Mareeba SHIRE COUNCIL

2025 RAY ROAD DRAINAGE MANAGEMENT PLAN

PREPARED FOR
MAREEBA SHIRE COUNCIL

Trinity Engineering and Consulting
design | consult | manage

September 2025

DOCUMENT CONTROL SHEET

Trinity Engineering and Consulting Cairns Office: 21-23 Sheridan Street Cairns QLD 4870 PO Box 7963 Cairns QLD 4870 Telephone (07) 4040 7111 www.trinityengineering.com.au	**Title:**	Ray Road Drainage Management Plan 2025
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	Synopsis:	The 2025 Ray Road Drainage Management Plan has been prepared to document the drainage upgrades required to address existing drainage and flooding issues within the Ray Road catchment area. This report also provides advice on the benefit and capital costs to undertake these drainage upgrades.

REVISION/CHECKING HISTORY					
Rev No.	**Author**	**Reviewer**	**Approved for Issue**		
			Name	**Signature**	**Date**
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Table of Contents

Attachments:

List of Figures

List of Tables

1.0 EXECUTIVE SUMMARY

The purpose of the 2025 Ray Road Drainage Management Plan (DMP) is to document the outcomes from the investigations undertaken for the Ray Road stormwater catchment area and provide advice on drainage upgrade recommendations to assist Council in planning projects to address the existing flooding and drainage issues.

The 2025 Ray Road DMP has been informed by the 2004 Maunsell Drainage Investigation and the 2024 Trinity Engineering and Consulting (TEC) Drainage Study reports.

The 2024 TEC report was prepared as an update to the 2004 report and to assess the drainage and flooding issues experienced by the local community within the Ray Road stormwater catchment area, particularly during the major rainfall events that occurred in early 2024.

The Ray Road stormwater catchment area is generally defined as the area of Mareeba bordered by McIver Road to the north, the Mareeba Airport to the south, Chinaman Creek to the west, and the Kennedy Highway to the east.

PURPOSE OF STUDY

For completeness, the purpose of the 2024 drainage study is included below:

- Identify the extents of the contributing stormwater catchments based on available LiDAR elevation data within the Ray Road study area;
- Compare findings with Council's 2004 Drainage Study;
- Assess the capacity of existing drainage infrastructure within the Ray Road study area;
- Identify opportunities to minimise existing drainage issues and improve accessibility / reduce the frequency of localised flooding; and
- Undertake preliminary flood modelling and document the modelling output within the flood plain investigation area between George Fabris Road and Chinaman Creek to inform local property owners.

INTENT OF THIS DMP

Informed by the findings and outcomes from the 2024 drainage study, the intent of this DMP is to:

a) Inform property owners located in the flood plain investigation area between George Fabris Road and Chinaman Creek;
b) Set development controls and development requirements that Council can reference when assessing new development applications as growth in the area expands; and
c) Guide Council's capital works to ensure drainage infrastructure upgrades are identified and scheduled with available resources and budgets.

DOCUMENTATION OF FINDINGS AND OUTCOMES

The 2025 DMP also expands on the findings and outcomes from the 2024 drainage study by documenting the following:

- Identifies and documents concept level drainage upgrades that seek to improve the level of service within the Ray Road catchment area including future drainage corridors;
- Provides infrastructure contributions advice for drainage upgrades associated with current subdivision developments within the Ray Road catchment area;
- Develops a shortlist list of drainage infrastructure upgrades to minimise the impacts of existing drainage and flooding issues; and
- Develops preliminary costing advice and schematic concept plans to support the drainage upgrades identified.

1.1 Key Findings from Stormwater Investigation

The Ray Road catchment area encompasses a footprint of approximately 820 hectares and generates a total runoff volume in the order of 170m^3/s discharging to the west during the 100-year Average Recurrence Interval (ARI) rainfall event. That is, rainfall events that have a probability of occurring, on average, once every 100 years and is also referred to as the 1% Annual Exceedance Probability (AEP) event. It is the event that has a 1% probability of being exceeded in any one year, or a 99% probability of not being exceeded.

Currently, there is limited capacity in the existing drainage infrastructure (road corridor, culvert crossings, and open drains) within the catchment area to convey runoff to receiving creek systems.

The existing drainage infrastructure within the catchment area generally has a level of service less than the 2-year ARI rainfall event. It is the rainfall event that have a probability of occurring, on average, once every 2 years.

Of the six (6) existing drainage corridors considered to have suitable land tenure arrangements, two (2) of these corridors outlet in the order of 80% of the peak flows from the Ray Road catchment area. These are Chinaman Creek and Coolamon Close drainage corridors.

The topography of the catchment area between George Fabris Road and Chinaman Creek forms a broad flood plain area with several existing Ray Road acreage lots located within the flow path of the floodplain.

Preliminary one-dimensional flood modelling undertaken using the HEC-RAS software package provided a general indication of the flood extent and the potential risk of flooding to the acreage lots between George Fabris Road and Chinaman Creek, (Refer Attachment 3).

Note: The preliminary one-dimensional flood modelling software (HEC-RAS) was used to inform Council and the community of the indicative flood extent and potential flooding risks to properties adjacent to Ray Road. This software has limitations being a one-dimensional model and must not be relied upon as being fully representative of flood immunity, flood depths or peak flood extents.

1.2 Opportunities To Address Flooding and Drainage Issues

From the investigation, it was considered that there is no single solution to resolve the drainage issues identified. It is assessed that implementation of multiple infrastructure upgrade solutions is required to progressively improve drainage performance and increase the level of flood immunity within the Ray Road catchment.

Potential opportunities to upgrade and/or provide significant capacity drainage infrastructure within the Ray Road catchment area have been identified. Due to the large contributing catchment areas and resulting peak flows, it is not possible to achieve the desired level of flood immunity (1% AEP, 100-year ARI) to all existing properties and buildings.

The combined impact of these solutions, if affordable, may not eliminate all flooding and drainage issues. However, they would benefit the existing level of service for drainage infrastructure within the Ray Road catchment area.

The potential drainage upgrades were investigated at a concept level to develop a list of recommended infrastructure that could be implemented to minimise the frequency and duration of existing flooding and drainage issues.

These proposed upgrades generally seek to improve the level of service achieved by existing drainage infrastructure and reduce flooding frequency currently experienced.

The assessment of existing drainage system indicates the existing capacity and immunity achieved is in the order of a 2-year ARI rainfall event. Upgrades seek to improve the road immunity by providing drainage capacity to convey runoff during the 10-year ARI event.

Improving the capacity of existing crossroad culverts and open drains, and detention of stormwater runoff within the catchment area are among the key upgrades proposed.

Advice on the benefit of the drainage upgrades is provided in terms of a ranking system classifying upgrades as highest, moderate or low benefit. This ranking system considered criteria including cost-to-benefit (value for money), importance for managing catchment peak flows, impact on minimising existing flooding and drainage issues, and alignment with developer driven growth in the area. However, these criteria are not exhaustive and will need to be reviewed as part of Council's decision making.

To assist with Council's review of the drainage upgrades proposed in the 2025 Ray Road DMP, costing advice to deliver these upgrades is also provided in the form of Opinions of Probable Cost.

2.0 INTRODUCTION

Trinity Engineering and Consulting (TEC) were engaged by Mareeba Shire Council (Council) to undertake a drainage investigation of the Ray Road stormwater catchment area in response to flooding (early 2024) and seasonal drainage issues.

An earlier 2004 study by Maunsell Australia had identified existing drainage and flooding issues for Ray Road associated with drainage capacity limitations in the local area.

The significant rainfall received during Cyclone Jasper in December 2023 and heavy seasonal rain in 2024 on the already saturated catchments resulted stormwater runoff ponding and overtopping at the road corridors/open drains. This led to flooding of private properties.

This 2025 Ray Road Drainage Management Plan (DMP) builds on the findings and outcomes from the initial 2004 Drainage Study and the 2024 Drainage Study by documenting concept level drainage upgrades to address the existing drainage and flooding issues in the Ray Road catchment area. This DMP also provides recommendations that consider the benefits of carrying out the drainage upgrades.

2.1 Purpose

The purpose of the 2025 Ray Road DMP is:

- Inform property owners located in the flood plain investigation area between George Fabris Road and Chinaman Creek;
- Set development controls and development requirements that Council can reference when assessing new development applications as growth in the area expands; and
- Guide Council's capital works program to ensure drainage infrastructure upgrades are identified and scheduled with available resources and budgets.

2.2 Project Location

Ray Road is located approximately 2.5km south of the Mareeba CBD and has a bitumen sealed length of approximately 6.0km between McIver Road in the north, and the Mareeba Airport and Aviation Industrial Precinct, to the south.

Figure 1: Ray Road, Mareeba

2.3 Project Background

Mareeba Shire Council commissioned Maunsell Australia (now AECOM) in 2004 to investigate drainage issues in the Ray Road stormwater catchment area (study area).

The 2004 Drainage Study was conducted in two phases:

- Phase 1: Investigation of the existing drainage infrastructure along Ray Road and the associated contributing stormwater catchments; and
- Phase 2: Investigation of the potential upgrades to existing drainage infrastructure along Ray Road to minimise the impacts of flooding and drainage issues by increase the level of service/capacity of this infrastructure.

Generally, the 2004 Drainage Study provided information on existing drainage infrastructure and associated drainage issues within the Ray Road stormwater catchments. Limited advice was documented regarding drainage corridors conveying flows away from Ray Road.

The 2004 Drainage Study report also provided design options to improve drainage performance within the Ray Road catchments and minimise the impacts of flooding to roads and properties.

The 2024 Drainage Study (TEC) sought to update the 2004 Drainage Study to reflect the changes that have occurred within the stormwater catchments over the last 20 years and investigate what options are available to improve drainage performance over the next 20-year design horizon.

2.4 Project Drivers – Recent Events

The scope of the 2024 Ray Road Drainage Study was influenced by recent events and planned subdivision developments in the catchment area, including:

- December 2023 (Ex-Cyclone Jasper) rain depression;
- Highly saturated ground conditions;
- Subsequent property flooding in the 2024 rainfall events;
- Stormwater runoff impacting Ray Road;
- Agricultural properties impacted;
- 20 years since the 2004 Drainage Study;
- Increased enquiries from residents and land developments within the study area;
- Council's aim to have an updated drainage report to:
    - Consider upgrade opportunities for future works;
    - Inform Council's assessment of development applications; and
    - Inform the community.

2.5 Stormwater Terminology

This report refers to terminology used to describe rainfall events in accordance with the terminology adopted by the Queensland Urban Drainage Manual (QUDM).

This is based on the probability that intensity and duration of a particular rainfall event will be exceeded in any given year.

For example:

- A 5-year Average Recurrence Interval (ARI) rainfall event is the event that occurs on average once every 5 years and is assessed as having an 18% Annual Exceedance Probability (AEP) or 18% probability of being exceeded in any given year;
- A 10-year ARI rainfall event has a 10% AEP or 10% probability of being exceeded in any given year; and
- A 100-year ARI rainfall event has a 1% probability of being exceeded in any given year.

The peak runoff from these events are sometimes more commonly/informally referred to as being the Q5, Q10, or Q100 design rainfall event where "Q" refers to flow in hydrology and hydraulic calculations.

Refer *Figure 2* below.

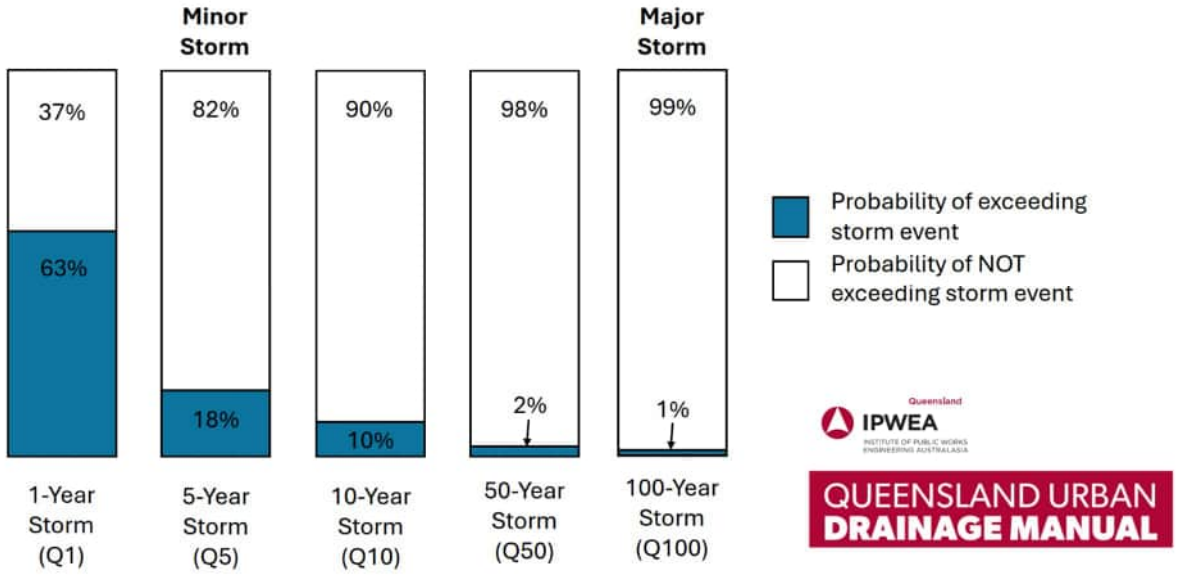


Figure 2: QUDM Storm Event Terminology

The FNQROC Development Manual refers to QUDM and the desired infrastructure level of service outcomes for the major and minor storm events. This establishes the level of service that the design of drainage infrastructure seeks to achieve.

For Mareeba Shire, the minor design storm event usually corresponds to the 5-year ARI rainfall event, and is the event that pipes and drains are generally designed to convey runoff with minimal nuisance to the community.

The major design storm event refers to the 100-year ARI rainfall event where the aim is for flows (in urban areas) to be contained to major flow paths in road reserves or drainage easements.

3.0 DRAINAGE INVESTIGATION

3.1 Stormwater Catchments

An assessment of the Ray Road stormwater catchments was undertaken based on site investigations, the latest (2018) LiDAR elevation data, survey, photographs and video footage provided by Council, and future development layouts. The total catchment area contributing to drainage and flooding issues along Ray Road is approximately 820 hectares of agricultural, residential, and commercial land. This area does not include Catchment G because this catchment generally drains away from Ray Road towards McIver Road and the Kennedy Highway.

For comparison, the Basalt Creek flood study prepared (by WMS in 2023) as part of the Bicentennial Lakes project identified a similar catchment area (of 820 Ha).

Generally, the stormwater catchment boundaries identified as part of this study align with those identified in the 2004 Drainage Study. This is with exception to some catchment boundaries resulting from subdivision developments and drainage upgrades that have occurred since 2004.

For example, Catchment B3 (located west from Ray Road) was not identified in the 2004 study. The development of LiDAR technology, not available in 2004, has allowed the 2024 Drainage Study (TEC) to be developed with greater resolution of the topography throughout the Ray Road catchment area.

The stormwater catchment boundaries are reproduced in *Figure 3* below based on the 2024 drainage scenario.

Refer *Attachment 1* for the 2024 Stormwater Catchment Plans.

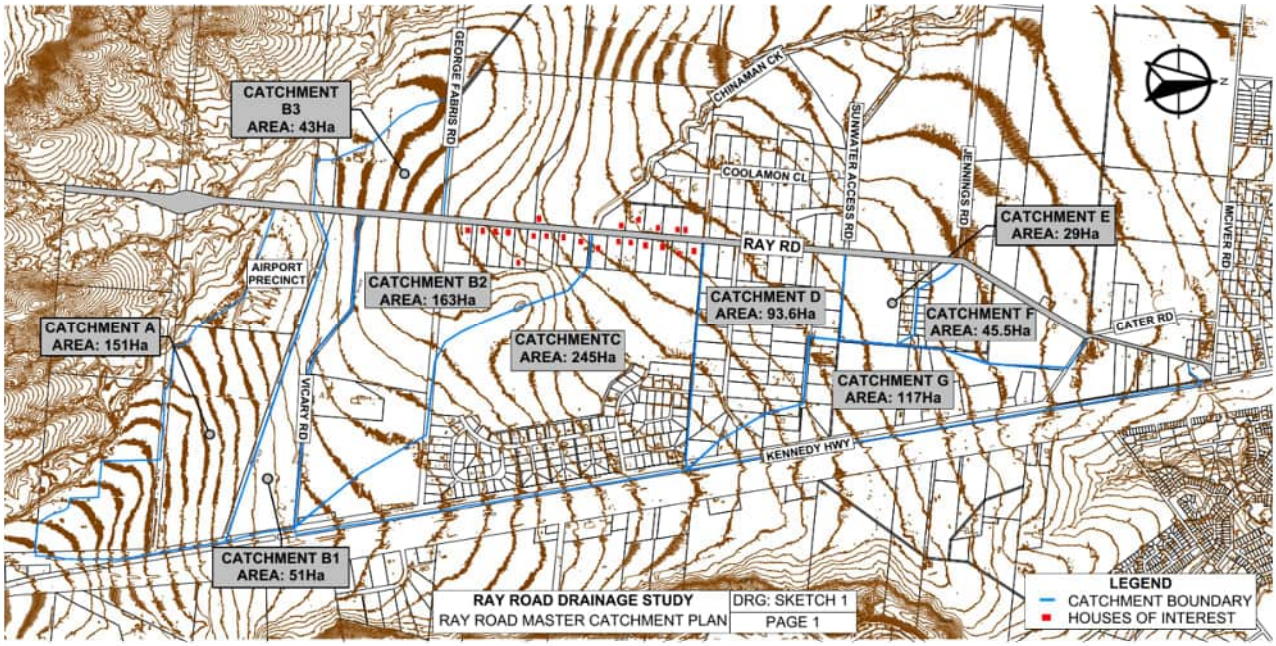


Figure 3: 2024 Ray Road Stormwater Catchments (2024 Scenario)

3.2 Hydrology and Hydraulic Analysis

The Rational Method (specified in QUDM) was adopted for the hydrology analysis of the Ray Road stormwater catchments to:

a) Calculate the peak discharge (peak flow for a particular design rainfall intensity); and
b) Compare the calculated peak flows with the capacity of existing drainage infrastructure located in stormwater catchments within the study area.

The peak flows calculated were for the 1, 2, 5, 10, and 100-year ARI design rainfall events and adopted a time of concentration of 60 minutes for each stormwater catchment (A, B1, B2, B3, C, D, E, F and G) based on the existing terrain and flow paths identified.

The 60-minute time of concentration was considered appropriate for the calculation of peak runoff flowrates to assess the implications for Ray Road drainage infrastructure based on QUDM's Rational Method design principles, and consideration of the times of concentration nominated in the 2023 Basalt Creek flood study.

Note, the peak flows calculated for each stormwater catchment as part of this study are based on the existing 2024 development scenario. Where stormwater catchments peak flows are likely to be impacted by proposed development in the study area, commentary is provided on how this will impact existing drainage infrastructure.

Refer to Section 5 of this report for further detail on proposed developments anticipated to impact existing drainage infrastructure.

Table 1 summarises the peak catchment flows calculated for each design rainfall event under the existing 2024 development scenario.

Table 1: Ray Road Peak Catchment Flows (2024 Development Scenario)

Catchment		Peak Flow (m^3/s)				
	Area (Ha)	1-year ARI	2-year ARI	5-year ARI	10-year ARI	100-year ARI
A	151.0	8.4	10.1	15.0	18.2	30.7
B1	51.0	2.9	3.5	5.2	6.4	10.8
B2	163.0	9.4	11.3	16.7	20.4	34.4
B3	43.0	2.4	2.8	4.2	5.1	8.6
C	245.0	14.1	16.9	25.2	30.7	51.7
D	93.6	5.4	6.5	9.6	11.7	19.7
E	29.0	1.7	2.0	3.0	3.6	6.1
F	45.5	2.6	3.1	4.7	5.7	9.6
G	117.0	6.8	8.1	12.0	14.7	24.7

Based on the peak flows shown in *Table 1* above, the total 100-year ARI peak flow for Ray Road is in the order of $170m^3/s$ discharging to the west and spread across Catchment A-F.

Table 3 correlates these catchments with the location of existing crossroad culverts providing outlets from the Ray Road catchment area.

3.3 Existing Infrastructure Capacity

The existing drainage infrastructure servicing the Ray Road stormwater catchments was investigated to assess the capacity limitations and the level of service achieved at various points of interest.

Within the study area, there are limited existing road and drainage corridor options for runoff to outlet from the stormwater catchments without establishing new land tenure arrangements (e.g. easements).

The available drainage outlets within the Ray Road catchment area are summarised in the table below.

Table 2: Ray Road Catchment Area – Drainage Outlets

Extent of Catchment Area	Drainage Outlet Location
Ray Road North	Kennedy Highway Crossing (north-east)
Ray Road Central	Jennings Road Sun Water Access Road Coolamon Close Chinaman Creek
Ray Road South	New Drain Outlet (opposite Airport precinct)

Figure 4 (below) shows the location of these drainage outlets in relation to Ray Road.

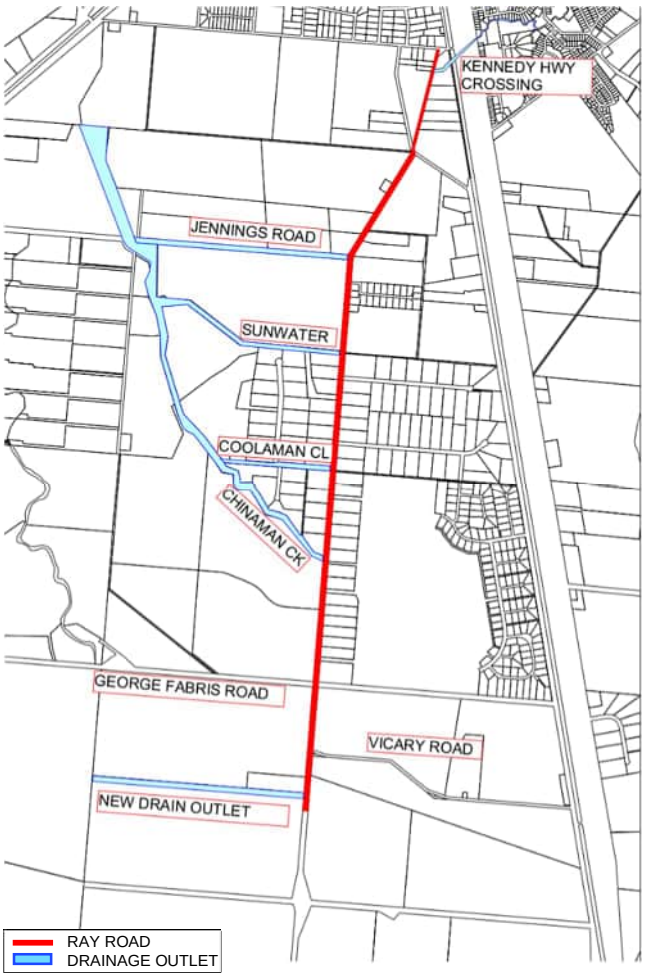


Figure 4: Available Drainage Outlets from Ray Road

The level of service achieved by the drainage corridor outlets identified in *Figure 4* are dependent on the combined capacity of the existing crossroad culverts under Ray Road and the Kennedy Highway. The total capacity of the crossroad culverts in all the identified drainage corridors is 126.7m^3/s. Refer *Table 3* below.

Table 3: Existing Capacity of Crossroad Culverts & Upstream Catchments

Culvert Location	Culvert Arrangement	Capacity (m3/s)	Approximate Existing Level of Service	Upstream Catchment (from Table 1 above)	100-year ARI Catchment Peak Flow (m3/s)[2]
Kennedy Highway Culverts	3/2100x1800 RCBC	36.7	100-Year ARI	G	24.7
Jennings Road Culverts	3/2600x1800 RCBC	38.8	100-Year ARI	E	6.1
Sunwater Access Culverts	3/1500x750 RCBC	7.5	2-Year ARI	D	19.7
Coolamon Close Culverts	4/900 RCP	7.6	< 1-Year ARI	C	51.7
Chinaman Creek Culverts	3/2100x600 RCBC	8.1	< 1-Year ARI	B	53.8
New Drain Outlet Culverts (opposite Airport Precinct)	3/1800x1800 RCBC	28.0[1]	50-Year ARI	A	30.7

[1] The peak flow arriving to this culvert is limited by the upstream airport drain and taxiway culverts.
[2] The 100-year ARI catchment peak flow assumes bypass flows from upstream catchments are excluded.

Compared with the peak flows in Table 1 above, the existing culvert infrastructure capacity within the Ray Road catchment area (Table 2) generally does not achieve a level of service catering for the major rainfall event (100-year ARI event).

The peak flows calculated for the 2-year, 10-year and 100-year ARI design rainfall event and assessed capacity of the existing culverts within the identified drainage corridor outlets are provided in *Attachment 2*.

Roadside table/open drains are the primary infrastructure conveying stormwater runoff from Ray Road to these downstream drainage corridor outlets. Initial capacity assessments of this drainage infrastructure compared with peak catchment flows identified that the level of service is low.

Photographic evidence of water overtopping Ray Road following a rainfall event on 22 December 2024 is shown in *Figure 5* and supports this identified low level of service in drainage infrastructure on Ray Road.

Figure 5: Example of Runoff Overtopping Ray Road Due to Exceeded Drain Capacity (Heading North on Ray Road, Just north from George Fabris Road, 22 December 2024)

The size (depth and width) of many of these roadside drains are generally constrained by the existing road reserve width and the longitudinal grade of Ray Road, limiting capacity upgrades.

Further review of the available drainage corridor outlets identified that the catchments contributing to discharge at Chinaman Creek and Coolamon Close represent almost 80% of the peak flows from the Ray Road catchment area.

Therefore, investigation of management options for the Chinaman Creek and Coolamon Close discharge points was a focus of the Ray Road Drainage Management Plan. By improving the drainage capacity of infrastructure at these two points of interest, it is anticipated that bypass flows conveyed downstream (north) along Ray Road, from Coolamon Close would be significantly minimised.

3.4 Ray Road Topography – Southern Catchment

Assessment of the Ray Road topography and adjacent stormwater catchments was undertaken using the latest LiDAR elevation data. It was assessed that the stormwater catchments generally flow from the south-east towards the north-west.

It was also identified that the footprint of the study area between George Fabris Road and Chinaman Creek is located within a broad “flood plain”. A ridge on George Fabris Road and at the rear of properties on the eastern side of Ray Road naturally form a flow path towards Chinaman Creek via Ray Road.

A cross section (looking north) per the blue line in *Figure 6* is shown in *Figure 7* to indicate the flood plain profile, approximate water spread and flood level of the 100-year ARI rainfall event relative to Ray Road and the existing lots on the east side of Ray Road (based on the 1-D HEC-RAS flood model).

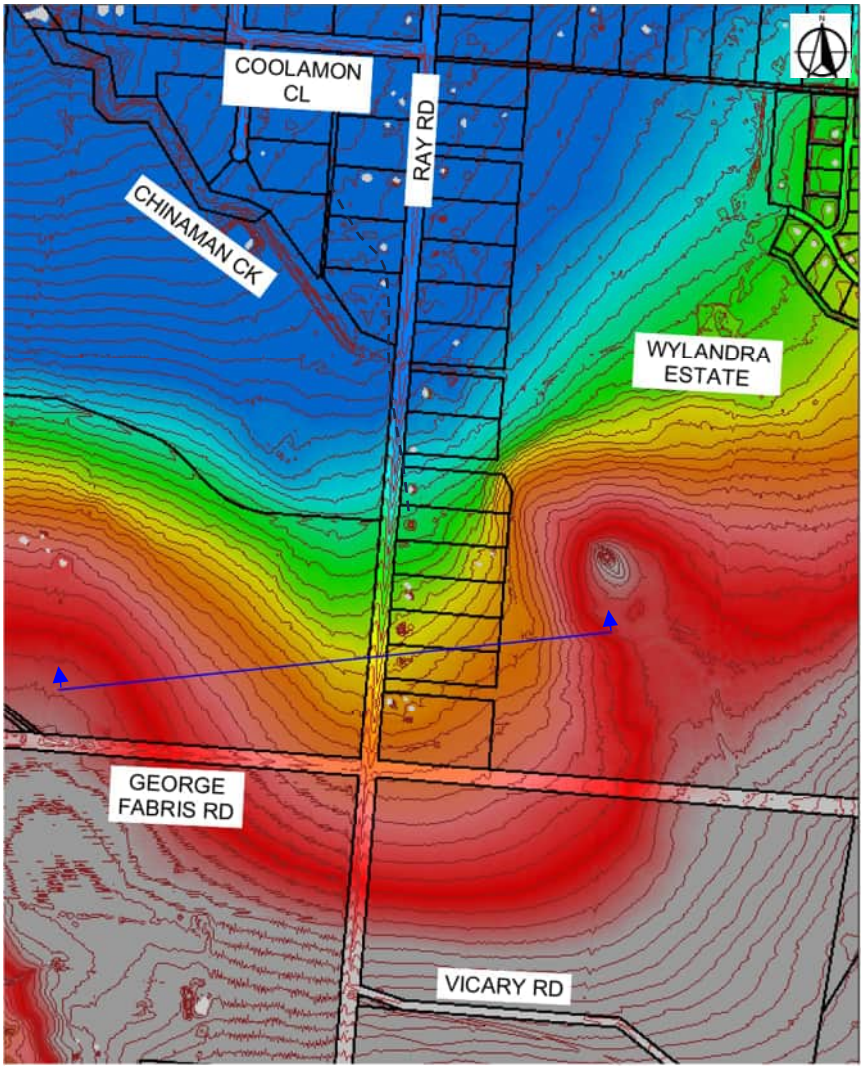


Figure 6: Ray Road Topography

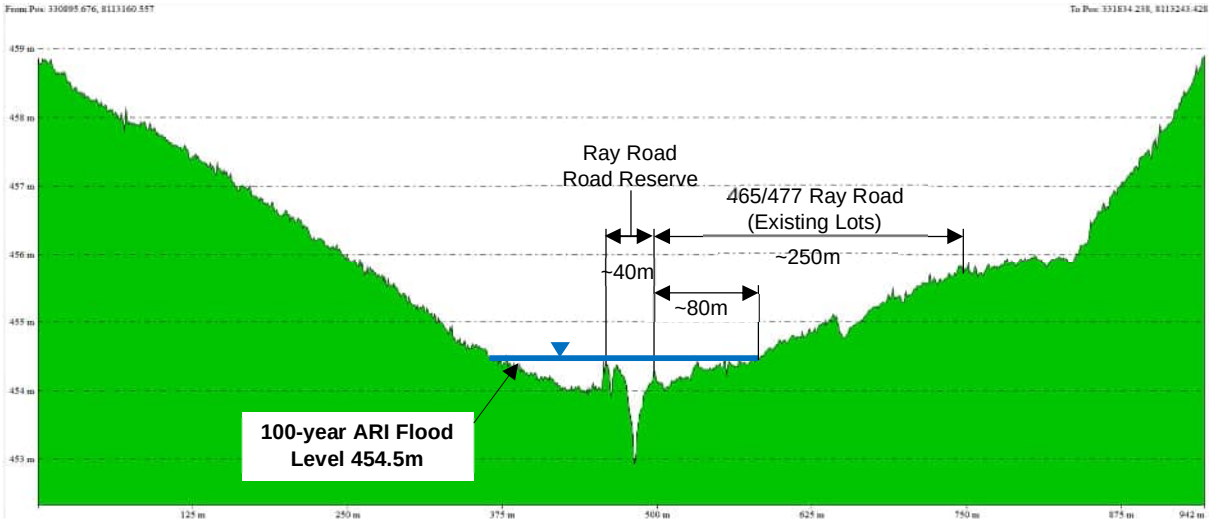


Figure 7: Assessed Cross Section of Ray Road Flood Plain Investigation Area Looking North

As shown in *Figure 6* and *Figure 7* above, Ray Road and the adjacent existing lots are generally located across the base of the flood plain. Preliminary analysis of the 100-year ARI rainfall event flood levels appears to indicate the road, and adjacent lots are vulnerable to flooding.

This vulnerability to flooding is discussed further below.

3.5 LiDAR Levels and Aerial Imagery

Further reviews of the stormwater catchments south from George Fabris Road were undertaken to confirm if the flow path of the flood plain identified in *Section 3.4* is consistent with the on-site operation and drainage features of the landscape.

In the 2009 aerial imagery, the low point of the flood plain and overland flow path are evident by the comparably greener and darker landscape between Ray Road and the existing dam located approximately 370m due west from Ray Road.

These features support the flood plain and overland flow path formation identified from LiDAR elevation data.

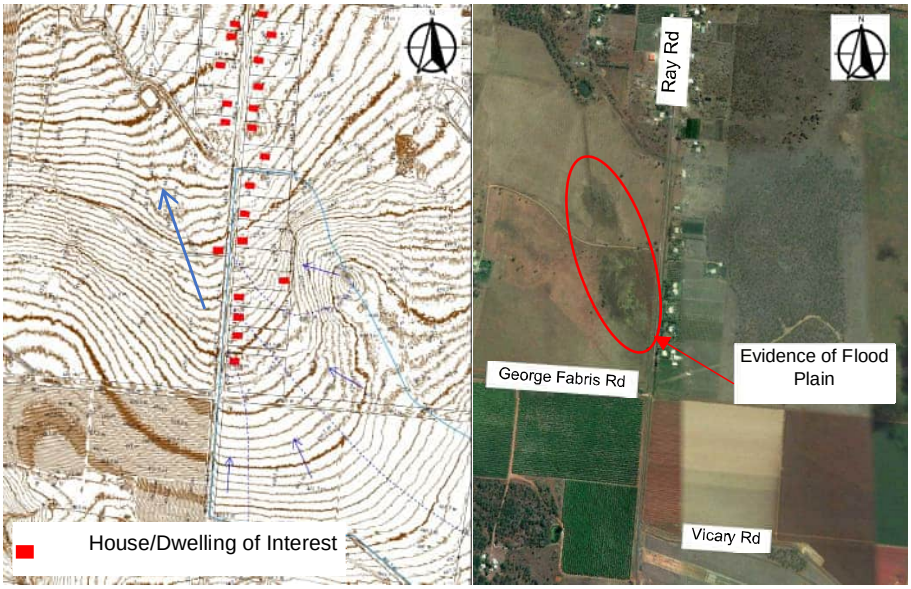


Figure 8: 2018 LiDAR Elevation Data & 2009 Aerial Imagery

The implications for overland flow paths through this flood plain investigation area remains relevant to the current review because:

a) The majority of this flood plain investigation area is currently agricultural land, consistent with the land use in 2009; and
b) The 2018 LiDAR elevation data was used to identify the low flow channel of the flood plain investigation area.

Shown in *Figure 8* above, several houses/dwellings of interest are generally located within the flood plain investigation area between George Fabris Road and Chinaman Creek. Investigation of the contour elevation data identified four (4) stormwater catchments (Catchment A, B1, B2, and B3) that contribute to stormwater runoff conveyed towards the flood plain investigation area.

Section 3.6 considers the extent of the flood plain investigation area during the 100-year ARI rainfall event relative to the flood risk for identified houses/dwellings of interest.

3.6 Southern Flow Path – Flood Investigation Area

Preliminary one-dimensional flood modelling was undertaken between George Fabris Road and Chinaman Creek for the 100-year ARI design rainfall event using the HEC-RAS software program.

The purpose of this preliminary modelling was to understand the potential extent of flooding within the Chinaman Creek catchment area and to identify how the flow paths during peak flow events interact with the available drainage corridors. The outcomes from the flood modelling enabled a greater understanding of the flooding risks to the houses/dwellings between George Fabris Road and Chinaman Creek with frontage to Ray Road.

The preliminary 100-year ARI flood plain investigation mapping developed using HEC-RAS is provided in *Attachment 3***.

Important <u>Note on modelling limitations:</u>

The one-dimensional HEC-RAS software program can generate a relatively quick and simplified model using available input data including stormwater peak flow information and LiDAR elevation data.

This model adopts several assumptions, catchment permeability fractions, runoff rates, and catchment response times that have not been independently verified. The output from the HEC-RAS model (i.e. 100-year ARI flood plain map) should not be considered a comprehensive representation of the flood plain investigation area.

The model was undertaken to inform the community of the <u>general flood extent</u> and potential flooding risks to properties adjacent to Ray Road.

The resolution of the model is <u>not</u> sufficient to confirm the flood implications for a particular house/dwelling or determine accurate flow depth across the flood extents.

This model must not be relied upon to inform flood immunity, flood depths or peak flood extents.

Mareeba Shire Council and Trinity Engineering and Consulting take no responsibility for decisions made by individual landowners based on this preliminary 100-year ARI flood plain investigation map.

The preliminary model indicated that there is a potential for several allotments fronting Ray Road between Chinaman Creek and George Fabris Road to be impacted by flooding, particularly those properties with the house/dwelling located towards the front of the property.

Property flooding near the George Fabris Road / Ray Road intersection is evident in photographs and video footage documented by Council and the community in previous rainfall events. *Figure 9* shows an example of water overtopping Ray Road near this intersection in March 2024.

Figure 9: George Fabris Road / Ray Road Intersection (Source: M. Campman)

The available elevation data and photo/video evidence was used to establish with reasonably high confidence that the formation of Ray Road typically restricts stormwater being conveyed from east to west until it reaches the cross-road culverts at Chinaman Creek. However, when the volume of stormwater exceeds the capacity of the large roadside drain, assessments indicate runoff will overtop the road as shown in *Figure 9*.

Inundation of properties is further supported by the road crown level typically being higher than the ground surface levels of properties with frontage to Ray Road between George Fabris Road and Chinaman Creek. Therefore, when the road is overtopped, the property inundation is further exacerbated.

The following drainage capacity limitations in the southern section of the catchment are noted:

a) The capacity of the Ray Road eastern drain between George Fabris Road and Chinaman Creek generally varies between 4m^3/s and 16m^3/s;
b) The existing Chinaman Creek crossroad culvert capacity is assessed as approximately 8m^3/s; and
c) The catchment runoff required to be conveyed by the above infrastructure significantly exceeds their capacity. Specifically, runoff north from the Mareeba Airport is in the order of 50m3/s* and is unable to be contained in current drainage corridors (e.g. runoff, in peak flow events, overtops Ray Road south from the Chinaman Creek culverts before it arrives at the road crossing);

   **Peak flow is for the 100-year ARI (1% AEP) rainfall event and assumes recommended upstream drainage infrastructure upgrades are in place.*

Runoff overtopping Ray Road and the localised inundation of properties are attributed to peak flows (and bypass flows) from upstream catchments (south from George Fabris Road and east from Ray Road) being far in excess of the eastern drain's capacity to contain these flows.

Assessment of runoff from the contributing stormwater catchments compared with existing roadside drainage capacity indicates that property inundation and overtopping Ray Road may be more frequent than the 2-year ARI rainfall event. Based on the assessments, flooding is likely to occur, on average, more frequently than once every two years.

Figure 10 to *Figure 12* below show examples of the existing ground surface levels (adjacent dwellings) relative to the level of Ray Road.

The review of ground surface levels for each property along the eastern side of Ray Road between George Fabris Road and Chinaman Creek is also provided in *Attachment 4*.

The validity of the preliminary flood model is considered reasonable for the purpose of identifying the general flood extent because it aligns with the topography and hydrology of the southern stormwater catchments. In particular, the runoff arriving to the flood plain investigation area is a combination of the following:

a) Approximately half of the total Ray Road catchment area (400 Ha) discharges to Chinaman Creek (Catchment B1, B2, B3, and most of Catchment A) less the flows conveyed within the existing drainage network;
   Note, it is conservatively assumed that runoff generally bypasses the intermediate catchments to reach the Chinaman Creek outlet.
b) The topography of the catchment area upstream (north) from George Fabris Road directs runoff into a flood plain corridor between George Fabris Road and Chinaman Creek; and
c) The capacity of existing drainage infrastructure, including the Ray Road table drains, are undersized and generally provide a level of service less than the 2-year ARI rainfall event.

As stated above, the preliminary modelling undertaken within the study area provides a general indication of the 100-year ARI flood extent and potential risk of flooding to existing houses/dwellings with frontage to Ray Road between George Fabris Road and Chinaman Creek. The preliminary model is not to be relied upon to inform flood immunity, flood depths or peak flood extents.

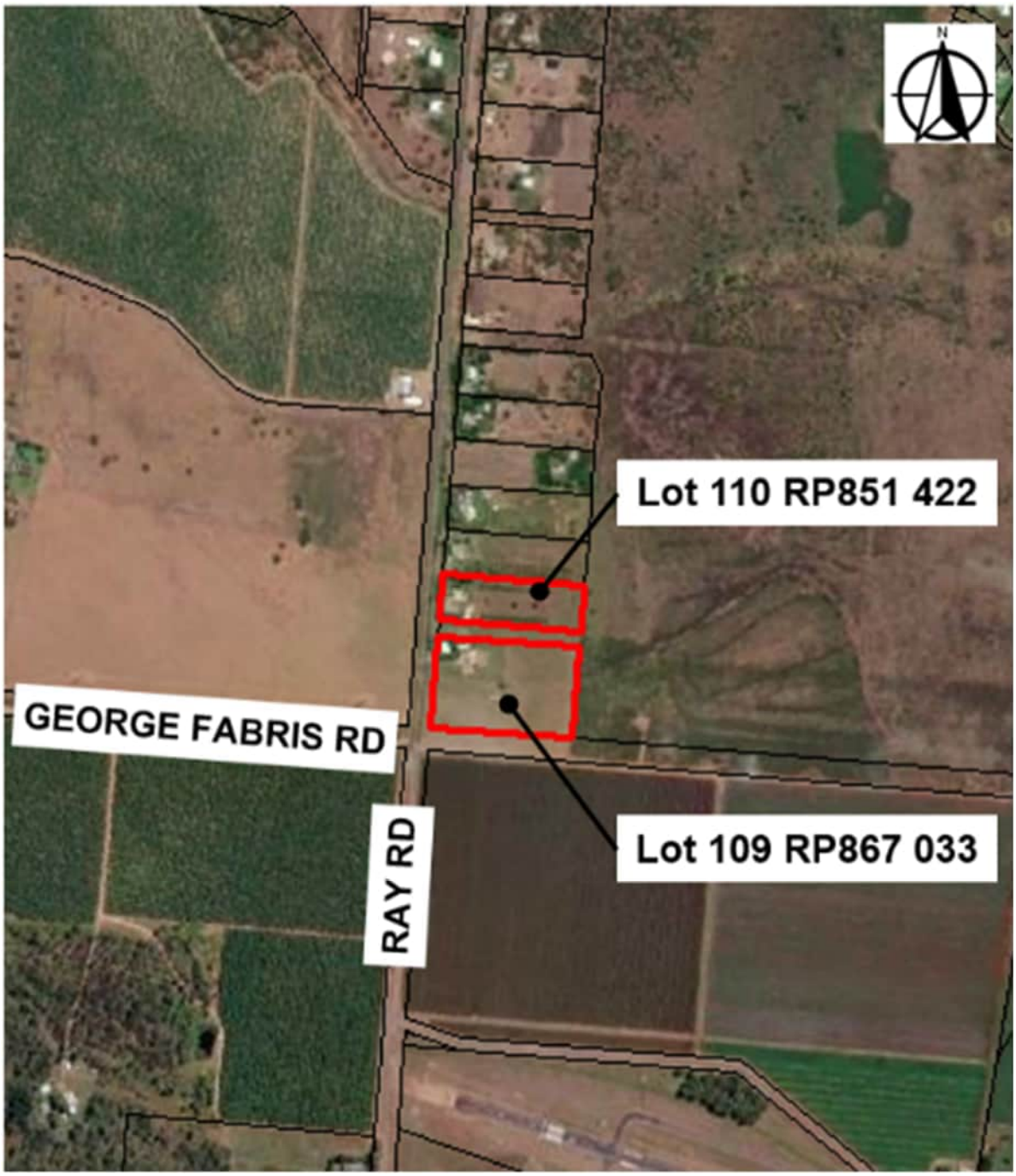


Figure 10: Ray Road Lots - Aerial Imagery

Lot 109 RP867033

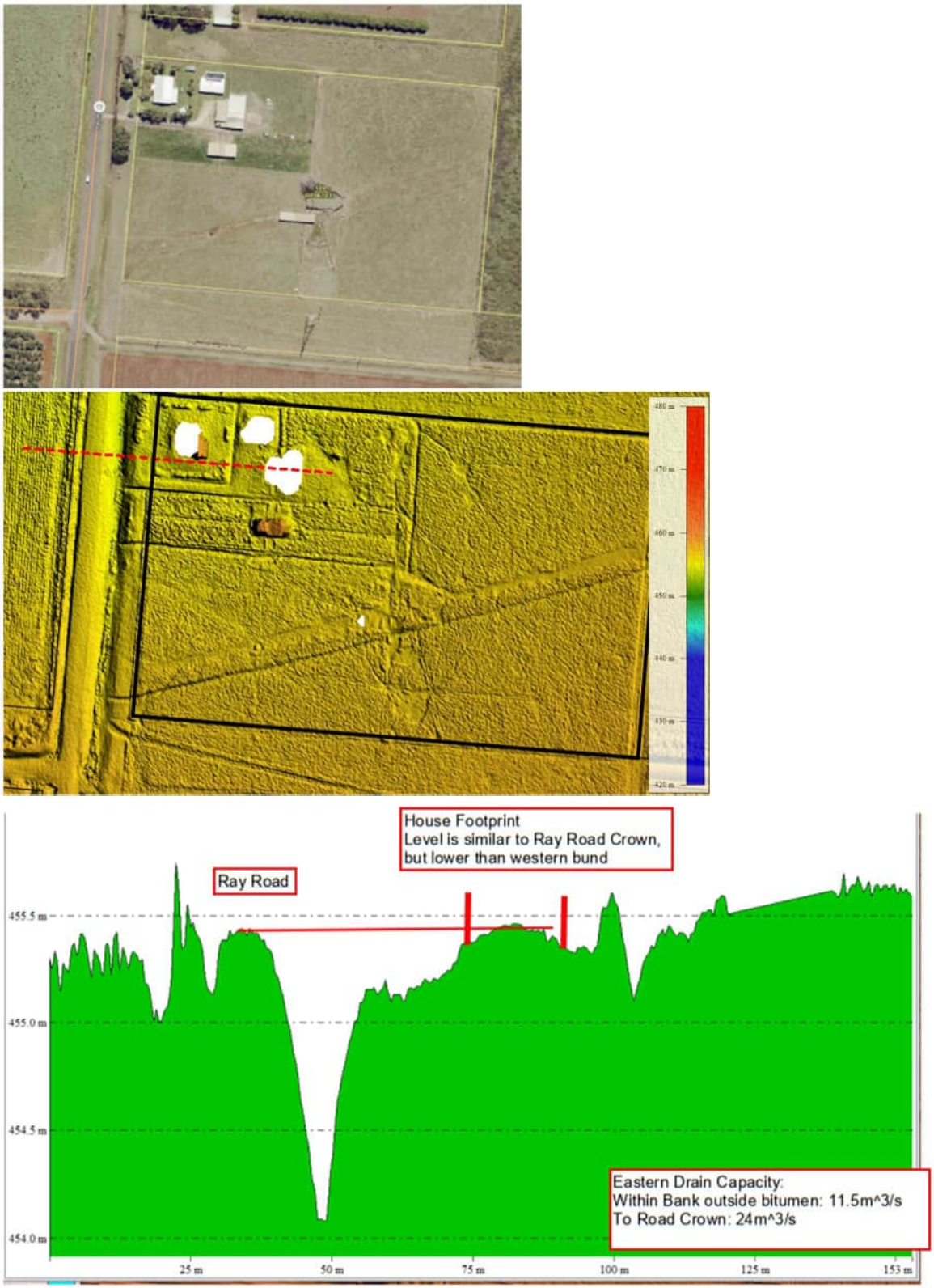


Figure 11: Ground Surface Levels – Lot 109 RP867033

Lot 110 RP851422

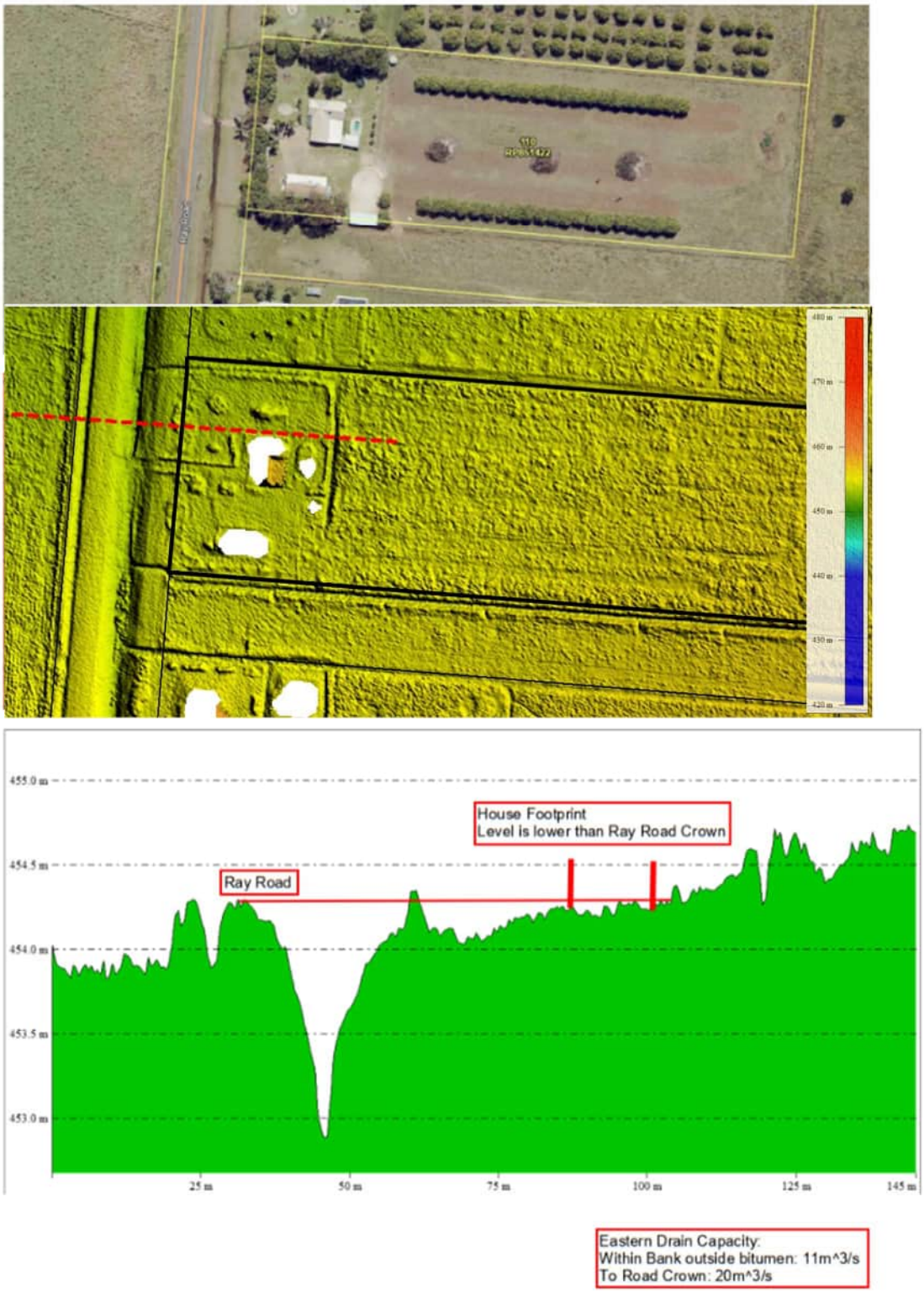


Figure 12: Ground Surface Levels – Lot 110 RP851422

3.7 Catchment Constraints

The Ray Road drainage investigation identified multiple constraints within the study area that represent a challenge for efficient drainage infrastructure upgrades.

The main catchment constraints were:

a) Total catchment area is approximately 820 hectares;
b) Peak flow during the 100-year ARI rainfall event in the order of 170m^3/s discharging to the west from Ray Road;
c) Existing crossroad culvert capacities along Ray Road generally provide a level of service for the 1 to 2-year ARI rainfall event (excluding Jennings Road and the Kennedy Highway culverts);
d) The flood plain corridor between George Fabris Road and Chinaman Creek does not have security of tenure west from Ray Road, so drainage capacity upgrades to infrastructure are currently restricted to the geometry and topography of the road reserve;
e) There are a limited number of available drainage corridors (with security of tenure). Those being:
    - Atherton Creek;
    - Chinaman Creek;
    - Coolamon Close;
    - Sun Water Access Road;
    - Jennings Road; and
    - The Kennedy Highway (via Zenel Road and Council's freehold land).
f) The floor levels of houses with frontage to Ray Road between George Fabris Road and Chinaman Creek appear to be generally built at or below the crown level of Ray Road; and
g) Driveway accesses to most properties along Ray Road are via a causeway or culvert crossover. The latter typically restricts flow conveyance in roadside drains resulting in stormwater ponding upstream from the access culvert and reduced capacity of the drain.

3.8 Findings From The 2024 Drainage Study

Key findings from the 2024 Drainage Investigation include:

a) The longitudinal grade of Ray Road is relatively flat (less than 1% grade) with large upslope stormwater catchment areas;
b) Many existing houses located between George Fabris Road and Chinaman Creek are located within the flood plain corridor and have limited flood immunity;
c) The current capacity of most crossroad culverts on Ray Road do not achieve the desired 10-year ARI level of service, (the desired level of service is informed by QUDM Table 7.3.1);
d) The flood plain corridor on the western side of Ray Road, between George Fabris Road and Chinaman Creek, does not have security of tenure;
e) Of the six (6) existing drainage corridors, two (2) corridors (Chinaman Creek and Coolamon Close outlet corridors) receive in the order of 80% of the peak flows from the Ray Road study area. Note, the western flood plain corridor ultimately reaches Chinaman Creek downstream from Ray Road.

4.0 DRAINAGE UPGRADE OPTIONS

The investigation of potential upgrade opportunities for Ray Road has identified that there is no single solution to effectively resolve the existing drainage issues. Rather multiple solutions to progressively improve the drainage performance and flood immunity within the Ray Road catchment area are required.

The large size of stormwater catchments, resulting peak flows, and cost of high-capacity drainage infrastructure are significant constraints to resolving the current drainage issues.

Note, the combined impact of multiple solutions, if affordable, does not eliminate all flooding and drainage issues. However, these outcomes would benefit the existing level of service of drainage infrastructure within the Ray Road catchment area.

The significant runoff generated by the catchment area and limited available stormwater outlet corridors with security of tenure for drainage, creates a challenge for mitigating drainage and flooding issues up to and including the 100-year ARI rainfall event.

The below sub-sections summarise the drainage infrastructure upgrades identified to increase the level of service from less than the 2-year ARI rainfall event, up to the desired level of service for the road generally able to convey the 10-year ARI rainfall event.

4.1 Drainage Upgrade Opportunities – General Advice

Drainage infrastructure upgrades identified in the DMP are based on the following principles:

a) Increase the capacity of crossroad culverts and associated downstream open drains to convey runoff under Ray Road and west towards downstream creek systems. These upgrades commence from the southern end of Ray Road to reduce bypass flows conveyed downstream;
b) Increase the capacity of existing roadside table drains to contain more stormwater within the road reserve and minimise runoff overtopping the road crown or entering adjacent private property;
c) Construction of detention basins for new developments proposed within the study area to avoid increased flows from development; and
d) Align road and drainage corridors in new development areas to direct runoff to locations aligning with new or proposed road crossing infrastructure and downstream drainage corridors.

Descriptions of drainage infrastructure upgrades are provided in the following sections.

Note, the *Flow Master* software package was used to calculate flow capacity of drainage infrastructure based on the Mannings Equation. Advice on drainage capacity is provided for the purpose of understanding the level of service achieved at a concept level. Further calculations and checks should be undertaken during detailed design and/or construction phase works to confirm the capacity achieved by drainage infrastructure.

4.2 Atherton Creek Cut Off Drain

This upgrade seeks to construct a new open drain (and/or formalise the existing drainage controls) located in an unformed road corridor contained within Catchment A, east from Ray Road and south-east from the airport. The cutoff drain is proposed to extend between the eastern road reserve boundary through to Atherton Creek (western boundary of Catchment A). Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to intercept and divert approximately 25% of the Catchment A runoff towards Atherton Creek to reduce the runoff conveyed to the Airport, and subsequently reduce the bypass flows downstream into the Chinaman Creek catchment.

The desired level of service for this drainage upgrade is for the 100-year ARI rainfall event to mitigate bypass flows conveyed downstream (south) towards the airport.

A drain of this capacity would have dimensions in the order of a 12m wide by 1m deep grass-lined trapezoidal drain with 1v in 4h batters (4m base width) and 1200m in length, refer Table 4 below.

Note, the practical depth of the drain will need to be assessed with the adjacent landowner(s) given ongoing farming operations on both side of the road reserve.

Table 4: Atherton Creek Cut Off Drain Capacity

		Drain
Existing	Drain Capacity [1]	Nil
	Level of Service [2]	Nil
Proposed	Drain Capacity	9.5 m3/s
	Drain Profile	1.0m depth x 4.0m base width (12.0m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~1200m (0.5%)
	Level of Service	100-year ARI

[1] The proposed drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flow from upstream catchments.

An extract of the Atherton Creek drainage upgrades is provided in *Figure 13* below.

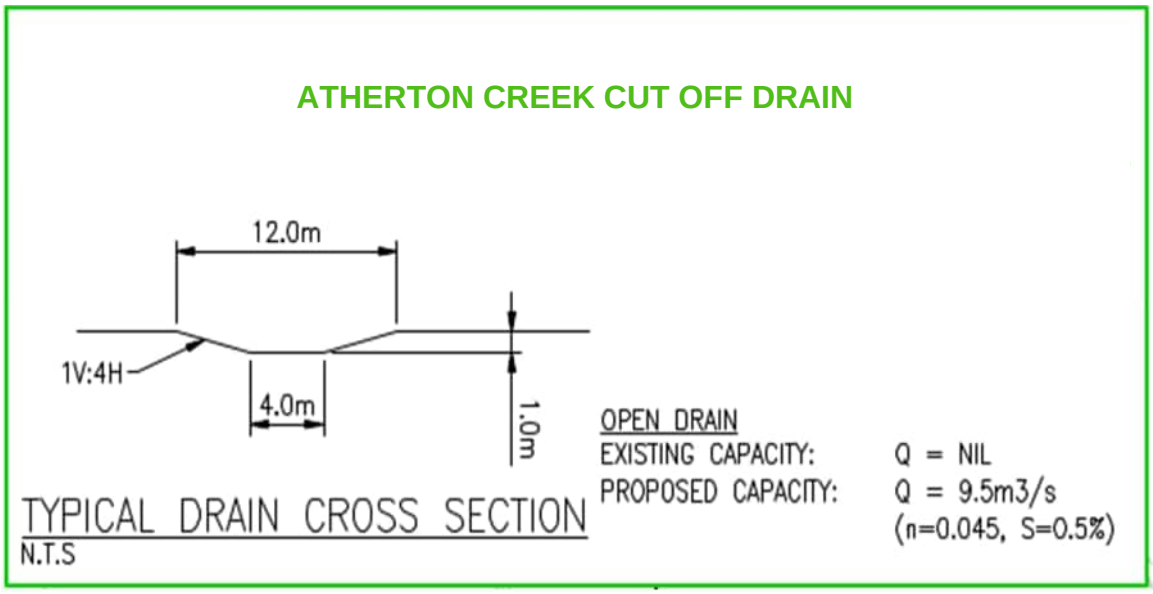


Figure 13: Atherton Creek Drainage Upgrades

4.3 Airport Drain & Culvert Widening

This upgrade proposes to widen the main airport drain and associated taxiway access culvert crossings. It is understood that the Civil Aviation Safety Authority (CASA) requirements for stormwater and drainage infrastructure adjacent the taxiway constrains the maximum depth of the drain. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to increase the capacity of the existing drain and associated culvert crossings to reduce the bypass flows conveyed to the Chinaman Creek catchment, noting the downstream high capacity (28.0m3/s) 3/1800x1800 RCBC array west from the airport (crossing under Ray Road) is currently underutilised. Refer *Figure 14* below.

Figure 14: Example of Runoff Exceeding the Capacity of the Airport Drain (Looking East from Ray Road)

The desired level of service for this drainage upgrade is for the 10-year ARI rainfall event, however, the topography of the existing airport and runway, and likely spatial constraints may limit the level of service to between the 2 and 5-year ARI rainfall event.

The drain upgrades seeks to widen the airport drain to a minimum 1.0m deep, 18.0m base width (30.0m top width) grass-lined trapezoidal drain with 1v in 6h batters and length of approximately 800m. It is expected that widening the drain will need to take into consideration any minimum clearances to the taxiway required under CASA.

Where possible, a low bund should also be considered along the northern bank of the drain to contain runoff currently observed escaping the drain and running north to Vicary Road.

The taxiway access culvert upgrades seeks to widen the existing culvert array to suit the upgraded drain width and capacity with three additional 1800 x 750 RCBC cells. Feasibility to be confirmed with detailed design.

Note, the culvert array upgrade described in Table 5 below is for one (1) taxiway access.

Table 5: Airport Drain Widening & Culvert Capacity

		Drain	Culverts
Existing	Capacity [1,2]	13.3 m3/s [3]	7.2 m3/s
			3/1800x750 RCBC
	Level of Service [4]	2-year ARI	50-year ARI
Proposed	Capacity	14.5m3/s	11.5m3/s
	Profile	1.0m depth x 18.0m base width (30.0m top width, 1v in 6h)	6/1800x750 RCBC
	Length (Average Longitudinal Grade)	~800m (0.1%)	~25m [5]
	Level of Service	5-year ARI	50-year ARI

[1] The proposed drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The proposed culvert capacity has been assessed based on a Mannings roughness coefficient of 0.013.
[3] The existing drain capacity is an average of the assessed capacity at multiple sections along the drain.
[4] The Level of Service excludes bypass flows from upstream catchments.
[5] The length of the proposed culvert array is based on a single culvert crossing of the airport drain.

An extract of the Airport drainage upgrades is provided in *Figure 15* below.

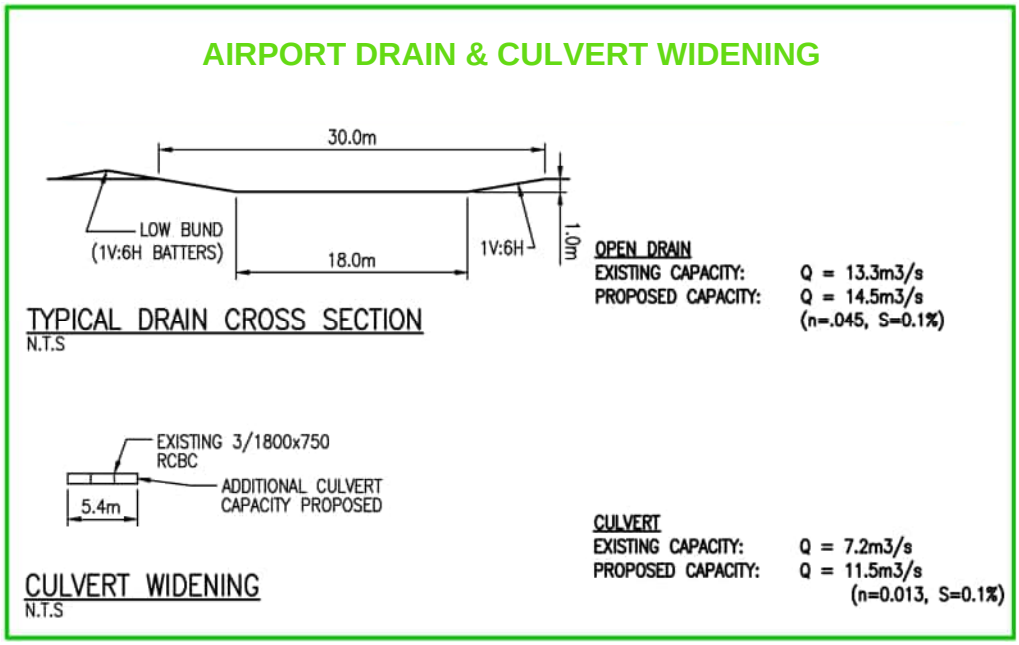


Figure 15: Airport Drainage Upgrades

4.4 Reprofile Table Drains – Airport to George Fabris Road

This upgrade seeks to increase the capacity of the eastern and western Ray Road table drains between the Airport and George Fabris Road. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

Note, it is considered that this upgrade and the other table drain upgrades identified in Sections 4.11 to 4.16 can be carried out under operational / maintenance works independently by Council. These upgrades are not considered major infrastructure works requiring external resources for investigation, construction and delivery compared with other drainage upgrades including the Chinaman Creek drainage upgrades identified in Section 4.2.

The intent of this DMP upgrade is to increase the capacity and level control of the roadside table drains to contain more runoff and minimise the extent and duration that bypass flows overtop the road crown.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserve of Ray Road without encroaching into the existing road pavement and property boundaries.

These drainage upgrades seek to reprofile each of the existing roadside table drains to a minimum 0.5m deep grass-lined trapezoidal drain profile with 1v in 4h batters and 2.0m base width (6.0m top width) with length of approximately 820m.

Table 6: Airport to George Fabris Road Table Drain Capacity

		Drain [1]
Existing	Drain Capacity [2]	~0.6 to 8.2 m3/s
	Level of Service [3]	Up to 5-year ARI
Upgraded	Drain Capacity	2.7 to 8.2 m3/s
	Drain Profile	0.5m depth x 2.0m base width (6.0m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~820m (1.6%)
	Level of Service	Up to 5-year ARI

[1] Drain capacity and profile nominated are the dimensions for a single table drain (i.e. one side of the road).
[2] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[3] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Airport to George Fabris Road table drain upgrades is provided in *Figure 16* below.

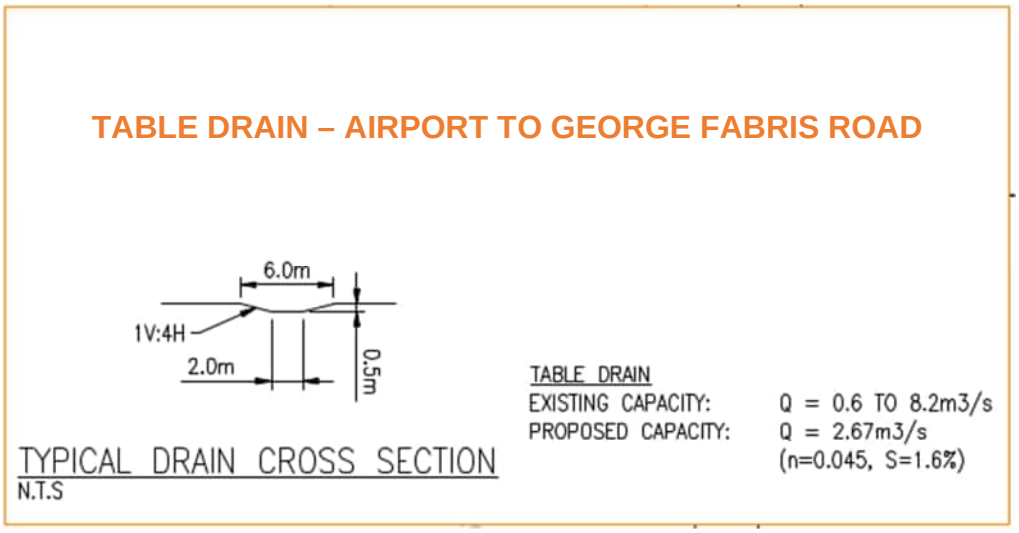


Figure 16: Airport to George Fabris Road Table Drain Upgrade

4.5 George Fabris Road Causeway

This drainage upgrade seeks to construct a new concrete causeway on George Fabris Road, at the George Fabris – Ray Road intersection. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to minimise the opportunity for stormwater runoff (from Catchment B3) and banana plant debris to overtop Ray Road towards the eastern roadside table drain at the George Fabris – Ray Road intersection.

The concrete causeway will be approximately 10-20m in length and the invert generally aligned with the existing flow path across George Fabris Road.

Earthworks excavation would also be required immediately north of the causeway to interface with the existing drain profile on the western side of Ray Road.

Note, it is expected that this causeway upgrade will be undertaken to interface with the drain reprofiling between George Fabris Road and Chinaman Creek (Section 4.6), and the future drainage corridor north from George Fabris Road (Section 4.7).

An extract of the George Fabris Road drainage is provided in *Figure 17* below.

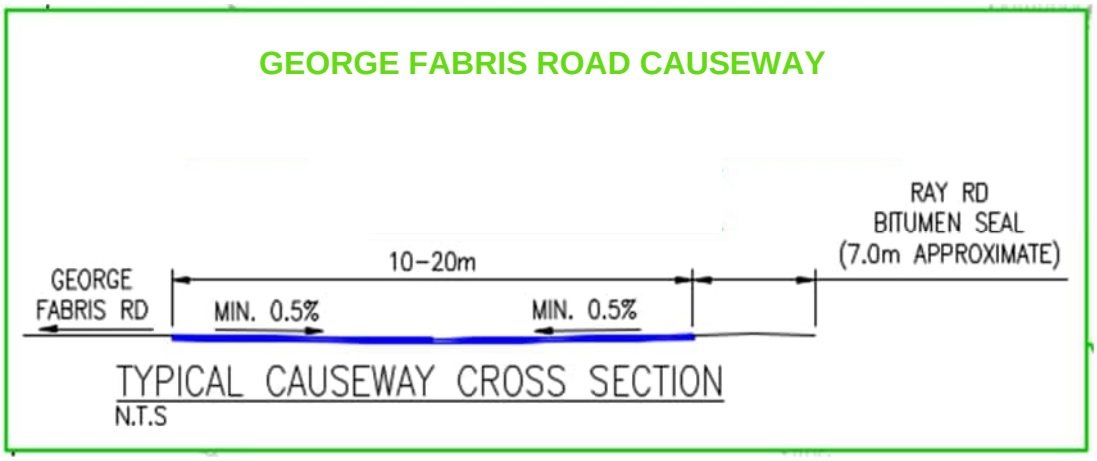


Figure 17: George Fabris Road Drainage Upgrades

4.6 Reprofile Western Table Drain – George Fabris Road to Chinaman Creek

This upgrade seeks to increase the capacity of only the western Ray Road table drain between the George Fabris Road and Chinaman Creek. It is considered that upgrading the eastern table drain would achieve minimal capacity improvement noting the existing profile is generally maximised between the edge of bitumen and adjacent property boundaries. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to reduce the extent and duration that runoff overtops Ray Road from the west into the eastern table drain before reaching Chinaman Creek by containing more runoff in the table drain.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserve of Ray Road without encroaching into the existing road pavement and property boundaries.

It is expected that this drainage upgrade will interface with the Chinaman Creek drainage upgrades outlined in Section 4.8 and the future drainage corridor upgrades outlined in Section 4.7.

These drainage upgrades seek to reprofile the western table drain to a minimum 0.6m deep grass-lined trapezoidal drain profile with 1v in 2h batters and 3.5m base width (5.9m top width) with length of approximately 940m.

Table 7: George Fabris Road to Chinaman Creek Western Table Drain Capacity

		Drain
Existing	Drain Capacity [1]	~2.4 to 5.0 m3/s
	Level of Service [2]	<1-year ARI
Upgraded	Drain Capacity	3.1 to 5.0 m3/s
	Drain Profile	0.6m depth x 3.5m base width (5.9m top width, 1v in 2h)
	Drain Length (Average Longitudinal Grade)	~940m (0.7%)
	Level of Service	<1-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

An extract of the George Fabris Road to Chinaman Creek drain upgrades is provided in *Figure 18* below.

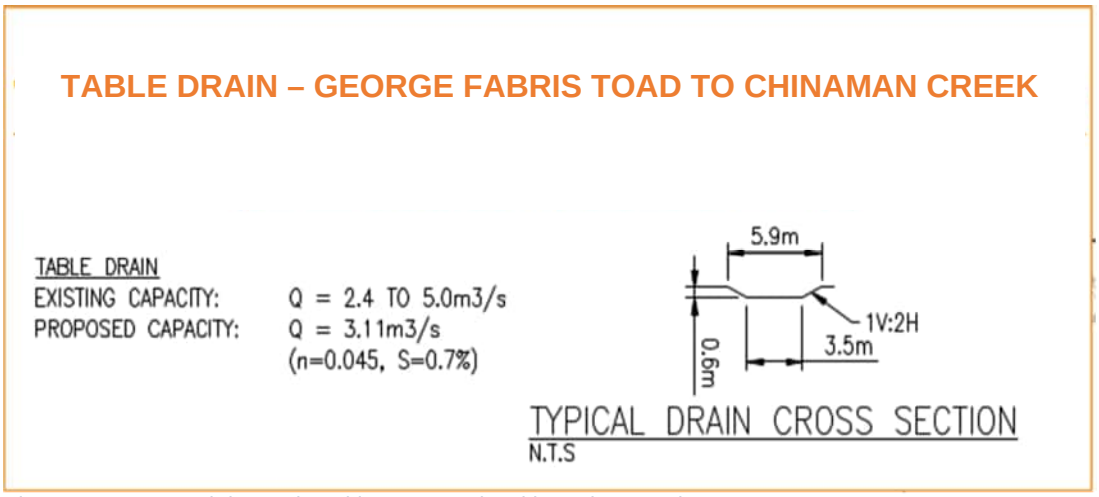


Figure 18: George Fabris Road to Chinaman Creek Table Drain Upgrade

4.7 Future Drainage Corridor – George Fabris Road to Chinaman Creek

This upgrade proposes to secure land tenure through drainage easements and/or land resumption to establish a new drainage corridor west from Ray Road between George Fabris Road and Chinaman Creek. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The proposed drainage corridor would be located over existing Lot 139 on SP179170 and Lot 12 on SP311000, two freehold land parcels with no existing security of tenure arrangements in place.

The intent of this DMP upgrade is to:

- Establish a high-capacity drainage corridor between George Fabris Road and Chinaman Creek generally aligned with the existing flood plain low point and overtopping points along George Fabris Road and Ray Road;
- Mitigate bypass flows conveyed downstream to Coolamon Close;
- Minimise the duration and frequency that allotments with frontage to Ray Road, north from George Fabris Road, are impacted by drainage issues and flooding; and
- Intercept runoff on the western side of Ray Road at George Fabris Road.

The desired level of service for this drainage upgrade is the 100-year ARI rainfall event to significantly minimise the impacts that the existing flood plain investigation area has on properties near Chinaman Creek.

Note: Council will need to initiate discussions with the property owner(s) of Lot 139 on SP179170 and Lot 12 on SP311000 to negotiate easement/s for drainage and/or purchase the land required for this drainage corridor prior to design and construction of the drainage corridor.

The drainage corridor is proposed to be nominally 25m wide and in the order of 1400m long. It is proposed that this corridor will contain a new 1.0m deep grass-lined trapezoidal drain profile with a 12.0m base width and 1v in 5h batters, and a 5m wide access track on one side of the drain.

Table 8: Future Table Drain – George Fabris Road to Chinaman Creek Capacity

		Drain
Existing	Drain Capacity [1]	NIL
	Level of Service [2]	NIL
Proposed	Drain Capacity	40.0m3/s
	Drain Profile	1.0m depth x 12.0m base width (20.0m top width, 1v in 5h)
	Drain Length (Average Longitudinal Grade)	~1400m (0.7%)
	Level of Service	100-year ARI

[1] The proposed drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

Further to delivery of the future drainage corridor, it is expected that this drainage upgrade will be undertaken generally in two stages. The first (immediate) stage will be initiating discussions and negotiations with landowners, supported by development of a concept level design, to establish a drainage corridor with security of tenure (either through land resumption or drainage easements).

The second stage will be to undertake detailed design and construction of the future drainage corridor between George Fabris Road and Chinaman Creek.

Note, the design process should also consider the following infrastructure elements:

- Culverts crossing the drain to maintain access along the existing private road just south from the structures in Lot 12 on SP311000; and
- Relief culverts connecting the Ray Road drain/s into the future drainage corridor to minimise the frequency and duration that runoff overtops Ray Road between George Fabris Road and Chinaman Creek.

An extract of the Future Drainage Corridor upgrades is provided in *Figure 19* below.

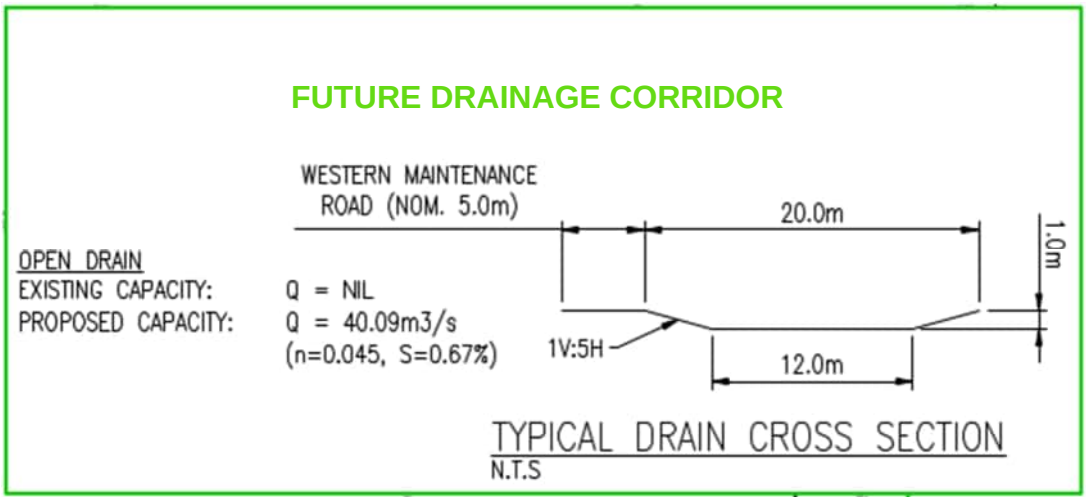


Figure 19: Future Drainage Corridor Upgrades

4.8 Chinaman Creek Culverts and Downstream Drain Widening

This drainage upgrade seeks to increase the capacity of the existing Chinaman Creek culvert crossing under Ray Road and widen the drainage corridor (Chinaman Creek) downstream from these culverts. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to:

- Intercept a majority of the upstream catchment runoff that currently bypasses north towards Coolamon Close;
- Minimise the flooding and drainage issues currently impacting properties in this part of the study area; and
- Provide capacity to convey a significant portion of the post-development runoff from the Wylandra Estate in coordination with the developer. Development contribution arrangements will be required between the landowner and Council.

The desired level of service for this drainage upgrade is for the 100-year ARI rainfall event to mitigate bypass flows conveyed downstream (north) towards Coolamon Close.

Note, the practical capacity of the crossroad culvert upgrade is constrained by the runoff able to reach Chinaman Creek, not the peak rainfall assessed for the arriving catchment. This is largely due to catchments flows being restricted by upstream property access crossings/culverts and the capacity of the existing Ray Road eastern drain south from Chinaman Creek.

The drainage upgrades seek to widen the existing Chinaman Creek profile between Ray Road and the eastern boundary of Lot 12 on RP843574 (land parcel 500m north-west from Ray Road). The preliminary profile of the widened drain is a 1.5m deep, 12m base width (24.0m top width) grass-lined trapezoidal drain with 1v in 4h batters and length of approximately 500m.

The culvert upgrades seek to replace the existing culvert array with 8/2100x1500 RCBCs.

Table 9: Chinaman Creek Culverts and Downstream Drain Widening Capacity

		Drain	Culverts
Existing	Capacity [1,2]	~4.0 m3/s (immediately downstream from Ray Road)	8.1 m3/s 3/2100x600 RCBC
	Level of Service [3]	<1-year ARI	<1-year ARI
Upgraded	Capacity	45.4m3/s	50.7m3/s
	Profile	1.5m depth x 12.0m base width (24.0m top width, 1v in 4h)	8/2100x1500 RCBC [4]
	Length (Average Longitudinal Grade)	~500m (0.5%)	~10m (headwall to headwall)
	Level of Service	100-Year ARI	100-Year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The upgraded culvert capacity has been assessed based on a Mannings roughness coefficient of 0.013.
[3] The Level of Service excludes bypass flows from upstream catchments.
[4] The culvert height of 1500mm is limited by existing downstream creek levels and maintaining a minimum creek invert grade of 0.5% at this concept design stage.

An extract of the Chinaman Creek drainage upgrades is provided in *Figure 20* below.

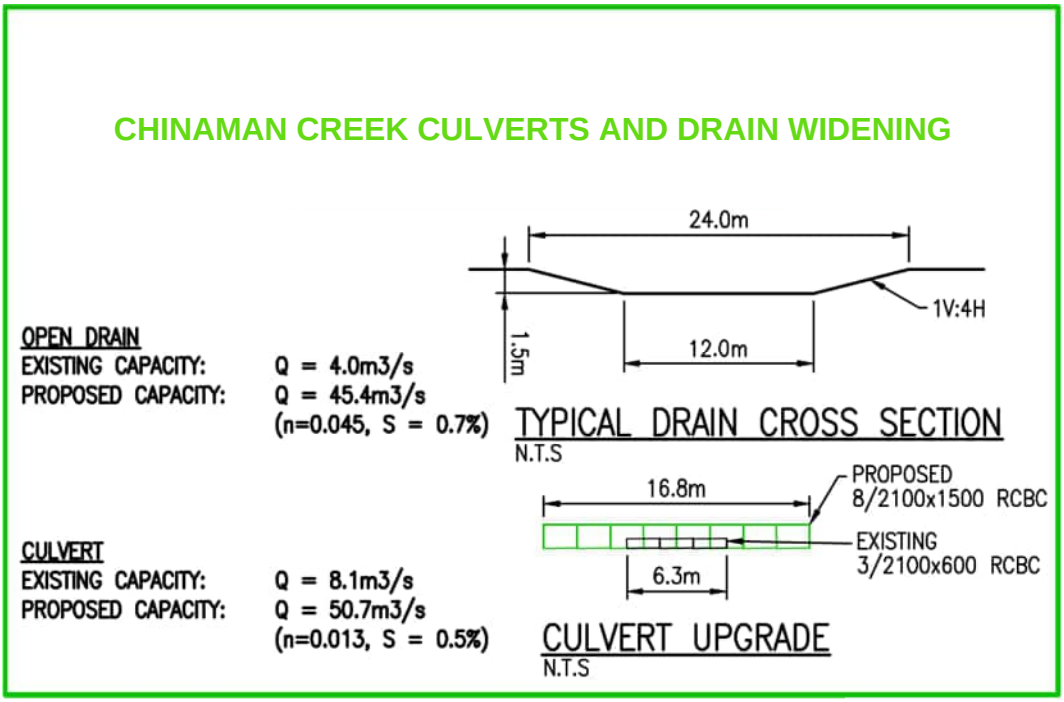


Figure 20: Chinaman Creek Drainage Upgrades

4.9 Reprofile Table Drains – Chinaman Creek to Coolamon Close

This upgrade seeks to increase the capacity of the eastern and western Ray Road table drains between Chinaman Creek and Coolamon Close. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to reduce the duration and extent that water ponds on Ray Road before discharging to the Coolamon Close culverts by containing more runoff within the roadside table drains.

The silt line identified in *Figure 21* highlights that the available capacity of the existing western Ray Road table drain was not sufficient to contain runoff to the road reserve during the rainfall event that occurred on 22 December 2024.

Figure 21: Silt Line On Property Fence West From Ray Road Following 22nd December 2024 Rainfall Event

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserve of Ray Road without encroaching into the existing road pavement and property boundaries.

These drainage upgrades seek to reprofile each of the existing roadside table drains to a minimum 0.4m deep grass-lined trapezoidal drain profile with 1v in 4h batters and 3.0m base width (6.2m top width) with length of approximately 730m.

Table 10: Chinaman Creek to Coolamon Close Table Drain Capacity

		Drain [1]
Existing	Drain Capacity [2]	~0.7 to 1.6 m3/s
	Level of Service [3]	<1-year ARI
Upgraded [1]	Drain Capacity	1.1 to 1.6 m3/s
	Drain Profile	0.4m depth x 3.0m base width (6.2m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~730m (0.5%)
	Level of Service	<1-year ARI

[1] Drain capacity and profile nominated are the dimensions for a single table drain (i.e. one side of the road).
[2] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[3] The Level of Service excludes bypass flows from upstream catchments.

It is noted that further improvement in the capacity of the western table drain may be achieved if the downstream invert can be lowered to better match the downstream invert of the Coolamon Close culverts. Currently, runoff is conveyed from the western table drain into the Coolamon Close drain across a ledge as shown in *Figure 22*.

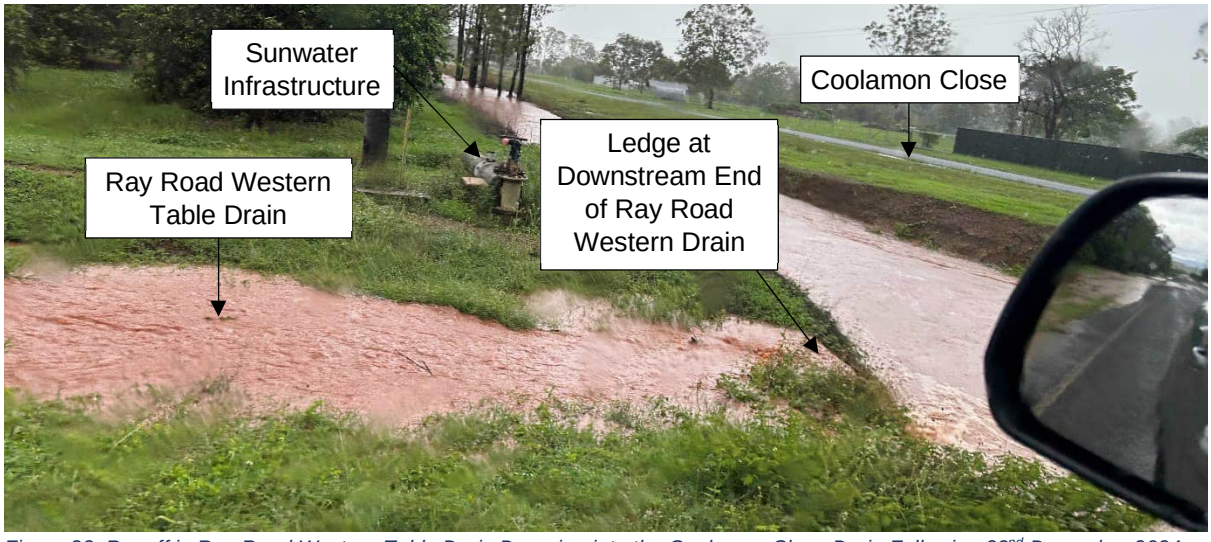


Figure 22: Runoff in Ray Road Western Table Drain Dropping into the Coolamon Close Drain Following 22nd December 2024 Rainfall Event

However, it is understood that Sunwater has existing piped water supply infrastructure in the Ray Road corridor that shares the same alignment as the western table drain and likely limits the depth of the drainage invert to achieve suitable pipe cover. It is inferred that the poor hydraulic outcome photographed in the figure above is a result of this shared drainage and water supply infrastructure corridor.

Potholing the existing Sunwater pipeline should be considered as part of this upgrade work scope, and other similar upgrade work scopes, to identify the depth of cover. It is considered that from this information, the depth and grade of this drainage infrastructure can be optimised.

Where potholing information identifies the pipeline as a potential constraint to the depth and grade of drainage infrastructure, advice on cover requirements and opportunities to relay or consider alternative alignments for piped infrastructure should be sought from Sunwater.

An extract of the Chinaman Creek to Coolamon Close drain upgrades is provided in *Figure 23* below.

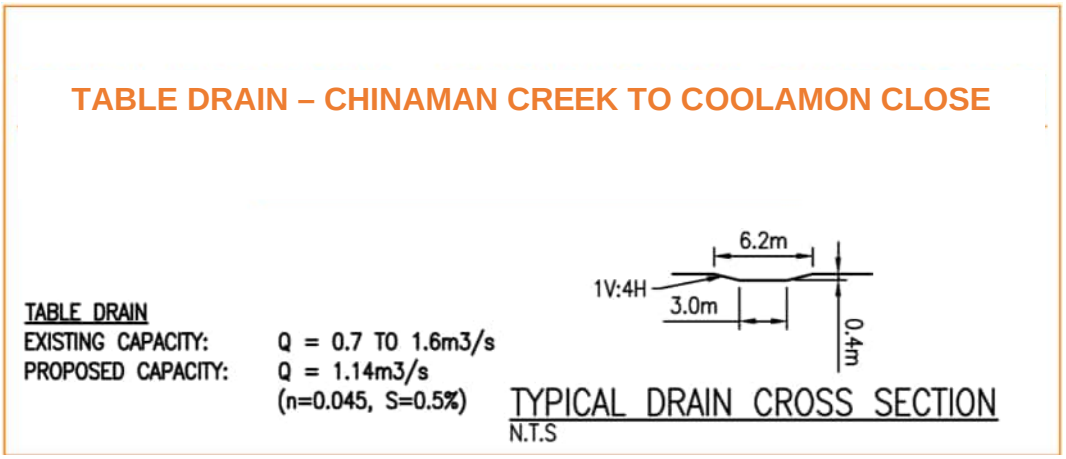


Figure 23: Chinaman Creek to Coolamon Close Table Drain Upgrade

4.10 Coolamon Close Culverts and Downstream Drain Widening

This drainage upgrade seeks to increase the capacity of the existing culvert array crossing Ray Road adjacent Coolamon Close, and widen the drain downstream from these culverts. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to:

- Upgrade this crossroad culvert to achieve capacity to minimise the duration and extent that runoff ponds in the upstream drain, and overtops the road crown of Ray Road;
- Minimise the bypass flow conveyed north towards the Sunwater Access Road; and
- Optimise the capacity increase of this drainage upgrade within the spatial constraints of the existing Coolamon Close road reserve.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing Coolamon Close road reserve without encroaching into the adjacent road pavement and property boundaries.

The drainage upgrades seeks to widen the existing Coolamon Close drain profile between Ray Road and Pleasant Close to a 1.25m deep, 6.0m base width (16.0m top width) grass-lined trapezoidal drain with 1v in 4h batters and length of approximately 385m.

The culvert upgrades seek to replace the existing 4/900 diameter RCP culverts with 8/900x900 RCBCs.

Table 11: Coolamon Close Culverts and Downstream Drain Widening Capacity

		Drain	Culverts
Existing	Capacity [1,2]	~5.5 m3/s (immediately downstream from Ray Road)	7.6 m3/s 4/900 RCP
	Level of Service [3]	<1-year ARI	<1-year ARI
Upgraded	Capacity	19.3m3/s	11.5m3/s
	Profile	1.25m depth x 6.0m base width (16.0m top width, 1v in 4h) *Note: A narrower drain width may be possible with concrete lining of the base of the drain*	8/900x900 RCBC
	Length (Average Longitudinal Grade)	~385m (0.5%)	~10m headwall to headwall (0.5%)
	Level of Service	2-year ARI	<1-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The upgraded culvert capacity has been assessed based on a Mannings roughness coefficient of 0.013.
[3] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Coolamon Close drainage upgrades is provided in *Figure 24* below.

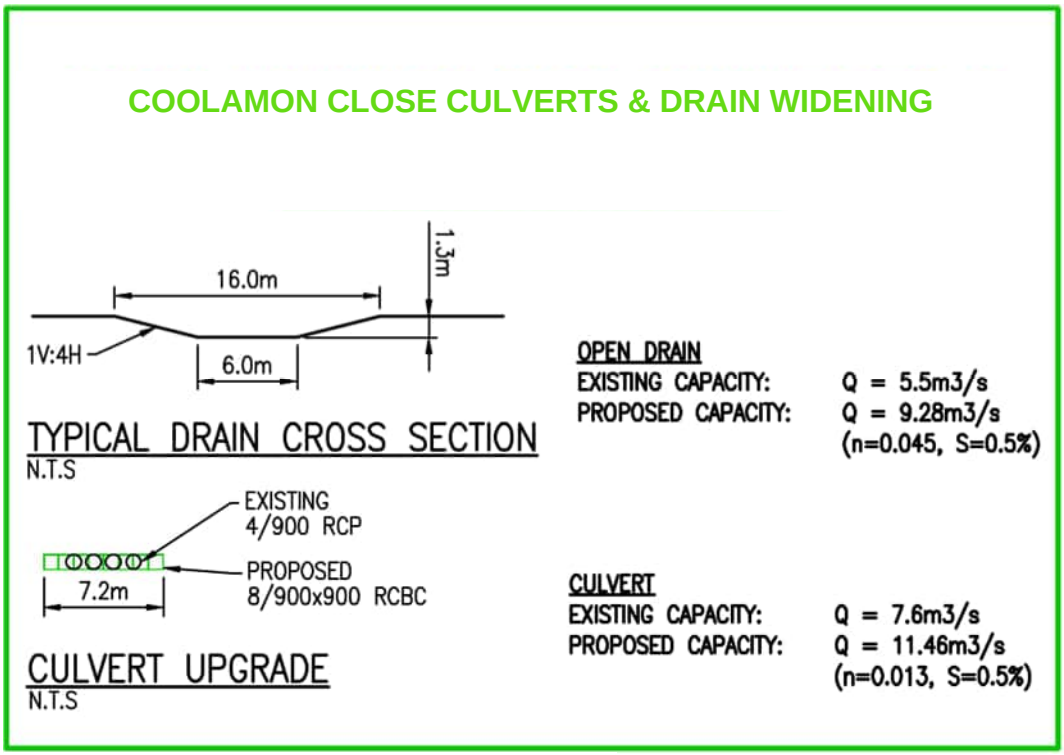


Figure 24: Coolamon Close Drainage Upgrades

4.11 Pleasant Close Culverts and Downstream Drain Widening

This drainage upgrade is effectively the downstream upgrade to the Coolamon Close upgrade under Section 4.3 above.

The upgrade seeks to increase the capacity of the existing Pleasant Close crossroad culvert array, and widen the open drain downstream from these culverts to match the upstream capacity. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to increase the capacity of this existing drainage infrastructure to avoid restricting the increased runoff conveyed from the upstream Coolamon Close culverts post-upgrade as outlined in Section 4.10.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing Coolamon Close and Pleasant Close road reserves without encroaching into adjacent road pavements and property boundaries.

The drainage upgrade seeks to widen the existing open drain profile between Pleasant Close and the existing dam in Lot 3 on RP720985 to a 1.25m deep, 6.0m base width (16.0m top width) grass-lined trapezoidal drain with 1v in 4h batters and length of approximately 460m.

The culvert upgrades seek to replace the existing 3/1050mm diameter RCP culverts with 8/900x900 RCBCs.

Table 12: Pleasant Close Culverts and Downstream Drain Widening Capacity

		Drain	Culverts
Existing	Capacity [1,2]	~8.3 m3/s	7.4 m3/s 3/1050 RCP
	Level of Service [3]	<1-year ARI	<1-year ARI
Upgraded	Capacity	24.4m3/s	11.5m3/s
	Profile	1.25m depth x 6.0m base width (16.0m top width, 1v in 4h) *Note: A narrower drain width may be possible with concrete lining of the base of the drain*	8/900x900 RCBC
	Length (Average Longitudinal Grade)	~460m (0.8%)	~12m headwall to headwall (0.5%)
	Level of Service	2-year ARI	<1-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The upgraded culvert capacity has been assessed based on a Mannings roughness coefficient of 0.013.
[3] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Pleasant Close drainage upgrades is provided in *Figure 25* below.

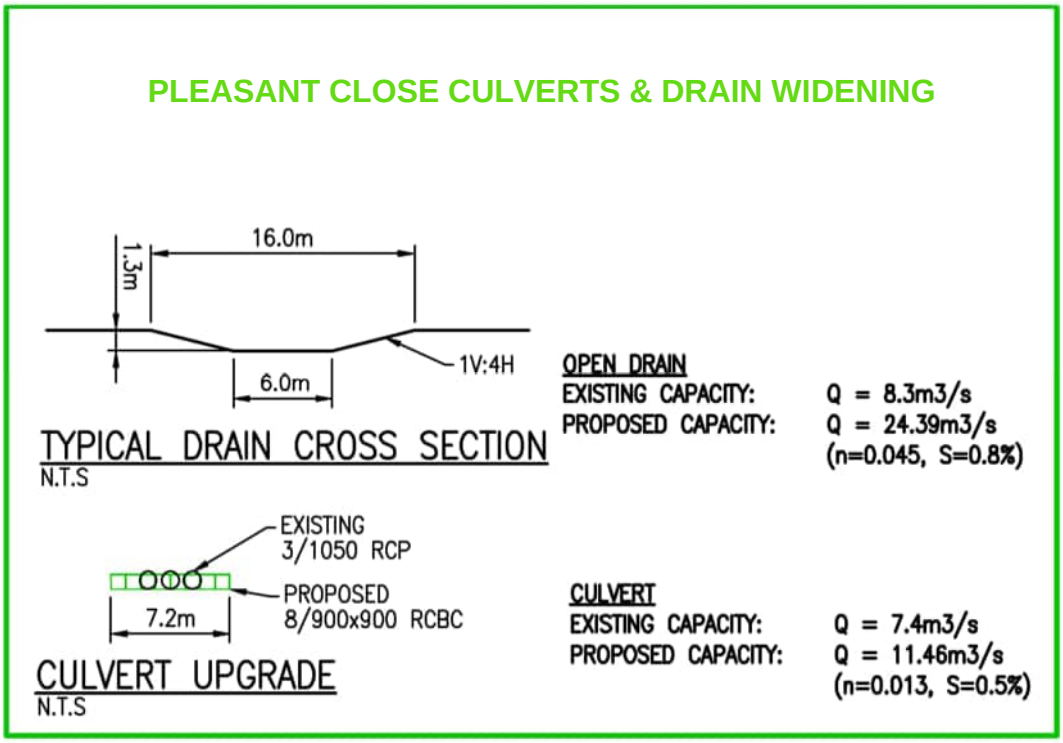


Figure 25: Pleasant Close Drainage Upgrades

4.12 Reprofile Table Drains – Coolamon Close to Sunwater Access Road

This upgrade seeks to increase the capacity of the eastern and western Ray Road table drains between Coolamon Close and the Sunwater Access Road. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to reduce the duration and extent that water ponds on Ray Road before discharging to the Sunwater Access Road culverts by containing more runoff within the roadside table drains.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserve of Ray Road without encroaching into the existing road pavement and property boundaries.

Note: Existing Sunwater infrastructure (water supply pipeline) shares the same corridor as the western roadside table drain at this section of Ray Road. Maintaining minimum cover over this pipeline may limit the depth of any table drain upgrades.

These drainage upgrades seek to reprofile each of the existing roadside table drains to a minimum 0.5m deep grass-lined trapezoidal drain profile with 1v in 4h batters and 4.0m base width (8.0m top width) with length of approximately 880m.

Table 13: Coolamon Close to Sunwater Access Road Table Drain Capacity

		Drain [1]
Existing [1]	Drain Capacity [2]	~1.2 to 2.8 m3/s
	Level of Service [3]	<1-year ARI
Upgraded [1]	Drain Capacity	2.2 to 2.8 m3/s
	Drain Profile	0.5m depth x 4.0m base width (8.0m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~880m (0.4%)
	Level of Service	<1-year ARI

[1] Drain capacity and profile nominated are the dimensions for a single table drain (i.e. one side of the road).
[2] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[3] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Coolamon Close to Sunwater Access Road drain upgrades is provided in *Figure 26* below.

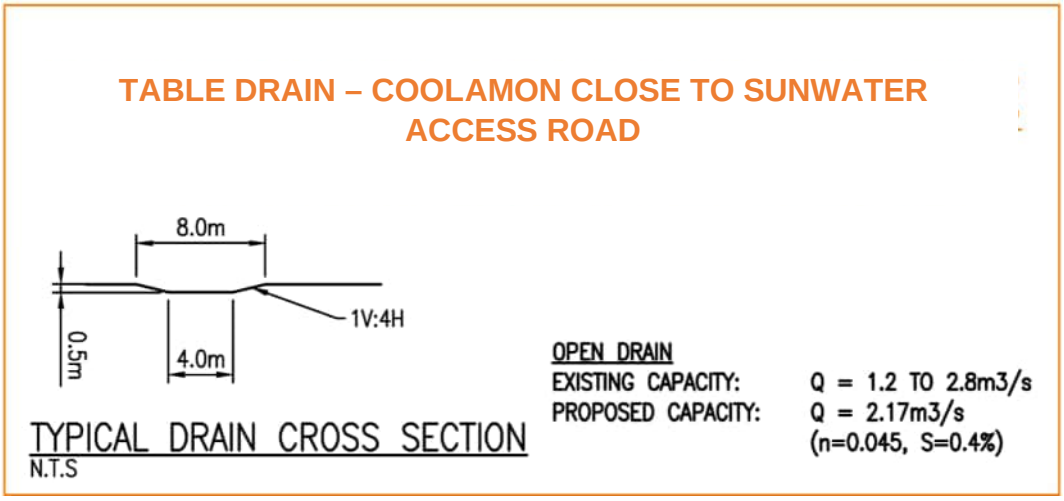


Figure 26: Coolamon Close to Sunwater Access Road Table Drain Upgrade

4.13 Sunwater Access Road Culverts and Downstream Drain Widening

This drainage upgrade seeks to increase the capacity of the existing culvert array crossing Ray Road adjacent to the Sunwater Access Road, and widen the drain downstream from these culverts. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to:

- Minimize the duration and extent that runoff ponds in the drain and overtops the road crown of Ray Road; and
- Minimise the bypass flows conveyed north to Jennings Road.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing Sunwater Access road reserve without encroaching into adjacent road pavements and property boundaries.

The drainage upgrades seek to widen the existing Sunwater Access Road drain profile between Ray Road and Chinaman Creek to a 1.25m deep, 6.0m base width (16.0m top width) grass-lined trapezoidal drain with 1v in 4h batters and length of approximately 1300m.

The culvert upgrades seek to replace [4] the existing 3/1500x750 RCBC array with 6/1500x900 RCBCs.

Table 14: Sunwater Access Road Culverts and Downstream Drain Widening Capacity

		Drain	Culverts
Existing	Capacity [1,2]	~17.6 m3/s	7.5 m3/s 3/1500x750 RCBC
	Level of Service [3]	50-year ARI	2-year ARI
Upgraded	Capacity	22.8m3/s	15.7m3/s
	Profile [4]	1.25m depth x 6.0m base width (16.0m top width, 1v in 4h)	6/1500x900 RCBC
	Length (Average Longitudinal Grade)	~1300m (0.7%)	~11m headwall to headwall (0.5%)
	Level of Service	100-year ARI	20-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The upgraded culvert capacity has been assessed based on a Mannings roughness coefficient of 0.013.
[3] The Level of Service excludes bypass flows from upstream catchments.
[4] It is acknowledged that alternative culvert arrangements may be more cost effective particularly utilising the existing crossroad culverts where possible. Detailed design should investigate the feasibility of achieving the required capacity whilst retaining the existing culverts.

An extract of the Sunwater Access Road drainage upgrades is provided in *Figure 27* below.

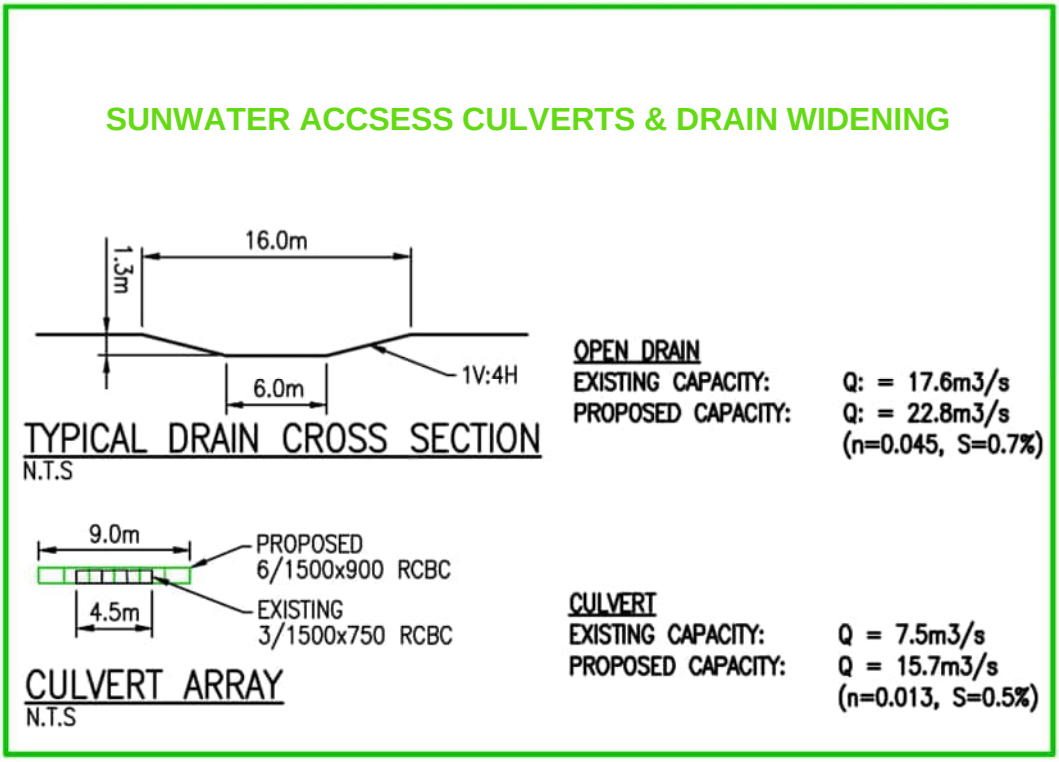


Figure 27: Sunwater Access Road Drainage Upgrades

4.14 Reprofile Eastern Table Drain – Sunwater Access Road to Jennings Road

This upgrade seeks to increase the capacity of the eastern Ray Road table drain between the Sunwater Access Road and Jennings Road. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

It is considered that upgrading the western table drain is not required because the stormwater catchments generally grade away from Ray Road and the runoff conveyed along this section of road is significantly reduced compared with the runoff arriving south from the Sunwater Access Road.

The intent of this DMP upgrade is to reduce the duration and extent that water ponds on Ray Road before discharging to the Jennings Road culverts by containing more runoff within the eastern roadside table drain.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserve of Ray Road without encroaching into the existing road pavement and property boundaries.

These drainage upgrades seek to reprofile the eastern roadside table drain to a minimum 0.5m deep grass-lined trapezoidal drain profile with 1v in 4h batters and 3.0m base width (7.0m top width) with length of approximately 730m.

Table 15: Sunwater Access Road to Jennings Road Eastern Table Drain Capacity

		Drain
Existing	Drain Capacity [1]	~1.3 to 16m3/s
	Level of Service [2]	Up to 100-year ARI
Upgraded	Drain Capacity	2.1 to 16 m3/s
	Drain Profile	0.5m depth x 3.0m base width (7.0m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~730m (0.6%)
	Level of Service	Up to 100-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Sunwater Access Road to Jennings Road drain upgrades is provided in *Figure 28* below.

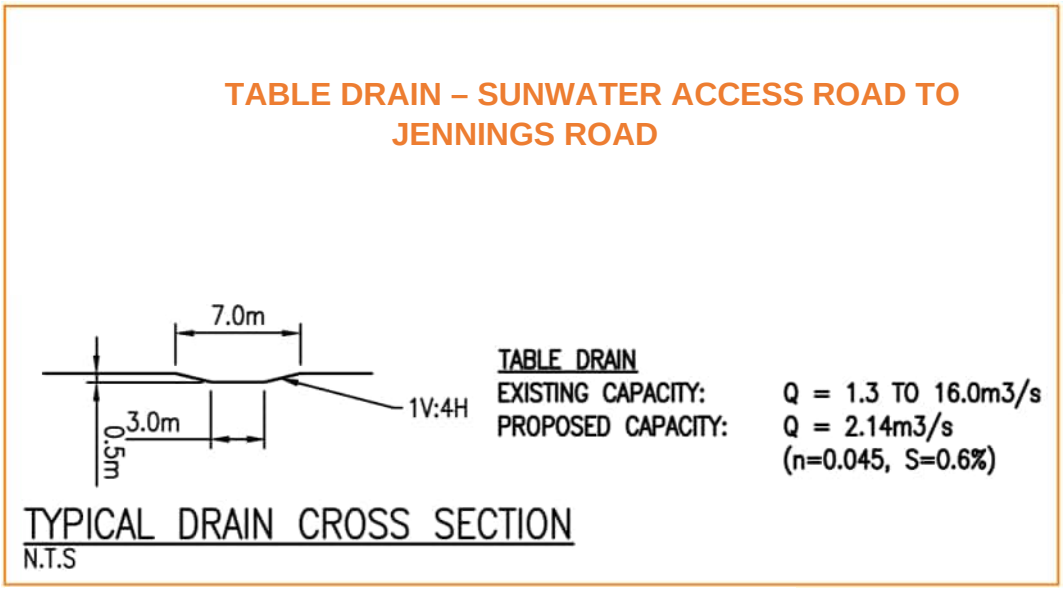


Figure 28: Sunwater Access Road to Jennings Road Table Drain Upgrade

4.15 Jennings Road Drain Widening

This drainage upgrade seeks to increase the capacity of the existing drain downstream from the culverts under Ray Road at the Ray Road - Jennings Road intersection to maximise the effectiveness of the existing large culverts at Ray Road/Jennings Road intersection. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to upgrade this open drain to achieve a similar capacity as these crossroad culverts. The desired level of service for the drain is that currently achieved by the existing Jennings Road culverts (100-year ARI with contingency capacity).

The drainage upgrades seeks to widen the existing drain profile adjacent Jennings Road, between Ray Road and Chinaman Creek, to a 2.0m deep, 8.0m base width (16.0m top width) grass-lined trapezoidal drain with 1v in 2h batters and length of approximately 1700m.

Table 16: Jennings Road Downstream Drain Widening Capacity

		Drain
Existing	Drain Capacity [1]	17.0m3/s
	Level of Service [2]	100-year ARI
Upgraded	Drain Capacity	39.8m3/s
	Drain Profile	2.0m depth x 8.0m base width (16.0m top width, 1v in 2h)
	Length (Average Longitudinal Grade)	~1700m (0.4%)
	Level of Service	100-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

Note, there will be a need to remove or upgrade the property access crossing the existing drain approximately 350m west from the Ray/Jennings Road intersection.

An extract of the Jennings Road drainage upgrades is provided in *Figure 29* below.

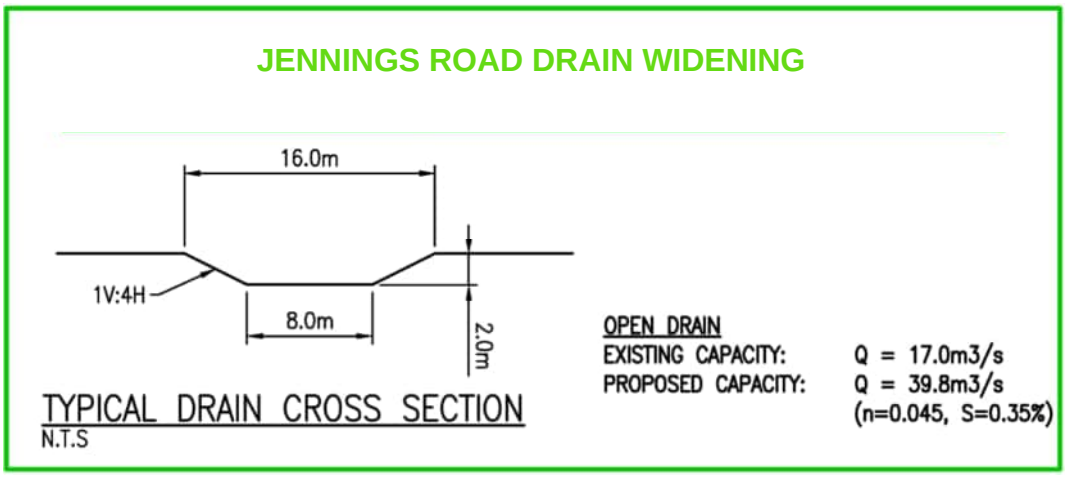


Figure 29: Jennings Road Drainage Upgrades

4.16 Reprofile Eastern Table Drain – Jennings Road to Zenel Road

This upgrade seeks to increase the capacity of the eastern Ray Road table drain between the Jennings Road and Zenel Road.

It is considered that upgrading the western table drain is not required because the stormwater catchments generally grades away from Ray Road and the runoff conveyed along this section of road is significantly reduced compared with the runoff arriving south from the Sunwater Access Road. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to reduce the duration and extent that water ponds on Ray Road along between Jennings and Zenel Roads by containing more runoff within the eastern roadside table drain.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserve of Ray Road without encroaching into the existing road pavement and property boundaries.

These drainage upgrades seek to reprofile the eastern roadside table drain to a minimum 0.3m deep grass-lined trapezoidal drain profile with 1v in 4h batters and 6.0m base width (8.4m top width) with length of approximately 950m.

Table 17: Jennings Road to Zenel Road Eastern Table Drain Capacity

		Drain
Existing	Drain Capacity [1]	~0.76 to 1.2m3/s
	Level of Service [2]	<1-year ARI
Upgraded	Drain Capacity	1.4 m3/s
	Drain Profile	0.3m depth x 6.0m base width (8.4m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~950m (0.5%)
	Level of Service	<1-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Jennings Road to Zenel Road drain upgrades is provided in *Figure **30*** below.

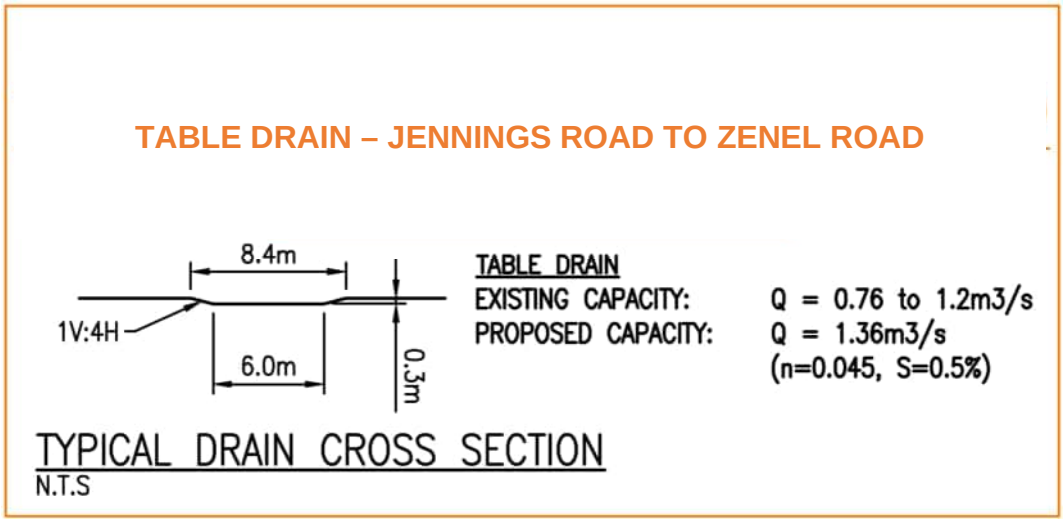


Figure 30: Jennings Road to Zenel Road Table Drain Upgrade

4.17 Zenel Road Reprofiling, Causeway and Table Drain

This drainage upgrade seeks to reprofile Zenel Road longitudinally and construct a new concrete causeway located approximately 245m east from Ray Road. A new/upgraded table drain profile on the southern side of Zenel Road will connect runoff conveyance between the Zenel / Ray Road intersection and this new causeway. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to:

- Minimise the runoff arriving to McIver Road by intercepting and diverting runoff conveyed north along Ray Road from Jennings Road;
- Minimise the runoff that bypasses Zenel Road into properties and causes drainage; and

- Undertake this drainage upgrade concurrently with the detention basin upgrade outlined in Section 4.18 below.

The desired level of service for this drainage upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the existing road reserves without encroaching into adjacent road pavements and property boundaries.

The concrete causeway would be approximately 20-30m in length and the invert generally aligned with the existing flow path across Zenel Road.

The new/upgraded table drain profile will be a 0.5m deep, 4.0m top width grass-lined V-drain (1v in 4h batters) and length of approximately 550m between Ray Road and Mines Road.

Table 18: Zenel Road Southern Table Drain Capacity

		Drain
Existing	Drain Capacity [1]	0.033m3/s (33L/s)
	Level of Service [2]	<1-year ARI
Upgraded	Drain Capacity	0.4m3/s (400L/s)
	Drain Profile	0.5m depth, 4.0m top width V-Drain, (1v in 4h)
	Drain Length (Average Longitudinal Grade)	~550m (0.2%)
	Level of Service	<1-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

Extracts of the Zenel Road causeway and drain upgrades are provided in *Figure* **31** and *Figure 32* below.

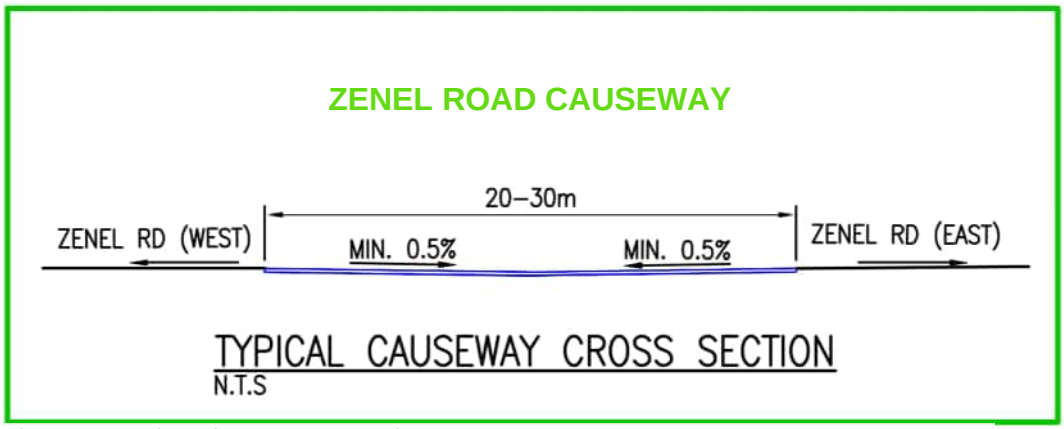


Figure 31: Zenel Road Causeway Upgrades

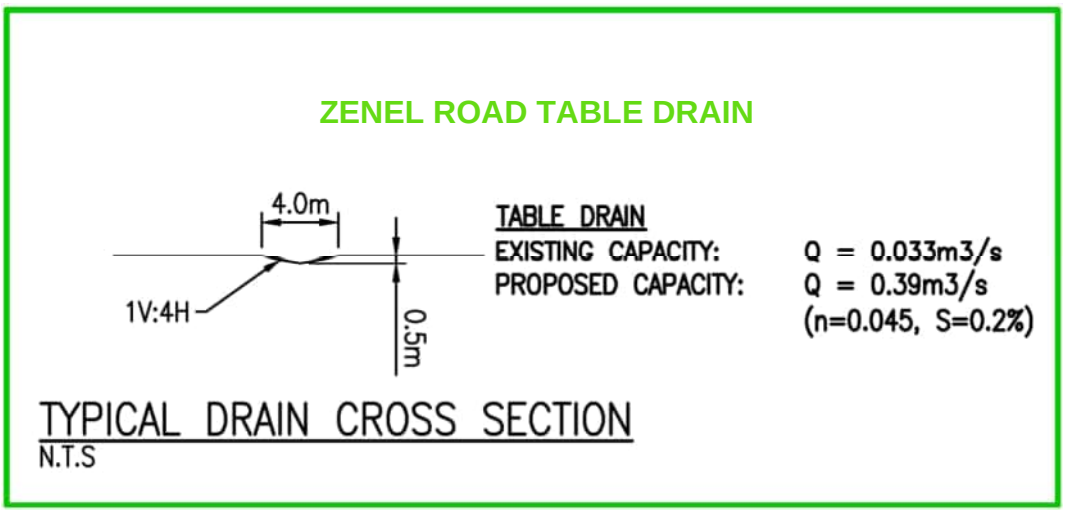


Figure 32: Zenel Road Table Drain Upgrade

4.18 Zenel Road Detention Basin and Downstream Drain

4.18.1 Detention Basin

This upgrade seeks to construct a detention basin formation within Lot 2 on RP747077 (land parcel owned by Council south from Zenel Road). Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to:

- Contain runoff and maximise the control of flows to the eastern drainage corridor;
- Attenuate runoff conveyed north towards McIver Road via overland flow paths through rural-residential/agricultural land parcels and the Ray Road drainage corridor;
- Undertake this upgrade concurrently with the Zenel Road causeway and drainage works outlined in Section 4.17 above.

The basin will consist of vegetation clearing and construction of an earth bund up to 1m in height and length of approximately 850m (bordering Lot 2 on RP747077). The outlet from the basin will include 3/1200x600 RCBCs.

Note, the footprint and arrangement for the detention basin is based on a concept level assessment of opportunities and constraints. Detailed design works are required to calculate and optimise the size of the detention basin required to attenuate the peak flow for the 100-year ARI rainfall event.

Earthworks to clear and grade out the basin to achieve a free draining area are expected to be required as part of constructing works.

Table 19: Zenel Road Detention Basin Outlet Culvert Capacity

	Culvert	
Existing	Culvert Capacity[1]	NIL
	Level of Service[2]	NIL
Upgraded	Culvert Capacity	3.0 m3/s[3]
	Culvert Profile	3/1200x600 RCBC
	Culvert Length (Average Longitudinal Grade)	~6m headwall to headwall (0.5%)
	Level of Service	<1-year ARI

[1] The upgraded culvert capacity has been assessed based on a Mannings roughness coefficient of 0.013.
[2] The Level of Service excludes bypass flows from upstream catchments.
[3] The capacity and profile of the outlet culvert may require refinement during detailed design to achieve the required flow attenuation in the detention basin.

4.18.2 Drain Downstream from Detention Basin

A new drain will provide an outlet to connect the detention basin (outlined above) to the existing west-east drainage corridor under the Kennedy Highway, (approximately 40m south from McIver Road). The alignment for the drain is proposed within the Sunwater (Lot 627 on NR4431) and Queensland Rail (Lot 211 on SP129906) corridors subject to discussions and approval from these stakeholders.

The intent is to construct an open drain from the detention basin to the lawful point of discharge (Kennedy Highway drainage corridor) and minimise the footprint of the drain to limit impacts to existing infrastructure within this corridor (water supply pipeline and overhead power lines).

The desired level of service for the drain is to accommodate the attenuated flows from the detention basin during the 100-year ARI rainfall event.

Note, during the concept verification phase, preliminary advice should be sought from Sunwater and Queensland Rail to confirm the feasibility of this drainage corridor prior to undertaking detailed design phase works as part of this drainage upgrade.

The drain has been considered as a minimum 1.0m deep earth-lined trapezoidal profile with 3.5m base width (11.5m top width) grass-lined trapezoidal drain with 1v in 4h batters, and length of approximately 540m.

Table 20: Drain Capacity Downstream from Detention Basin

	Drain	
Existing	Drain Capacity [1]	NIL
	Level of Service [2]	NIL
Upgraded	Drain Capacity	8.7 m3/s
	Drain Profile	1.0m depth x 3.5m base width (11.5m top width, 1v in 4h)
	Drain Length (Average Longitudinal Grade)	~540m (0.5%)
	Level of Service	2-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

Extracts of the Zenel Road detention and downstream drainage upgrades are provided in *Figure 33* and *Figure 34* below.

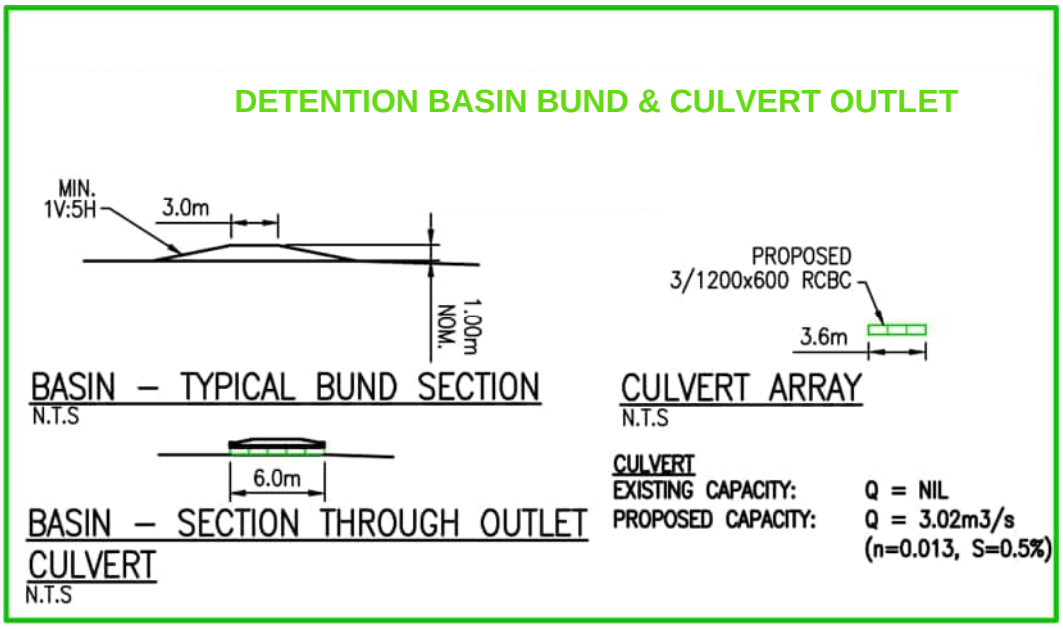


Figure 33: Zenel Road Detention Drainage Upgrades

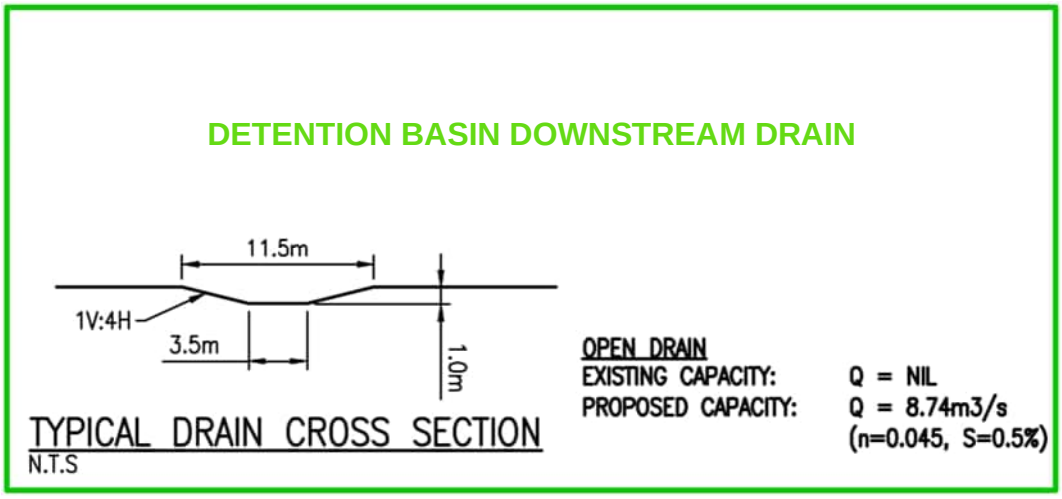


Figure 34: Zenel Road Downstream Drain Upgrade

4.19 Ray Road Eastern Table Drain – Zenel to McIver Road

This section of Ray Road will ultimately be upgraded to a kerb and channel/underground pipe drainage solution and will likely be staged to suit development timelines and Council funding.

A temporary table drain upgrade may be required to increase the capacity of the eastern Ray Road table drain between Zenel Road and McIver Road subject to other elements progressing under the DMP. In particular, the Zenel Road diversion drain. Refer the TEC concept sketches for location of the upgrade provided as Attachment 5.

The intent of this DMP upgrade is to:

- Minimise the extent and duration that drainage issues impact adjacent properties within this part of the study area; and
- Undertake this upgrade as a short-term drainage improvement until Council secures funding to upgrade the eastern side of Ray Road to a kerb and channel formation.

The desired level of service for this upgrade is the highest capacity infrastructure that can be constructed within the spatial constraints of the road reserve for Ray Road without encroaching into the existing road pavement and property boundaries.

It is noted that the development over Lot 1 on RP747077 proposes to upgrade the western side of Ray Road to a kerb and channel road formation with an underground drainage system as part of their Conditions of Approval. It is expected that the developer's construction program will result in the western side of Ray Road being upgraded before Council secures funding to upgrade the eastern side of Ray Road.

These drainage upgrades seek to reprofile the existing table drain to a minimum 0.6m deep grass-lined trapezoidal drain profile with 1v in 2h batters and 3.4m base width (5.8m top width) with length of approximately 800m.

Table 21: Zenel Road to McIver Road Eastern Table Drain Capacity

		Drain
Existing	Drain Capacity [1]	~1.7 to 2.0 m3/s
	Level of Service [2]	<1-year ARI
Upgraded	Drain Capacity	2.6 m3/s
	Drain Profile	0.6m depth x 3.4m base width (5.8m top width, 1v in 2h)
	Drain Length (Average Longitudinal Grade)	~800m (0.5%)
	Level of Service	<1-year ARI

[1] The upgraded drain capacity has been assessed based on a Mannings roughness coefficient of 0.045.
[2] The Level of Service excludes bypass flows from upstream catchments.

An extract of the Zenel Road to McIver Road drain upgrades is provided in *Figure 35* below.

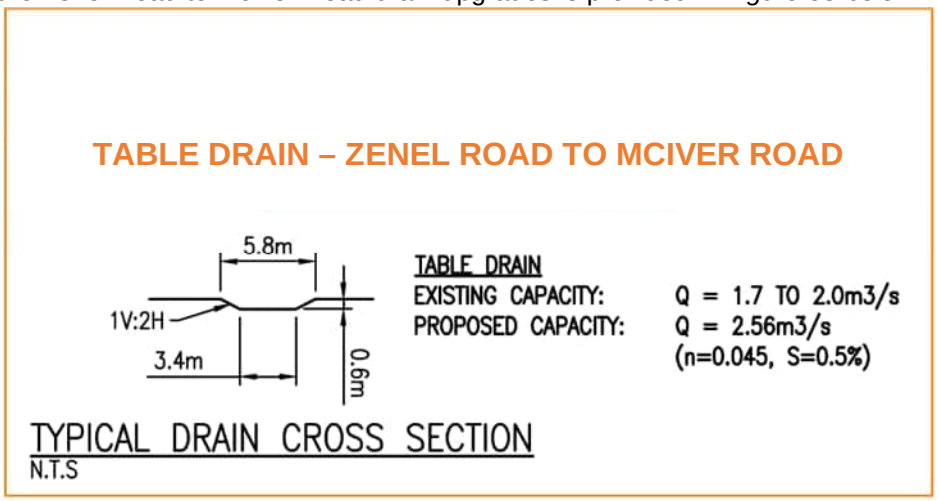


Figure 35: Zenel Road to McIver Road Table Drain Upgrade

5.0 BENEFIT OF DRAINAGE UPGRADES

This DMP recognises the delivery/implementation of the required Ray Road drainage upgrades are constrained by funding allocations. This advice has been developed to inform Council's planning and delivery of these upgrades over time subject to available funds.

The assessed benefit of the drainage upgrades was based on the criteria in Table 22 below.

Table 22: Criteria for Benefit Assessment of Drainage Upgrades

Benefit of Upgrade	Drainage Upgrade
High Benefit Upgrades	The drainage upgrades nominated as being "high" benefit are upgrades that best align with the following criteria: • The upgrade is important for management of peak flows within multiple stormwater catchments; • The upgrade will result in improved immunity and functionality for Ray Road; • The upgrade will provide significant cost-to-benefit outcomes for Council; • The upgrade will improve flooding and drainage issues for property owners; and/or • The upgrade aligns with current development activities within the Ray Road catchment area.
Moderate Benefit Upgrades	The drainage upgrades nominated as being "moderate" benefit are upgrades that best align with the following criteria: • The upgrade is important for management of peak flows within at least one stormwater catchment; • The upgrade will result in improved immunity and functionality for Ray Road; • The upgrade will provide some cost-to-benefit outcomes for Council; • The upgrade will positively impact flooding and drainage issues for property owners; and/or • The upgrade aligns with current development activities within the Ray Road catchment area.
Low Benefit Upgrades	The drainage upgrades nominated as being "low" benefit are upgrades that best align with the following criteria: • The upgrade is important for management of peak flows within a local stormwater catchment; • The upgrade will result in improved immunity and functionality for Ray Road; • The upgrade will provide minor cost-to-benefit outcomes for Council; and/or • The upgrade will achieve minor improvement in flooding and drainage issues for property owners.

Table 23 highlights the benefit of the drainage upgrades recommended. The rationale for the anticipated extent of benefit yielded for each drainage upgrade is discussed below.

Table 23: Assessed Benefit of Drainage Upgrades

Benefit of Upgrade	Drainage Upgrade	DMP Section
High Benefit Upgrades	• Chinaman Creek Crossroad Culverts and Downstream Drain Widening	4.8
	• George Fabris Road Causeway	4.5
	• Security of Tenure for the Future Drainage Corridor (George Fabris Road to Chinaman Creek)	4.7
	• Zenel Road Detention Basin and Downstream Drain	4.18
	• Zenel Road Causeway and Table Drain	4.17
Moderate Benefit Upgrades	• Coolamon Close Culverts and Drain Widening	4.10
	• Pleasant Close Culverts and Drain Widening	4.11
	• Sunwater Access Road Culverts and Drain Widening	4.13
	• Airport Drain & Culvert Widening	4.3
	• Atherton Creek Cut Off Drain	4.2
	• Detailed Design & Construction for the Future Drainage Corridor (George Fabris Road to Chinaman Creek)	4.7
	• Reprofile Western Table Drain (George Fabris Road to Chinaman Creek)	4.6
	• Reprofile Table Drains (Chinaman Creek to Coolamon Close)	4.9
	• Reprofile Eastern Table Drain (Zenel Road to McIver Road)	4.19
Low Benefit Upgrades	• Reprofile Table Drains (Airport to George Fabris Road)	4.4
	• Reprofile Table Drains (Coolamon Close to Sunwater Access Road)	4.12
	• Reprofile Eastern Table Drain (Sunwater Access Road to Jennings Road)	4.14
	• Reprofile Eastern Table Drain (Jennings Road to Zenel Road)	4.16
	• Jennings Road Downstream Drain Widening	4.15

High Benefit Upgrades

Chinaman Creek Crossroad Culverts and Downstream Drain Widening

The Chinaman Creek culverts and downstream drain widening upgrade scope is considered a high benefit because it is well placed to manage the conveyance of runoff from multiple catchments. It is also connected with desirable stormwater outcomes for the Wylandra Estate Development, (with a net positive improvement to areas north from this estate).

George Fabris Road Causeway

The George Fabris Road causeway is considered a high benefit upgrade because seeks to address a current runoff scenario with frequent overtopping of Ray Road downstream from George Fabris Road.

Security of Land Tenure for the Future Drainage Corridor (George Fabris Road to Chinaman Creek)

Securing land tenure for the future drainage corridor from George Fabris Road to Chinaman Creek is considered a high benefit upgrade because it is anticipated to greatly benefit the long-term management of the catchment and achieve greater flood immunity for properties along Ray Road. This initial "Land Tenure" stage is proposed to facilitate consultation with landowner/s before detailed design and construction works can start.

Zenel Road Detention Basin and Downstream Drain

The Zenel Road detention basin and new downstream drain is considered a high benefit upgrade because it was identified as an upgrade of the 2004 Drainage Study and is now a desirable stormwater outcome to better manage downstream impacts from McIver Road and new development at the Ray Road Estate site.

Zenel Road Causeway and Table Drain

The Zenel Road causeway and table drain is considered a high benefit upgrade because it would be logical and cost-effective to undertake this project in coordination with the Zenel Road detention basin and downstream drainage upgrades and to further manage stormwater in the local area.

Moderate Benefit Upgrades

Coolamon Close, Pleasant Close, and Sunwater Access Road Culverts and Drain Widening

The Coolamon Close, Pleasant Close and Sunwater Access Road culverts and downstream drain widening upgrades are considered moderate benefit upgrades because they are anticipated to be most effective once other higher benefit drainage upgrades are undertaken upstream to address existing bypass flows.

Furthermore, the capacity that can be achieved by these upgrades is physically limited by existing site constraints at these locations.

Airport Drain & Culvert Widening

Widening the main airport drain and the associated taxiway culvert crossing is considered a moderate benefit upgrade because it has the potential to positively impact bypass flows conveyed to downstream drainage infrastructure at Chinaman Creek. This upgrade has additional constraints due to the proximity to the runway and constraints with airport operations.

Atherton Creek Cut Off Drain

The Atherton Creek cut off drain is considered a moderate benefit upgrade because it has the potential to positively impact bypass flows conveyed to downstream drainage infrastructure at the airport. It is not considered a high benefit piece of infrastructure because in the context of the Ray Road catchment area, the Atherton Creek cut off drain will deal with in the order of only 9.5m3/s.

Detailed Design & Construction of the Future Drainage Corridor (George Fabris Road to Chinaman Creek)

Detailed design and construction of the future drainage corridor from George Fabris Road to Chinaman Creek is considered a moderate benefit upgrade because it is anticipated to greatly benefit the long-term flood immunity of the road and adjacent properties along Ray Road. However, resolution of land tenure to contain the drain is required before design and construction works can proceed.

Reprofile Western Table Drain – George Fabris Road to Chinaman Creek

Reprofiling the western table drain between George Fabris Road and Chinaman Creek is considered as a moderate benefit upgrade because it is anticipated to positively impact property inundation until such time that the future drainage corridor is constructed.

Some constraints exist, including Sun Water's water mains, power poles and driveway access culverts that will limit the practical capacity able to be achieved from this upgrade.

Reprofile Table Drains – Chinaman Creek to Coolamon Close

Reprofiling the table drains (eastern and western) between Chinaman Creek and Coolamon Close are considered moderate benefit upgrades because they are anticipated to positively impact property inundation and current flooding issues on Ray Road.

Recent flood water extents from the event on 22 December 2024 confirm that additional capacity would be beneficial to this section of road.

Reprofile Eastern Table Drain – Zenel Road to McIver Road

Reprofiling the eastern table drain between Zenel Road and McIver Road is considered a moderate benefit upgrade because while it would not achieve an appreciable drainage capacity improvement (relative to the catchment area), this drain is connected with desirable stormwater outcomes for the Ray Road Estate Development.

It is assumed that the western side of Ray Road will be upgraded by the Developer as part of their operational works (Council Ref: OPW240009 Ray Road).

Low Benefit Upgrades

Note, the low benefit upgrades are not considered high or moderate benefit because they do not offer the capacity increase of higher benefit upgrades and/or already have some existing infrastructure in place.

Reprofile Table Drains – Airport to George Fabris Road

Reprofiling the table drains (eastern and western) between the Airport and George Fabris Road are considered low benefit upgrades because they are anticipated to benefit the conveyance of runoff through Catchment B only.

The lower cost of this upgrade may allow it to be completed as part of other works or maintenance programs.

Reprofile Table Drains – Coolamon Close to Sunwater Access Road

Reprofiling the table drains (eastern and western) between Coolamon Close and the Sunwater access road are considered low benefit upgrades because they are anticipated to benefit the conveyance of runoff through Catchment D only.

The lower cost of this upgrade may allow it to be completed as part of other works or maintenance programs.

Reprofile Eastern Table Drain – Sunwater Access Road to Jennings Road

Reprofiling the eastern table drain between the Sunwater access road and Jennings Road is considered a low benefit upgrade because it is anticipated to benefit the conveyance of runoff through Catchment E only.

The lower cost of this upgrade may allow it to be completed as part of other works or maintenance programs.

Reprofile Table Drains – Jennings Road to Zenel Road

Reprofiling the eastern table drain between Jennings Road and Zenel Road is considered a low benefit upgrade because it is anticipated to benefit the conveyance of runoff through Catchment F only.

The lower cost of this upgrade may allow it to be completed as part of other works or maintenance programs.

Jennings Road Drain Widening

While the Jennings Road drain widening is desirable to match the capacity of the crossroad culverts immediately upstream, it is considered a low benefit upgrade because the capacity of this drainage infrastructure is considerably greater than other drainage infrastructure within the study area.

6.0 DRAINAGE UPGRADES – COSTING ADVICE

Preliminary advice on the construction costs for the drainage infrastructure upgrades considered in this DMP have been provided below to assist Council with decisions regarding the allocation of capital works budgets and planning opportunities for funding.

This advice is provided based on a high-level review of the drainage solutions proposed and a 40% contingency.

The table below provides preliminary costing advice to construct the drainage upgrades proposed with 1 being the lowest cost and 18 being the highest cost upgrade.

Table 24: Preliminary Costing Advice of Proposed Drainage Upgrades

Drainage Upgrade	Total Cost* (incl. GST)	Rank By Cost
Atherton Ck Cutoff Drain	$1,152,720	10
Airport Drain & Culvert Widening	$2,760,000	14
Reprofile Table Drains (Airport to George Fabris Rd)	$130,235	6
George Fabris RD Causeway	$321,430	8
Reprofile Table Drain (George Fabris Rd to Chinaman Ck)	$29,860	1
Future Drainage Corridor (George Fabris Rd to Chinaman Ck)	$1,681,055	12
Chinaman Ck Culverts & Downstream Drain Widening	$4,105,500	18
Reprofile Table Drains (Chinaman Ck to Coolamon Cl)	$46,375	3
Coolamon Cl Culverts & Downstream Drain Widening	$2,888,340	15
Pleasant Cl Culverts & Downstream Drain Widening	$2,994,945	16
Reprofile Table Drains (Coolamon Cl to Sunwater Access Rd)	$130,445	7
Sunwater Access Rd Culverts & Downstream Drain Widening	$3,013,060	17
Reprofile Table Drain (Sunwater Access Rd to Jennings Rd)	$38,650	2
Jennings Rd Downstream Drain Widening	$1,656,000	11
Reprofile Table Drain (Jennings Rd to Zenel Rd)	$50,295	4
Zenel Road Causeway and Table Drain	$430,315	9
Zenel Road detention basin and new downstream drain	$1,922,285	13
Reprofile Table Drain (Zenel Rd to McIver Rd)	$76,235	5

**This Costing Advice is based on the following assumptions and provisions:*

- *This costing advice makes provision for Survey, Geotechnical Investigations and Engineering Design Services calculated as 15% of the Construction Costs. This is with exception to the causeway projects that adopted 25% to account for anticipated more extensive engineering design costs.*
- *This costing advice assumes a 40% contingency on the Total Cost (excluding GST);*
- *Survey, Geotechnical investigation and Engineering Design Services provisions are assumed as not being required for reprofiling of table drains; and*
- *This costing advice does not make allowances for potholing services, project management, construction phase services, stakeholder consultation, approvals, or land resumption.*

Refer to Attachment 6 for a breakdown of costs considered.

Note:
This advice provides a preliminary indication of costs only, prepared to assist Council in establishing an order of cost for each of the proposed drainage upgrades. This preliminary advice cannot be used for any other purpose including, without limitation, determining to proceed with the project, to obtain finance or for sale purposes.
It has been prepared based on certain assumptions that have not been independently verified.
It is intended for use only by Mareeba Shire Council under the agreed Terms of Engagement with Trinity Engineering and Consulting and may not be relied on by any other person.
Trinity Engineering and Consulting, its employees, contractors and partners are released from any liability, action or demand due to any damage or loss (including consequential loss) occurring or arising directly or indirectly from non-compliance with the above conditions.

7.0 DRAINAGE UPGRADES – DEVELOPMENT CONTRIBUTIONS

As of May 2025, Council is aware of three rural-residential developments currently proposed within the Ray Road stormwater catchment area that will subdivide existing grassed/open pastured (pervious) land parcels. All three development sites have lodged an application for operational works for the next stage of development and are expected to proceed to construction in 2025.

These developments are:

- Wylandra Estate Stage 1 – 14 lots (west from Wylandra Drive);
- Rayfield Estate Stage 2 – 23 lots (north from Rayfield Avenue); and
- Ray/Cater Road Development Stage 1 – 18 lots (between Cater and Ray Roads)

By developing these pervious land parcels into residential allotments, the increased runoff from these sites will need to be accommodated within Council's drainage infrastructure.

Consideration for how, where and when these developments connect into the existing drainage infrastructure within the Ray Road catchment area is important for Council to not only plan capital works projects, but also identify staging requirements to deliver drainage upgrades.

Noting that delivery of any combination of the drainage upgrades recommended in Section 4 above will likely be challenging for Council from a resourcing perspective, there may be opportunities to infrastructure contributions from developers when development growth triggers a need for these drainage upgrades.

Advice on the drainage infrastructure upgrades that Council should seek to negotiate development contributions for are outlined below.

Note, this advice is provided to inform and assist with initiating discussions with relevant stakeholders and should not be solely relied upon to support development contribution agreements.

7.1 Wylandra Estate Development

The Wylandra Estate Development is an existing development located between Coolamon Close to the north, the Kennedy Highway to the east, George Fabris Road to the south and Ray Road to the west comprising an area of 220 hectares. The current stage of development (as of July 2025) proposes to construct 14 lots west from Wylandra Drive. Refer *Figure 36* below.

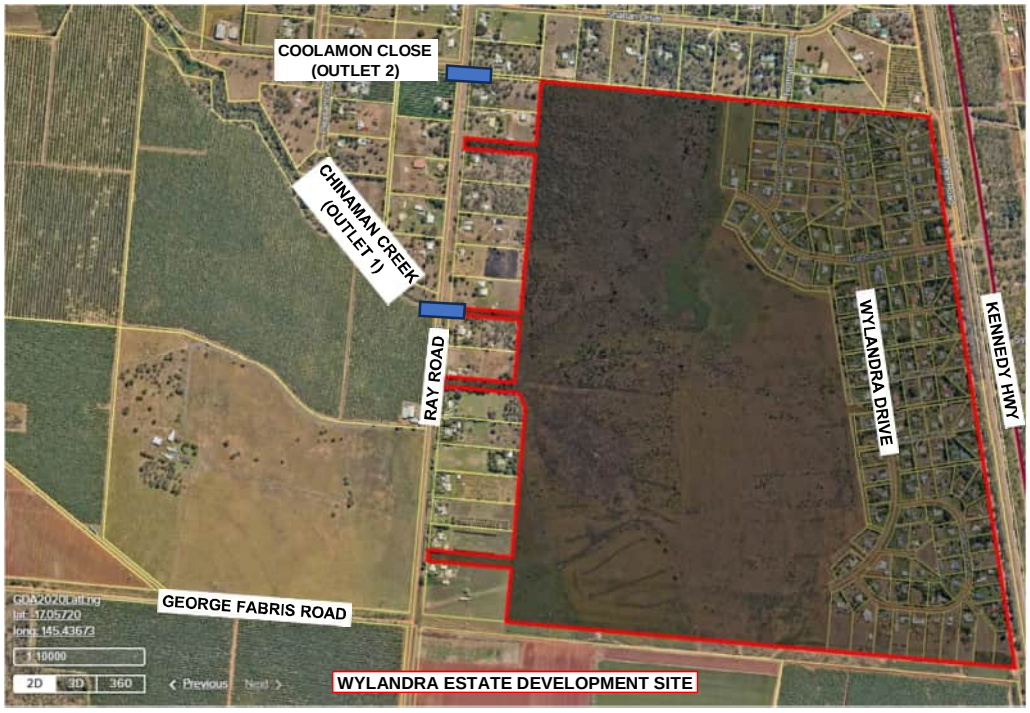


Figure 36: Wylandra Estate Development Footprint

7.1.1 Chinaman Creek Drainage Outlet

Ray Road stormwater investigations identified the existing runoff arriving to the Chinaman Creek culverts is in the order of 20m3/s during the 100-year ARI rainfall event (excluding any existing runoff from the Wylandra Estate development site). This is considered the ultimate peak flow that can reach Chinaman Creek within the limitations of the existing catchment topography and low level of service drainage infrastructure.

Note, the Chinaman Creek catchment peak flow during the 100-year ARI rainfall event is assessed as exceeding 20m3/s, however, existing constraints within the catchment area limit the runoff physically able to reach Chinaman Creek. This is due to approach runoff exceeding the eastern drain capacity and overtopping Ray Road into the western flood plain corridor upstream from the Chinaman Creek crossroad culverts.

The Developer's stormwater management plan confirms runoff will be directed to Chinaman Creek as one of two lawful points of discharge from the development site. Based on catchment area, the maximum runoff able to be directed to the Chinaman Creek crossroad culverts is in the order of 25-30m3/s during the 100-year ARI rainfall event for the existing (mostly undeveloped) site in 2024.

The runoff arriving to the Chinaman Creek culverts during the 100-year ARI rainfall event when Wylandra Estate is fully developed is expected to more than double.

On this basis, there may be an opportunity for Council to negotiate infrastructure contributions with the Wylandra Estate Developer to upgrade the Chinaman Creek crossroad culverts.

Reference is made to the 2004 Drainage Study that identified the Wylandra Estate Development "should demonstrate that connection of the internal drainage network to the Ray Road drainage system will not adversely impact on the external drainage system and the existing residences downstream from the development site."

Notwithstanding infrastructure contribution arrangements, it is considered critical for Council and the Wylandra Estate Developer to take a cooperative approach to deliver drainage infrastructure at Chinaman Creek to ensure a non-worsening impact within the greater Ray Road catchment area.

7.1.2 Coolamon Close Drainage Outlet

The Developer's stormwater management plan confirms runoff from the site will also be directed to Coolamon Close as the second lawful point of discharge from the site. To achieve a non-worsening impact downstream, the Developer proposes to manage the increased runoff caused by development of the site with detention of stormwater.

Internal runoff is proposed to be attenuated via a basin at the northern boundary of the development site prior to discharging to the Coolamon Close culverts. The design and outflow from this detention basin is proposed (and expected) as part of a future development stage but is not yet available to Council.

Noting the Developer's intent to attenuate flows from the development site to pre-development flows arriving to Coolamon Close, it is considered that no development contribution arrangements are applicable to the drainage upgrades at Coolamon Close.

7.2 Ray Road Estate Development

The Ray Road Estate Development is proposed as a 59 lot rural-residential subdivision over existing Lot 1 on RP747077 in the ultimate development scenario. Stage 1 proposes to construct the first 18 lots west from Ray Road. Refer *Figure 37* for the Ray Road Estate Development footprint below.

Figure 37: Ray Road Estate Development Footprint

The development proposes to direct all runoff from the site to the existing drainage corridor east from the site that ultimately discharges to the Kennedy Highway crossroad culverts.

Council and the Developer understand that the western half of Ray Road and the table drain will need to be upgraded as part of Stage 1 to facilitate access to the proposed allotments with frontage to Ray Road and achieve compliant stormwater drainage outcomes.

As a condition of the Developer's approval for operational works, the western half of Ray Road is required to be widened between McIver Road and Cater Road. The approval includes replacement of the existing roadside table drain with kerb and channel and underground drainage infrastructure.

The costs to upgrade the western half of Ray Road (pavement and drainage infrastructure) is solely at the Developer's expense, as is the drainage infrastructure to convey stormwater from the development site under Ray Road, to the existing drainage corridor (east from the site).

Note, the Developer's design plans document the ultimate road and verge profile for Ray Road between McIver Road and Cater Road. It is expected that upgrading the eastern side of Ray Road (pavement and drainage infrastructure) to the ultimate road and verge profile will be solely at Council's expense.

It is also considered that any requirement to upgrade the capacity of the existing drainage corridor east from Ray Road is wholly the responsibility of the Developer.

7.3 Rayfield Development

The Rayfield Development is proposed as a 45-lot rural-residential subdivision over existing Lot 46 on SP210288 in the ultimate development scenario. Stage 1 (22 lots) was previously delivered, and all 22 lots have existing dwellings built. Stage 2 proposes to construct another 23 lots north from Rayfield Avenue. Refer *Figure 38* for the Rayfield Development footprint below.

Figure 38: Rayfield Development Footprint

From the Developer's development plans, it is understood that the stormwater outlet from the site will be the Ray Road eastern table drain just north from Rayfield Avenue. From here, runoff will be conveyed north to the Jennings Road culverts (crossroad culverts under Ray Road, adjacent Jennings Road).

Capacity assessments of the existing eastern Ray Road table drain (between Rayfield Avenue and Jennings Road) and the Jennings Road culverts indicate that this infrastructure was upgraded to accommodate the ultimate development scenario in Stage 1 of the Rayfield Development.

Based on this assessment, upgrading the capacity of the Ray Road eastern table drain between Rayfield Avenue and Jennings Road is not required as part of Stage 2 for this development.

8.0 SUMMARY, CONCLUSIONS & RECOMMENDATIONS

8.1 Summary and Conclusions

Council requested an update to the 2004 Ray Road Drainage Study following the heavy rainfall and saturated catchment conditions that followed ex-Tropical Cyclone Jasper in December 2023.

Drainage and flooding issues were identified within the Ray Road catchment area in the 2004 Drainage Study undertaken by Maunsell (now AECOM). The outcomes of the 2004 study recommended several infrastructure upgrades to improve the level of service for drainage infrastructure in the catchment area to minimise identified drainage and flooding issues, including culvert upgrades and maximising the capacity of existing table drains.

The review of the 2004 Ray Road Drainage Study assisted with identifying the current stormwater catchment boundaries and hydrology, capacity of existing drainage infrastructure, and identification of potential drainage infrastructure upgrade options.

The drainage options were investigated at a concept level to develop a list of recommendations that were considered feasible to address drainage and flooding issues. It was noted that some of these recommendations may be cost prohibitive.

Land tenure reviews identified six (6) available, formalised corridors providing drainage outlets from the within the Ray Road catchment area. Due to the topography of the land and location of the drainage outlets, the crossroad culverts at Chinaman Creek and Coolamon Close receive the majority of runoff from the study area.

It was identified from the 1-dimensional modelling that during peak rainfall events, runoff conveyed north from George Fabris Road causes significant drainage and flooding issues for properties with frontage to Ray Road between George Fabris Road and Chinaman Creek. The property flooding issues are a result of the properties being within a broad flood plain corridor and the road crown generally being at a higher elevation than the adjacent property surface / dwelling floor levels.

On this basis, a list of drainage infrastructure upgrades were investigated at a concept level to develop a list of proposed projects that seek to address existing flooding and drainage issues based on their anticipated level of benefit. Among the highest benefit projects were the Chinaman Creek drainage upgrades, construction of the causeway at George Fabris Road, and securing land tenure for the future drainage corridor.

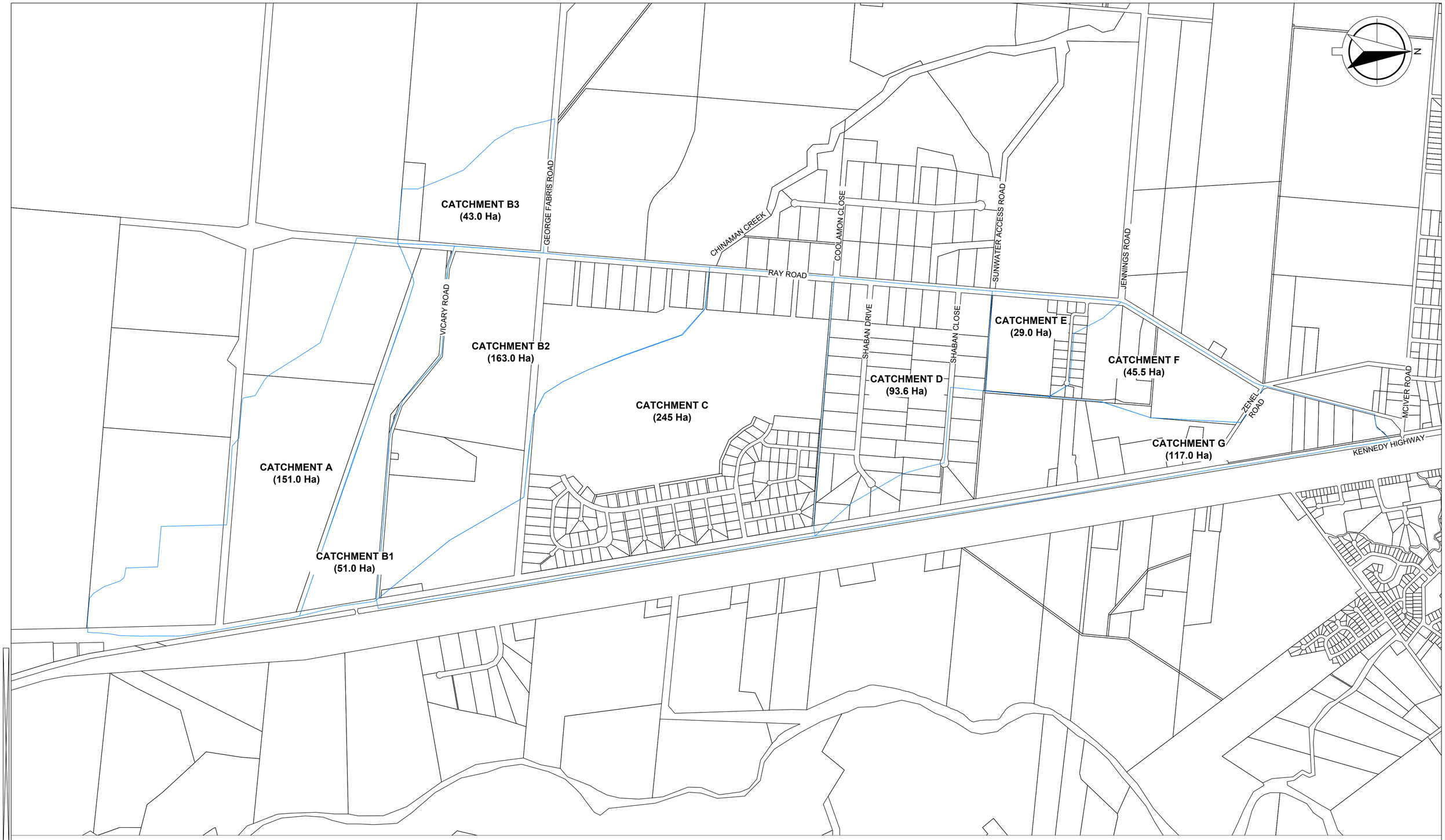
8.2 Recommendations

Based on the findings and outcomes of the updated 2024 Drainage Study and this 2025 Drainage Management Plan, it is recommended that Council:

a) Adopt this Drainage Management Plan as the foundation for future drainage projects proposed within the Ray Road stormwater catchment area;
b) Use this DMP to guide Council's capital works and ensure drainage infrastructure upgrades are scheduled with available resources and budgets; and
c) Refer to this DMP to assist Council's Planning Officers with setting development controls and development requirements that Council can reference when assessing new development applications as growth in the area expands;
d) Commence drainage upgrades based on the highest benefit upgrades identified in this DMP; and
e) Initiate discussions and negotiations with landowners to secure a drainage corridor within the flood plain's low flow path between George Fabris Road (west) and Chinaman Creek.

Attachment 1

2024 Stormwater Catchment Plans



RAY ROAD STORMWATER CATCHMENT PLAN

CONCEPT ONLY

Mareeba SHIRE COUNCIL

Trinity Engineering and Consulting

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Cairns QLD 4870
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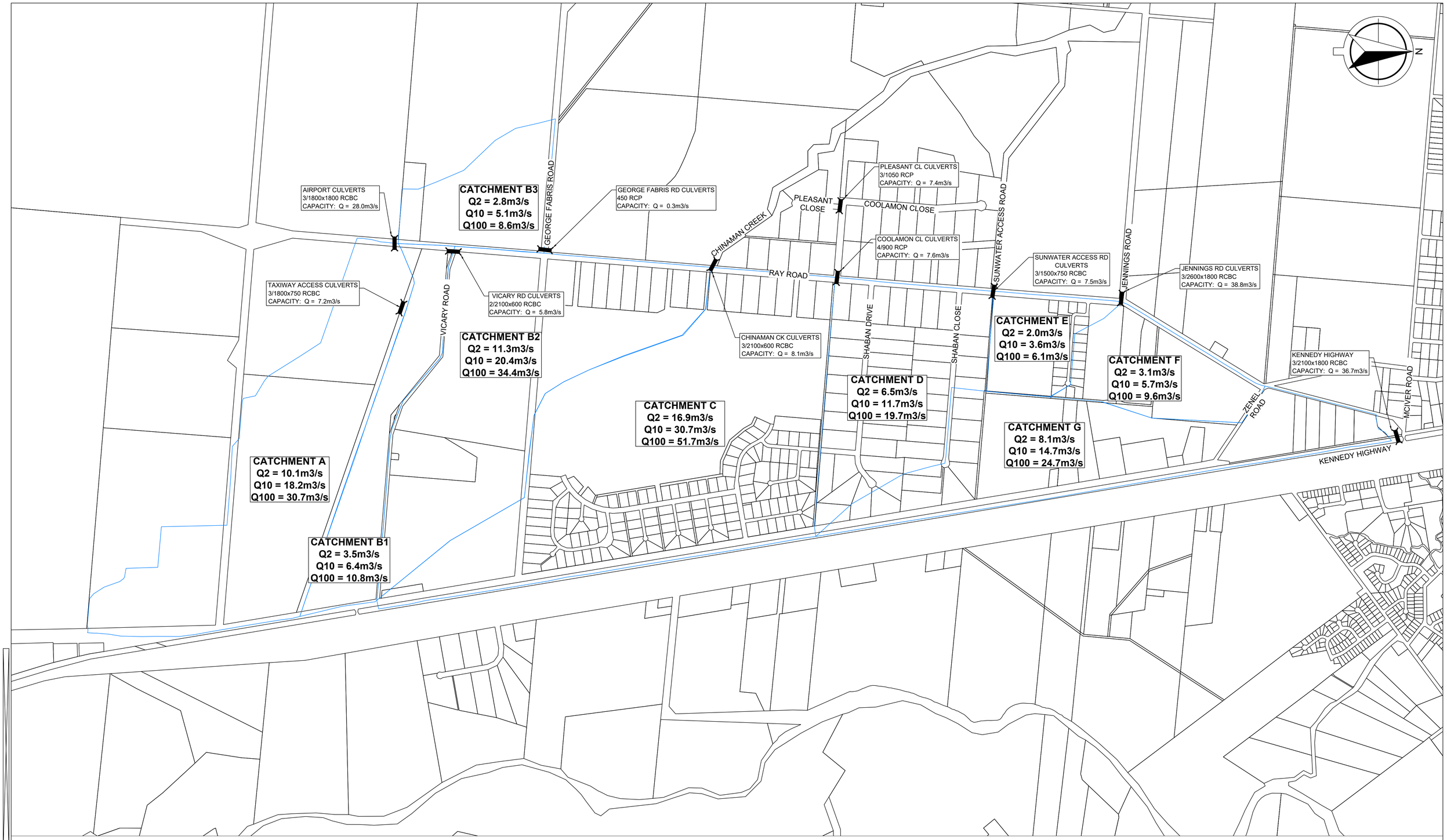
Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD DRAINAGE INVESTIGATION
Title	STORMWATER CATCHMENT PLAN

JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	N.T.S	30 MAY 2025	SKETCH 1756-2	A

Attachment 2

2024 Catchment Flows & Existing Drainage Capacity



RAY ROAD STORMWATER CATCHMENT PLAN

LEGEND

STORMWATER CATCHMENT BOUNDARY
EXISTING CULVERT LOCATION

CONCEPT ONLY

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Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD DRAINAGE INVESTIGATION
Title	STORMWATER CATCHMENT PEAK FLOWS

JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	N.T.S	30 MAY 2025	SKETCH 1756-3	A

Attachment 3

100-Year Flood Plain Investigation Mapping

SHABAN DRIVE

N

PLEASANT CLOSE

COOLAMON CLOSE

RAY ROAD

CHINAMAN CREEK

EXTENT OF INVESTIGATION AREA NOT DEFINED DUE TO INTERFACE WITH COOLAMON CLOSE DRAINAGE CATCHMENT

CHINAMAN CREEK FLOOD INVESTIGATION AREA

THIS PROPERTY NOT ASSESSED IN MODELLING

GEORGE FABRIS ROAD

RAY ROAD

THIS PROPERTY NOT ASSESSED IN MODELLING

VICARY ROAD

LEGEND

- COOLAMON CLOSE CATCHMENT AREA
- Q100 FLOOD MODEL AREA*
- CHINAMAN CREEK FLOOD INVESTIGATION AREA
- CHINAMAN CREEK

SCALE 1:7500

* SIMPLIFIED INUNDATION MODEL

INFORMATION ONLY

0 75 150 225 300m

SCALE 1:7500 (A3 SIZE)

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Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD
Title	FLOOD INVESTIGATION AREA

JOB No.	Scale (A3 size)	Date	Drawing No.	Revision
1756	1:7500	07/04/2025	SKETCH 1756-1	A

TEC External References: TEC-TITLE-SKETCH-A3P_b.dwg ; X-AERIAL.dwg ; X-AERIAL-COVERUP.dwg ; Mareeba Shire Council 2017.png ; Aerial .png ; Aerial .png ;

TEC File: T:\1756 Ray Road Drainage Study\Technical\JK HEC-RAS\ SKETCH 1756-1.dwg

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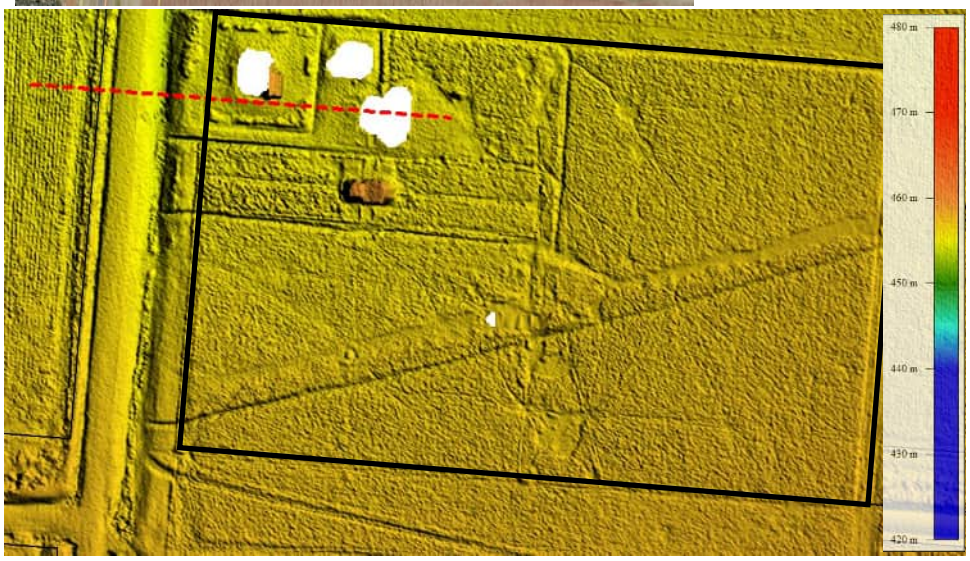
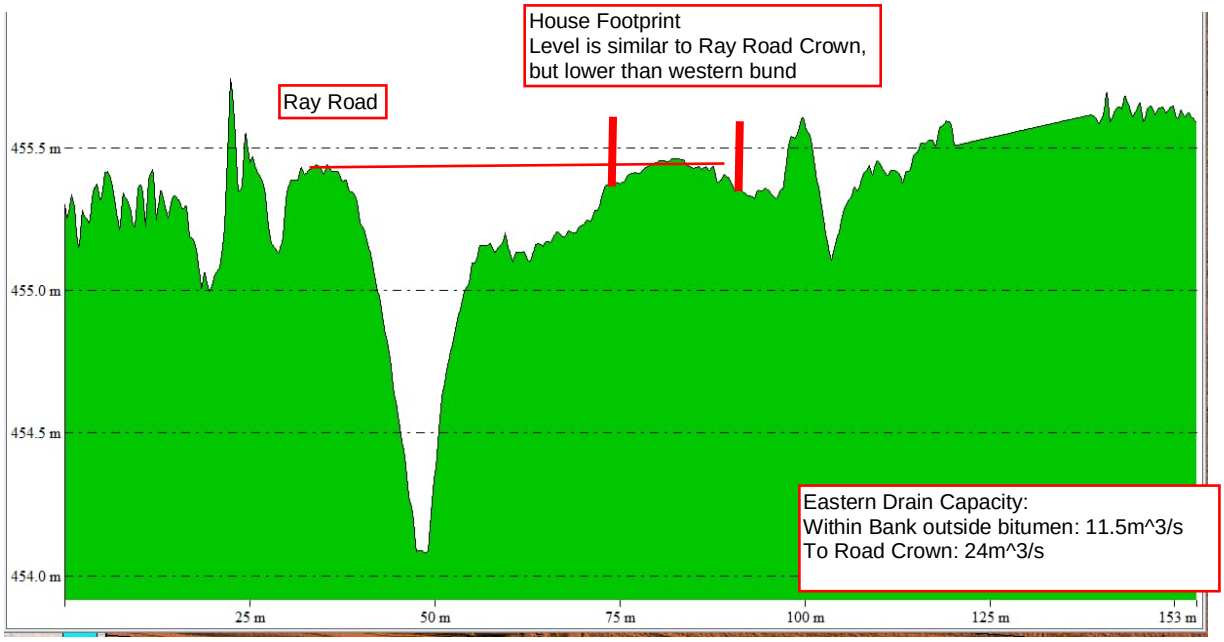
Attachment 4

Ground Surface Levels for Properties Along Ray Road

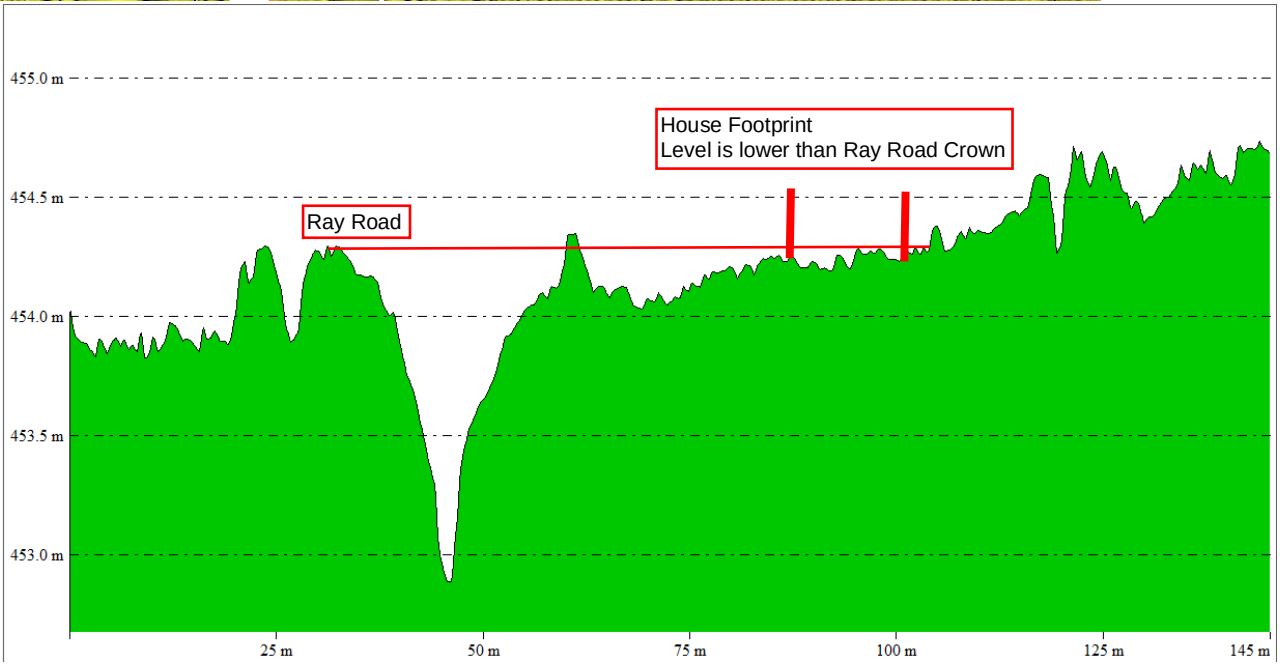
1756 Cross Sections Through Lots between George Fabris and Chinaman Creek

Lot 109 RP867033



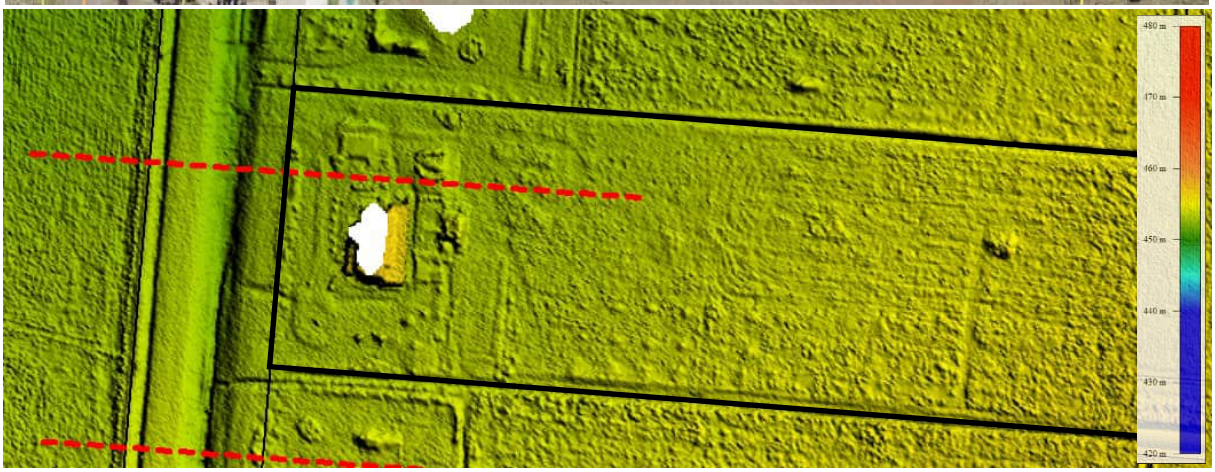


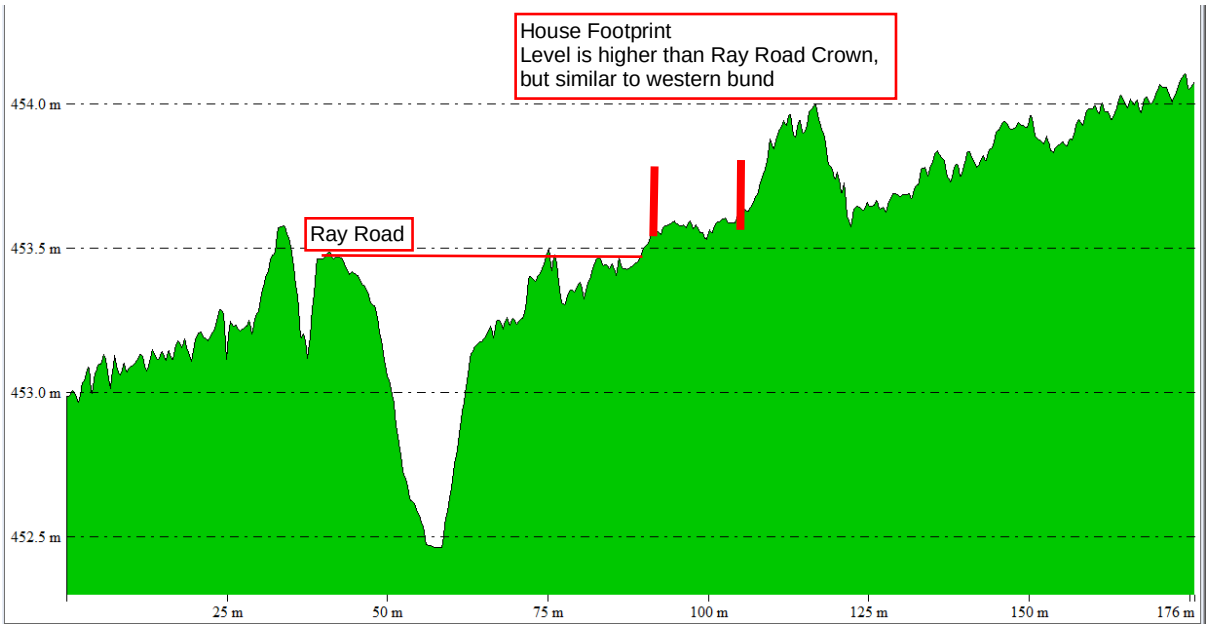
Lot 110 RP851422



Eastern Drain Capacity:
Within Bank outside bitumen: 11m^3/s
To Road Crown: 20m^3/s

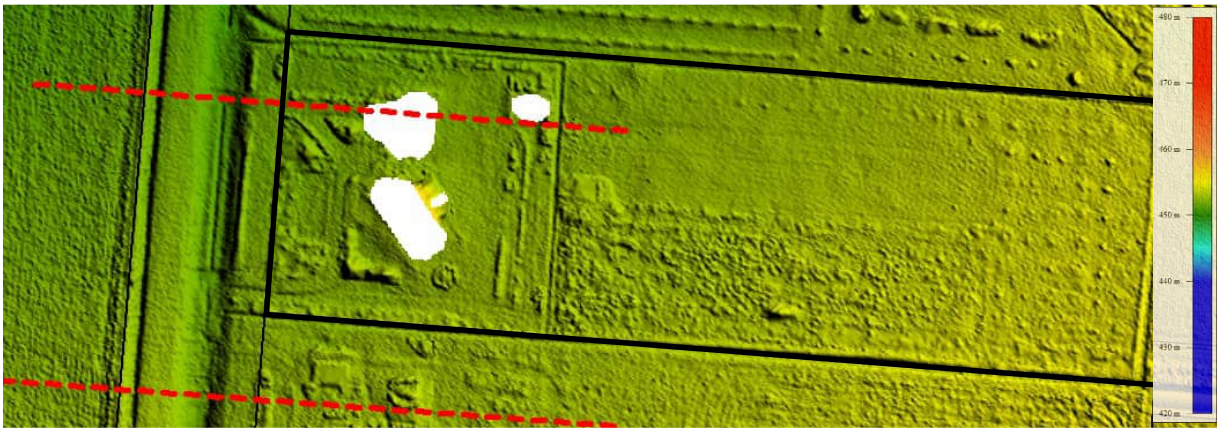
Lot 63 RP851422

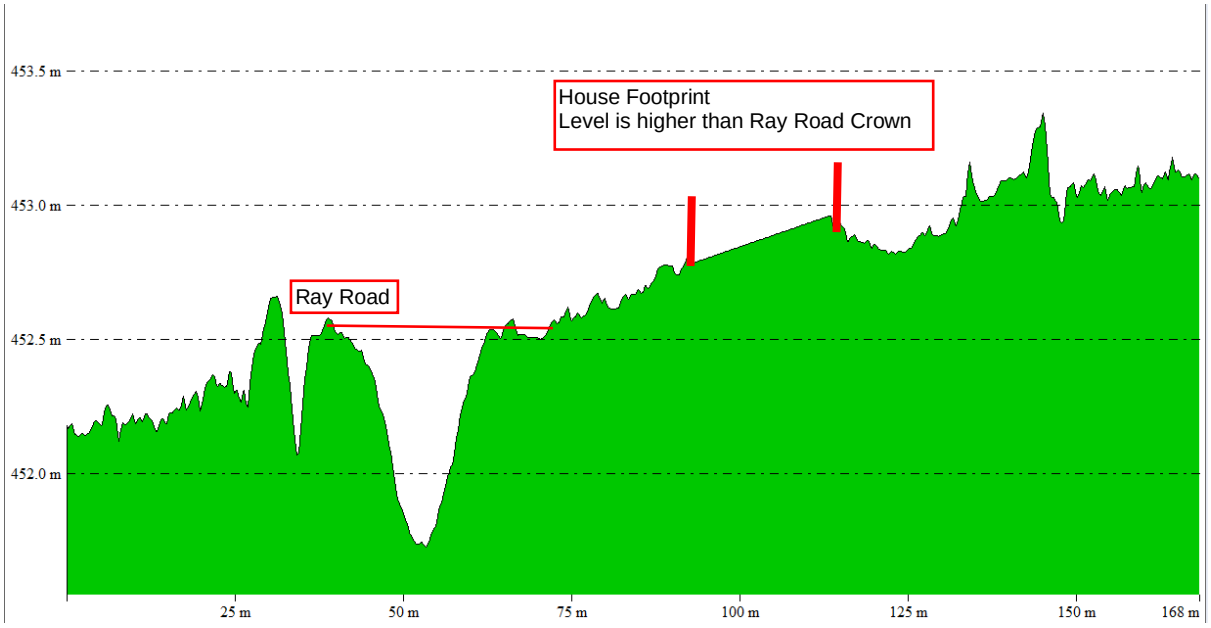




Eastern Drain Capacity:
Within Bank outside bitumen: 7.5m^3/s
To Road Crown: 15m^3/s

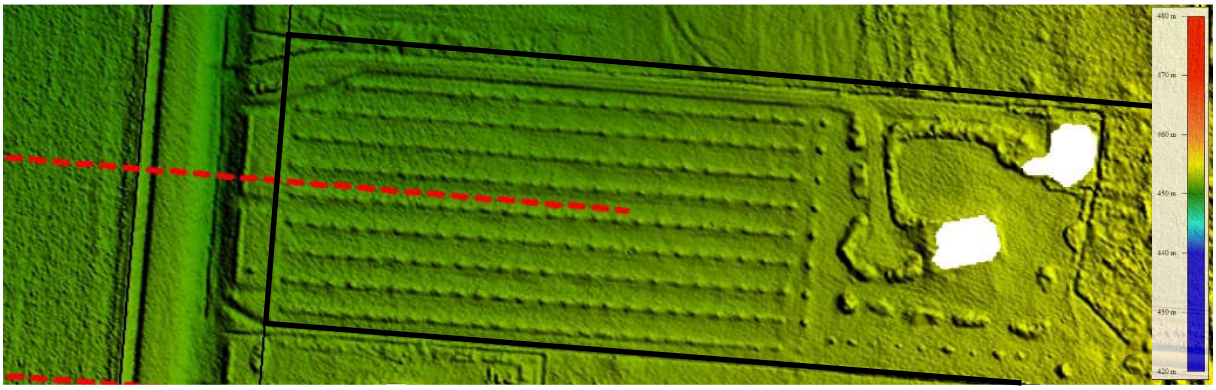
Lot 62 RP851422

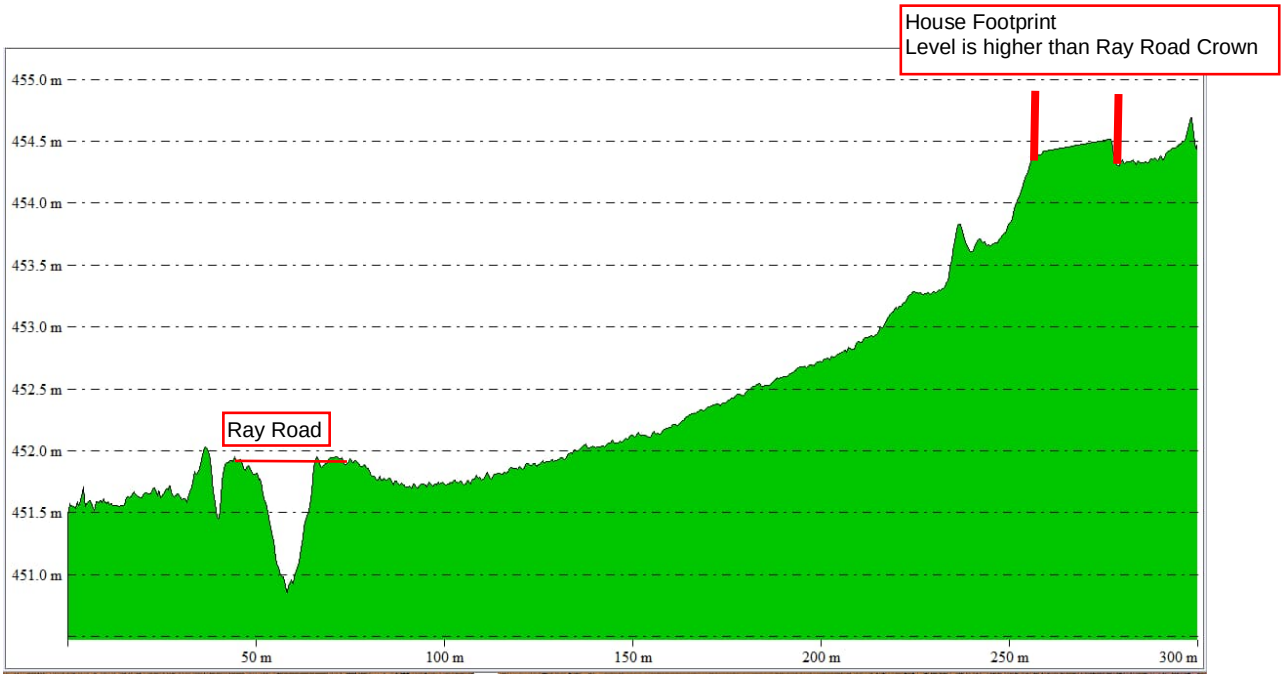




Eastern Drain Capacity:
Within Bank outside bitumen: 6.5m^3/s
To Road Crown: 12.6m^3/s

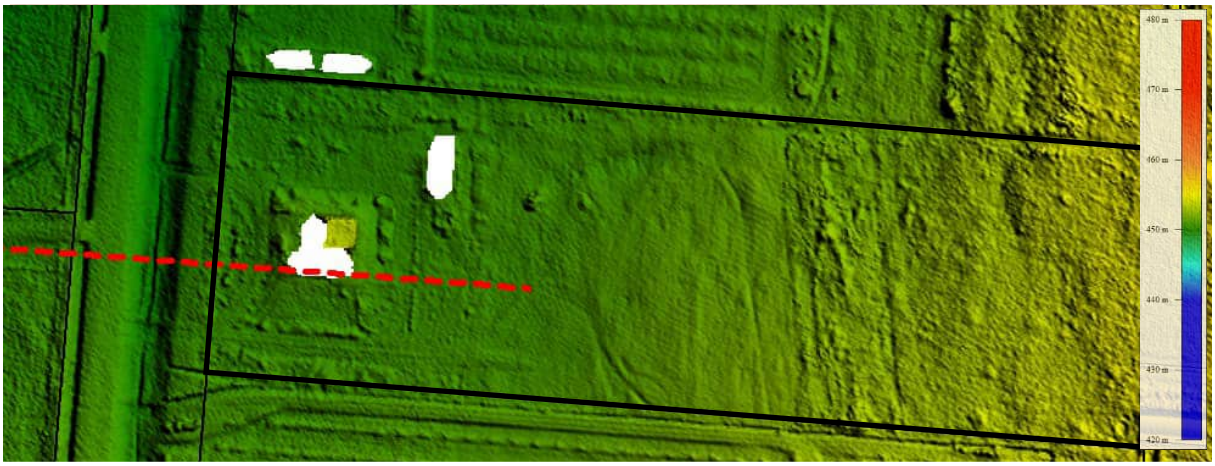
Lot 61 RP851422

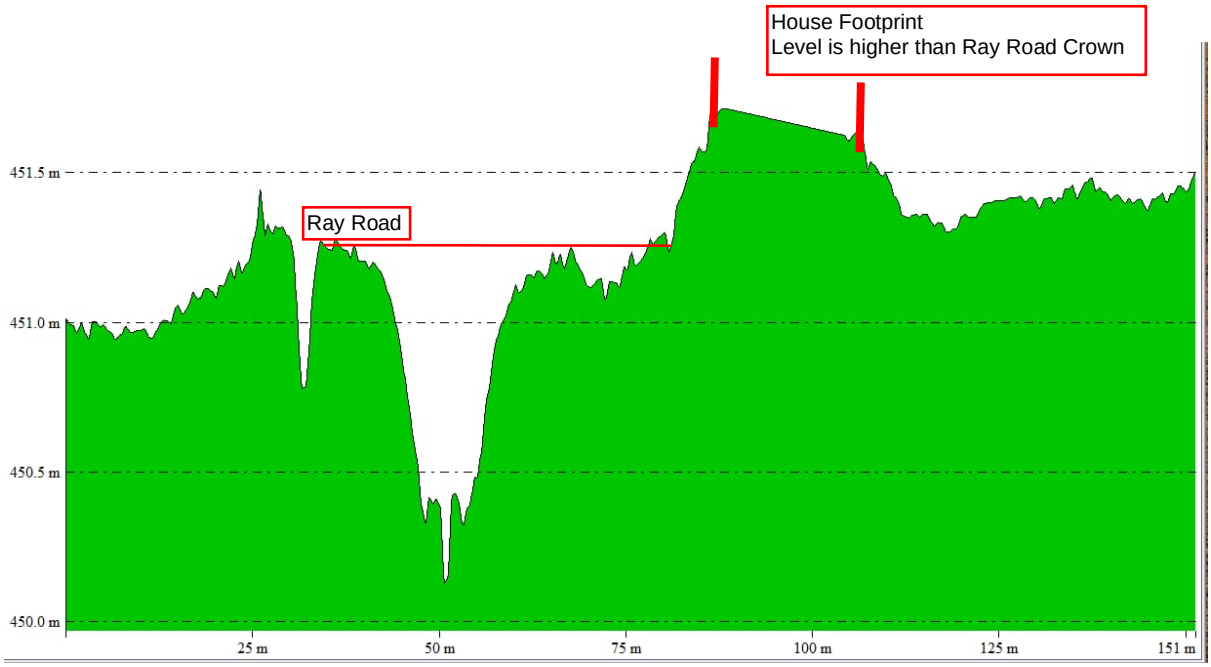




Eastern Drain Capacity:
Within Bank outside bitumen: 9.3m^3/s
To Road Crown: 19.4m^3/s

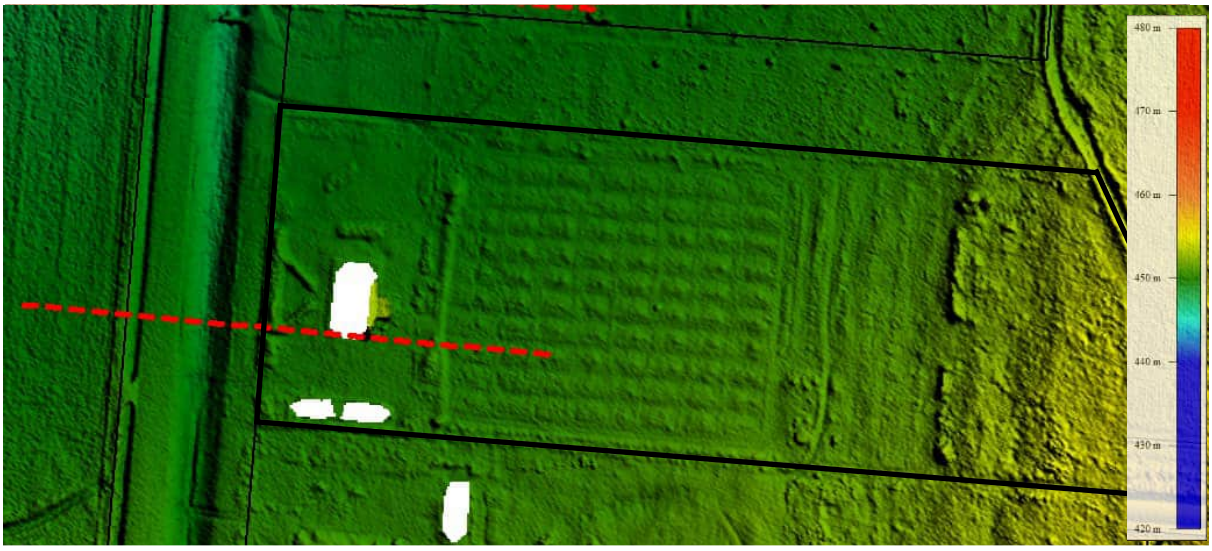
Lot 60 RP851422

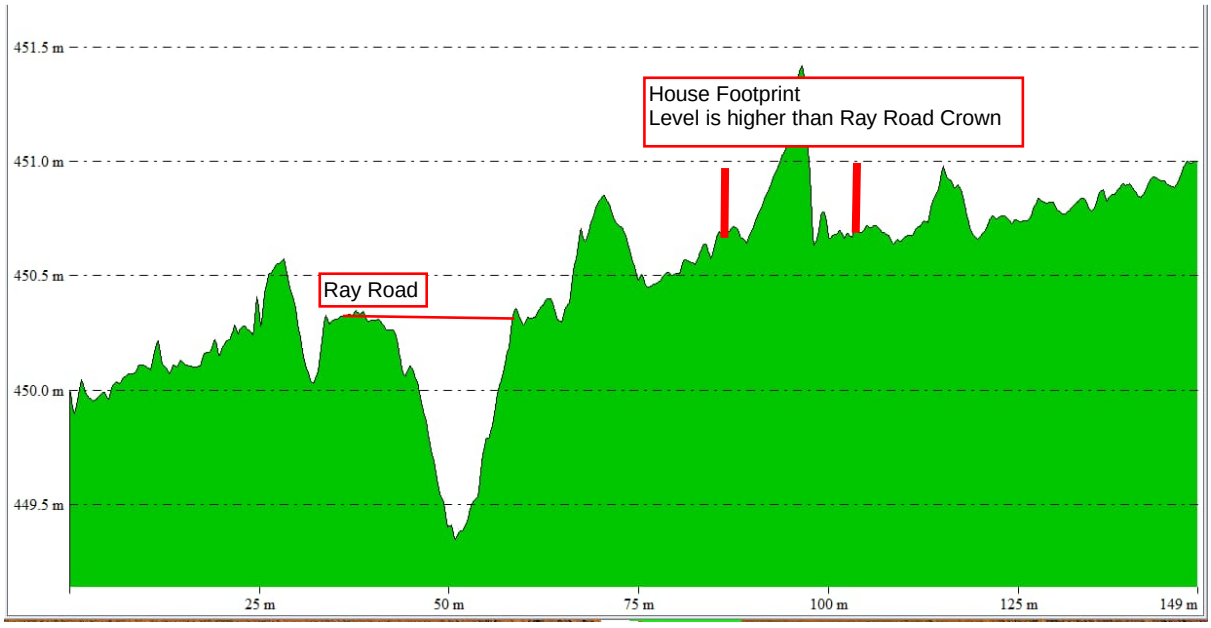




Eastern Drain Capacity:
Within Bank outside bitumen: 10.8m^3/s
To Road Crown: 16.1m^3/s

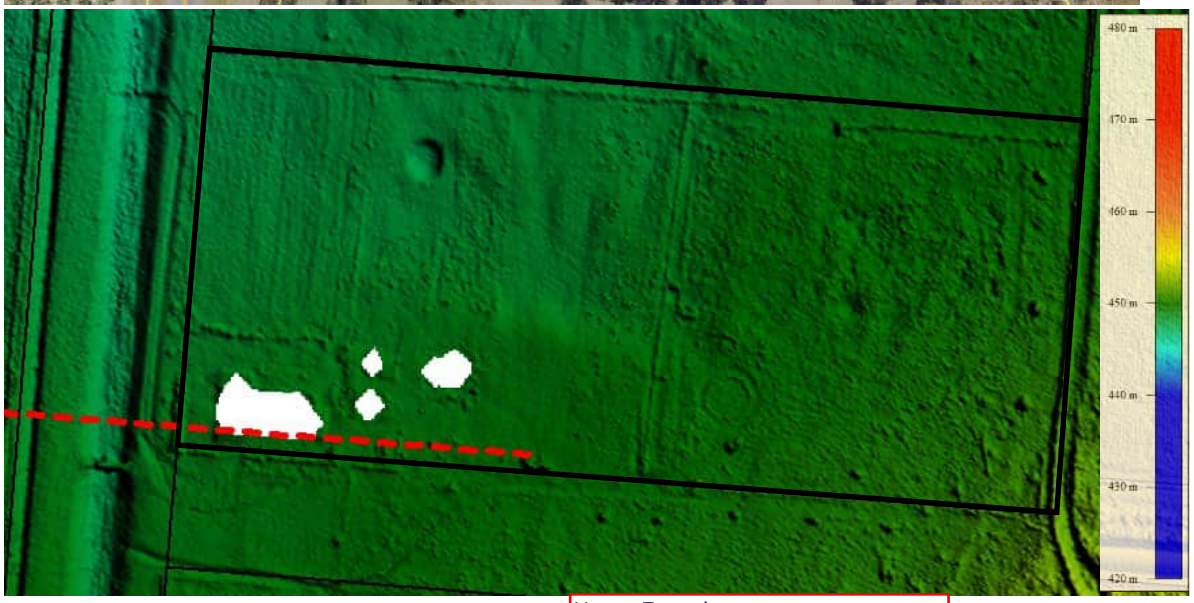
Lot 59 RP851422

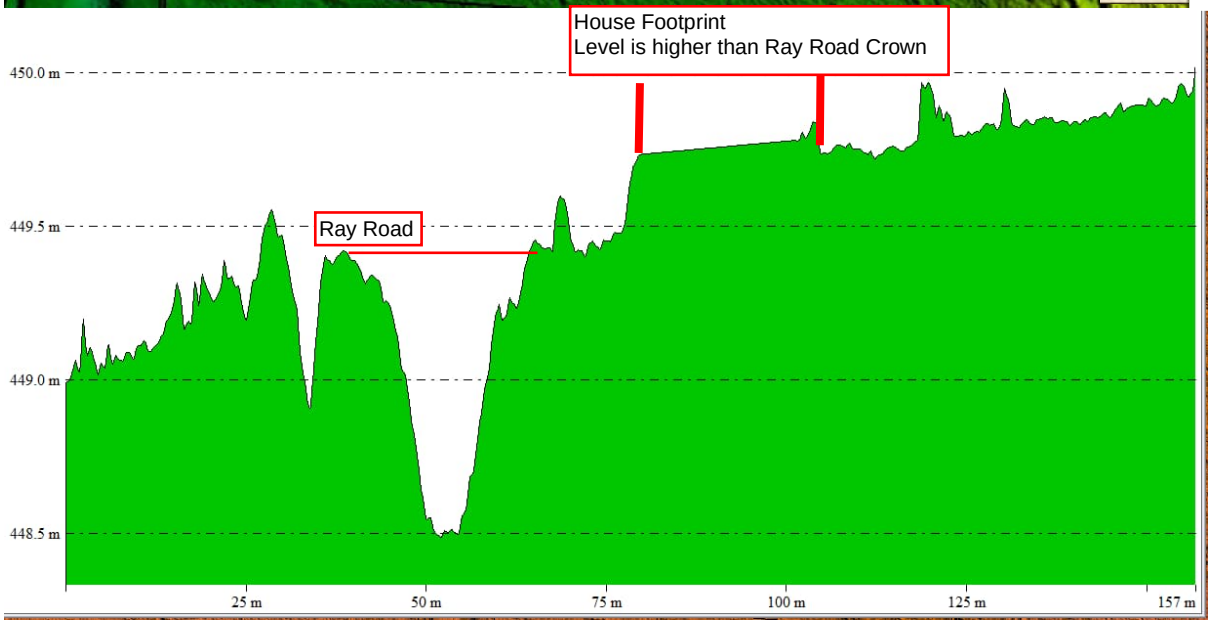




Eastern Drain Capacity:
Within Bank outside bitumen: 10.9m^3/s
To Road Crown: 13.3m^3/s

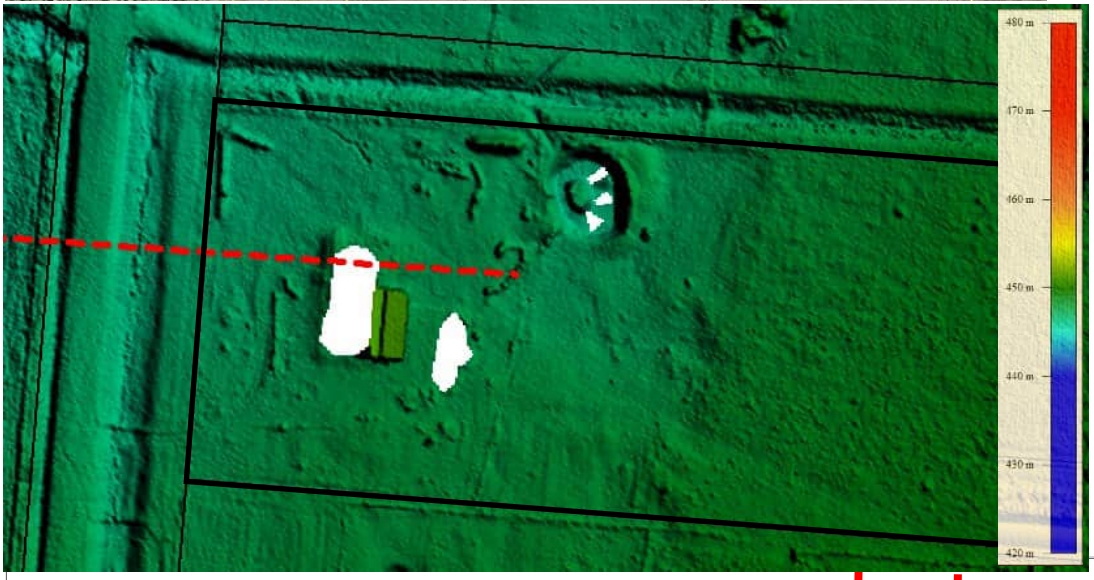
Lot 37 RP851422

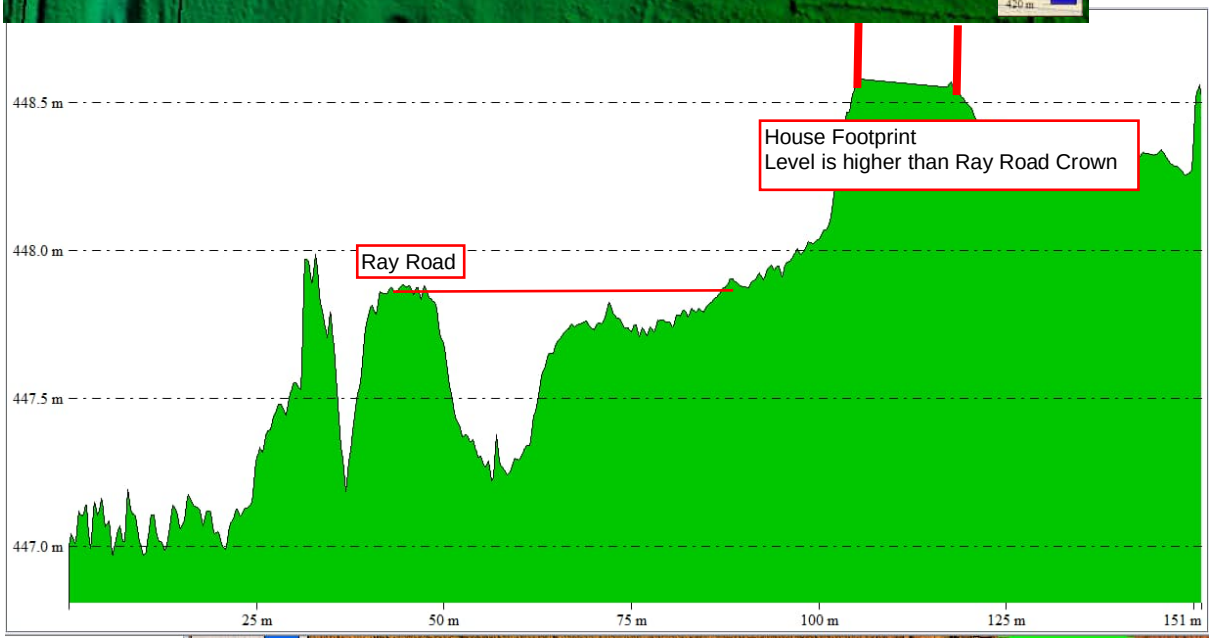




Eastern Drain Capacity:
Within Bank outside bitumen: 10.8m^3/s
To Road Crown: 16.2m^3/s

Lot 36 RP851422





Eastern Drain Capacity:
Within Bank outside bitumen: 6.9m^3/s
To Road Crown: 10.5m^3/s

Attachment 5

2025 Ray Road Stormwater Upgrades – Schematic Plans

LEGEND

- CONTOURS (5m INTERVAL)
- TOP OF BATTER
- TOE OF BATTER
- ACCESS & MAINTENANCE ROAD
- LAND TENURE SECURED
- SECURITY OF LAND TENURE REQUIRED
- EXISTING CULVERT
- EXISTING CULVERT (PROPOSED TO BE UPGRADED)
- NEW CULVERT (PROPOSED)
- NEW CAUSEWAY (PROPOSED)
- PROPOSED UPGRADE – OPERATIONS & MAINTENANCE
- PROPOSED UPGRADE – INFRASTRUCTURE PROJECT

N

GEORGE FABRIS ROAD CAUSEWAY

FUTURE DRAINAGE CORRIDOR & DRAIN CROSSING

PLEASANT CLOSE CULVERT & DRAIN WIDENING

JENNINGS ROAD CULVERT & DRAIN WIDENING

AIRPORT DRAIN & CULVERT WIDENING

CHINAMAN CREEK CULVERT & DRAIN WIDENING

COOLAMON CLOSE CULVERT & DRAIN WIDENING

SUNWATER ACCESS ROAD CULVERT & DRAIN WIDENING

ZENEL ROAD CAUSEWAY & TABLE DRAIN

ZENEL ROAD DETENTION BASIN & OUTLET CULVERT

DETENTION BASIN - DOWNSTREAM DRAIN

ATHERTON CREEK CUT OFF DRAIN

NEW CULVERT CROSSING (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

EXISTING STRUCTURES & HARDSTAND AREA

POTENTIAL NEW RELIEF CULVERT (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

GEORGE FABRIS ROAD

VICARY ROAD

CHINAMAN CREEK

RAY ROAD

PLEASANT CLOSE

COOLAMON CLOSE

SUNWATER ACCESS ROAD

JENNINGS ROAD

SHABAN DRIVE

SHABAN CLOSE

MCIVER ROAD

ZENEL ROAD

KENNEDY HIGHWAY

KENNEDY HIGHWAY

RAY ROAD STORMWATER UPGRADES

SCALE 1:10,000

CONCEPT ONLY

NOTE

1. THIS CONCEPT PLAN IS SCHEMATIC ONLY. THE LOCATION, SIZE AND ORIENTATION OF STORMWATER/DRAINAGE INFRASTRUCTURE SHOWN MAY NOT BE REPRESENTATIVE OF THE EXISTING SITE CONSTRAINTS AND/OR CONDITIONS.
2. ALL DIMENSIONS ARE NOMINAL AND MAY BE SUBJECT TO CHANGE DURING DETAILED DESIGN AND/OR CONSTRUCTION.

0 100 200 300 400 500m
SCALE 1:10,000 (A1 SIZE)

Mareeba SHIRE COUNCIL

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21-23 Sheridan Street | PO Box 7963
Cairns QLD 4870
Email: admin@trinityengineering.com.au

Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD DRAINAGE INVESTIGATION
Title	SCHEMATIC - RAY ROAD STORMWATER UPGRADES SHEET 1 OF 2 - MAJOR STORMWATER INFRASTRUCTURE

JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	1:10,000	19 JUNE 2025	SKETCH 1756-10	B

TEC File: T:\1756 Ray Road Drainage Study\Drawings\Revisions\Ray Road\ 1756 - X-Design.dwg

Printed: 19 June 2025, 1:31 PM (dylan)

TEC External References: DCDB.dwg ; Catchment Boundaries.DWG ; TEC-TITLE-SKETCH-A1_b.dwg ; 5m CONTOURS - X-DESIGN.DWG ; Mareeba Shire Council 2017.png ;

N

TABLE DRAIN - AIRPORT TO GEORGE FABRIS ROAD

TABLE DRAIN - GEORGE FABRIS ROAD TO CHINAMAN CREEK

TABLE DRAIN - CHINAMAN CREEK TO COOLAMON CLOSE

TABLE DRAIN - COOLAMON CLOSE TO SUNWATER ACCESS ROAD

TABLE DRAIN - SUNWATER ACCESS ROAD TO JENNINGS ROAD

TABLE DRAIN - JENNINGS ROAD TO ZENEL ROAD

TABLE DRAIN - ZENEL ROAD TO MCIVER ROAD

GEORGE FABRIS ROAD

NEW CULVERT CROSSING (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

EXISTING STRUCTURES & HARDSTAND AREA

POTENTIAL NEW RELIEF CULVERT (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

CHINAMAN CREEK

PLEASANT CLOSE

COOLAMON CLOSE

SUNWATER ACCESS ROAD

JENNINGS ROAD

RAY ROAD

VICARY ROAD

SHABAN DRIVE

SHABAN CLOSE

MCIVER ROAD

ZENEL ROAD

KENNEDY HIGHWAY

KENNEDY HIGHWAY

RAY ROAD STORMWATER UPGRADES

SCALE 1:10,000

CONCEPT ONLY

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3. REFER SKETCH 1756-10 FOR LEGEND.

0 100 200 300 400 500m

SCALE 1:10,000 (A1 SIZE)

Mareeba SHIRE COUNCIL

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Cairns QLD 4870
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Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD DRAINAGE INVESTIGATION
Title	SCHEMATIC - RAY ROAD STORMWATER UPGRADES SHEET 2 OF 2 - MINOR STORMWATER INFRASTRUCTURE

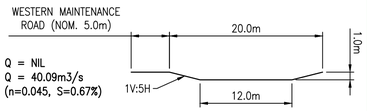
JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	1:10,000	19 JUNE 2025	SKETCH 1756-11	B

TEC File: T:\1756 Ray Road Drainage Study\Drawings\Revisions\Ray Road\ 1756 - X-Design.dwg

Printed: 19 June 2025, 1:32 PM (dylan)

TEC External References: DCDB.dwg ; Catchment Boundaries.DWG ; TEC-TITLE-SKETCH-A1_b.dwg ; 5m CONTOURS - X-DESIGN.DWG ; Mareeba Shire Council 2017.png ;

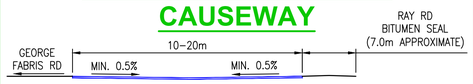
FUTURE DRAINAGE CORRIDOR



OPEN DRAIN
EXISTING CAPACITY: Q = NIL
PROPOSED CAPACITY: Q = 40.09m3/s (n=0.045, S=0.67%)

TYPICAL DRAIN CROSS SECTION
N.T.S

GEORGE FABRIS ROAD CAUSEWAY



TYPICAL CAUSEWAY CROSS SECTION
N.T.S

NEW CULVERT CROSSING (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

POTENTIAL NEW RELIEF CULVERT (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

EXISTING CLEARED AREA & STRUCTURES

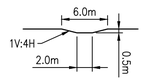
GEORGE FABRIS ROAD

CHINAMAN CREEK

RAY ROAD

VICARY ROAD

TABLE DRAIN - AIRPORT TO GEORGE FABRIS ROAD

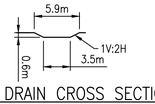


TYPICAL DRAIN CROSS SECTION
N.T.S

TABLE DRAIN
EXISTING CAPACITY: Q = 0.6 TO 8.2m3/s
PROPOSED CAPACITY: Q = 2.67m3/s (n=0.045, S=1.6%)

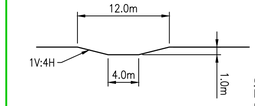
TABLE DRAIN - GEORGE FABRIS ROAD TO CHINAMAN CREEK

TABLE DRAIN
EXISTING CAPACITY: Q = 2.4 TO 5.0m3/s
PROPOSED CAPACITY: Q = 3.11m3/s (n=0.045, S=0.7%)



TYPICAL DRAIN CROSS SECTION
N.T.S

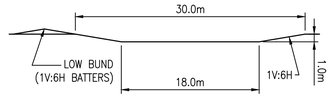
ATHERTON CREEK CUTOFF DRAIN



TYPICAL DRAIN CROSS SECTION
N.T.S

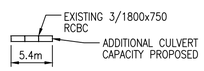
OPEN DRAIN
EXISTING CAPACITY: Q = NIL
PROPOSED CAPACITY: Q = 9.5m3/s (n=0.045, S=0.5%)

AIRPORT DRAIN & CULVERT WIDENING



TYPICAL DRAIN CROSS SECTION
N.T.S

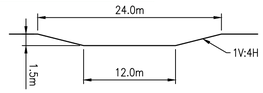
OPEN DRAIN
EXISTING CAPACITY: Q = 13.3m3/s
PROPOSED CAPACITY: Q = 14.5m3/s (n=.045, S=0.1%)



CULVERT WIDENING
N.T.S

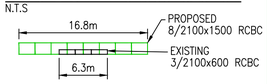
CULVERT
EXISTING CAPACITY: Q = 7.2m3/s
PROPOSED CAPACITY: Q = 11.5m3/s (n=0.013, S=0.1%)

CHINAMAN CREEK CULVERTS AND DRAIN WIDENING



OPEN DRAIN
EXISTING CAPACITY: Q = 4.0m3/s
PROPOSED CAPACITY: Q = 45.4m3/s (n=0.045, S = 0.7%)

TYPICAL DRAIN CROSS SECTION
N.T.S



CULVERT
EXISTING CAPACITY: Q = 8.1m3/s
PROPOSED CAPACITY: Q = 50.7m3/s (n=0.013, S = 0.5%)

CULVERT UPGRADE
N.T.S

RAY ROAD STORMWATER UPGRADES - SOUTH

SCALE 1:4000

CONCEPT ONLY

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3. REFER SKETCH 1756–10 FOR LEGEND.

0 40 80 120 160 200m
SCALE 1:4000 (A1 SIZE)

Mareeba SHIRE COUNCIL

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Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD DRAINAGE INVESTIGATION
Title	RAY ROAD STORMWATER UPGRADES - DETAILS SHEET 1 OF 3

JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	1:4000	25 SEPTEMBER 2025	SKETCH 1756-12	C

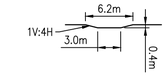
TEC File: T:\1756 Ray Road Drainage Study\Drawings\Revisions\Ray Road\2025-09-25 Updated Culvert Cell Widths\ 1756-SKETCH-012(C)-013(C)-014(C).dwg

Printed: 25 September 2025, 1:38 PM (Liam)

TEC External References: DCDB.dwg ; Catchment Boundaries.DWG ; TEC-TITLE-SKETCH-A1_b.dwg ; 5m CONTOURS - X-DESIGN.DWG ; Mareeba Shire Council 2017.png ;

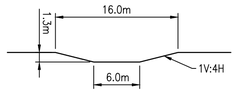
TABLE DRAIN - CHINAMAN CREEK TO COOLAMON CLOSE

TABLE DRAIN
EXISTING CAPACITY: Q = 0.7 TO 1.6m3/s
PROPOSED CAPACITY: Q = 1.14m3/s (n=0.045, S=0.5%)



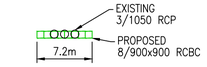
TYPICAL DRAIN CROSS SECTION
N.T.S

PLEASANT CLOSE CULVERTS & DRAIN WIDENING



TYPICAL DRAIN CROSS SECTION
N.T.S

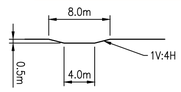
OPEN DRAIN
EXISTING CAPACITY: Q = 8.3m3/s
PROPOSED CAPACITY: Q = 24.39m3/s (n=0.045, S=0.8%)



CULVERT UPGRADE
N.T.S

CULVERT
EXISTING CAPACITY: Q = 7.4m3/s
PROPOSED CAPACITY: Q = 11.46m3/s (n=0.013, S=0.5%)

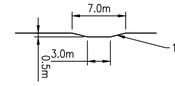
TABLE DRAIN - COOLAMON CLOSE TO SUNWATER ACCESS ROAD



TYPICAL DRAIN CROSS SECTION
N.T.S

OPEN DRAIN
EXISTING CAPACITY: Q = 1.2 TO 2.8m3/s
PROPOSED CAPACITY: Q = 2.17m3/s (n=0.045, S=0.4%)

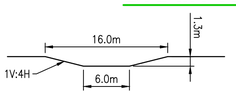
TABLE DRAIN - SUNWATER ACCESS ROAD TO JENNINGS ROAD



TYPICAL DRAIN CROSS SECTION
N.T.S

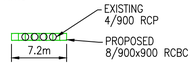
TABLE DRAIN
EXISTING CAPACITY: Q = 1.3 TO 16.0m3/s
PROPOSED CAPACITY: Q = 2.14m3/s (n=0.045, S=0.6%)

COOLAMON CLOSE CULVERTS & DRAIN WIDENING



TYPICAL DRAIN CROSS SECTION
N.T.S

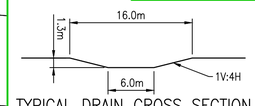
OPEN DRAIN
EXISTING CAPACITY: Q = 5.5m3/s
PROPOSED CAPACITY: Q = 9.28m3/s (n=0.045, S=0.5%)



CULVERT UPGRADE
N.T.S

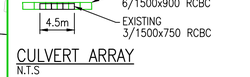
CULVERT
EXISTING CAPACITY: Q = 7.6m3/s
PROPOSED CAPACITY: Q = 11.46m3/s (n=0.013, S=0.5%)

SUNWATER ACCESS CULVERTS & DRAIN WIDENING



TYPICAL DRAIN CROSS SECTION
N.T.S

OPEN DRAIN
EXISTING CAPACITY: Q: = 17.6m3/s
PROPOSED CAPACITY: Q: = 22.8m3/s (n=0.045, S=0.7%)



CULVERT ARRAY
N.T.S

CULVERT
EXISTING CAPACITY: Q = 7.5m3/s
PROPOSED CAPACITY: Q = 15.7m3/s (n=0.013, S=0.5%)

NEW CULVERT CROSSING (SUBJECT TO APPROVAL OF FUTURE DRAINAGE CORRIDOR)

EXISTING CLEARED AREA & STRUCTURES

PLEASANT CLOSE

COOLAMON CLOSE

CHINAMAN CREEK

RAY ROAD

SUNWATER ACCESS ROAD

JENNINGS ROAD

SHABAN DRIVE

SHABAN CLOSE

N

RAY ROAD STORMWATER UPGRADES - CENTRAL

SCALE 1:4000

CONCEPT ONLY

NOTE
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2. ALL DIMENSIONS ARE NOMINAL AND MAY BE SUBJECT TO CHANGE DURING DETAILED DESIGN AND/OR CONSTRUCTION.
3. REFER SKETCH 1756-10 FOR LEGEND.

0 40 80 120 160 200m
SCALE 1:4000 (A1 SIZE)

Mareeba SHIRE COUNCIL

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21-23 Sheridan Street | PO Box 7963
Cairns QLD 4870
Email: admin@trinityengineering.com.au

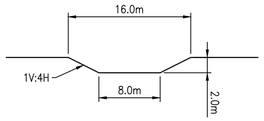
Client: MAREEBA SHIRE COUNCIL
Project: RAY ROAD DRAINAGE INVESTIGATION
Title: RAY ROAD STORMWATER UPGRADES - DETAILS SHEET 2 OF 3

JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	1:4000	25 SEPTEMBER 2025	SKETCH 1756-13	C

Printed: 25 September 2025, 1:38 PM (Liam) TEC File: T:\1756 Ray Road Drainage Study\Drawings\Revisions\Ray Road\2025-09-25 Updated Culvert Cell Widths\ 1756-SKETCH-012(C)-013(C)-014(C).dwg

TEC External References: DCDB.dwg ; Catchment Boundaries.DWG ; TEC-TITLE-SKETCH-A1_b.dwg ; 5m CONTOURS - X-DESIGN.DWG ; Mareeba Shire Council 2017.png ;

JENNINGS ROAD DRAIN WIDENING



TYPICAL DRAIN CROSS SECTION
N.T.S

OPEN DRAIN
EXISTING CAPACITY: Q = 17.0m3/s
PROPOSED CAPACITY: Q = 39.8m3/s
(n=0.045, S=0.35%)

TABLE DRAIN - JENNINGS ROAD TO ZENEL ROAD

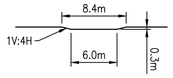


TABLE DRAIN
EXISTING CAPACITY: Q = 0.76 to 1.2m3/s
PROPOSED CAPACITY: Q = 1.36m3/s
(n=0.045, S=0.5%)

TYPICAL DRAIN CROSS SECTION
N.T.S

TABLE DRAIN - ZENEL ROAD TO MCIVER ROAD

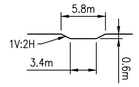
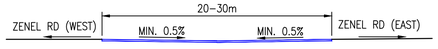


TABLE DRAIN
EXISTING CAPACITY: Q = 1.7 TO 2.0m3/s
PROPOSED CAPACITY: Q = 2.56m3/s
(n=0.045, S=0.5%)

TYPICAL DRAIN CROSS SECTION
N.T.S

ZENEL ROAD CAUSEWAY



TYPICAL CAUSEWAY CROSS SECTION
N.T.S

ZENEL ROAD TABLE DRAIN

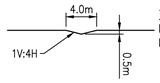
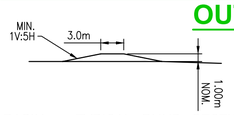


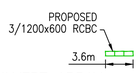
TABLE DRAIN
EXISTING CAPACITY: Q = 0.033m3/s
PROPOSED CAPACITY: Q = 0.39m3/s
(n=0.045, S=0.2%)

TYPICAL DRAIN CROSS SECTION
N.T.S

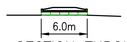
DETENTION BASIN BUND & CULVERT OUTLET



BASIN – TYPICAL BUND SECTION
N.T.S



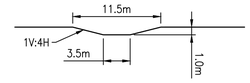
CULVERT ARRAY
N.T.S



BASIN – SECTION THROUGH OUTLET CULVERT
N.T.S

CULVERT
EXISTING CAPACITY: Q = NIL
PROPOSED CAPACITY: Q = 3.02m3/s
(n=0.013, S=0.5%)

DETENTION BASIN DOWNSTREAM DRAIN



TYPICAL DRAIN CROSS SECTION
N.T.S

OPEN DRAIN
EXISTING CAPACITY: Q = NIL
PROPOSED CAPACITY: Q = 8.74m3/s
(n=0.045, S=0.5%)

JENNINGS ROAD
RAY ROAD
ZENEL ROAD
MCIVER ROAD
KENNEDY HIGHWAY

RAY ROAD STORMWATER UPGRADES - NORTH

SCALE 1:4000

CONCEPT ONLY

NOTE
1. THIS CONCEPT PLAN IS SCHEMATIC ONLY. THE LOCATION, SIZE AND ORIENTATION OF STORMWATER/DRAINAGE INFRASTRUCTURE SHOWN MAY NOT BE REPRESENTATIVE OF THE EXISTING SITE CONSTRAINTS AND/OR CONDITIONS.
2. ALL DIMENSIONS ARE NOMINAL AND MAY BE SUBJECT TO CHANGE DURING DETAILED DESIGN AND/OR CONSTRUCTION.
3. REFER SKETCH 1756–10 FOR LEGEND.

0 40 80 120 160 200m
SCALE 1:4000 (A1 SIZE)

Mareeba SHIRE COUNCIL

Trinity Engineering and Consulting

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Cairns QLD 4870
Email: admin@trinityengineering.com.au

Client	MAREEBA SHIRE COUNCIL
Project	RAY ROAD DRAINAGE INVESTIGATION
Title	RAY ROAD STORMWATER UPGRADES - DETAILS SHEET 3 OF 3

JOB No.	Scale (A1 size)	Date	Drawing No.	Revision
1756	1:4000	25 SEPTEMBER 2025	SKETCH 1756-14	C

TEC File: T:\1756 Ray Road Drainage Study\Drawings\Revisions\Ray Road\2025-09-25 Updated Culvert Cell Widths\ 1756-SKETCH-012(C)-013(C)-014(C).dwg
Printed: 25 September 2025, 1:38 PM (Liam)
TEC External References: DCDB.dwg ; Catchment Boundaries.DWG ; TEC-TITLE-SKETCH-A1_b.dwg ; 5m CONTOURS - X-DESIGN.DWG ; Mareeba Shire Council 2017.png ;

Attachment 6

Preliminary Costing Advice for Drainage Infrastructure Upgrades

		Atherton Creek Cutoff Drain	Airport Drain & Culvert Widening	Reprofile Table Drains (Airport to George Fabris Rd)	George Fabris Rd Causeway	Reprofile Table Drain (George Fabris Rd to Chinaman Ck)	Future Drainage Corridor (George Fabris Rd to Chinaman Ck)	Chinaman Ck Culverts & Downstream Drain Widening	Reprofile Table Drains (Chinaman Ck to Coolamon Cl)	Coolamon Cl Culverts & Downstream Drain Widening
Drain Works										
	Additional Waterway Area (m2)	8	2	1.5	0	0.6	16	22	0.6	6
	Length (m)	1200	800	1640	0	940	1400	500	1460	385
	Volume (m3)	9600	1600	2460	0	564	22400	11000	876	2310
	Unit Rate ($/m3)	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00
	Clearing/stripping works (m2)	19200	6400	0	0	0	11200	6000	0	1540
	Unit Rate ($/m2)	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00
	Drain Sub-Total (ex GST)	**$ 576,000.00**	**$ 144,000.00**	**$ 73,800.00**	**$ -**	**$ 16,920.00**	**$ 840,000.00**	**$ 420,000.00**	**$ 26,280.00**	**$ 92,400.00**
Culvert Works										
	No. Crowns (1.2m long)		63					72		72
	Unit Rate ($/crown)		$ 12,000.00					$ 16,000.00		$ 12,000.00
	Remove existing culverts (1.2m long)							27		36
	Unit Rate ($/crown)							$ 4,000.00		$ 500.00
	Culvert Sub-Total (ex GST)	**$ -**	**$ 756,000.00**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 1,260,000.00**	**$ -**	**$ 882,000.00**
Causeway										
	Causeway footprint (m2)				240					
	Unit Rate ($/m2)				$ 500.00					
	Causeway Sub-Total (ex GST)	**$ -**	**$ -**	**$ -**	**$ 120,000.00**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Preliminaries & Erosion and Sediment Controls[1]		**$ 67,764.71**	**$ 300,000.00**	**$ 8,682.35**	**$ 34,285.71**	**$ 1,990.59**	**$ 98,823.53**	**$ 300,000.00**	**$ 3,091.76**	**$ 300,000.00**
Roadworks, Earthworks and Miscellaneous Items[1]		**$ 24,480.00**	**$ 400,000.00**	**$ 4,341.18**	**$ 17,142.86**	**$ 995.29**	**$ 35,700.00**	**$ 400,000.00**	**$ 1,545.88**	**$ 400,000.00**
	Construction Costs (ex GST)	**$ 668,244.71**	**$ 1,600,000.00**	**$ 86,823.53**	**$ 171,428.57**	**$ 19,905.88**	**$ 974,523.53**	**$ 2,380,000.00**	**$ 30,917.65**	**$ 1,674,400.00**
	15% for Survey, Geotechnical investigations and Engineering Design Services[2]	$ 100,236.71	$ 240,000.00	$ -	$ 42,857.14	$ -	$ 146,178.53	$ 357,000.00	$ -	$ 251,160.00
	Total Construction Cost (ex GST)	**$ 768,481.41**	**$ 1,840,000.00**	**$ 86,823.53**	**$ 214,285.71**	**$ 19,905.88**	**$ 1,120,702.06**	**$ 2,737,000.00**	**$ 30,917.65**	**$ 1,925,560.00**
	40% Contingency	$ 307,392.56	$ 736,000.00	$ 34,729.41	$ 85,714.29	$ 7,962.35	$ 448,280.82	$ 1,094,800.00	$ 12,367.06	$ 770,224.00
	GST	$ 76,848.14	$ 184,000.00	$ 8,682.35	$ 21,428.57	$ 1,990.59	$ 112,070.21	$ 273,700.00	$ 3,091.76	$ 192,556.00
	Total Construction Cost (incl. GST)	**$ 1,152,722.12**	**$ 2,760,000.00**	**$ 130,235.29**	**$ 321,428.57**	**$ 29,858.82**	**$ 1,681,053.09**	**$ 4,105,500.00**	**$ 46,376.47**	**$ 2,888,340.00**

[1] Budget allowance based on 2024/25 culvert construction contracts (Emerald End Road and Carman Road)

[2] Allowance for survey, geotechnical investigation and engineering services is increased to 25% for causeway projects

		Pleasant Cl Culverts & Downstream Drain Widening	Reprofile Table Drains (Coolamon Cl to Sunwater Access Rd)	Sunwater Access Rd Culverts & Downstream Drain Widening	Reprofile Table Drain (Sunwater Access Rd to Jennings Rd)	Jennings Rd Downstream Drain Widening	Reprofile Table Drain (Jennings Rd to Zenel Rd)	Zenel Rd Causeway and Table Drain	Zenel Rd Detention Basin & Downstream Drain	Reprofile Table Drain (Zenel Rd to McIver Rd)
Drain Works										
	Additional Waterway Area (m2)	9.5	1.4	3.3	1	14	1	1	7.5	1.8
	Length (m)	460	1760	1300	730	1700	950	550	540	800
	Volume (m3)	4370	2464	4290	730	23800	950	550	4050	1440
	Unit Rate ($/m3)	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00	$ 30.00
	Clearing/stripping works (m2)	1840	0	5200	0	6800	0	2200	6210	0
	Unit Rate ($/m2)	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00
	Drain Sub-Total (ex GST)	**$ 158,700.00**	**$ 73,920.00**	**$ 206,700.00**	**$ 21,900.00**	**$ 816,000.00**	**$ 28,500.00**	**$ 49,500.00**	**$ 214,650.00**	**$ 43,200.00**
Culvert Works										
	No. Crowns (1.2m long)	72		60					30	
	Unit Rate ($/crown)	$ 12,000.00		$ 12,000.00					$ 12,000.00	
	Remove existing culverts (1.2m long)	27		30						
	Unit Rate ($/crown)	$ 500.00		$ 4,000.00						
	Culvert Sub-Total (ex GST)	**$ 877,500.00**	**$ -**	**$ 840,000.00**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 360,000.00**	**$ -**
Causeway										
	Causeway footprint (m2)							240		
	Unit Rate ($/m2)							$ 500.00		
	Causeway Sub-Total (ex GST)	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 120,000.00**	**$ -**	**$ -**
Detention Basin										
	Bund Length (m)								850	
	Bund x-sectional area (m2)								8	
	Bund Volume (m3)								6800	
	Unit Rate ($/m3)								$ 30.00	
	Clearing/stripping works (m2)								11050	
	Unit Rate ($/m2)								$ 6.00	
	Basin Sub-Total (ex GST)	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 270,300.00**	**$ -**
Preliminaries & Erosion and Sediment Controls[1]		**$ 300,000.00**	**$ 8,696.47**	**$ 300,000.00**	**$ 2,576.47**	**$ 96,000.00**	**$ 3,352.94**	**$ 32,727.27**	**$ 215,533.33**	**$ 5,082.35**
Roadworks, Earthworks and Miscellaneous Items[1]		**$ 400,000.00**	**$ 4,348.24**	**$ 400,000.00**	**$ 1,288.24**	**$ 48,000.00**	**$ 1,676.47**	**$ 27,272.73**	**$ 53,883.33**	**$ 2,541.18**
Construction Costs (ex GST)		**$ 1,736,200.00**	**$ 86,964.71**	**$ 1,746,700.00**	**$ 25,764.71**	**$ 960,000.00**	**$ 33,529.41**	**$ 229,500.00**	**$ 1,114,366.67**	**$ 50,823.53**
15% for Survey, Geotechnical investigations and Engineering Design Services[2]		$ 260,430.00	$ -	$ 262,005.00	$ -	$ 144,000.00	$ -	$ 57,375.00	$ 167,155.00	$ -
Total Construction Cost (ex GST)		**$ 1,996,630.00**	**$ 86,964.71**	**$ 2,008,705.00**	**$ 25,764.71**	**$ 1,104,000.00**	**$ 33,529.41**	**$ 286,875.00**	**$ 1,281,521.67**	**$ 50,823.53**
40% Contingency		$ 798,652.00	$ 34,785.88	$ 803,482.00	$ 10,305.88	$ 441,600.00	$ 13,411.76	$ 114,750.00	$ 512,608.67	$ 20,329.41
GST		$ 199,663.00	$ 8,696.47	$ 200,870.50	$ 2,576.47	$ 110,400.00	$ 3,352.94	$ 28,687.50	$ 128,152.17	$ 5,082.35
Total Construction Cost (incl. GST)		**$ 2,994,945.00**	**$ 130,447.06**	**$ 3,013,057.50**	**$ 38,647.06**	**$ 1,656,000.00**	**$ 50,294.12**	**$ 430,312.50**	**$ 1,922,282.50**	**$ 76,235.29**

[1] Budget allowance based on 2024/25 culvert construction contracts (Emerald End Road and Carman Road)

[2] Allowance for survey, geotechnical investigation and engineering services is increased to 25% for causeway projects