CENTRE
TATURA MILK
TATURA MILK
MOYOLA RETIREMENT
RESIDENTIAL
RURAL LIVING
SNOWBRAND
NATIVE VEGETATION RESERVE
5
TATURA PRIMARY SCHOOL
TATURA NETBALL/ TENNIS
TATURA OVAL
ABATTOIRS
TATURA CRICKET OVALS
MURTON RD PRECINCT
SHEPPARTON-TATURA RACE TRACK
RURAL LIVING
LOW DENSITY
MURTON ROAD
DRAFT TATURA STRUCTURE PLAN
FOR CONSULTATION
Plan Number: V_20-018-008
Revision Number: E
Drawn By: MP and NR
Client: Shepparton City Council
Scale: 1:10,000@A2
Date Issued: 30.03.2021
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GREATER SHEPPARTON CITY COUNCIL

CONVERSATION REPORT

Tatura Structure Plan
Pre-draft Consultation

MARCH 2021

GREATER SHEPPARTON


ULV 902
FAMILY
THOMAS
BUTCHERS

Contents

About the Tatura Structure Plan

Tatura is situated approximately 18km west of Shepparton to the south of the Midland Highway. At the 2016 census, Tatura had a population of 4,669 making it the largest township in Greater Shepparton outside of the Shepparton – Mooroopna urban area.

Greater Shepparton is continuing to grow and there has been substantial interest in larger scale development in Tatura in recent years. Tatura has proven popular with home buyers due to its attractive country-town vibe that is in close proximity with services and infrastructure in the Shepparton urban area.

Since the completion of the popular Northlinks estate, the *Shepparton Residential Land Supply & Demand Assessment September 2019* has identified a shortage of residential zoned land in Tatura and concluded that additional residential land supply must be realised in the short-term.

The future expansion of Tatura is supported by the following strategic planning documents, which were implemented into the Greater Shepparton Planning Scheme (Planning Scheme). This includes the:

- *Greater Shepparton Housing Strategy 2011* (GSHS), which was prepared to guide the long term identification and provision of residential land within Greater Shepparton. The GSHS included framework plans for all urban areas and townships in the municipality (including Tatura) that identified land that may accommodate future development following detailed investigations. The framework plan identified the north, north-east, and east of Tatura for possible future development. The GSHS was implemented into the Planning Scheme by Amendment C93 in 2012.
- *Greater Shepparton Townships Framework Plan Review 2019* (the Review), which was prepared to evaluate and update the framework plans for nine of the ten townships contained in the GSHS. The Review updated the framework plan for Tatura, and was implemented into the Planning Scheme by Amendment C212 in 2020.

In response to land supply shortages and the need for additional residential development in Tatura, Council has begun the preparation of a high-level Tatura Structure Plan (Structure Plan) for land to the north, north-east and east of Tatura. The Structure Plan will incorporate the recommendations of the updated framework plan for Tatura, provide information on appropriate densities for future residential development, identify all appropriate regional infrastructure required to support residential development and outline the cost of this infrastructure.

The future implementation of the Structure Plan into the Planning Scheme will provide the strategic justification to rezone additional land in Tatura for residential development realising much-needed residential land supply.

Acknowledgements

Greater Shepparton City Council gratefully acknowledges the assistance of local government and service agencies, and the Tatura community in the preparation of the Tatura Structure Plan.

Pre-draft Consultation

In order to inform the preparation of the Structure Plan, Council engaged consultants to prepare a Traffic Impact Assessment and an Integrated Water Management Plan to identify and cost all appropriate regional stormwater drainage and transport infrastructure to support future residential development.

Council undertook pre-draft consultation with the Tatura community between 7 July 2020 and 10 August 2020 to help inform the preparation of these two reports to understand the aspirations of the community and identify any key issues that can be considered in the preparation of the Structure Plan.

Methods of engagement included:

- A letter to all landowners and occupiers of land within the Tatura Structure Plan study area.
- A letter to relevant stakeholder and referral agencies.
- A media release, which attracted media attention from the Shepparton News and Shepparton Adviser.
- A consultation webpage on Council's website with an online submission form.
- One-on-one meetings between Council officers and individual stakeholders.
- A meeting with the Tatura Community Plan Steering Committee.

Submissions were invited via an online submission form, by email and by post.

Who did we hear from?

A total of 30 submissions were received by Council during the public consultation process. This included:

- 24 submissions from landowners, residents and community groups within Tatura; and
- 6 submissions from government referral agencies, including;
  - The Department of Environment, Land, Water and Planning;
  - The Department of Transport;
  - Country Fire Authority;
  - Environmental Protection Authority;
  - Goulburn Valley Water; and
  - Goulburn-Murray Water.


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What we heard

Traffic Considerations

A number of submissions from the community asked for improved pedestrian and cycling linkages within the Structure Plan area, the broader Tatura township and to neighbouring townships. This includes improved access to the Hogan Street commercial area, completion of the Tatura 10km Loop, additional off-road shared paths, the provision of wombat crossings in high-pedestrian areas and a review of speed limits.

The draft Traffic Impact Assessment and the Structure Plan layout has established a hierarchy of roads that ensures safe movement of vehicles, pedestrians and cyclists. The Structure Plan layout has incorporated the use of green corridors, which is a series of landscaped shared paths and trails that will connect open space, neighbourhoods and existing areas of Tatura.

Several submissions also called for improved public transport within Tatura, including additional services and relocating the town's main bus stop. While the provision of public transport is a Department of Transport responsibility, Council is acutely aware of the lack of public transport services in Tatura and has advocated to the State Government to establish a bus service between Tatura and Shepparton–Mooroopna. The Structure Plan layout has incorporated higher-order roads that will be capable of supporting buses, including school buses.

As part of the preparation of the draft Traffic Impact Assessment, an additional request for information was undertaken with members of the Tatura Community Plan Steering Committee to understand the roads residents use to travel in and out of Tatura. As part of this engagement 11 comments were received. It was understood that many residents prefer to use Ferguson Road to access Shepparton and Mooroopna due to safety concerns on the Midland Highway, particularly at the intersection with Dhurringile Road. The draft Traffic Impact Assessment has accounted for an increase in usage on Ferguson Road, and has recommended that further investigations be conducted into safety at the Midland Highway and Dhurringile Road intersection.

Integrated Water Management Considerations

Council received multiple submissions relating to the use of stormwater runoff to enhance existing wetlands; particularly Cussen Park. Other submissions mentioned the need to incorporate natural features and open space within existing drainage lines and future retarding basins. The draft Integrated Water Management Plan has designed a number of catchments to the south of Pyke Road to retain stormwater in retarding basins which then discharge into Cussen Park to enhance the park with more water. The Structure Plan layout has listed the indicative locations of the retarding basins, subject to further consultation with the community and consultants.

One submission was concerned about the levels of stormwater runoff the Structure Plan would have on agricultural properties to the north side of the Midland Highway outside of the Structure Plan Area. To address this concern the draft Integrated Water Management Plan has included a retarding basin on the north-west corner of the study site, with the intent of capturing runoff and discharge it at a steady rate so that the increased runoff from development will not increase flood levels on downstream properties.

Ecological Considerations

Council received a submission from the Department of Environment, Land, Water and Planning that outlined several ecological considerations when preparing the Structure Plan. This included the need to retain native flora and fauna within the Structure Plan area, the creation of biodiversity links, and the widespread planting of native trees and shrubs. The submission also contained information on the possible locations of native flora and fauna. Based on this submission Council commissioned an additional background report to undertake a high-level Ecological Assessment of the study area to assess the extent of native flora and fauna for all land within the Structure Plan area.

The draft Ecological Assessment identified 60.05 hectares of native vegetation within the study area, including a large patch of significant remnant Plains Grassland in the north-east corner of the study area south of the Midland Highway and 151 scattered trees. The Structure Plan layout has designated the remnant Plains Grassland as a conservation reserve to allow it to be protected from residential development and appreciated by the community.

A number of submissions received from government agencies and community members requested the retention of native vegetation and tree planting within the study area, including in public open space, road reserves, bike paths and for the creation of habitat linkages.

The Structure Plan layout aims to preserve and integrate scattered native vegetation within new and existing road reserves, green corridors and dedicated conservation open spaces. It will also seek to retain existing roadside vegetation, and introduce new plantings within open spaces, green corridors and local streets. The green corridors will also provide habitat linkages between Cussen Park and the retarding basins.

Other Matters

Council received 11 submissions relating to the provision of a High School within Tatura. The aspiration for a high school in Tatura was originally identified through consultation with the Tatura Community Plan (TCP). The original TCP, developed in 2010, noted an action to explore opportunities to attract a component of secondary school education to Tatura e.g. Year 8 - Year 10 with the Catholic and independent school systems.

A review of the TCP in 2015 saw this raised again. The TCP sought advice from the Department of Education and Training to clarify what criteria would need to be met for a secondary school to be considered in Tatura. The response received from the Department of Education and Training indicated that Tatura would not meet the required criteria any time in the foreseeable future. The action was removed from the TCP.

Because the establishment and funding of schools is a State Government responsibility, it is unable to be considered in the preparation of the Structure Plan. All submitters who enquired about the secondary school were sent a letter of response from Council early in the consultation process, and all submitters were sent an email outlining the status of the secondary school.

Other matters raised in submissions including development requirements for subdivisions and housing, including lot orientation, energy requirements, use of recycled water, provision of open space, and environmental and bushfire requirements from government agencies. Development requirements will undergo further assessment as part of the statutory planning process for subdivisions once the Structure Plan is incorporated into the Planning Scheme.

The remaining submissions received were from landowners within the study area outlining their aspirations for the development of their land.

What's next?

All of the responses received during the pre-draft consultation were considered as part of the development of a draft Tatura Structure Plan, including the preparation of the three background reports and the draft Structure Plan layout itself.

Referral agencies, landowners, residents, and community members will have further opportunity to provide input when the draft Structure Plan is exhibited for public comment and feedback, following consideration at a future ordinary council meeting.

Following this draft consultation process, further revisions to the Structure Plan in response to public comments is expected. The final *Tatura Structure Plan* will then be considered for adoption at an ordinary council meeting later in 2021, before being incorporated into the Greater Shepparton Planning Scheme via a planning scheme amendment. Additional consultation will occur as part of this process.

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