CALVALE TO CALLIOPE RIVER TRANSMISSION LINE REINFORCEMENT

Surface Water Impact Assessment

Powerlink Queensland & Umwelt (Australia) Pty Ltd

24 July 2025

2254-01-B4

DETAILS

Report Title	Calvale to Calliope River Transmission Line Reinforcement, Surface Water Impact Assessment
Client	Umwelt (Australia) Pty Ltd

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1 INTRODUCTION

1.1 OVERVIEW

Umwelt (Australia) Pty Ltd (Umwelt), on behalf of Powerlink Queensland (Powerlink), is seeking a Ministerial Infrastructure Designation (MID) from the Minister of the Department of State Development, Infrastructure and Planning (DSDIP) for the Calvale to Calliope River (C2C) Transmission Line Reinforcement Project (the Project).

The Project extends from 10 kilometres (km) east of Biloela to 2 km north of Clinton, near Gladstone, Queensland and traverses both the Gladstone Regional and Banana Shire Local Government Areas (LGA). The Project runs parallel with the existing Powerlink transmission infrastructure and is split into five sections as detailed in Table 1.1. For a full description of the Project, including construction activities and methodologies, please refer to the MID Proposal Report.

Table 1.1 Project Sections

Section	Start of section	End of section	Approximate length	Existing Powerlink infrastructure
Section A	-24.3418, 150.6270	-24.3268, 150.6560	3.5 km	132 kV and 275 kV lines Calvale substation
Section B	-24.3268, 150.6560	-23.9344, 150.9174	51.5 km	One 275 kV line
Section C	-23.9344, 150.9174	-23.9230, 151.0733	16 km	Two 275 kV lines
Section D	-23.9230, 151.0733	-23.8484, 151.1754	13.5 km	One 275 kV line
Section E	-23.8484, 151.1754	-23.8580, 151.1943	2 km	Two 275 kV lines Calliope River substation

A large portion of the Project is contained within approved MIDs. Works to be undertaken within the approved MIDs are categorised as accepted development in accordance with section 44(6)(b) of the *Planning Act* 2016 (Planning Act). The assessment of impacts, therefore, focuses on the areas of the Project that fall outside of the approved MIDs (the MID proposal). The MID proposal captures a small portion of Section A and Section E and larger areas of Section C and Section D.

The MID proposal is shown in Figure 1.1 and comprises Sections C and D and the MPA within Section A and Section E.

The MID proposal is likely to comprise the following components:

- A new double circuit, 275 kilovolt (kV) transmission line within a 60 metre (m) wide easement.
- Steel lattice towers (up to 66 m in height).
- Brake and winch sites.
- Laydown areas.
- Concrete batching plants.
- A mobile site office.
- Upgrades to existing access tracks.

The Project area boundaries referred to throughout this report are defined as follows:

Study Area - The Study Area extends from the Calvale Substation site to the Calliope River Substation site and includes the existing powerline easement with a varying buffer for each section. The Study Area covers approximately 14,293 hectares (ha) and extends for 87 kilometres (km).

Disturbance Footprint – The area required to construct and operate the Project. This includes the transmission line, grid connection of the new transmission line to the Calvale Substation, expansion of the Calliope River substation, and other ancillary infrastructure (i.e. tower pads, access tracks, laydown areas, batch plants and brake and winch sites).

MID Proposal Area (MPA) – Refers to the areas of the Project alignment that are not captured by an existing MID and, therefore, are the subject of the MID proposal. The MPA includes a small portion of Section A and Section E and larger areas of Section C and Section D.

MID Disturbance Area (MDA) – Refers to the disturbance footprint within the MPA. The MDA represents the extent of direct impacts (i.e., vegetation clearing) proposed for the MID proposal.

1.2 PURPOSE OF REPORT

This report summarises the Project's potential impacts on the surface water environment. The surface water assessment includes the following key components:

- Outline the regulatory framework with respect to water quality, flooding and coastal hazards;
- Describe the existing surface water environment, including drainage features and catchments that traverse the alignment;
- Qualitatively assess coastal and flood risks within the MID Proposal Area in relation to proposed infrastructure; and,
- Proposed mitigation strategies to manage risks from storm tide, hydrology and flooding.

1.3 REPORT STRUCTURE

This report is structured as follows:

- Section 2 outlines the Project Infrastructure and activities;
- Section 3 provides details of the regulatory framework;
- Section 4 describes the existing surface water and coastal environment;
- Section 5 presents the appraisal hydrologic and flooding risks;
- Section 6 discusses potential impacts and mitigations;
- Section 7 provides a summary;
- Section 8 is a list of references;
- Section 9 is a list of abbreviations and definitions; and,
- Appendix A provides mapping of the corridor alignment.

WRM

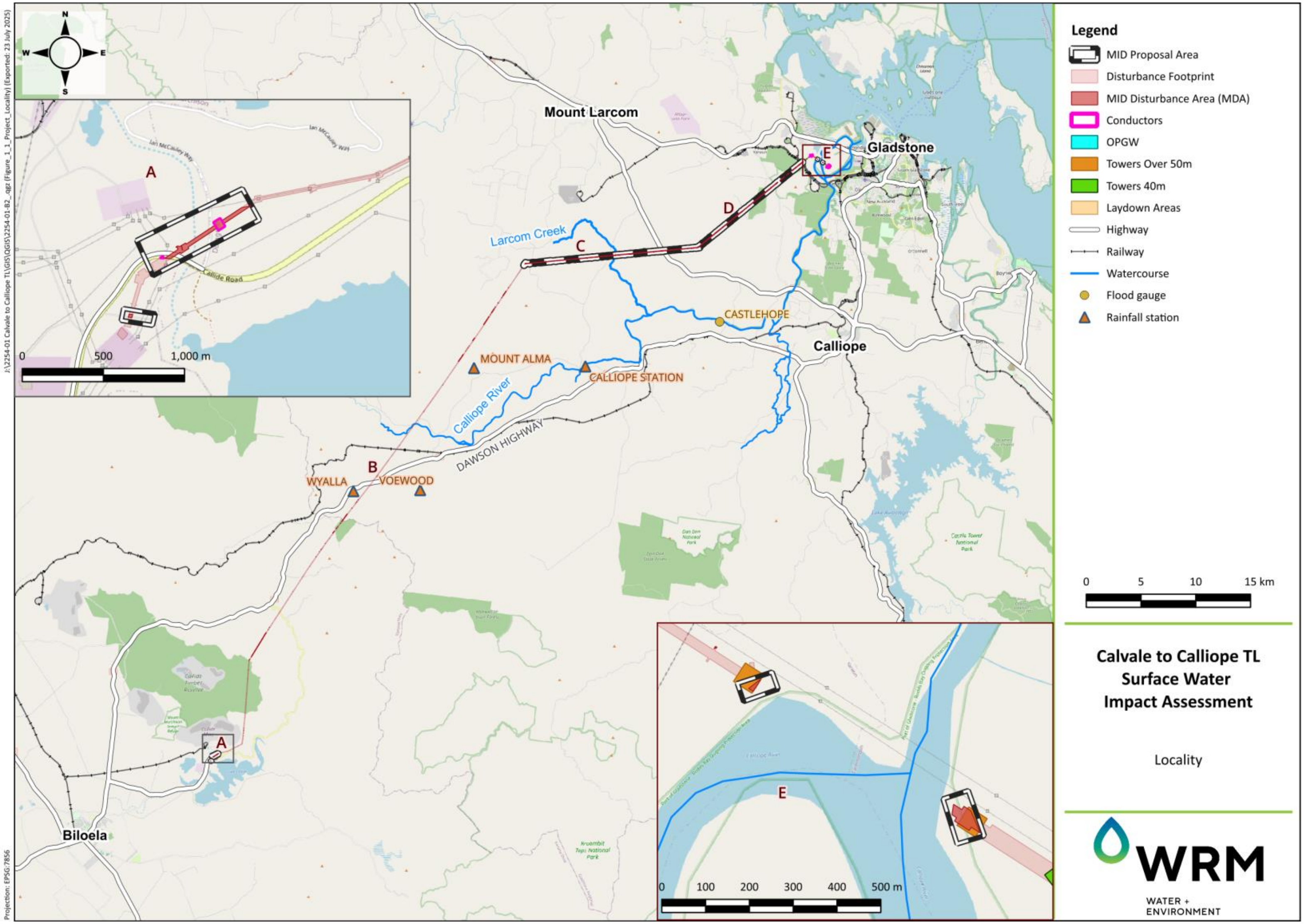


Figure 1.1 Project locality

2 PROJECT OVERVIEW

2.1 PROPOSED INFRASTRUCTURE ACTIVITIES

Construction of the transmission line will include the completion of the following activities:

- Site preparation, including site set out, pre-clearance surveys and vegetation clearing
- Establishment of batch plants, laydowns and offices
- Installation of gates, grids, clean-down bays and access tracks
- Tower site benching
- Foundation excavation and installation
- Establishment of brake and winch sites, and,
- Structure assembly and erection using a large mobile crane.

Prefabricated components are usually assembled adjacent to the tower construction sites. A large mobile crane will be used to erect the towers in sections. An indicative arrangement of the proposed tower is shown in Figure 2.1. Note that the arrangement shows minimal cross-sectional area at ground level, as the legs are tied to the bored piles.

2.1.1 Wire Stringing

Conductor and earth wire stringing are carried out as conventional or aerial stringing, as described below. The methodology is determined based on several factors, including, but not limited to, structure and alignment design, terrain, environmental and cultural heritage constraints, sensitive receptors, land usage and/or landowner constraints, schedule, cost-effectiveness, or risk.

- Conventional stringing involves the clearing of two or more tracks directly underneath and in line with the structure cross-arms. Earth-moving equipment (tractor, bulldozer or similar) will then pull steel draw wire across the ground in a slack state from one structure to another down the alignment. The draw wire is then manually raised and placed into the stringing pulleys attached to the cross arms, which are ready for the running conductor.
- Aerial stringing is the method of attaching draw wire or specialised rope to either a helicopter or drone, which is then flown from one structure to another, lowering the draw wire or rope directly into the stringing pulleys. Aerial stringing may be carried out under tension with the assistance of a tensioner or other braking equipment (tesmec puller/tensioner) or in a slackened state where the draw wire or rope is able to be pulled at very low or no tension with the use of a heli-brake or similar and may be pulled across the ground where permitted.
- Stringing will be completed in sections of varying lengths of up to 10 km between termination structures, depending on constraints, terrain, and access. Specialised equipment, including a powerful winch (puller), a braking device (tensioner) and pulleys (stringing sheaves), will be required.

Site rehabilitation was disturbed, including reinstating pre-existing topography, topsoil, and fences.

- Where practicable, all disturbed areas that will not accommodate permanent infrastructure will be reinstated progressively during construction. The short-term goal of reinstatement is to stabilise soils to provide a suitable matrix for vegetation establishment, which will aid in preventing erosion.

2.2 DESIGN AND CONSTRUCTION ACTIVITIES

This section provides an overview of the activities that will impact surface water aspects within the MID Proposal Area. These are activities considered likely during the construction phase of the transmission line and associated infrastructure.

2.2.1 Disturbance footprint

Within the MID Proposal Area, a Disturbance Footprint was determined, which includes all Project elements and temporary disturbance areas. The Disturbance Footprint was established to avoid and minimise environmental, social and engineering constraints in the immediate vicinity of the Project, including wetlands and waterways, proximity to road and railway corridors, slope and constructability constraints, and landholder's ongoing usage requirements.

2.2.2 Proposed timeframes

Construction is expected to commence in mid 2026, with an anticipated completion date of December 2028. The construction phase of the Project is anticipated to be around 30 months.

2.2.3 Hardstand areas

A range of hardstand areas may be required, such as for construction compounds and operation and maintenance facilities. The construction of hardstand areas will vary depending on localised ground conditions. Conditions impacting construction are dependent on specific existing vegetation, localised topography, nature of the topsoil, levels of moisture in the ground and geotechnical base.

2.2.4 Access tracks

The construction of access tracks will vary depending on localised ground conditions. Conditions impacting construction include existing vegetation, localised topography, nature of the topsoil, levels of moisture in the ground and geotechnical base.

2.2.5 Foundation Installation

The construction of tower foundations usually consists of the following steps:

- Setting out, to mark the location of the excavation
- Excavation/boring
- Leg stub/base set-up
- Placement of reinforcing steel/concreting
- Concreting of excavated foundations
- Installation of earthing.

Bored foundations, see Figure 2.2, are excavated using specialised piling equipment, such as track-mounted drill rigs. Depending on the geology of the surrounding soil, foundations are typically excavated to approximately four to twelve metres. If suitable, the excavated material or imported fill is used to backfill mass concrete foundations. Surplus material is spread evenly about the site or removed, depending on quantity and suitability.

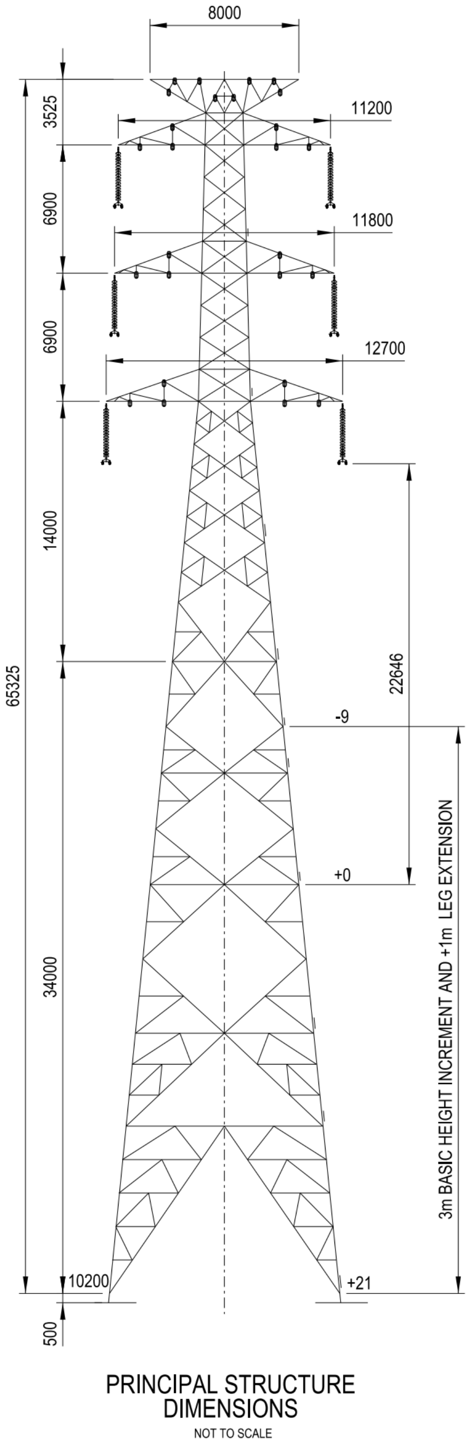
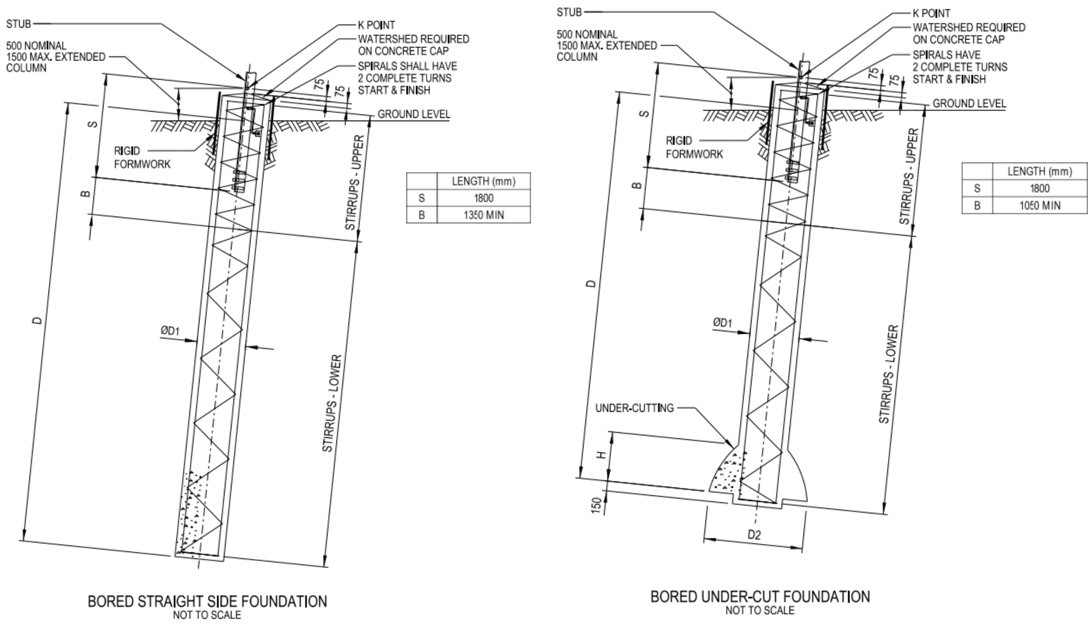


Figure 2.1 Indicative general arrangement of tower

Source: Powerlink



	LENGTH (mm)
S	1800
B	1350 MIN

	LENGTH (mm)
S	1800
B	1050 MIN

Figure 2.2 Indicative typical detail of bored pile arrangements

Source: Powerlink

3 REGULATORY FRAMEWORK

3.1 OVERVIEW

This section describes the regulatory framework (legislation, policies, and standards) at the Commonwealth and State level that would apply to surface water management for The Project. In undertaking these assessments, the key relevant Acts include:

- *Water Act* 2000 (Water Act)
  - Water Regulation 2016
- *Environmental Protection Act* 1994 (EP Act)
  - *Environmental Protection* (Water and Wetland Biodiversity) *Policy* 2019 (EPP Water)
- *Planning Act* 2016 (Planning Act)
  - Planning Regulation 2017
  - State Planning Policy 2017

3.2 WATER ACT 2000

In Queensland, the Water Act is the primary statutory document that establishes a system for planning, allocating and using non-tidal water. The Department of Local Government, Water and Volunteers administers the Water Act. The Water Act prescribes the process for preparing Water Plans (WPs) and Water Management Protocols (WMPs) for specific catchments within Queensland. Under this process, WPs are prepared to identify:

- desired outcomes, measures and strategies for achieving the outcomes;
- performance indicators;
- amounts of water available for consumptive use and future use;
- specifications of water management areas and trading zones; and
- criteria for deciding water licences.

The WMPs provide details of:

- water dealing/trading rules;
- water sharing rules for unsupplemented water;
- seasonal water assignment rules; and
- any volumes of unallocated water reserved for particular purposes or stated locations.

The WPs and WMPs determine conditions for granting water allocation licences, permits and other authorities, as well as rules for water trading and sharing. The WP sets Environmental Flow Objectives (EFOs) to protect waterway health, and Water Allocation Security Objectives (WASOs) to maintain community water supplies.

3.3 QUEENSLAND ENVIRONMENTAL PROTECTION ACT 1994

All persons have a legal duty under the EP Act Section 319 to take all reasonable and practicable measures to minimise or prevent environmental harm. Such harm can be caused if sediment from a construction site enters (washes, blows, falls or otherwise) into drains or waterways. Section 443 of the EP Act stipulates that a person must not cause or allow a contaminant to be placed in a position where it could reasonably be expected to cause serious or material environmental harm or environmental nuisance (e.g. placing a stockpile adjacent to a waterway). Section 440ZG of the EP Act requires that a person must not unlawfully deposit a prescribed water contaminant at another place and in a way so that the contaminant could reasonably be expected to wash, blow, fall or otherwise move into waters or stormwater drainage.

The Principal Contractor who becomes aware of serious or material harm in association with their work (e.g. significant loss of sediment from their site works into a watercourse) has a legal duty under Section 320A of the EP Act to notify the Department of Environment, Tourism, Science and Innovation (DETSI).

3.3.1 EPP Water and Wetland Biodiversity Policy

The EPP Water is subordinate legislation under the EP Act. The EPP Water seeks to protect Queensland's waters while allowing for development that is ecologically sustainable. Queensland waters include water in rivers, streams, wetlands, lakes, aquifers, estuaries, and coastal areas. This purpose is achieved within a framework that includes:

- identifying environmental values (EVs)
- determining water quality guidelines (WQGs), and
- water quality objectives (WQOs) to enhance or protect the environmental values.

The EVs and WQOs applying to The Project are outlined in Section 4.2.2.

3.4 PLANNING ACT 2016

The Planning Act is the mechanism for assessing developments within Queensland. The Planning Act is supported by the Planning Regulation 2017 (Planning Regulation), the State Planning Policy and the Gladstone Regional Council Planning Scheme 2017 and the Banana Shire Council Planning Scheme 2021. The Planning Act provides the encompassing principles for the management of stormwater within the MID Proposal Area.

Planning Schemes for Gladstone Regional and Banana Shire Council provide the strategic framework for planning and development and are the primary instrument governing surface water resources (specifically stormwater) within the MID Proposal Area. Assessment benchmarks are based on principles of ecological sustainability established by the Planning Act and are the basis for the measures of Planning Schemes.

3.4.1 State Planning Policy 2017

Stormwater management must comply with State Planning Policy (SPP). The SPP outlines the desired outcomes for the following aspects:

Drainage control desired outcomes:

1. Manage stormwater flows around or through areas of exposed soil to avoid contamination;
2. Manage sheet flows in order to avoid or minimise the generation of rill or gully erosion;
3. Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works, which for a design life >24 months requires drainage structure to pass the 10% AEP flood event, and culvert crossings to pass the 63% AEP flood event;
4. Provide emergency spillways for sediment basins to achieve the construction phase stormwater management design objectives for emergency spillways on temporary sediment basins which requires spillway capacity for a 2% AEP flood event.

Waterway stability and flood flow management desired outcomes:

1. Where measures are required to meet post-construction waterway stability objectives, the reduction in mean annual load is to reduce: total suspended solids by 85%, total phosphorous by 60%, total nitrogen by 45% and gross pollutants by 90%;
2. Earthworks and the implementation of erosion and sediment controls are undertaken in ways that ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 1% AEP.

Litter, hydrocarbons and other contaminants desired outcomes:

1. Remove gross pollutants and litter;
2. Avoid the release of oil or visible sheen to released waters;
3. Dispose of waste containing contaminants at authorised facilities.

State Interests relating to the Coastal environment

Development is to protect and enhance the coastal environment while supporting opportunities for coastal-dependent development, compatible urban form, and maintaining appropriate public use of and access to and along state coastal land. The State interests also include land where erosion-prone areas are within a coastal management district. The following two policy items are from State Interests, and numbers 8 and 9 were retained for consistency. Erosion-prone areas and coastal management districts are shown on Figure 4.10.

Policy 8. Development does not occur unless the development cannot feasibly be located elsewhere and is: (a) coastal-dependent development; or (b) temporary, readily relocatable or able to be abandoned development; or (c) essential community infrastructure; or (d) minor redevelopment of an existing permanent building or structure that cannot be relocated or abandoned.

Policy 9. Development permitted in policy 8 above, mitigates the risks to people and property to an acceptable or tolerable level.

4 EXISTING SURFACE WATER ENVIRONMENT

4.1 REGIONAL CLIMATE CONDITIONS

4.1.1 Overview

Located in the central coast region beneath the Tropic of Capricorn, the MID Proposal Area experiences a subtropical climate with significant summer rainfall, predominantly occurring between December and March. Rainfall ranges from low to moderate in the coastal plains, increasing to moderate to high in the steeper ranges due to orographic influences.

According to the Köppen Classification system, as outlined by the Bureau of Meteorology of Australia, the climate of the MID Proposal Area falls within the moderately dry winter subtropical zone. Rainfall is seasonally distributed, characterised by a wet season from October to March and a drier season from April to September.

4.1.2 Rainfall

Daily rainfall records have been maintained since 1922 at Voewood (Station No. 39233), southwest of the MID Proposal Area, shown on Figure 1.1. Rainfall data recorded at this station is considered representative of rainfall likely to fall in the vicinity of the MID Proposal Area. Table 4.1 shows summary details of the rainfall stations, including the dates on which each were operated. The highest annual rainfall at this station (1,588 mm) was estimated as being the 1892/93 water year as shown on Figure 4.3. During the 1974 water year, an annual total of 1,408 mm was observed, which is about double the median annual rainfall total of 786 mm.

Table 4.1 Weather stations

Station No.	Station Name	Latitude	Longitude	Elevation (mAHD)	Opened	Closed
39125	Mount Alma	24.02	150.87	99	1960	2006
39020	Calliope Station	24.02	150.97	58	1906	2016
39233	Voewood	24.12	150.82	n/a	1913	1978
39249	Wyalla	24.12	150.76	200	1959	2000

Synthetic historical rainfall and evaporation data for the Mount Alma gauge from the SILO Data Drill service (QLD, 2023) were adopted to describe the rainfall variability of the MID Proposal Area (refer Figure 4.1). The key advantage of adopting the Data Drill dataset is that it has been adjusted to remove accumulated totals over multiple days and to fill periods of missing data using rainfall from nearby stations.

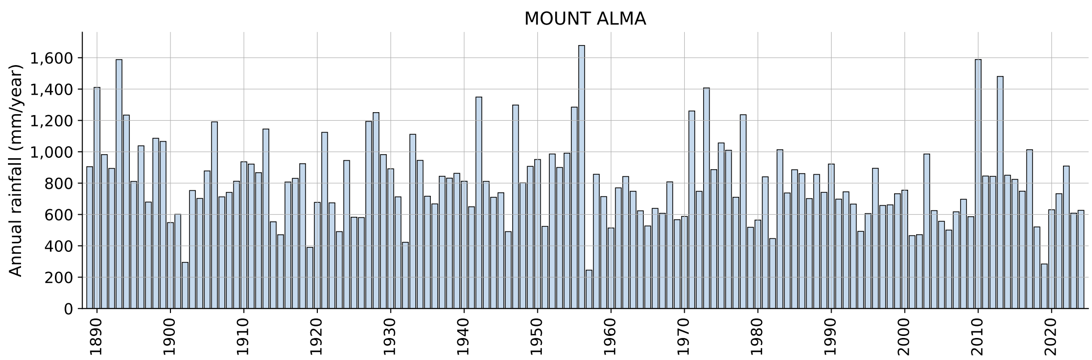


Figure 4.1 Annual total rainfall from synthetic daily rainfall data at MID Proposal Area

Figure 4.2 shows summary rainfall statistics, with the highest monthly rainfalls occurring in January and February. Evaporation peaks between November and January (inclusive). The upper panel of Figure 4.3 indicates that large rainfalls can occur throughout the year, with a notable monthly rainfall occurring in December 1973.

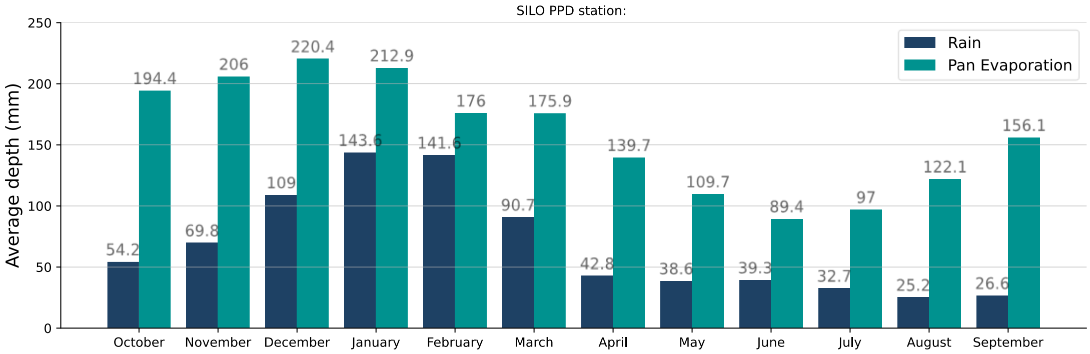


Figure 4.2 Distribution of monthly rainfall and pan evaporation

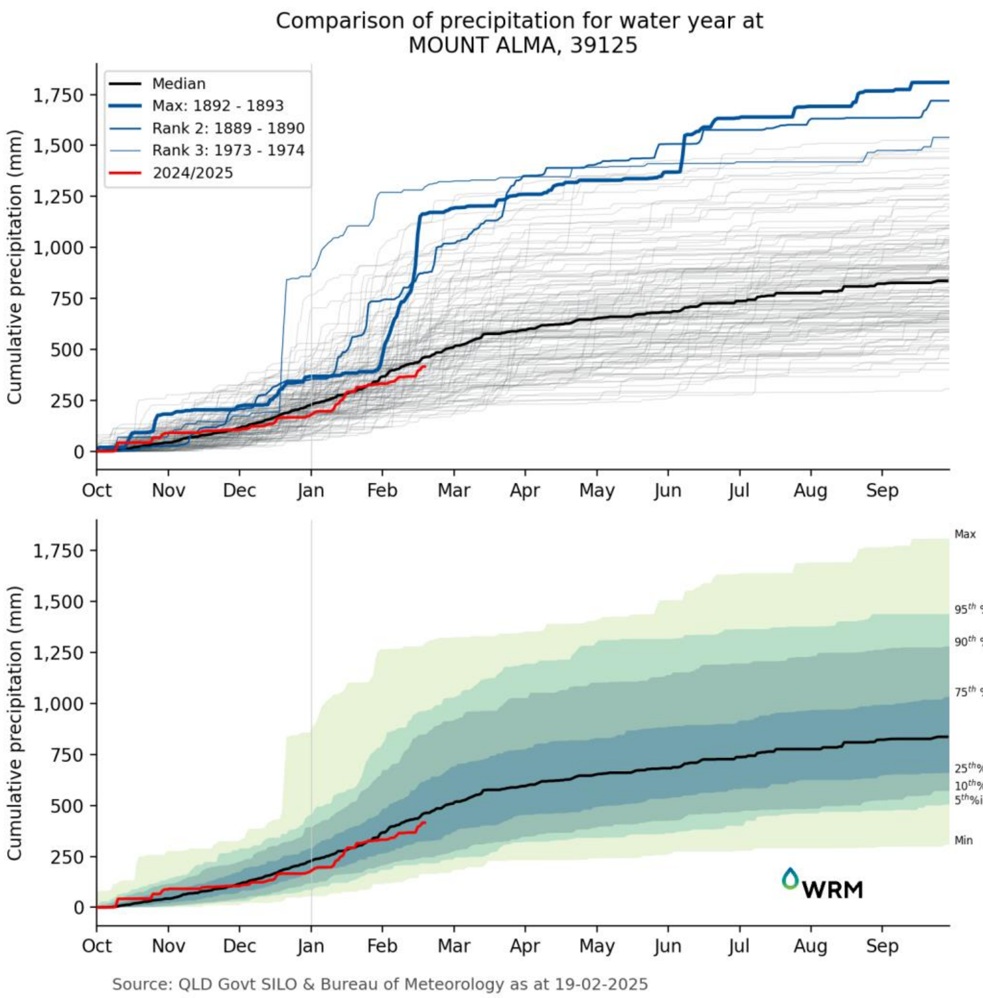


Figure 4.3 Timeseries of rainfall near MID Proposal Area

4.2 WATER QUALITY ASPECTS

4.2.1 Overview

Schedule 1 of the EPP Water[1] locates the MID Proposal Area within the Curtis Island, Calliope River and Boyne River Basins[2]. The MID Proposal Area is located in Basin 132 in the Upper Calliope River's southern tributaries (WQ1311). The applicable EVs and WQOs were written pursuant to the provisions of legislation the EP Act. The EPP Water provides a framework for identifying EVs for Queensland waters and deciding the WQOs to protect or enhance those EVs, including the identified EVs and WQOs under Schedule 1.

4.2.2 Environmental values

The Curtis Island, Calliope River and Boyne River Basins EVs and WQOs document contains EVs for waters in the Calliope River southern tributaries as listed under schedule 1 of the EPP (Water). The applicable EVs are as follows:

- Aquatic ecosystems - the intrinsic value of aquatic ecosystems, habitat in waterways;
- Irrigation - water supply for irrigation;
- Farm supply/use - non-potable farm water supply;
- Stock water - water supply for the production of healthy livestock;
- Human consumer - producing aquatic foods from natural waterways;
- Primary recreation - full body contact and frequent immersion;
- Secondary recreation – contact with limbs and regular wetting;
- Visual recreation – uses that require no direct contact with water;
- Drinking water - suitable as a supply to water treatment plant; and
- Cultural and spiritual values – scientific, social or cultural heritage.

4.2.3 Water quality objectives

WQOs are defined under the Water Act and EPP (Water) for the purpose of protecting the identified EVs for a particular receiving environment. Relevant local guideline values are defined at a sub-basin level. Relevant aquatic ecosystem WQOs for baseflow conditions for the Surface Fresh Waters (Management Intent – Moderately Disturbed) are outlined as follows, and the values are based on:

- The Calliope Fresh Waters Outside State Development Area water quality guidelines:
  - ammonia N: <10 µg/L
  - oxidised N: <15 µg/L
  - total nitrogen: <250 µg/L
  - filterable reactive phosphorus (FRP): <15 µg/L
  - total phosphorus: <30 µg/L
  - chlorophyll a: n/a

[1] https://www.legislation.qld.gov.au/view/pdf/2023-10-20/sl-2019-0156

[2] https://environment.desi.qld.gov.au/__data/assets/pdf_file/0034/87775/boyne-calliope-curtis-evs-wqos.pdf

- dissolved oxygen: 90%–110% saturation
- turbidity: <25 NTU
- suspended solids: ‘id’ insufficient data.
- pH: 6.5–7.5

4.2.4 Surface water quality

No direct water quality measurements or qualitative water quality information is publicly available for any watercourses relevant to the MID Proposal Area. Water quality within the MID Proposal Area is expected to be commensurate with moderately disturbed streams nearby that are subject to limited vegetation clearing, grazing and erosion.

4.3 LAND USE AND CLASSIFICATION

Land use within the Calliope River basin predominantly consists of dryland grazing practices, with smaller pockets dedicated to irrigated cropping and industrial activities. Water resource allocation within the basin is low and reflective of the relatively undeveloped state of the area. Estimated water consumption from the river and its tributaries predominantly serves irrigation needs.

The MID Proposal Area is located in a largely rural and sparsely settled landscape mostly used for light grazing and livestock production. The Queensland Land Use layer maps the primary land usage as production from relatively natural environments, such as grazing native vegetation. Cattle grazing is the dominant land use in the catchment, primarily confined to the coastal plains where much of the natural vegetation has been thinned or removed. At the same time, the ranges mostly retain undisturbed eucalypt forests. The MID Proposal Area does not contain water storage, and the landform though cleared of large stands of trees, is relatively unmodified from its natural condition. Vegetation throughout the MID Proposal Area is sparse, with some significant riparian vegetation along drainage corridors.

Figure 4.4 shows the land classification according to the Queensland Government’s agricultural land types within the MID Proposal Area, namely:

- Pastureland – sown pastures and native pastures (C1); and,
- Pastureland – native pastures (C2).

4.4 SOILS AND GEOLOGY

The MID Proposal Area is mapped as having a Dermosol soil and other soil types adjacent, as shown on Figure 4.5. These soil types within the MID Proposal Area were obtained through soil and land resource datasets provided by the Queensland Government's open data portal.

The development of erosion and salinity problems on marginal land has led to land management being identified as a high priority to reduce sediment loads being transported by rivers into the Great Barrier Reef.

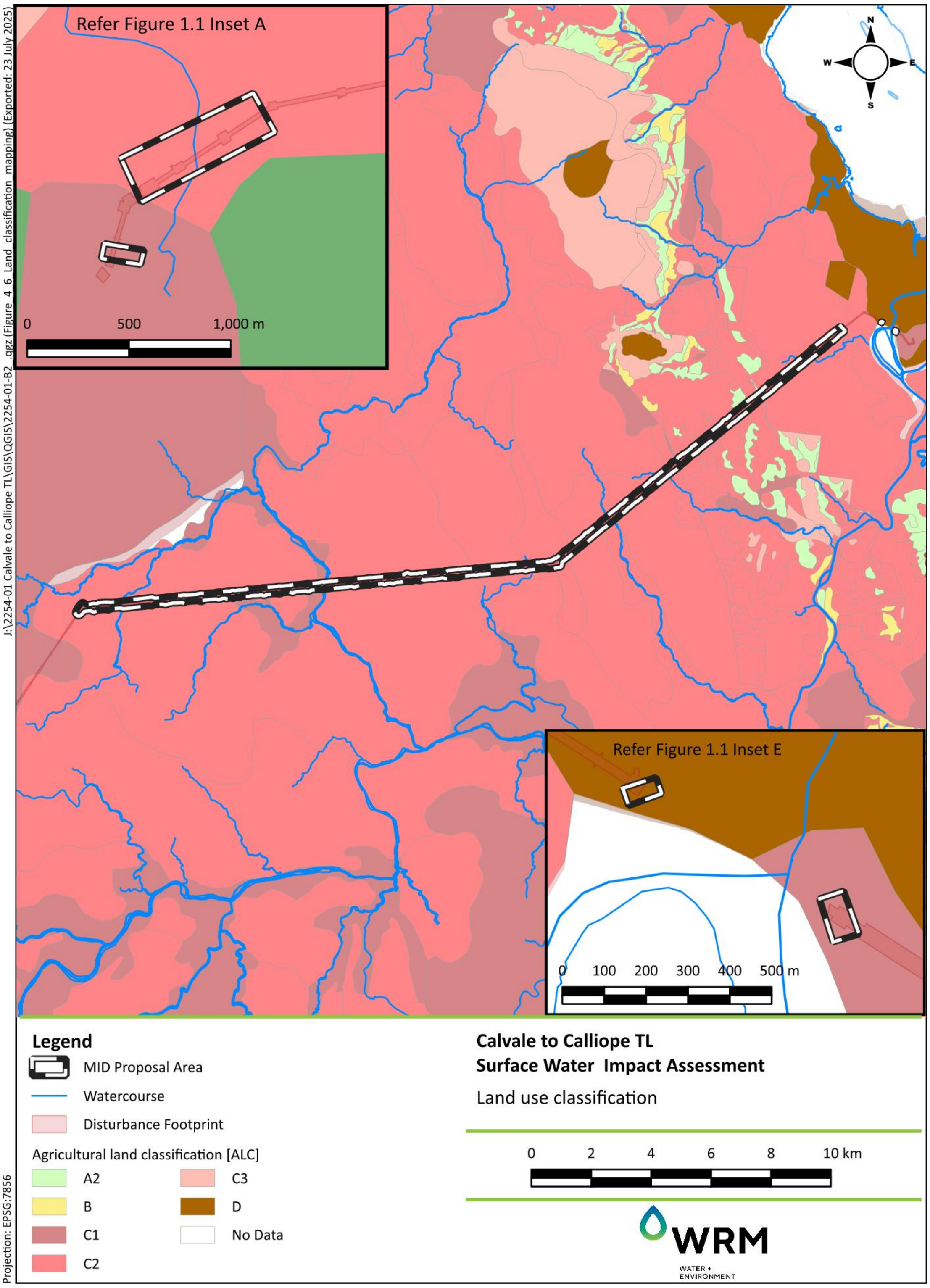


Figure 4.4 Agricultural Land Classification

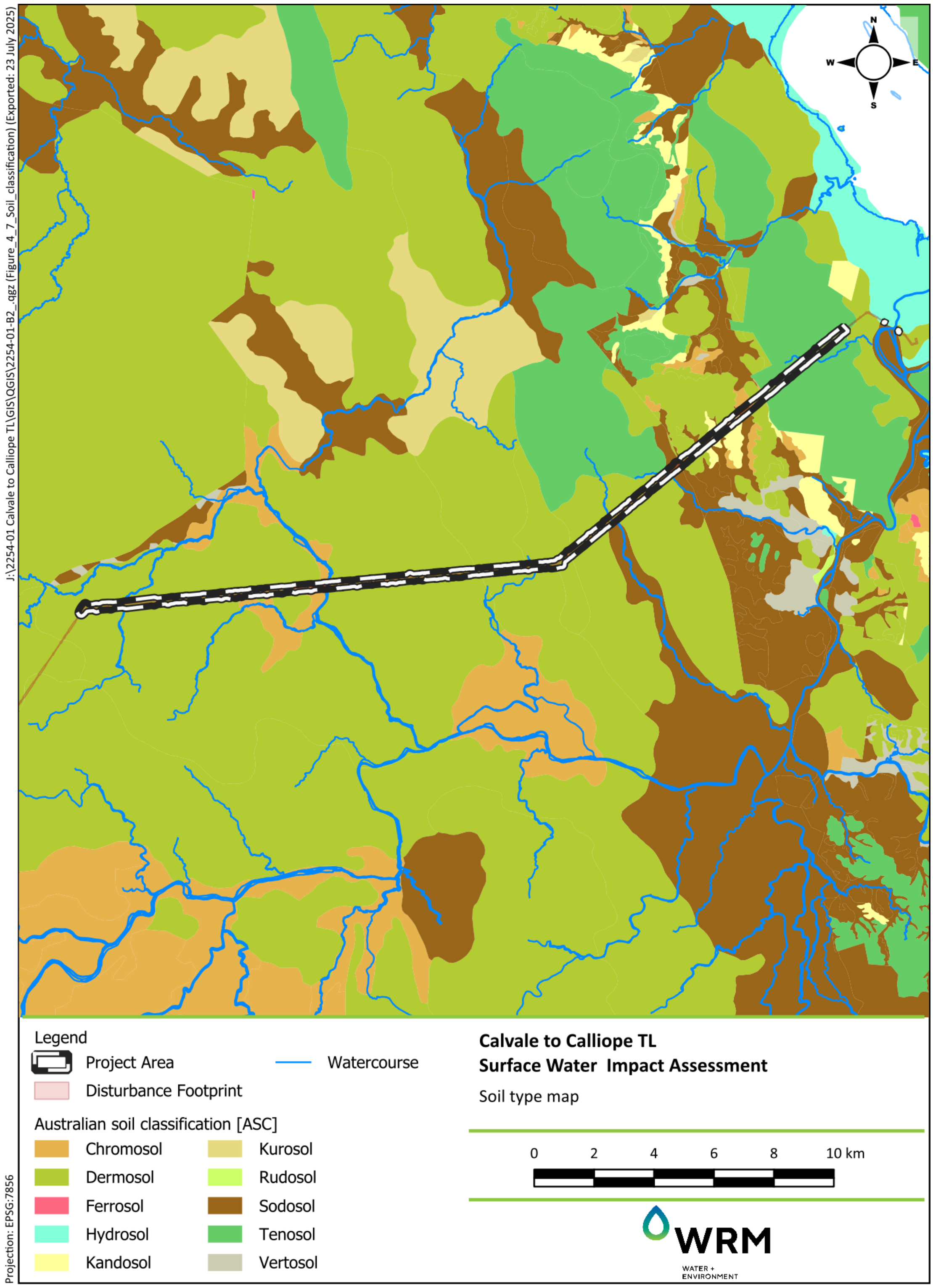


Figure 4.5 Australian Soil Classification

4.5 REGIONAL DRAINAGE CHARACTERISTICS

The Calliope River, originating near Cedric Mountain in the Don River State Forest, meanders almost 100 kilometres before reaching the Pacific Ocean near Gladstone. The river flows parallel to the MID Proposal Area before reaching the Calliope River at Section E, as shown on Figure 1.1. This broader region is geographically confined by the Mount Larcom Range to the east and the Calliope Range to the west. The Calliope River basin's catchment area is 1,890 km^2. The Calliope River gathers water from significant tributaries such as Oakey Creek and Larcom Creek, as shown on Figure 4.6. Also shown are catchment areas draining through Section C and Section D of the MID Proposal Area. The catchments are identified by the tower's identifier. For example, Larcom Creek catchment drains past a tower identified as 'CC135'. Larcom Creek is also the longest contributing creek to Calliope River and drains approximately 270 km^2 through Section C.

A GIS dataset identifying the stream order data for the watercourses in the MID Proposal Area was available from the Queensland Spatial Catalogue (QSpatial). This dataset was based on Geoscience Australia's drainage network of Queensland where streams are connected and ordered according to the Strahler method (DNMRE, 2010). Strahler stream order is shown on Figure 4.7.

Section C and Section D of the proposed transmission corridor cross *unmapped watercourses* and *drainage features* as defined by the Water Act. Numerous *drainage features* are mapped and crossed by Section D. The Water Act predominately identifies a series of first-order streams near the MID Proposal Area that are designated as *unmapped* watercourses, as shown on Figure 4.7 and Figure 4.8. Farmer Creek and Six Mile Creek are mapped as defined *watercourses*. It is notable, that while Larcom Creek is a fourth-order stream when it passes through the MID Proposal Area. However, the Water Act does not define Larcom Creek as a *watercourse*. It is only further downstream (about two kilometres) of Section C of the MID Proposal Area that Larcom Creek is then defined as a *watercourse*.

The Calliope River basin's current ecological state reflects a balance between human impact and natural resilience. While the basin has witnessed considerable clearing of native vegetation, estimated up to two-thirds, riparian zones comprising native flora still exist along major creeks within the basin. This riparian vegetation plays a vital role in maintaining in-stream water quality, offering a degree of protection against the impacts of grazing, cropping, and industrial activities within the catchment.

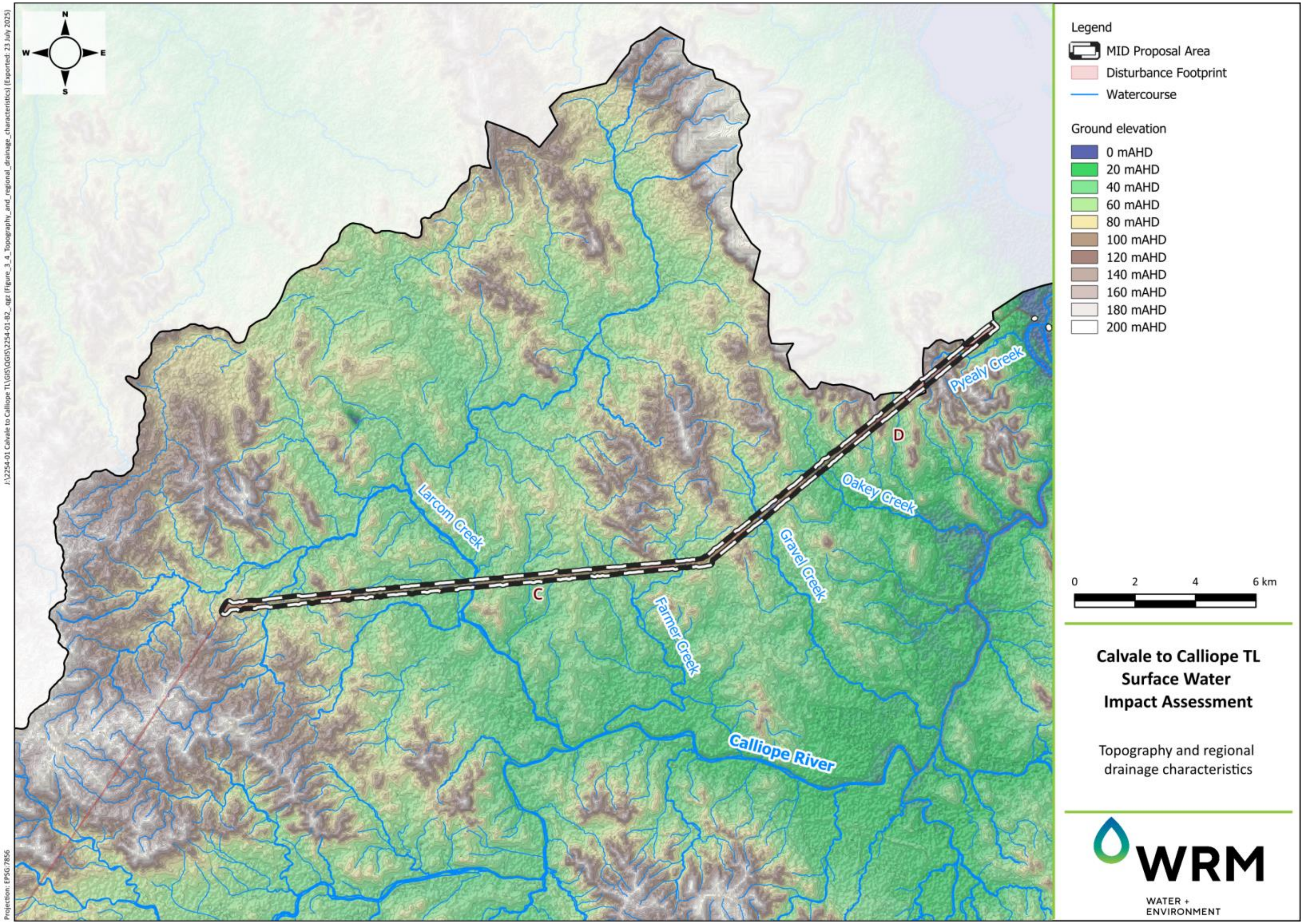


Figure 4.6 Topography and regional drainage characteristics

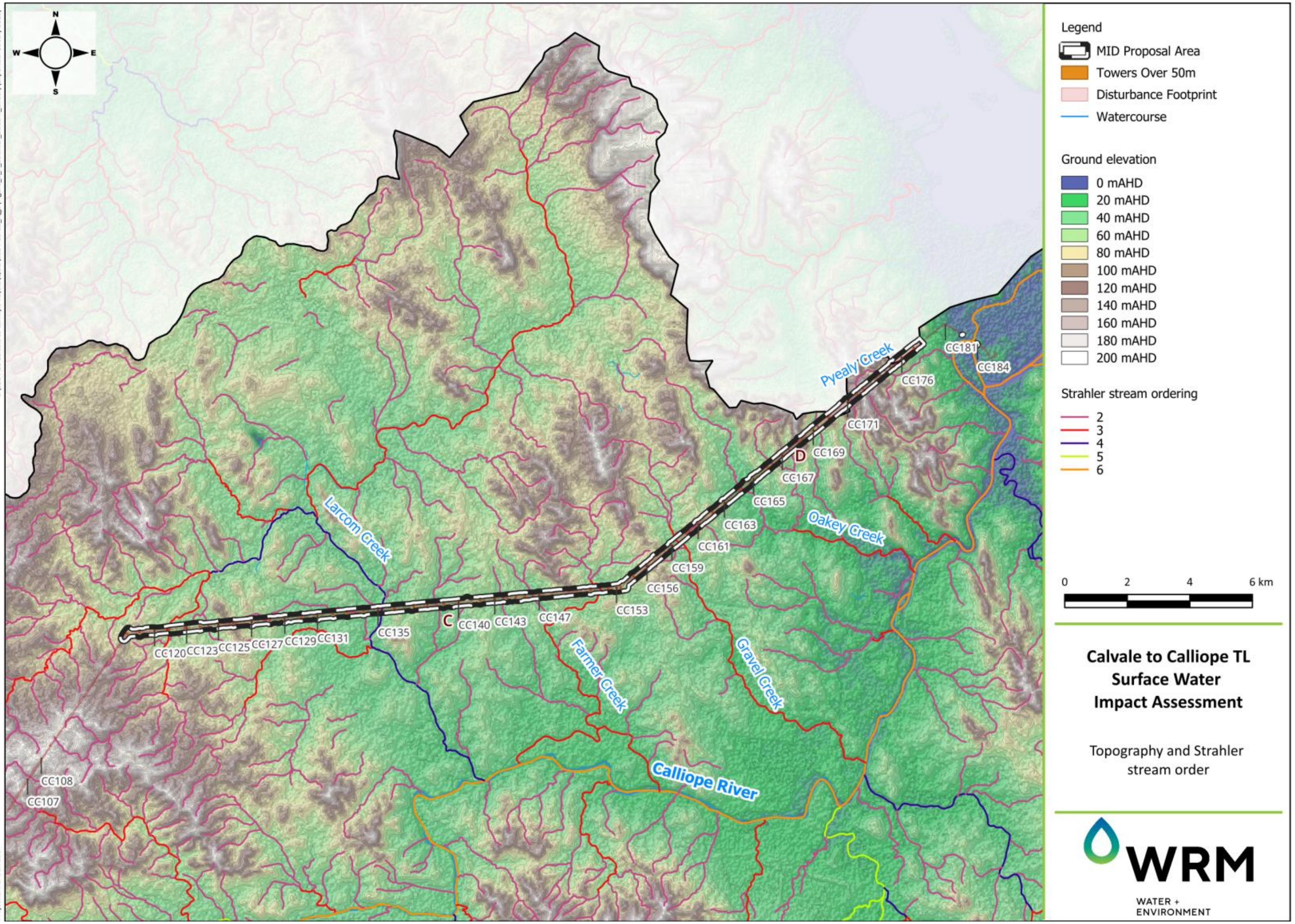


Figure 4.7 Strahler stream order

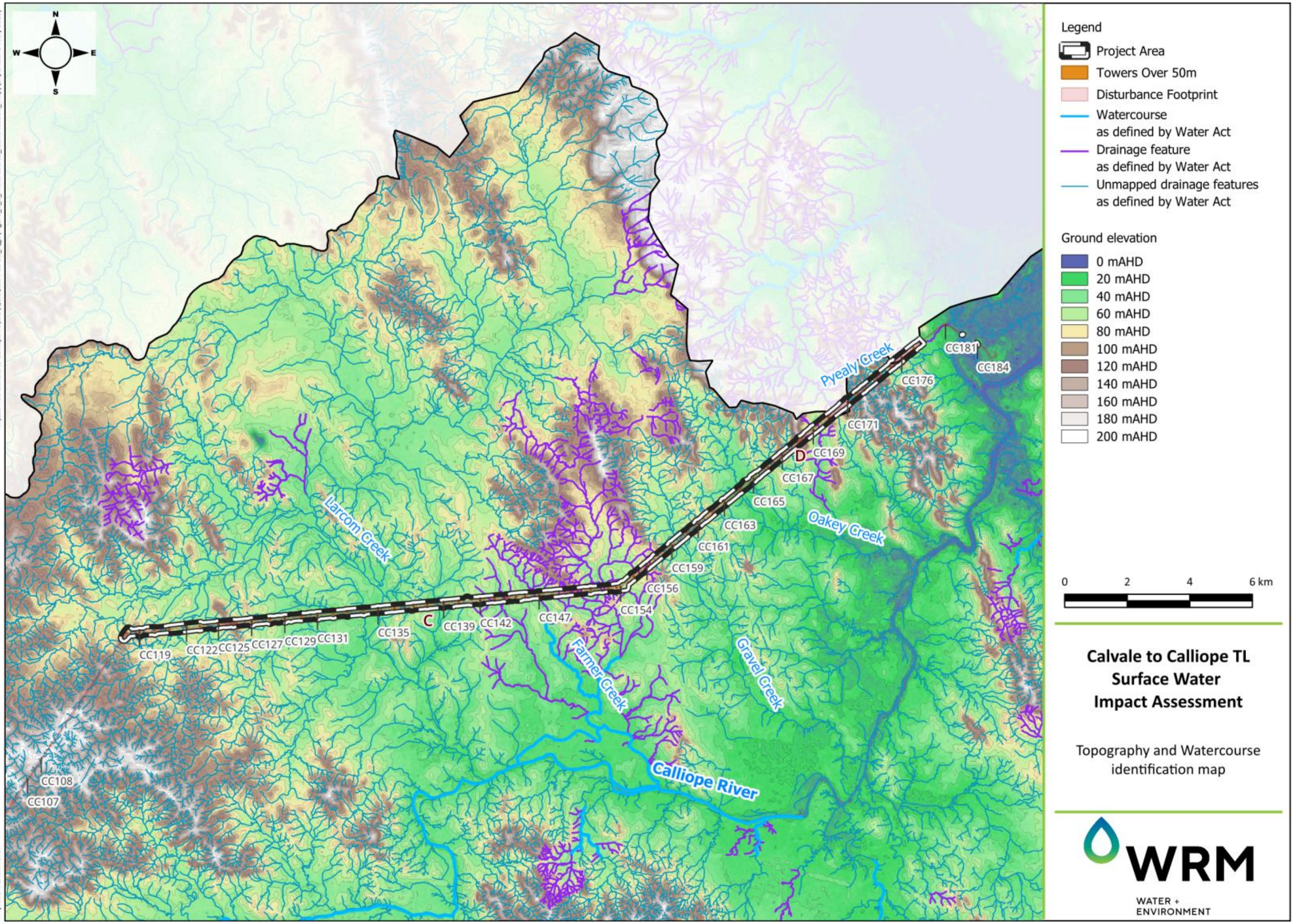


Figure 4.8 **Watercourse identification map (*Water Act* 2000)**

4.6 COASTAL ENVIRONMENT

The MID Proposal Area passes into the coastal management district as shown on Figure 4.10. There is no coastal building line defined near the MID Proposal Area. The State Planning Policy State Interest – Coastal Environment requires that development protect and enhance the coastal environment while supporting opportunities for coastal-dependent development. Policy 8 permits development in coastal erosion-prone areas where it cannot be feasibly relocated and is essential community infrastructure. It also requires that risks to people and property from the development of essential infrastructure be mitigated to a tolerable level.

Coastal hazards include erosion of sandy coastlines coupled with short or long-term seawater inundation of low-lying areas along the coastline. Storm tide inundation is caused by an abnormal elevation of sea levels beyond normal tide levels resulting from low-pressure systems. Figure 4.9 provides a diagrammatic example of the constituent components. A storm surge is a major risk associated with a cyclone, they can also form with low-pressure systems in non-tropical areas. A storm surge is a rise above the normal water level along a shore resulting from strong onshore winds and/or reduced atmospheric pressure. When the wind blows towards the coast (onshore), water piles up against the coast to raise the sea level. The wave setup refers to an increase in the mean water level towards the shoreline caused by wave action. A further component of coastal hazard is the wave run-up component. Wave run-up depends on many factors, including wave height, wave period, and the slope and composition of the coastal line.

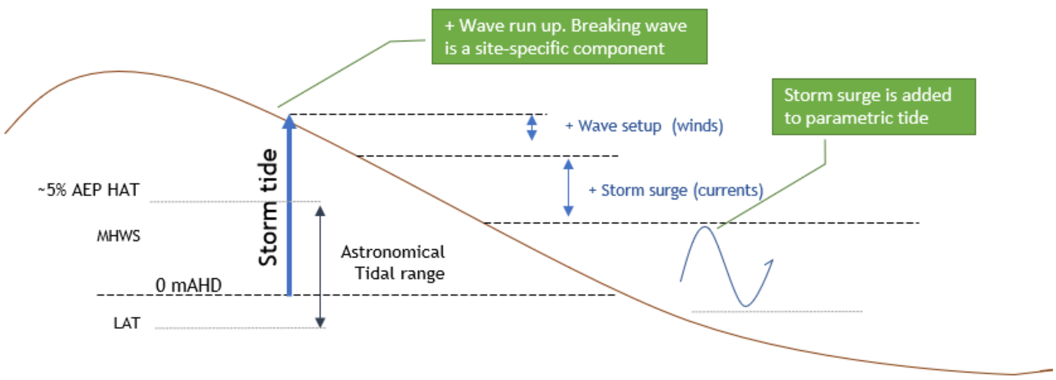


Figure 4.9 Water level component of a storm tide

Gladstone Regional Council's *Our Coast Our Future Strategic Plan* is a long-term Gladstone Region Coastal Hazard Adaptation Strategy (CHAS) that aims to manage and adapt to the impacts of coastal hazards. The CHAS involved a detailed coastal hazard modelling study, the results of which were used to inform the maps shown as Figure 4.10 through Figure 4.12.

There are six storm tide evacuation zones for the MID Proposal Area, as shown on Figure 4.11. The Bureau of Meteorology provides advice on the predicted storm tide height. The storm surge components that results from the high onshore winds (wind setup), wave energy (wave setup) and/or low atmospheric pressures, this is mapped as *high-hazard area* on Figure 4.12. The wind setup component is the vertical rise of a body of water above the still water level caused by the wind stresses on the surface of the water and is mapped on Figure 4.12 as a *medium hazard area*.

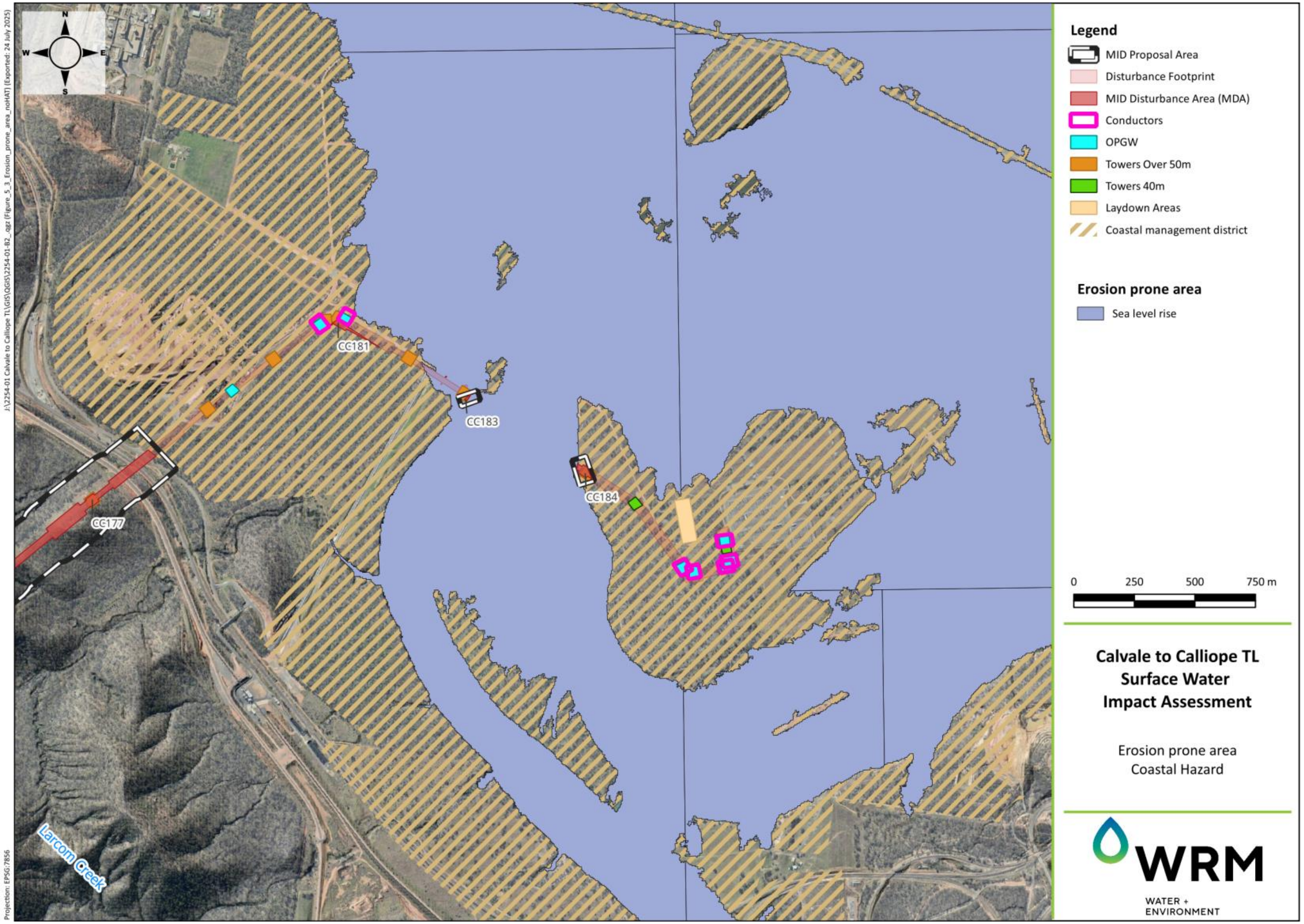


Figure 4.10 **Erosion prone area and Coastal Management District**

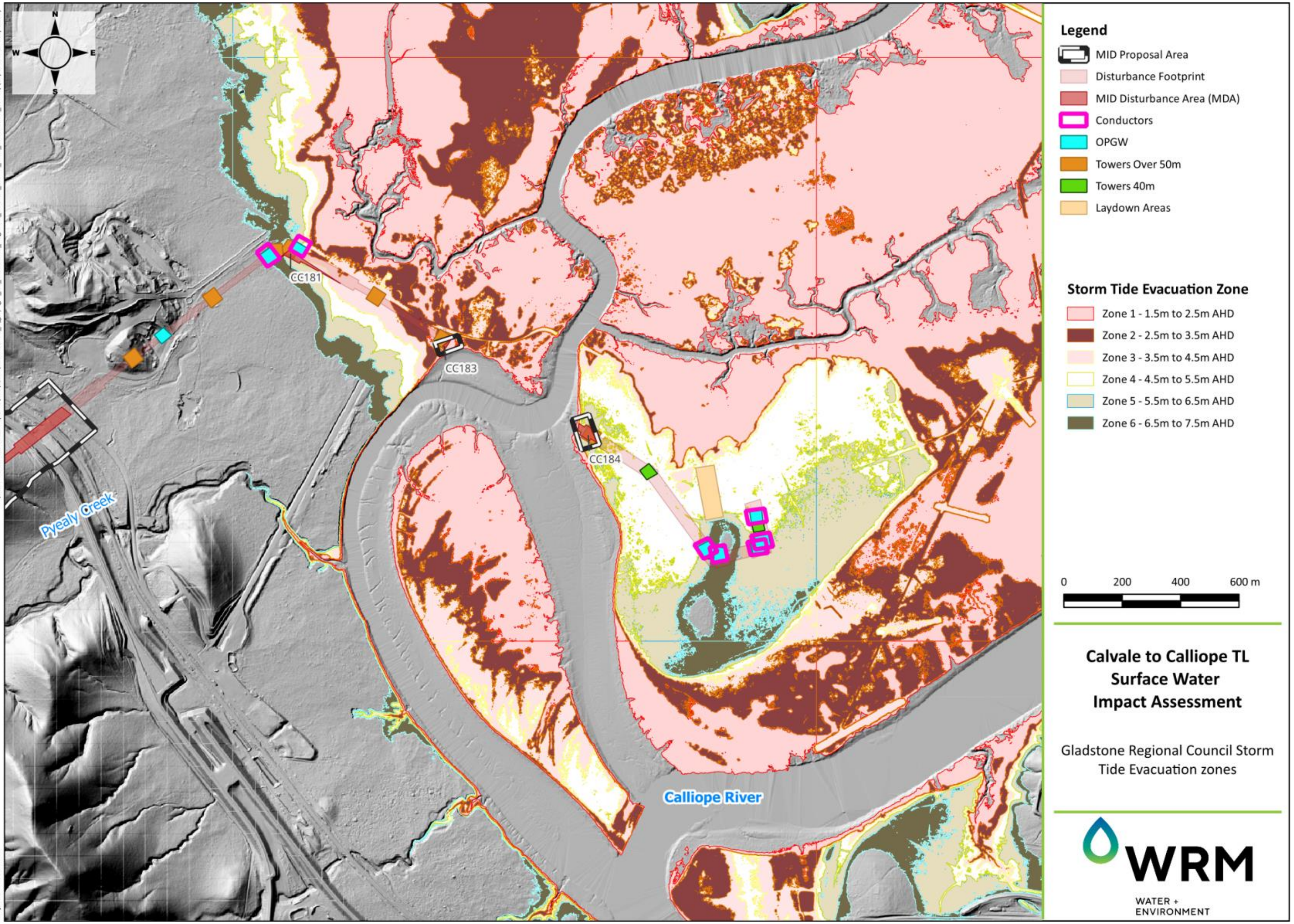


Figure 4.11 **Gladstone Regional Council Storm Tide Evacuation zones**

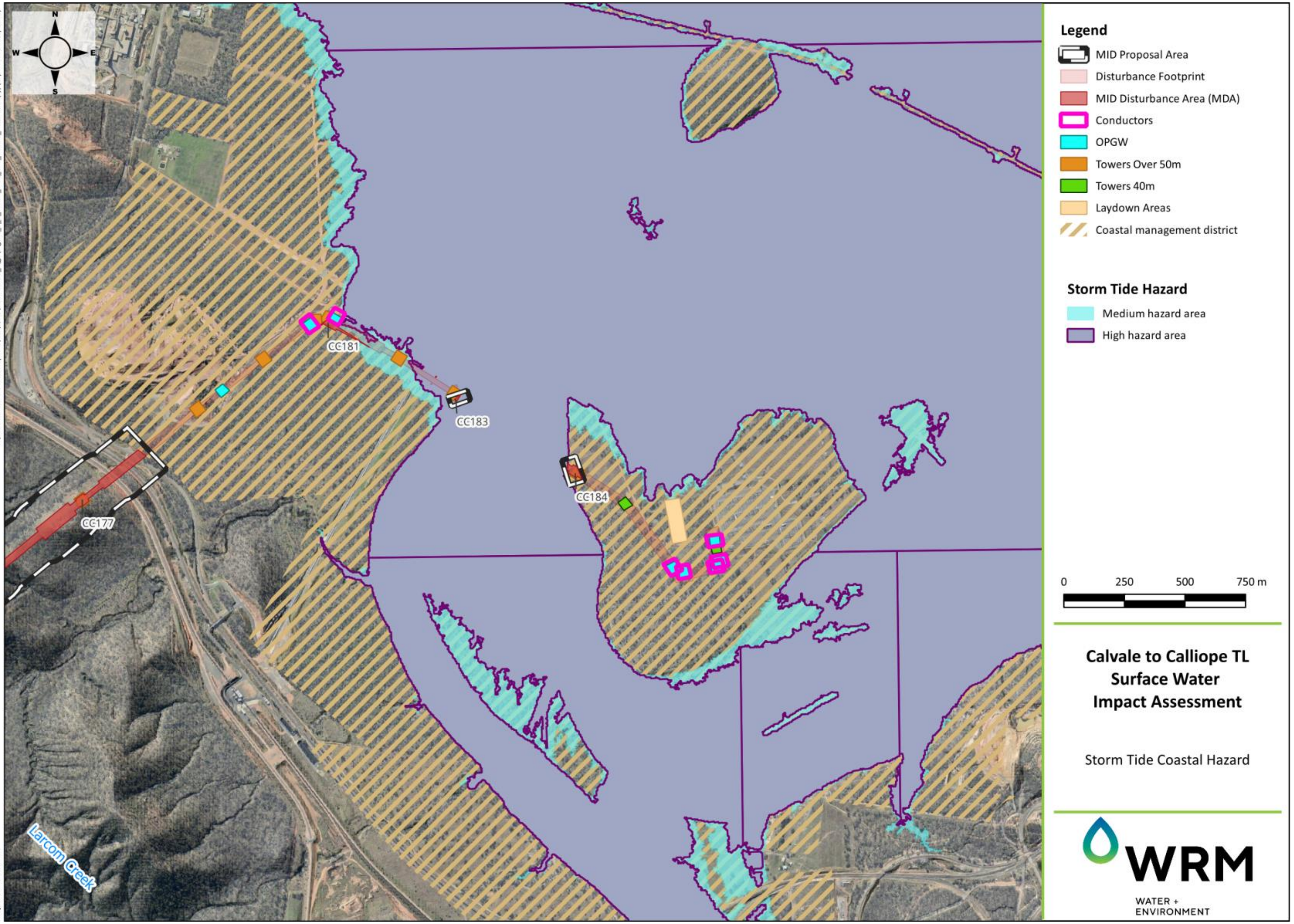


Figure 4.12 **Storm Tide and Coastal Management District**

5 HYDROLOGIC APPRAISAL

5.1 OVERVIEW

The MID Proposal proposes a new transmission line on the northern side of the existing corridor. This new transmission line will cross Larcom Creek in Section C and Calliope River in Section E. As Section C does not have sufficient space in the existing easement, widening the existing easement will be necessary to accommodate the proposed transmission infrastructure. Conversely, the new transmission line in Section D will be integrated within the existing Powerlink easements. Similar to the existing transmission line, the MID Proposal Area will cross several drainage features, as indicated on Figure 4.7 and Figure 4.8. Appendix A provides more detailed mapping along the corridor concerning the proposed towers. Overall, the transmission line traverses much of the floodplain, and limited interaction with the surface water is anticipated.

5.2 HYDROLOGIC AND HYDRAULIC DATA

There are no flood level gauges recording water levels within any of the catchment areas, as shown on Figure 4.6, that drain through the MID Proposal Area. Furthermore, the catchments above the MID Proposal Area have insufficient topographic resolution to enable hydraulic models to predict peak flows and velocities reliably. Figure 5.2 presents the available LiDAR that could be used to construct hydraulic models. While fine resolution LiDAR was captured by Powerlink within the MID Proposal Area, it is unsuitable to be used in a flood study. The DEM contains reflections from the existing powerlines and does not cover a wide enough corridor. The majority of catchment areas draining to the MID Proposal Area's Section C are only resolved at a 30-metre grid cell size and are sourced from satellite topography missions. This dataset is only suitable for generating flood extents and is unsuitable for calculating peak flood velocity or depths within the MID Proposal Area.

5.2.1 Regional Flood History

The closest active streamflow gauge to the MID Proposal Area is Castlehope (station number GS132001A), located 20 km downstream of Larcom Creek's path through the MID Proposal Area, refer Figure 1.1. The stream flows recorded at the gauge are presented in Table 5.1. The Castlehope gauge is the only streamflow gauging station currently in operation in the Calliope River basin. It was opened in 1938 and has a catchment area of 1,288 km². The Calliope River at Mount Alma gauge (132002A) operated from 1968 to 1988. It is located in the upper catchment and has a catchment area of only 165 km². While flood history was available at the Calliope River at Castlehope gauge, this dataset only provides regionalised information on typical flood behaviour. Figure 5.1 is an analysis of the flood flows based on the Flike Bayesian fitting software. The flood frequency analysis had narrow confidence intervals indicating acceptable convergence of flood fitting software.

Table 5.1 Calliope River at Castlehope (GS12300A) gauge peak flow events

Year	Max Flow (m³/s)	Year	Max Flow (m³/s)	Year	Max Flow (m³/s)	Year	Max Flow (m³/s)	Year	Max Flow (m³/s)
1940	180	1957	1,417	1974	256	1991	772	2008	21
1941	1,600	1958	2,099	1975	3,864	1992	1,912	2009	1,086
1942	47	1959	302	1976	675	1993	313	2010	366
1943	2,828	1960	172	1977	738	1994	245	2011	2,021
1944	539	1961	117	1978	1,333	1995	362	2012	1,893
1945	424	1962	632	1979	2,908	1996	7	2013	543
1946	41	1963	456	1980	450	1997	1,905	2014	3,269
1947	163	1964	1,409	1981	273	1998	396	2015	1,421
1948	**4,038**	1965	108	1982	1,385	1999	308	2016	2,296
1949	732	1966	3	1983	38	2000	310	2017	475
1950	2,589	1967	8	1984	1,228	2001	143	2018	1,991
1951	605	1968	72	1985	89	2002	704	2019	555
1952	494	1969	685	1986	174	2003	166	2020	2
1953	194	1970	15	1987	667	2004	2,768	2021	283
1954	521	1971	107	1988	134	2005	494	2022	112
1955	1,204	1972	2,154	1989	281	2006	155	2023	170
1956	1,527	1973	710	1990	1,200	2007	61	2024	18

n.b. Flood of record shown in bold

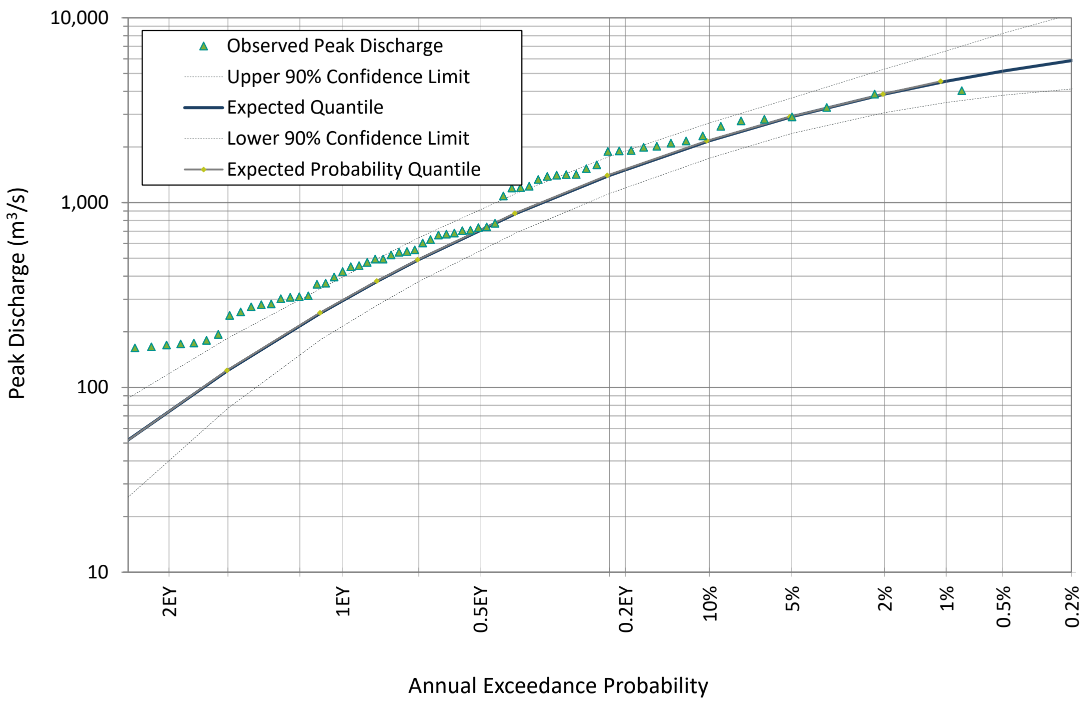


Figure 5.1 Flood frequency analysis at Calliope River at Castlehope (GS12300A)

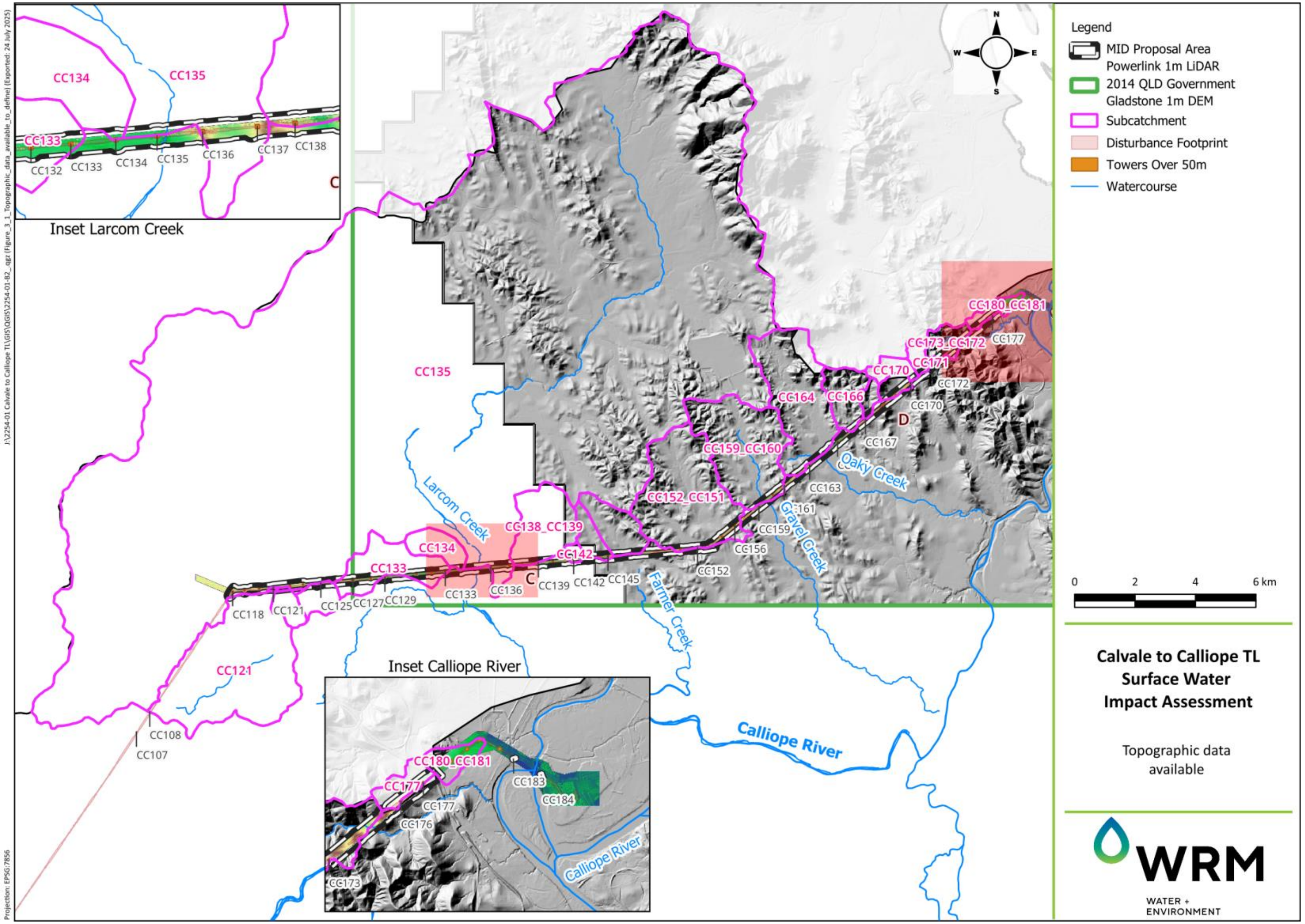


Figure 5.2 Topographic data available

5.3 QUALIFICATION OF MODELLING

The accuracy of hydraulic and hydrologic modelling is subject to sources of uncertainty and limitations. Some potential sources of inaccuracy leading to uncertainty in the hydraulic model are as follows:

- Inaccurate topographic information—The hydraulic model relies upon the representation of the ground topography to model the movement of water across the land. The DEM used to inform the model topography was captured at different times and with differing resolutions. This also implies a variance in vertical and horizontal accuracy for the survey. The accuracy of the DEM will impact the veracity of the model results. For example, the model may not be well-represented in minor flow paths smaller than the DEM resolution.
- No calibration to historical events—It is best practice to calibrate a hydraulic model to a historical event. However, calibration data for historical events is not available, making model calibration impossible. While the model parameters have been chosen in line with ARR 2019 recommendations and within industry-accepted bounds, the ability of the model to reproduce actual flood behaviour is untested.

This assessment has undertaken indicative modelling of a representative design flood event. This is not intended to represent any historical or actual event. A design flood is a probabilistic or statistical estimate, being generally based on some form of probability analysis of flood or rainfall data. An Annual Exceedance Probability (AEP) is attributed to the estimate. The frequency of flood events is expressed as an AEP; for example, if a flood magnitude has 10% AEP, there is a 10% probability (or 1 in 10 chance) that there would be floods of that magnitude or greater each year. The frequency of flood events with a 1% AEP is categorised as on the boundary of rare to very rare. A 10% AEP flood is categorised as being on the boundary of frequent to rare.

The approach to estimating an actual (or historic) flood from a particular rainfall event is quite different in concept and is of a deterministic nature. All causes and effects are directly related to the specific event under consideration. The actual antecedent conditions prevailing at the time of occurrence of the rain are directly reflected in the resulting flood and must be allowed for in its estimation. No real information on the probability of the historic flood can be gained from consideration of a single actual flood event.

5.4 UNGAUGED CATCHMENTS

The absence of recorded streamflow data in the MID Proposal Area prevented the calibration of flood flows. In this scenario, the typical approach is to estimate predicted flood discharges using the Regional Flood Frequency Estimation (RFFE) model. RFFE is a tool developed for Australian Rainfall and Runoff to estimate design flows for ungauged catchments. It uses a region-of-influence approach based on gauged data and at-site flood frequency estimates, similar to the analysis presented in Section 5.2.1.

Figure 5.3 and Figure 5.4 are scatter plots of the catchment area and the peak discharges; these are shown as blue diamonds. The regional at-site flood frequency analysis areas and peak discharges are plotted in green. There are no nearby regional FFA's available that are similar in area to those of the catchments within the MID Proposal Area, refer Table 5.2.

Table 5.2 Regional Flood Frequency Estimation of peak discharges

Location	Area (km^2)	Outlet		Centroid		Shape Factor	10% AEP	5% AEP	1% AEP
CC121	14.86	150.9296	-23.934	150.918	-23.956	0.713	405	678	1569
CC122	1.40	150.9441	-23.934	150.945	-23.936	0.255	265	463	1153
CC133	2.14	150.9699	-23.9310	150.974	-23.937	0.529	287	501	1255
CC135	263.2	150.9966	-23.9295	150.985	-23.874	0.385	748	1185	2540
CC144	1.05	151.0353	-23.9286	151.034	-23.921	0.832	265	461	1148
CC146	3.15	151.0458	-23.9263	151.042	-23.919	0.519	322	554	1346
CC151	6.50	151.0665	-23.9244	151.060	-23.905	0.900	370	632	1510
CC152	3.58	151.0673	-23.9238	151.073	-23.914	0.673	333	572	1391
CC160	9.31	151.0904	-23.9099	151.083	-23.893	0.655	398	671	1577
CC164	6.63	151.1108	-23.8951	151.100	-23.874	0.991	379	637	1489
CC166	4.36	151.1280	-23.8902	151.122	-23.883	0.479	397	675	1614
CC172	2.10	151.1613	-23.8639	151.154	-23.864	0.516	358	603	1414

Source: https://rffe-2021.wmawater.com.au/

RFFE uses a parameter regression technique that relates rainfall intensity, catchment area and catchment shape factor in the following way.

$$\log_{10}(Q_{50\%\ AEP}) = b_0 + b_1(Area) + b_2(Intesity_{6h,50\%aep}) + b_3(Shape\ Factor)$$

Once the peak flow for the 50% AEP event is determined, the flood frequency curve's slope is applied. This then allows the other flood frequencies to be estimated. Table 5.2 compares the peak discharges calculated using the RFFE. The estimates for 1% AEP seem to be remarkably consistent regardless of the catchment area.

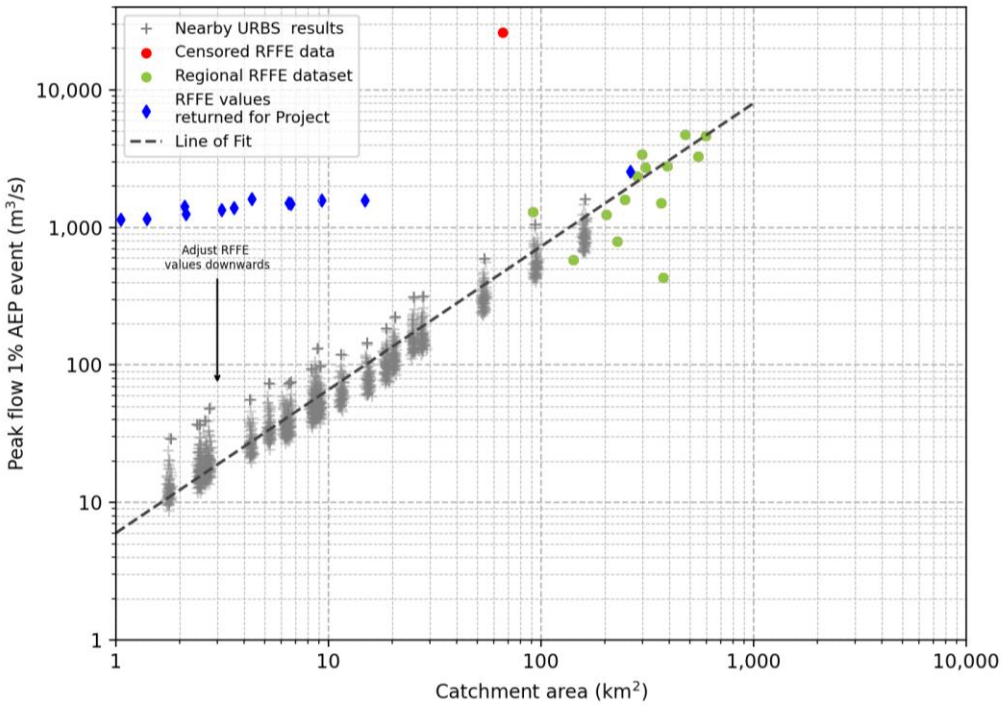


Figure 5.3 1% AEP from adjacent at-site FFA, nearby hydrologic models and RFFE output

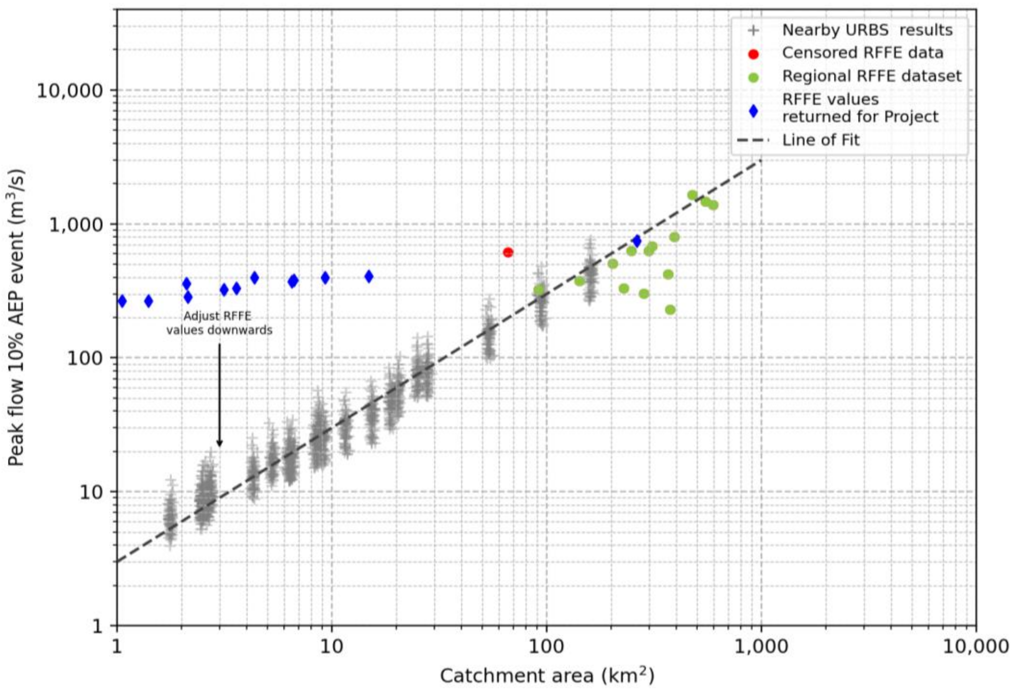


Figure 5.4 10% AEP from adjacent at-site FFA, nearby hydrologic models and RFFE output

An explanation for why the RFFE is returning values that do not decrease with diminishing catchment area relates to the structure of the equation. The absence of regional flood frequency discharges with similar catchment areas to those in the MID Proposal Area appears to be a large limitation. As such, the term related to the equation's catchment area can be reduced towards a unit value, and the other terms will dominate. Additionally, the at-site flood frequency analysis appears to incorporate an outlier from the Kenbula Station on the Dee River, shown as red in Figure 5.3 and Figure 5.4. The inclusion of this data point and the schematisation of the model appear to result in the RFFE model overpredicting peak discharges relative to catchment areas in the MID Proposal Area, as shown in blue.

To confirm this hypothesis, the peak-modelled flows from an available URBS hydrologic model, also located in the Calliope River basin, are shown in the figures as grey plotting positions. These URBS results fit with the expected behaviour of the at-site flood frequency analysis values shown in green.

The original RFFE values were adjusted to account for these demonstrated anomalies. The values shown in Table 5.3 were adjusted based on fitting the values in Table 5.2 to a more natural relationship. Table 5.3 provides a summary of likely estimates of regional flood frequency at each location after allowing for the catchment area.

Table 5.3 Adjusted RFFE model peak discharge

Location	Area (km^2)	10% AEP	5% AEP	1% AEP
CC121	14.86	43	65	119
CC122	1.40	4.1	6.1	11.2
CC133	2.14	6.2	9.3	17
CC135	263.2	763	1145	2106
CC144	1.05	3.0	4.6	8.4
CC146	3.15	9.1	14	25
CC151	6.50	19	28	52
CC152	3.58	10	16	29
CC160	9.31	27	40	74
CC164	6.63	19	29	53
CC166	4.36	13	19	35
CC172	2.10	6.1	9.1	17

5.5 FLOOD MAPPING

The flood modelling of the MID Proposal Area was limited to the ability to calibrate and validate modelled flows. Furthermore, the coarse nature of the DEM available for the majority of the MID Proposal Area significantly limited the ability to conduct detailed hydraulic modelling. Appendix A contains flood modelling available from the Queensland Reconstruction Authority's (QRA) Flood Check[3] mapping platform for the 1% AEP event. Also, included in Appendix A is coarse flood modelling of the corridor utilising the same approach used by QRA informed by the flood flows in Table 5.3. This mapping is coarse, limited by the available survey, and only intended to indicate possible flood extents within the MID Proposal Area corridor.

[3] https://floodcheck.information.qld.gov.au/

6 INFRASTRUCTURE POTENTIAL IMPACTS

6.1 OVERVIEW

Section 2 outlines the infrastructure activities related to the proposed works in the MID Proposal Area. Within MID Proposal Area's Section C and Section D, the placement of transmission line infrastructure is designed to span over constraints without the need to clear vegetation or disturb beds or banks. An indicative arrangement of the transmission tower, with leg stubs and bored piles, is shown in Figure 2.2. Section A and Section E within the MID Proposal Area is shown on Figure 1.1's Inset A and Inset E.

6.2 COASTAL IMPACTS

As shown in Figure 1.1, the span between towers CC183 and CC184 requires disturbance within the Calliope River estuary, particularly the western bank of the Calliope River near CC183. Immediately to the East of CC183 there are two existing transmission towers. The southernmost tower is located within ten metres of the bank of the Calliope River at a natural elevation of 4.94 mAHD. This area is mapped as being erosion-prone land (see Figure 4.10) and also high-hazard areas at risk of storm surge or storm tide inundation (see Figure 4.12). Figure 6.1 and Figure 6.2 are artist impressions of the towers (CC183 and CC184) located in Section E of the MID Proposal Area near the Calliope River. The ground elevation at the base of the proposed towers can be found within the LiDAR survey acquired by Powerlink for the corridor. The elevations measured at the base of CC183 are 3.31 mAHD, and at CC184, it is 5.46 mAHD. These elevations place the tower bases above the normal tidal range and into the storm tide zones of Zone 2 and Zone 4, respectively. The Storm Tide evacuation zones shown on Figure 4.11 are indicative of the probability of impacts to each zone based on storm tide modelling. As such, CC183 is in Zone 2 and has a higher likelihood of being impacted by a storm tide than CC184 in Zone 4. At this elevation, any regular impacts on coastal processes are unlikely as they will remain dry.

The location of these towers cannot be easily relocated due to the route required to reach the Calliope River substation. State Code 8 of the State Development and Assessment Provisions (SDAP) outlines the Performance Outcomes for coastal development. This proposed development *complies with PO1* of State Code 8, as this work is essential to community infrastructure, as it is part of the electricity transmission supply network.

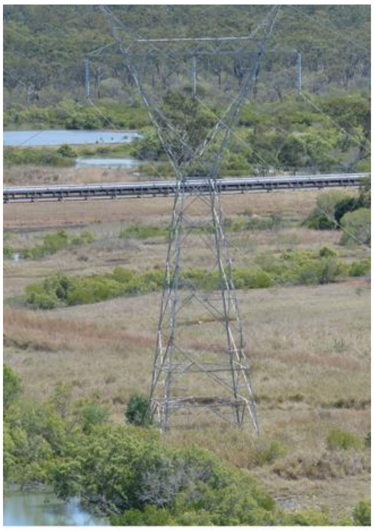


Figure 6.1 Artist impression looking towards Tower CC183

Source: Powerlink (314876E, 7360988S EPSG:7856)

Figure 6.2 Artist impression looking towards Tower CC184

Source: Powerlink (315261E, 7360734S EPSG:7856)

6.3 COASTAL MITIGATIONS

Figure 6.1 indicates how the proposed tower would sit in the landscape near the Calliope River, but this is only to a conceptual level of detail. This artist's render does not show details regarding erosion protection and revetment treatments likely to be required to protect against the defined storm tide event's (DSTE) extent as shown in Figure 4.10. The expected protective treatment that is commonly used is revetment treatment, which will protect the base of the tower. This treatment may be a combination of rock riprap or flexible interlocking matting; the level of treatment will be confirmed during the detailed design phase.

The proposed development *complies with PO2* of State Code 8 as the construction of CC183 is unlikely to have any tangible impact on coastal processes and the protective function of the coastal landform. As shown in the conceptual photographs, the base of the tower sits outside of the normal tidal range. At ground level, the cross-sectional area of the tower's leg stubs will have negligible disruption to the existing behaviour of surface water during storm tides and storm surges. The design of the leg stubs and bored piles required for CC183 will ensure that they are protected against storm surge and related coastal erosion processes.

The erosion-prone areas are considered vulnerable to coastal erosion processes or become permanently inundated by tidal waters within a 100 year planning horizon. To mitigate this risk, the towers will be designed with footings that can withstand saturated and brackish environments. The base of the tower may require fill to construct a stable pad above projected tidal range. The existing coastal environment will be protected by ensuring that the native and remnant vegetation is preserved and not adversely impacted by the proposed towers. Construction will avoid the importation of any material considered likely to form a sediment plume (i.e. silts, clays or fine sands that rapidly erode) or contain weed seed. Any boring of piles will take adequate measures to avoid exposing acid sulfate soils.

The assessment has concluded, after reviewing the available coastal hazard modelling, that the proposed infrastructure and protective treatments can mitigate the coastal erosion risk to a low level.

6.4 FLOODING IMPACTS

During the detailed design phase of works, the new transmission line should be sited through careful consideration of topography. The modelling undertaken was limited and indicative only due to the coarse resolution of the available elevation grids in Larcom Creek. Modelled flows are approximate estimates that were not able to be calibrated to local flood gauges or validated via RFFE. Appendix A provides corridor mapping with the best available information on where land may be flood-prone. This imagery also provides an indication of the available terrain.

Figure 6.3 shows the proposed towers CC134, CC135, and CC136 located on the high ground above Larcom Creek. The lowest elevation of these towers is 46 mAHD, while the bed of Larcom Creek is 30.3 mAHD. Larcom Creek is expected to see large flood flows within this area, but peak water depths are unlikely to reach 15 metres. The placement of towers is located on relatively higher land and above expected surface water flow paths. As such, there is no foreseeable mechanism for the placement of the tower to disrupt overland flow and, in turn, generate afflux. Equally, impacts are considered as unlikely outside of the MID Proposal Area.

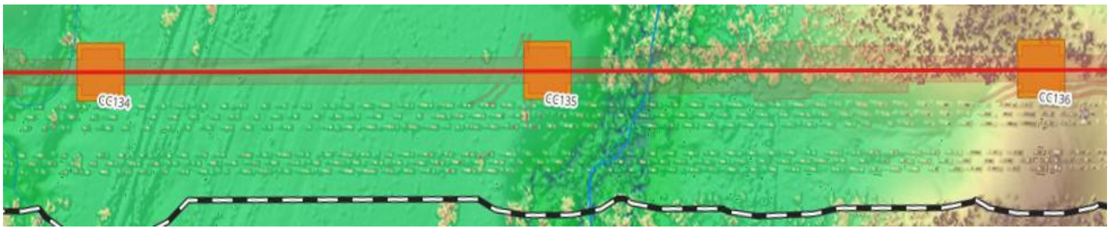


Figure 6.3 Larcom Creek and overbank topography

Source: Powerlink supplied LiDAR of corridor, refer to Inset - Figure 5.2

6.5 FLOOD MITIGATION

In general, the risk posed to the structural integrity of the towers by out-of-bank surface water flows can be mitigated by engineering design. The mitigation of this flood risk will comprise the use of deeper bored piles and revetment treatment to protect the base of the tower. This mitigation treatment may be a combination of rock riprap or flexible interlocking matting, depending on the durability of the rock. The towers are located in the highest possible locations to maximise span distances. This design would ensure bored piles are well protected from unstable ground conditions and would not require the clearing of existing riparian vegetation.

6.6 JOINT PROBABILITY

Towers CC183 and CC184 are within Section E, located at the Calliope River's mouth. The CHAS involved a detailed coastal hazard modelling study, the results of which are shown in Figure 4.12. The hazard modelling for Section E required assumptions relating to both the flooding within the Calliope River and the likely coastal water level at the time of the flood. Rare floods and tide events are understood to be partially dependent as they are driven by large weather systems, such as cyclones and East Coast lows. As such, it is not appropriate to model the 1% AEP flood flows with a 1% AEP (DSTE) storm tide as a tidal boundary, as it will result in a flood level rarer than the 1% AEP within the zone of joint probability, refer to Figure 6.4. As flood and coastal hazards are highly dependent on each other, the interpretation of any hazard mapping should appreciate the interdependence of this risk.

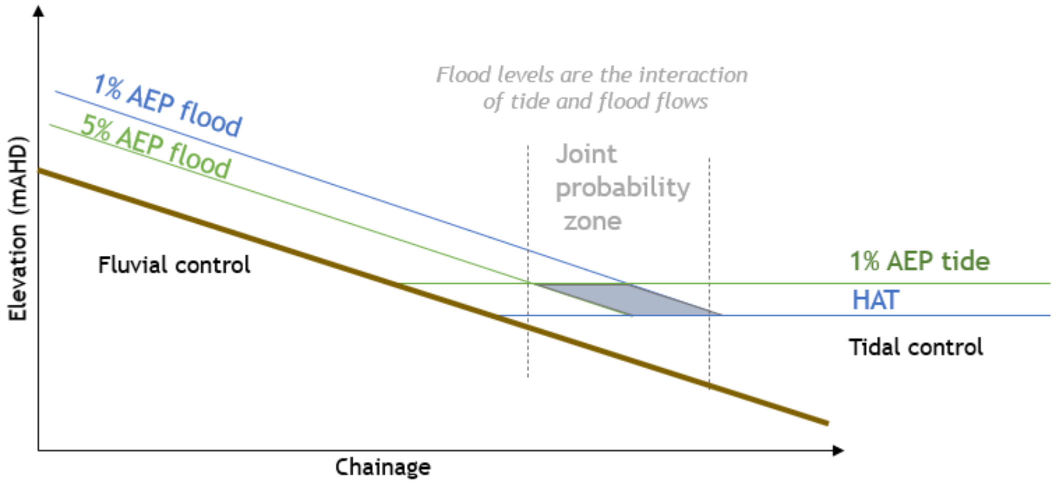


Figure 6.4 Conceptualising the joint probability zone

6.7 FLOOD HAZARD CATEGORISATION

The location of energy transmission infrastructure will avoid land subject to flooding hazards categorised in Table 6.1 as H3 and above, the categorisation of flood hazards requires a detailed terrain survey (1m grid), commencing well upstream of the location of interest, to predict depth and velocity accurately. Flood hazard (or hydraulic hazard) defines the nature of a flood for a specific event, for example, depth, depth x velocity and velocity. ARR 2019 adopted the combined flood hazard classification based on research presented in the *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017). The flood hazard categories, according to the AIDR definition, are summarised in the Table 6.1 and flood hazard colour-coded curves are shown in Figure 6-5.

Table 6.1 Hazard Classification (AIDR, 2017)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)	Description
H1	D*V ≤ 0.3	0.3	2.0	Generally safe for vehicles, people and buildings.
H2	D*V ≤ 0.6	0.5	2.0	Unsafe for small vehicles.
H3	D*V ≤ 0.6	1.2	2.0	Unsafe for vehicles, children, and older people.
H4	D*V ≤ 1.0	2.0	2.0	Unsafe for vehicles and people.
H5	D*V ≤ 4.0	4.0	4.0	Unsafe for vehicles and people. All buildings are vulnerable to structural damage. Some less robust buildings are subject to failure.
H6	D*V ≥ 4.0	-	-	Unsafe for vehicles and people. All building types are considered vulnerable to failure.

Source: AIDR, 2017

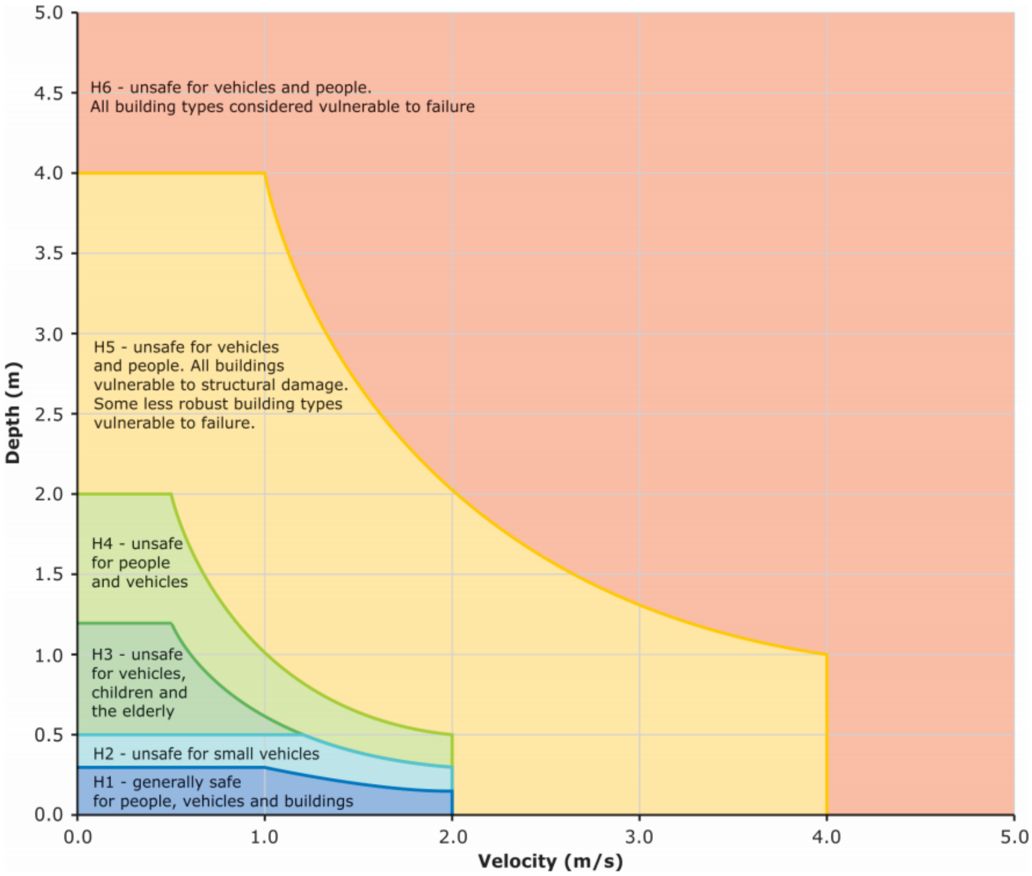


Figure 6-5 Combined Flood Hazard Curves

Source: Smith et al. 2014

7 CONCLUSIONS

7.1 SUMMARY

On behalf of Powerlink, Umwelt is preparing a Ministerial Infrastructure Designation (MID) for Sections C and D of the Calvale to Calliope River Transmission Line Reinforcement Project. The MID Proposal Area intends to construct a new transmission line on the existing corridor's northern side. The MID proposal is shown in Figure 1.1 and comprises Sections C and D and the MPA within Section A and Section E. The MID proposal is likely to comprise the following components:

- A new double circuit, 275 kilovolt (kV) transmission line within a 60 metre (m) wide easement.
- Steel lattice towers (up to 66 m in height).
- Brake and winch sites.
- Laydown areas.
- Concrete batching plants.
- A mobile site office.
- Upgrades to existing access tracks.

The Surface Water Assessment has evaluated the potential impacts of the MID Proposal, and included the following:

- Outlined the applicable regulatory framework pertaining to water quality, flooding and coastal hazards;
- Described and characterised the existing surface water environment, including all drainage features and catchments that intersect with the MID Proposal Area;
- Qualitatively assessed the coastal and flood risks within the MID Proposal Area in relation to the proposed infrastructure; and,
- Proposed mitigation strategies to manage risks from coastal and flooding processes.

The assessment concluded that the Project is anticipated to exert minimal influence on surface water conditions due to the MID Proposal Area being located predominantly within an existing corridor. The Project's interaction with the coastal environment is consistent with the coastal outcomes of the State Planning Policies.

7.2 KEY FINDINGS

The assessment has determined that potential risks to surface water are primarily confined to the MID Proposal's construction phase. These construction-phase risks can be effectively mitigated through the implementation of well-established environmental management practices and appropriate design methodologies. The transmission line infrastructure was purposefully designed and located on locally elevated terrain. This has placed them above drainage feature surface flow paths. Where water depths (i.e., storm surge) reach the base of a tower, the transmission tower leg stubs' cross-sectional footprint has a negligible impact on any surface water flow paths due to the associated low velocities. During the detailed design phase, the engineering leg stubs and associated bored piles for structure CC183 may incorporate specific protective measures such as rock riprap or a raised base to place the tower above DSTE. This location is above the normal tidal range but within the coastal sea level rise and erosion-prone areas, as shown on Figure 4.10 and Figure 4.12.

8 REFERENCES

BOM, 2024	Design Rainfall Data System (2016), Commonwealth of Australia. http://www.bom.gov.au/water/designRainfalls/revised-ifd/
Queensland Government, 2023	*SILO – Australian Climate Data From 1889 to Yesterday*
Ball et al, 2019	'*Australian Rainfall and Runoff: A Guide to Flood Estimation*', Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), © Commonwealth of Australia (Geoscience Australia), 2019.
Geoscience Australia, 2019	AR&R Data Hub (software), Geoscience Australia, Version 2019_v1, April 2019, <http://data.arr-software.org/>.

9 ABBREVIATIONS AND DEFINITIONS

Table 9.1 Key project terminology

Term	Definition
Ancillary infrastructure	All permanent infrastructure necessary for the construction and operation, including but not limited to internal roads, main and collector substations, switchyard, operations and maintenance facility, underground and overhead electricity transmission lines and poles, communication cables (includes control cables and earthing) and water storage tanks
Construction	The construction of The Project, including but not limited to the construction of project infrastructure, battery storage and ancillary infrastructure but excluding pre-construction works.
MID Proposal Area	Total area that includes the disturbance footprint/s, as well as avoidance area/s. the MID Proposal Area includes areas of permanent works as well as temporary works. the MID Proposal Area may occur in one contiguous land area or be spread out over multiple, separated areas of land.
Rehabilitation	The restoration of land disturbed by The Project to its former condition (as much as practicable), to ensure it is safe, stable, and non-polluting.
Substation (as defined by Gladstone Regional Council planning scheme)	Premises forming part of a transmission grid or supply network under the *Electricity Act 1994*, and used for: • converting or transforming electrical energy from one voltage to another • regulating voltage in an electrical circuit • controlling electrical circuits • switching electrical current between circuits • a switchyard, or • communication facilities for 'operating works' as defined under the *Electricity Act 1994* or for workforce operational and safety communications. • Examples include substations, switching yards.
Temporary facilities	Temporary facilities used for the construction, repowering and/or decommissioning of The Project, including but not limited to the temporary workforce accommodation, site offices, amenities, construction compounds and laydown areas (including stockpiling and materials storage areas), on-site borrow pits, rock crushing facilities, concrete or asphalt batching plants, minor 'work front' construction access roads.

Table 9.2 Flooding Abbreviations and Definitions

Term/ Abbreviation	Definition
AEP (Annual Exceedance Probability)	Annual Exceedance Probability. The change of a flood of a given or large size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. The following relationships between AEP and ARI applies to this study (ARR, 2019).

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.50
Frequent	1	63.2	1.58	1.00
	0.69	50.00	2	1.44
	0.5	39.35	2.54	2.00
	0.22	20.00	5	4.48
	0.2	18.13	5.52	5.00
Infrequent	0.11	10.00	10.00	9.49
	0.05	5.00	20	20.0
	0.02	2.00	50	50.0
	0.01	1.00	100	100
Rare	0.005	0.50	200	200
	0.002	0.20	500	500
	0.001	0.10	1000	1000
Extremely Rare	0.0005	0.05	2000	2000
	0.0002	0.02	5000	5000
Extreme			PMP	

Term/ Abbreviation	Definition
AHD	Australian Height Datum. A common national surface level datum approximately corresponding to mean sea level.
ARR 2019	Australian Rainfall and Runoff. Guidelines prepared by the Institute of Engineers Australia for the estimation of design floods.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

Term/ Abbreviation	Definition
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below: Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. Continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
Flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
ha	Hectares
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
Hydrology	The study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
mAHD	Metres Australian Height Datum (AHD).
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
m^3/s	Cubic metres per second or “cumecs”. A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
MW	Megawatt.
MID Proposal Area	The total area in which The Project would be developed. the MID Proposal Area covers approximately 708 ha.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual, it is the likelihood of consequences arising from the interaction of floods, communities, and the environment.
Runoff	The amount of rainfall which ends up as a streamflow, also known as rainfall excess.

APPENDIX A MAPPING

A.1 AERIAL IMAGERY OF CORRIDOR ALIGNMENT

Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

Alignment with latest aerial imagery

WRM WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_9_Alignment_Aerial) (Exported: 19 March 2025)

Projection: EPSG:7856

Legend

MID Proposal Area

Subcatchment

Towers Over 50m

Watercourse

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

Alignment with latest aerial imagery

WRM WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_9_Alignment_Aerial) (Exported: 19 March 2025)

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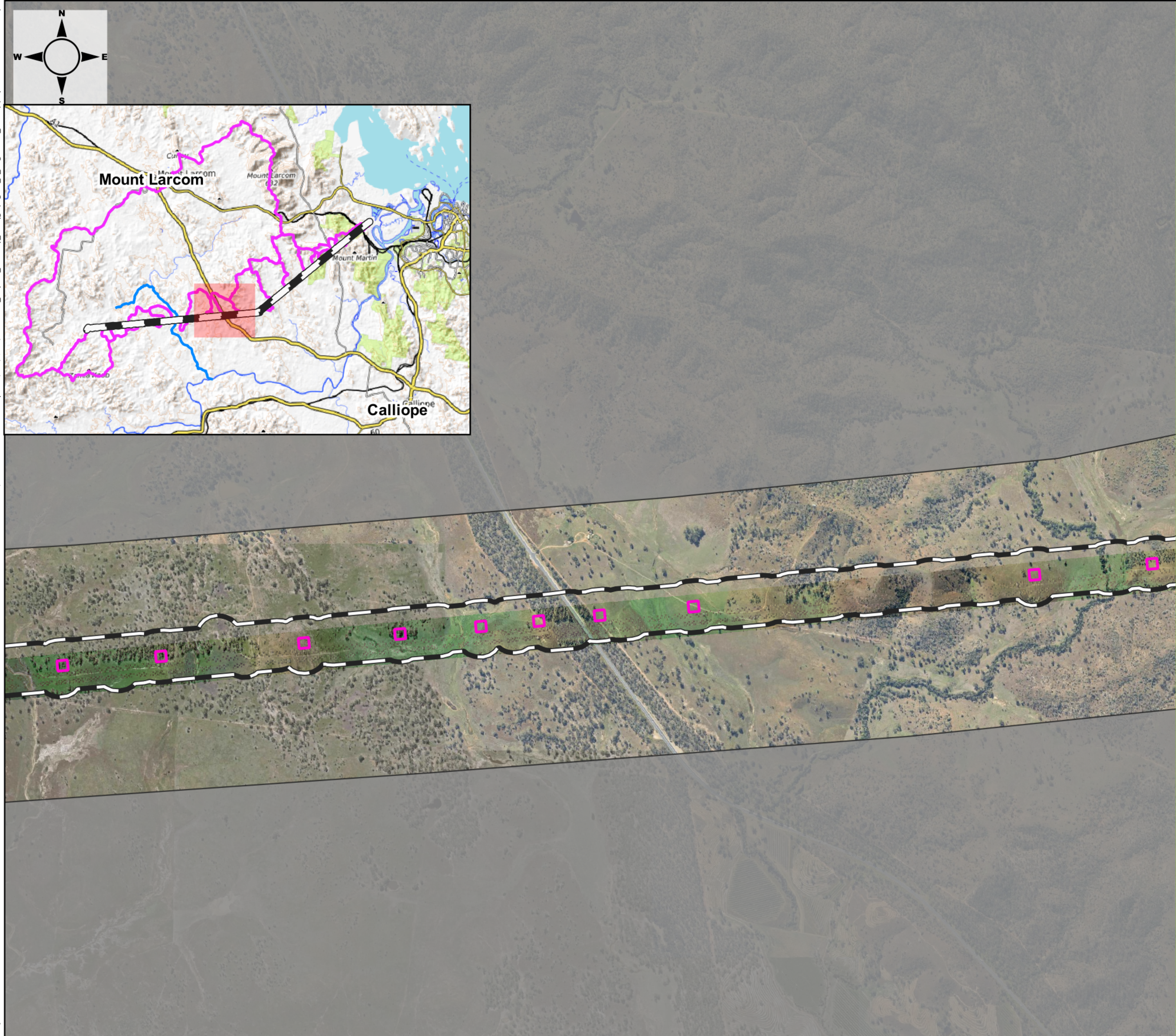

Legend
- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

Alignment with latest aerial imagery

WRM WATER + ENVIRONMENT

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Projection: EPSG:7856

Legend

MID Proposal Area

Subcatchment

Towers Over 50m

Watercourse

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

Alignment with latest aerial imagery

WRM WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_9_Alignment_Aerial) (Exported: 19 March 2025)

Projection: EPSG:7856

Legend

MID Proposal Area

Subcatchment

Towers Over 50m

Watercourse

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

Alignment with latest aerial imagery

WRM

WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_9_Alignment_Aerial) (Exported: 19 March 2025)

Projection: EPSG:7856

Legend

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- Subcatchment
- Towers Over 50m
- Watercourse

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

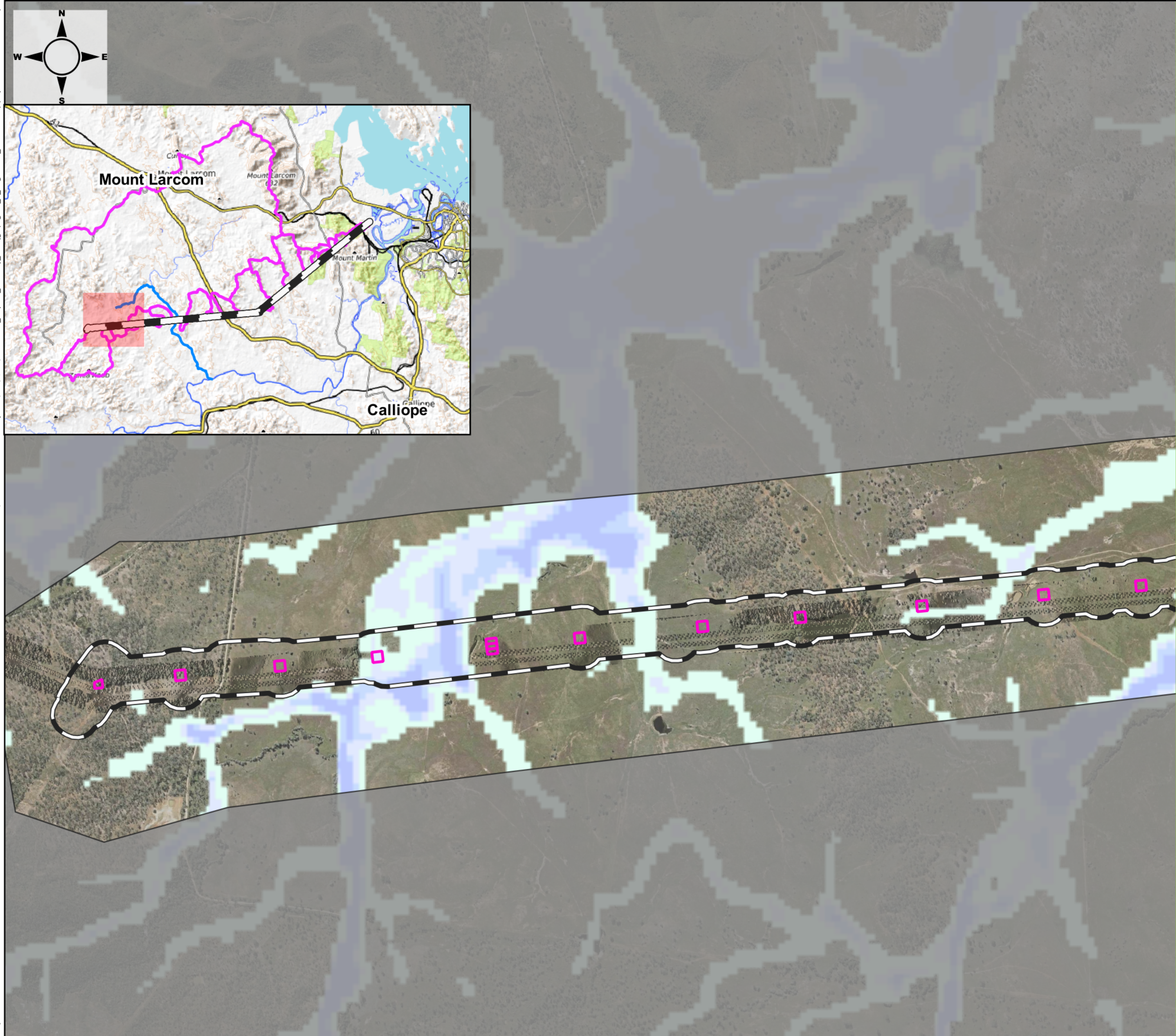
Alignment with latest aerial imagery

WRM WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_9_Alignment_Aerial) (Exported: 19 March 2025)

Projection: EPSG:7856

A.2 QRA FLOOD CHECK MAPPING



Legend

MID Proposal Area

Subcatchment

Towers Over 50m

Watercourse

Flood Depth (m)

0 - 1

1 - 2

2 - 4

> 4

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

QRA 1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

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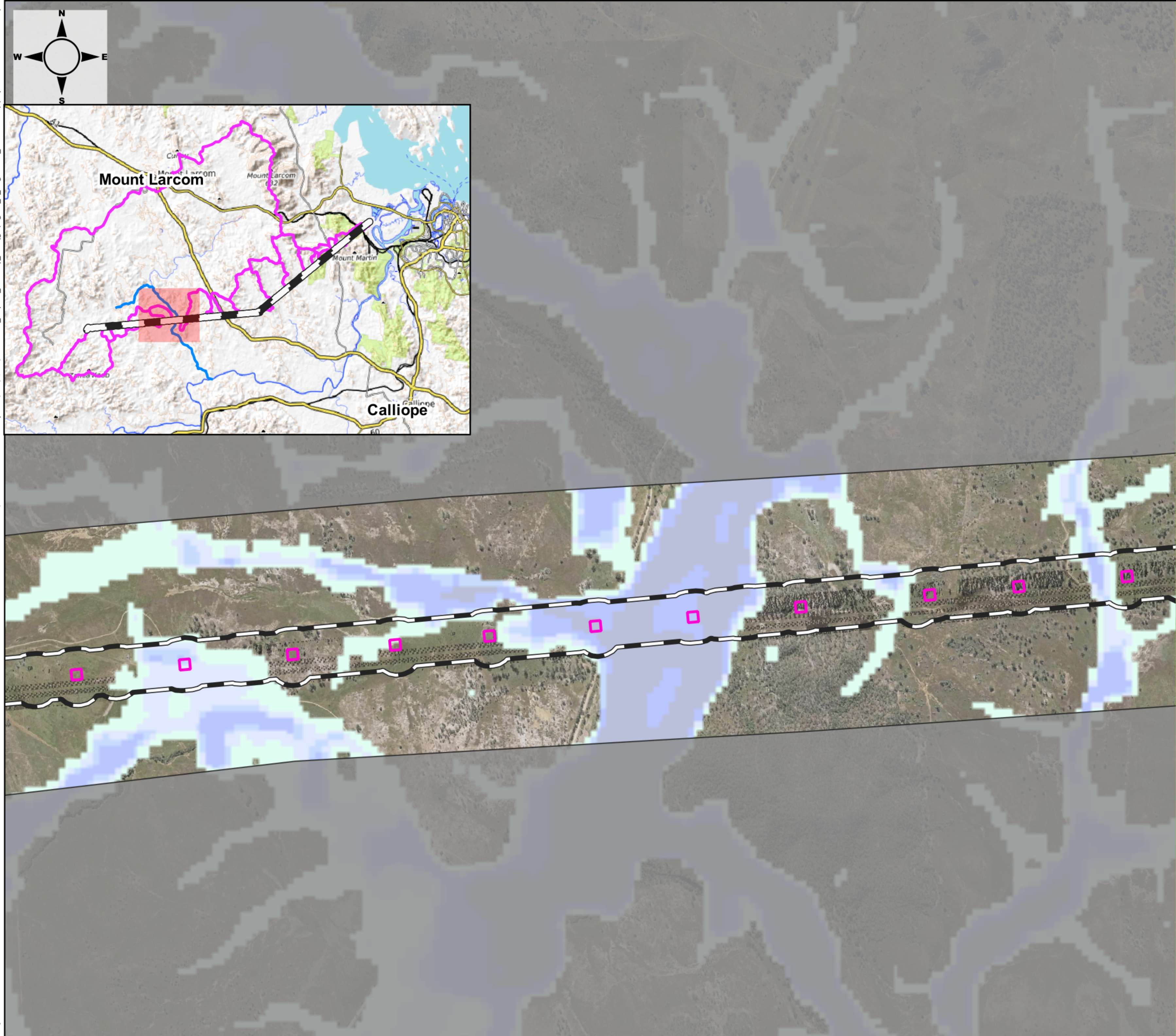

Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

Flood Depth (m)

- **0 - 1**
- **1 - 2**
- **2 - 4**
- **> 4**

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

QRA 1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_8_Alignment_FloodCheck) (Exported: 19 March 2025)

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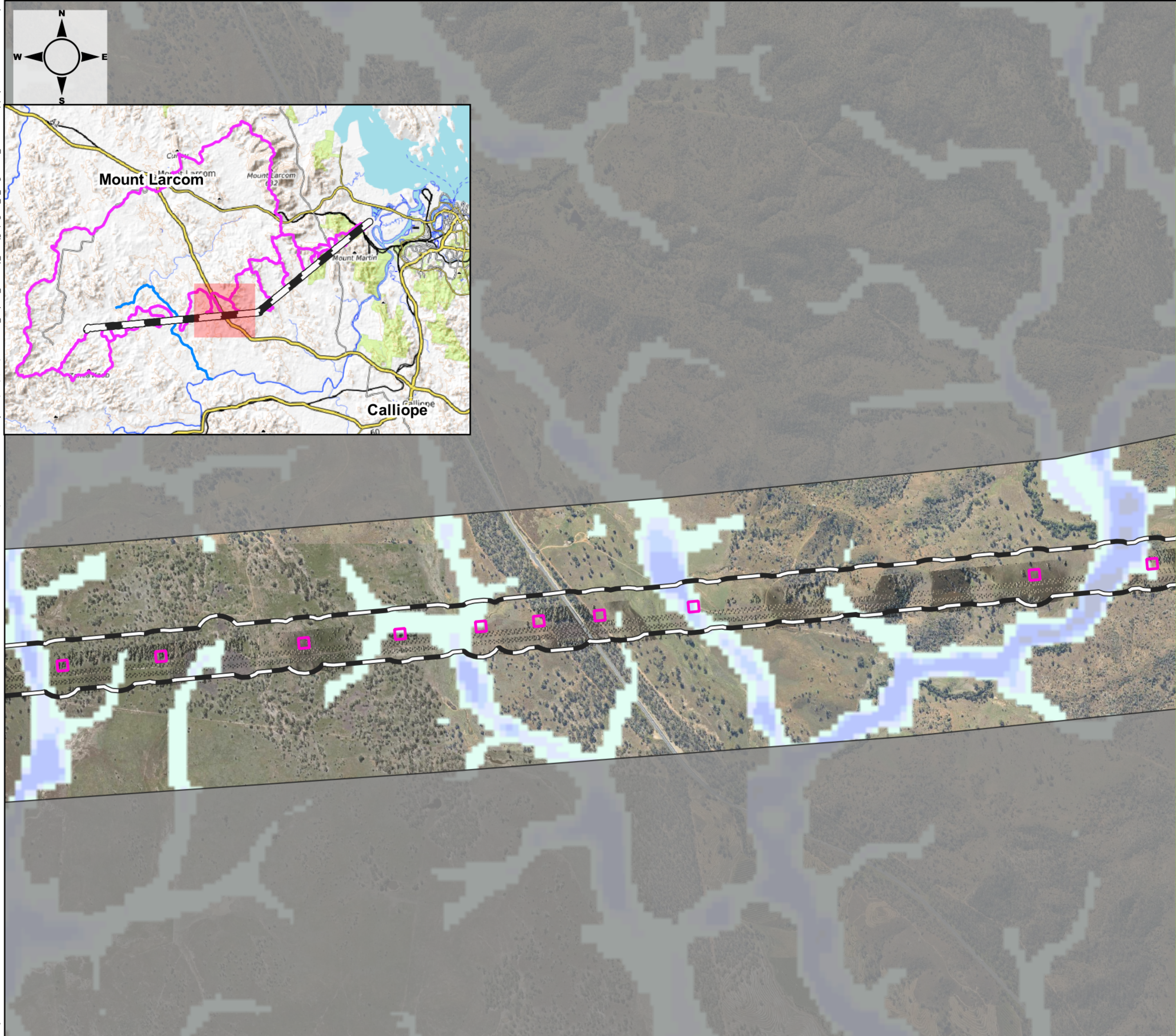


Legend
MID Proposal Area
Subcatchment
Towers Over 50m
Watercourse

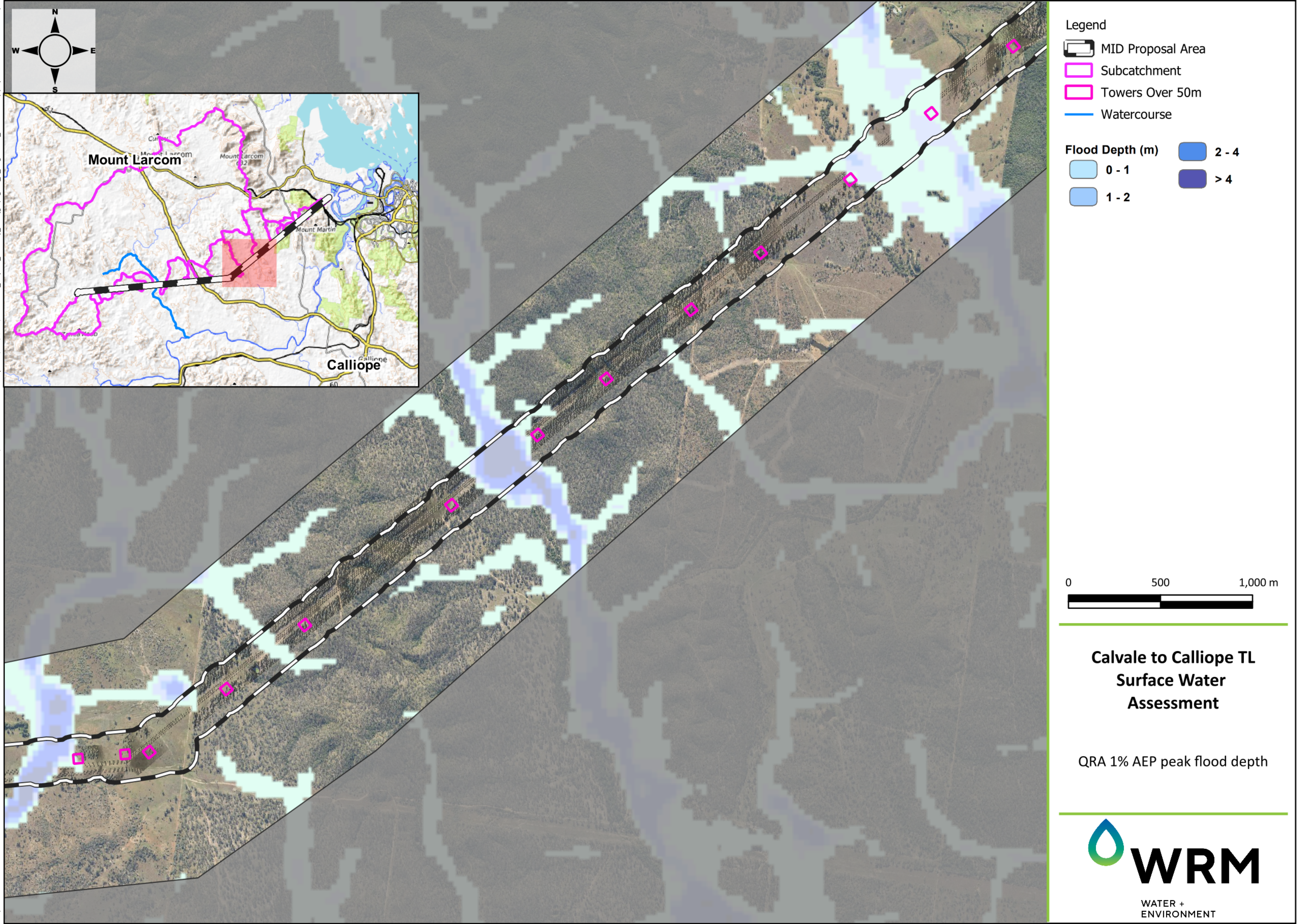
Flood Depth (m)
0 - 1
1 - 2
2 - 4
> 4

0 500 1,000 m

Calvale to Calliope TL Surface Water Assessment

QRA 1% AEP peak flood depth

WRM WATER + ENVIRONMENT



Calvale to Calliope TL Surface Water Assessment

QRA 1% AEP peak flood depth

WRM WATER + ENVIRONMENT

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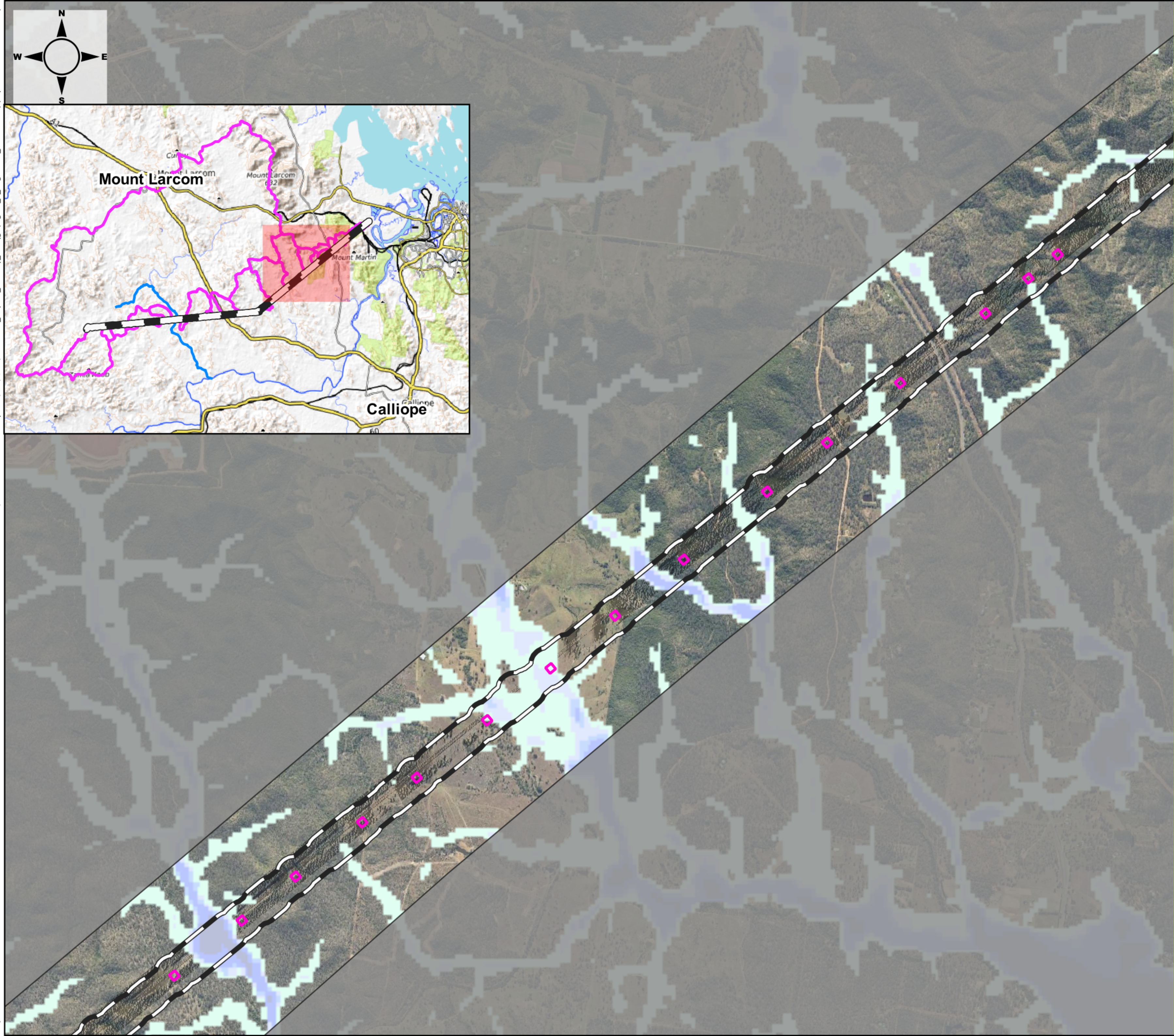
Projection: EPSG:7856



Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

Flood Depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- > 4

0 500 1,000 m

Calvale to Calliope TL
Surface Water Assessment

QRA 1% AEP peak flood depth

WRM WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_8_Alignment_FloodCheck) (Exported: 19 March 2025)

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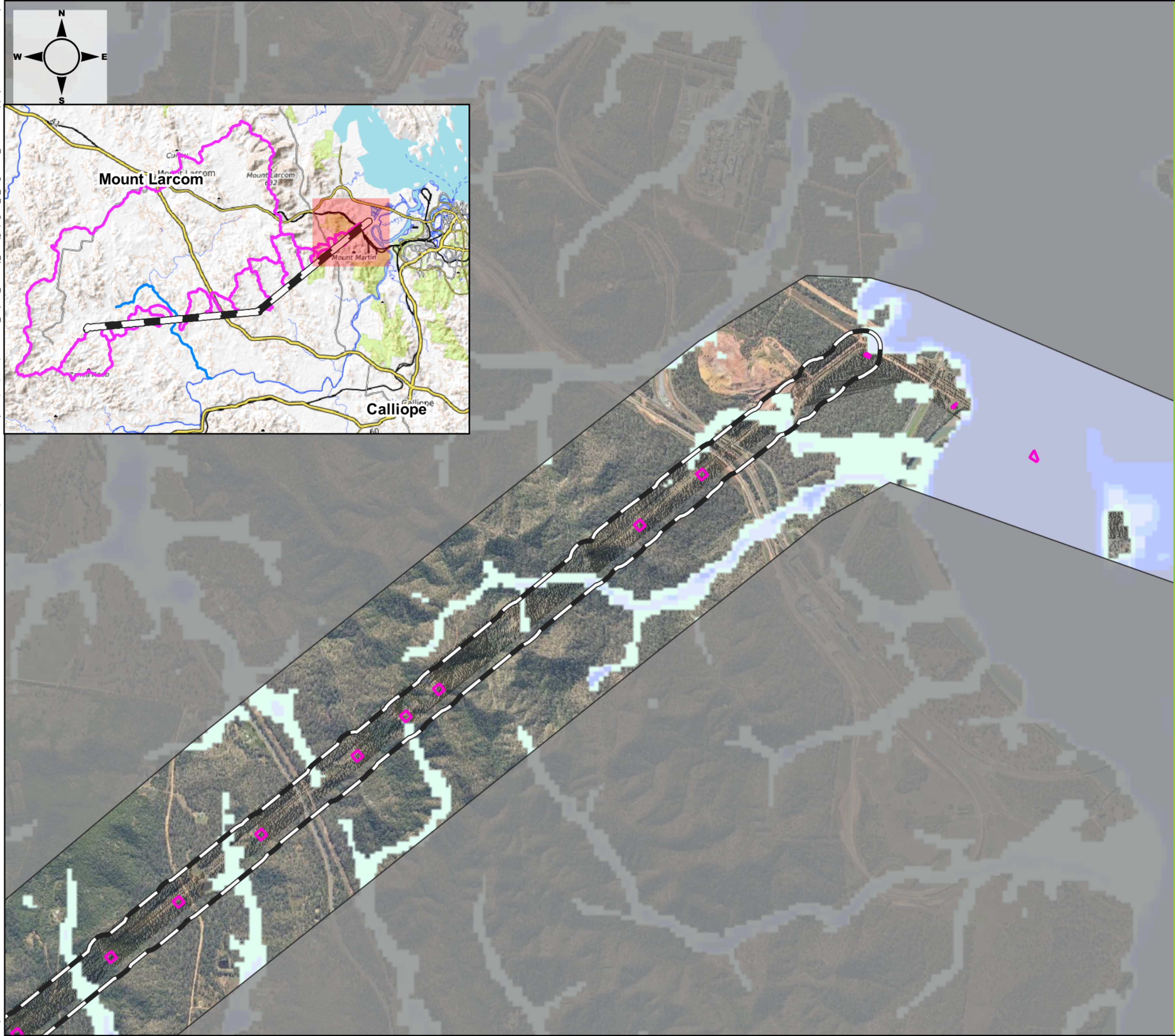


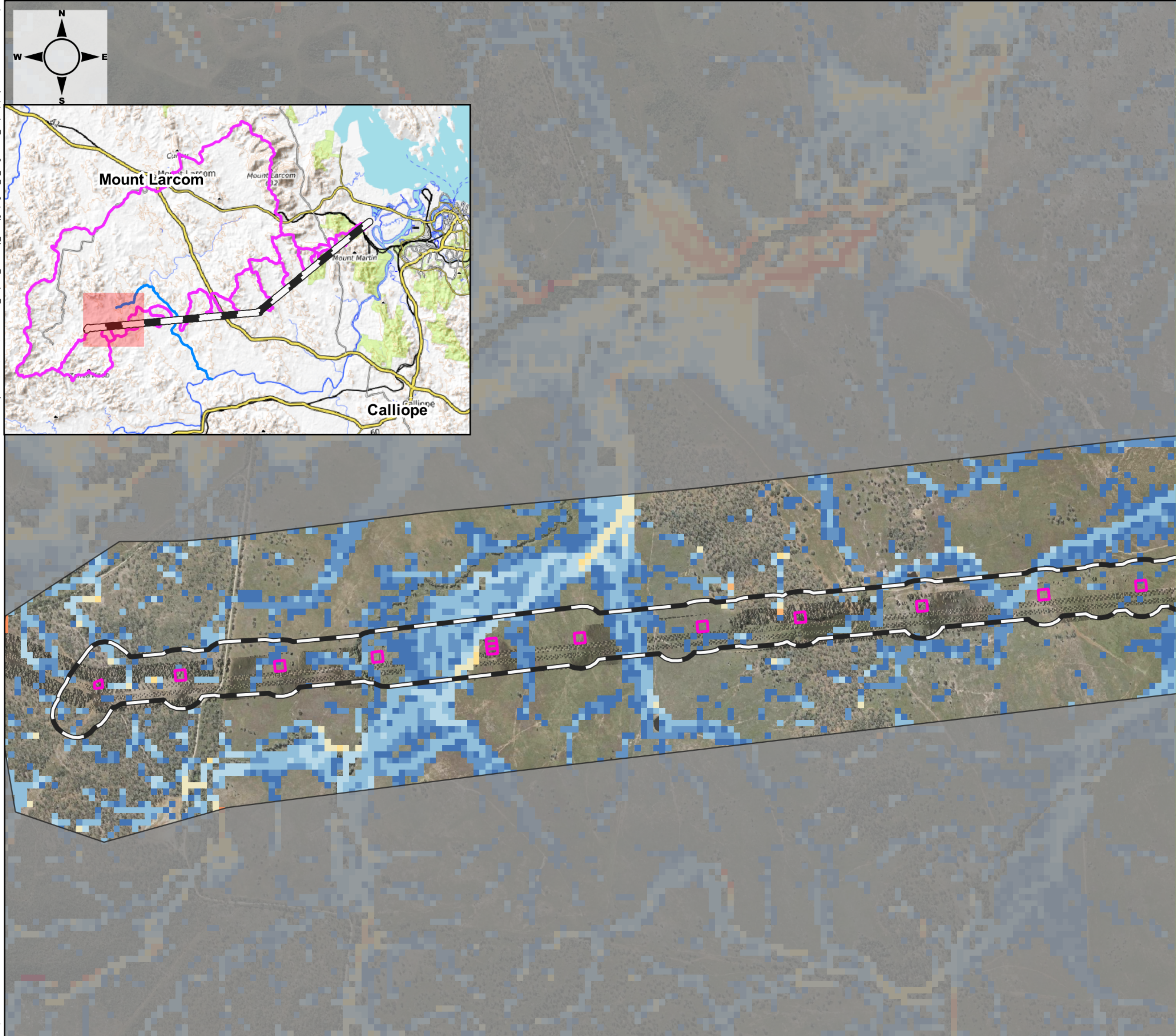
Calvale to Calliope TL Surface Water Assessment

QRA 1% AEP peak flood depth

WRM WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_8_Alignment_FloodCheck) (Exported: 19 March 2025)

Projection: EPSG:7856



Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

Flood depth (m)

- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

0 500 1,000 m

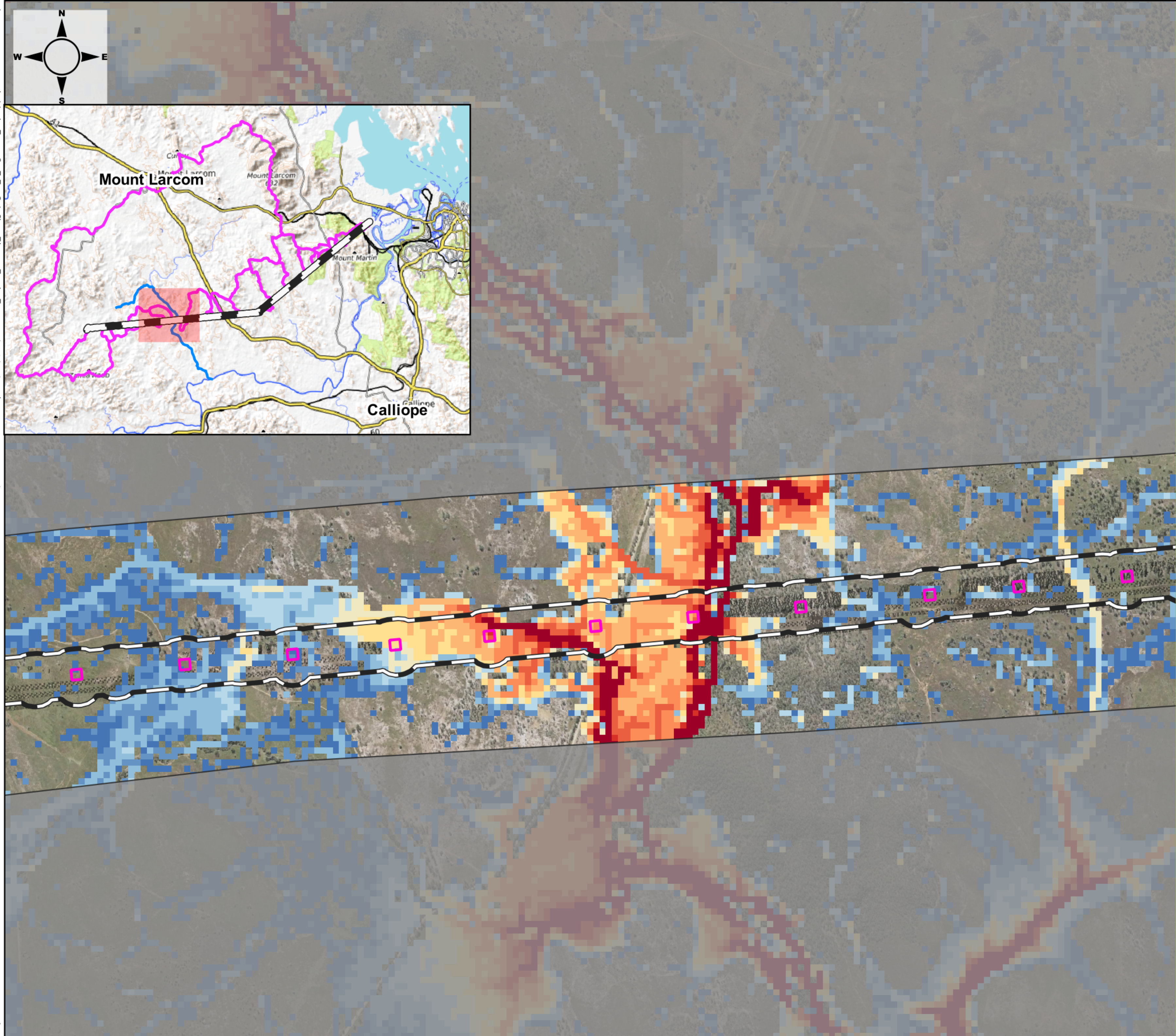
Calvale to Calliope TL
Surface Water
Impact Assessment

1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_7_Alignment_Depth) (Exported: 19 March 2025)

Projection: EPSG:7856



Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

Flood depth (m)

- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

0 500 1,000 m

Calvale to Calliope TL
Surface Water
Impact Assessment

1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_7_Alignment_Depth) (Exported: 19 March 2025)

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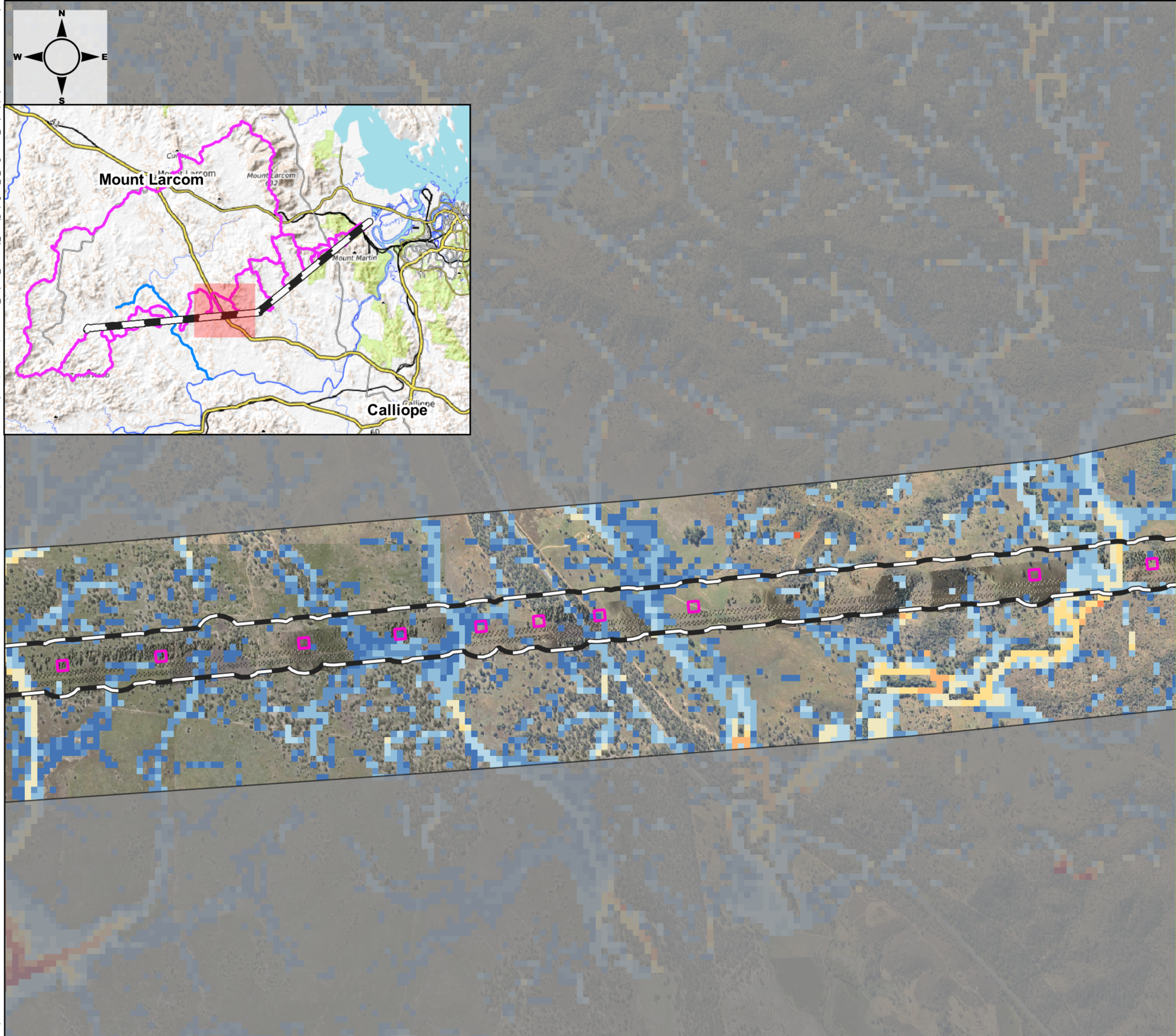

Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

Flood depth (m)

- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

Calvale to Calliope TL
Surface Water
Impact Assessment

1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_7_Alignment_Depth) (Exported: 19 March 2025)

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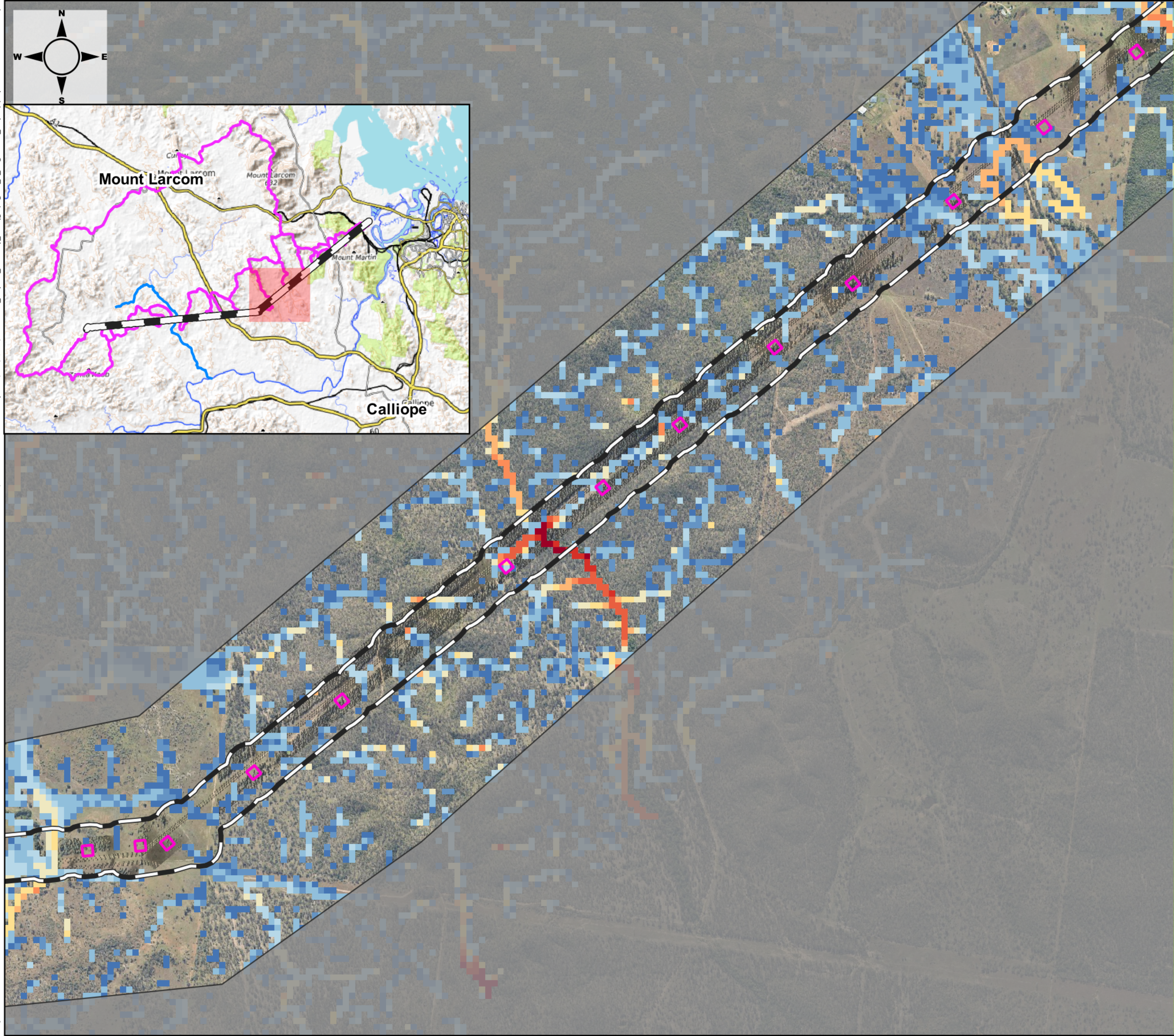

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Projection: EPSG:7856

Legend

MID Proposal Area

Subcatchment

Towers Over 50m

Watercourse

Flood depth (m)

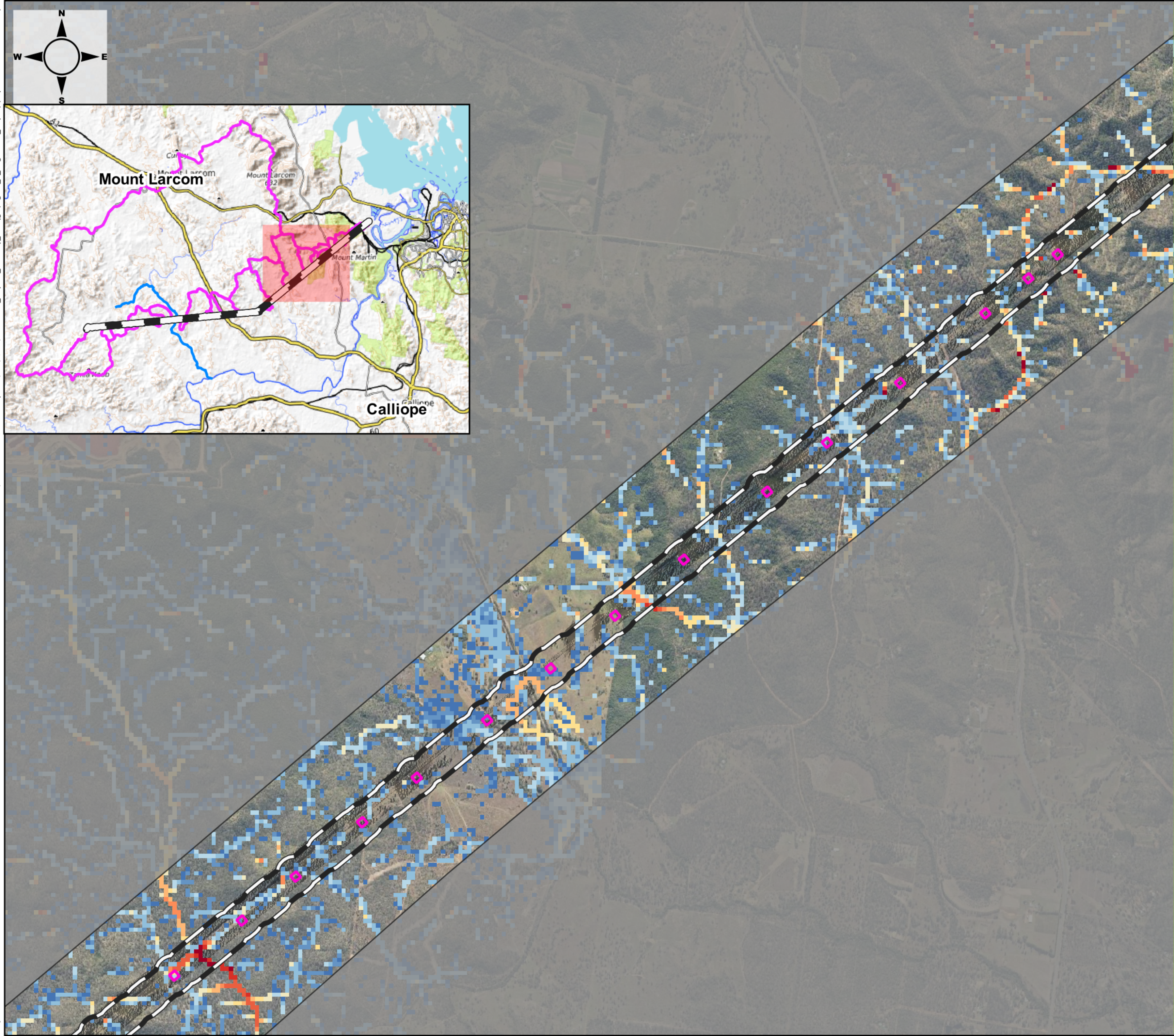
- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

0 500 1,000 m

Calvale to Calliope TL Surface Water Impact Assessment

1% AEP peak flood depth

WRM
WATER + ENVIRONMENT



Legend

MID Proposal Area
Subcatchment
Towers Over 50m
Watercourse

Flood depth (m)

up to 0.25 m
0.25 to 0.5 m
0.5 to 1.0 m
1.0 to 1.5 m
1.5 to 2.0 m
2.0 to 2.5 m
2.5 to 3.0 m
3.0 to 3.5 m
3.5 to 4.0 m
4.0 to 4.5 m
> 4.5 m

0 500 1,000 m

Calvale to Calliope TL
Surface Water
Impact Assessment

1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

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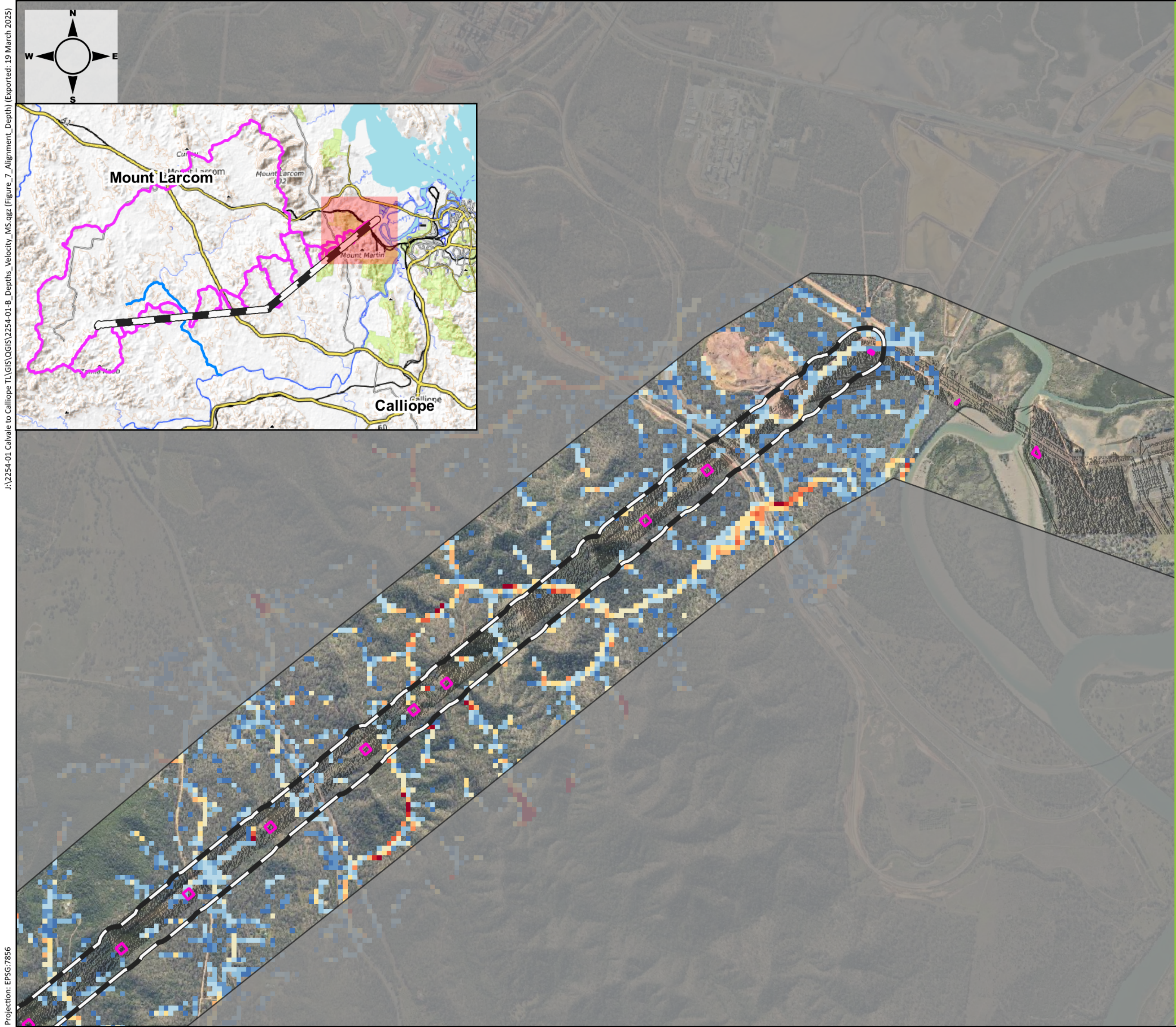

Legend

- MID Proposal Area
- Subcatchment
- Towers Over 50m
- Watercourse

Flood depth (m)

- up to 0.25 m
- 0.25 to 0.5 m
- 0.5 to 1.0 m
- 1.0 to 1.5 m
- 1.5 to 2.0 m
- 2.0 to 2.5 m
- 2.5 to 3.0 m
- 3.0 to 3.5 m
- 3.5 to 4.0 m
- 4.0 to 4.5 m
- > 4.5 m

0 500 1,000 m

Calvale to Calliope TL
Surface Water
Impact Assessment

1% AEP peak flood depth

WRM
WATER + ENVIRONMENT

J:\2254-01 Calvale to Calliope TL\GIS\QGIS\2254-01-B_Depths_Velocity_MS.qgz (Figure_7_Alignment_Depth) (Exported: 19 March 2025)

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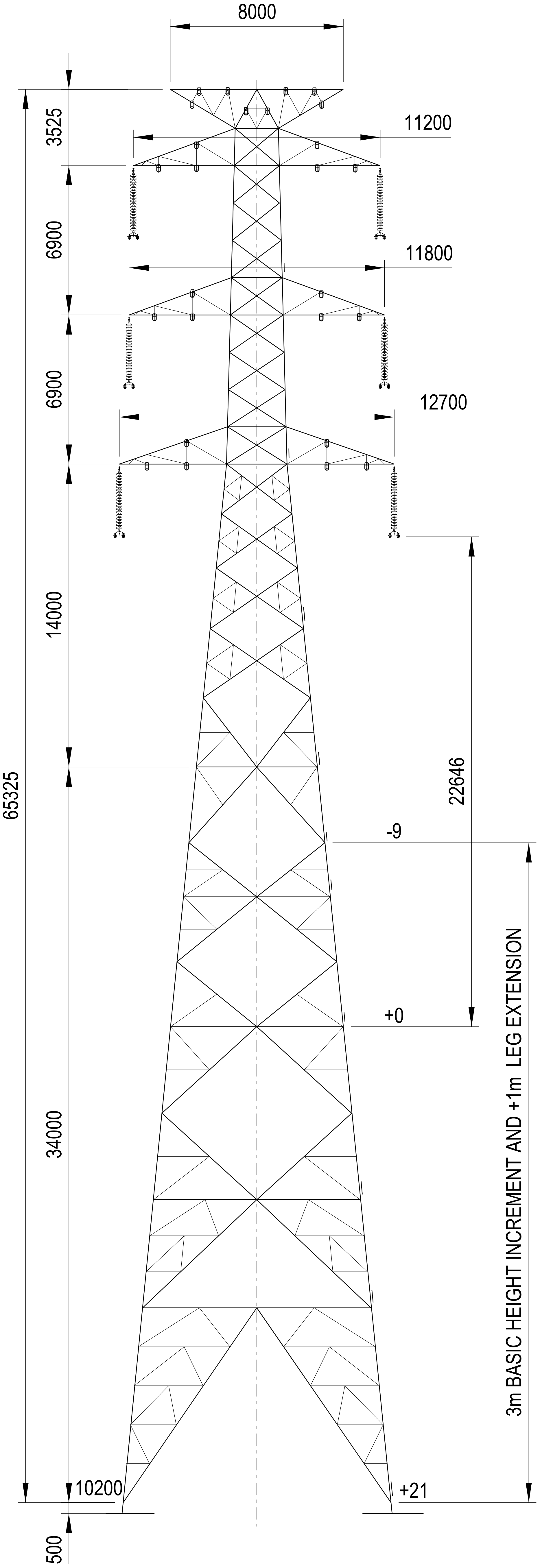
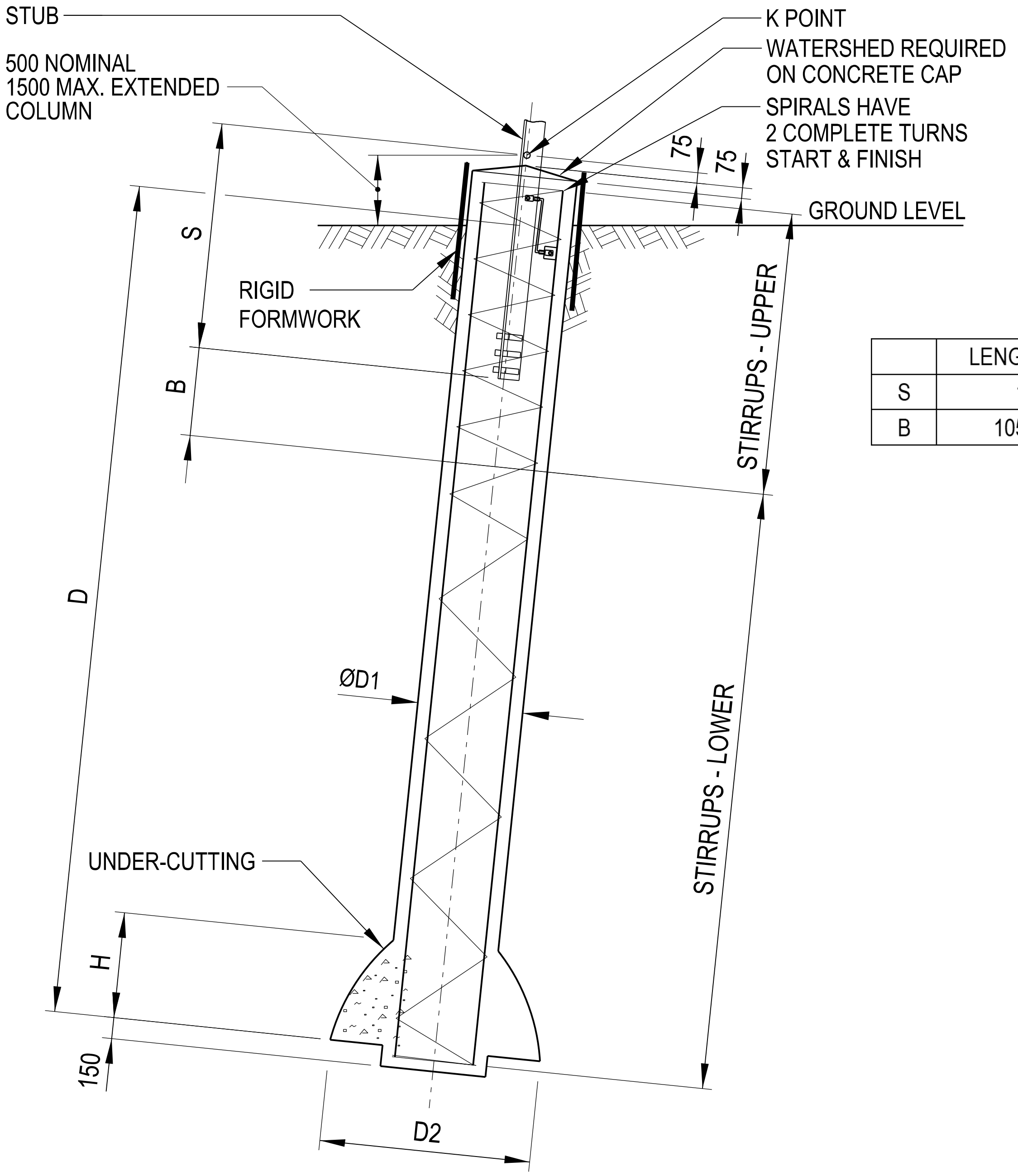


PRINCIPAL STRUCTURE
DIMENSIONS

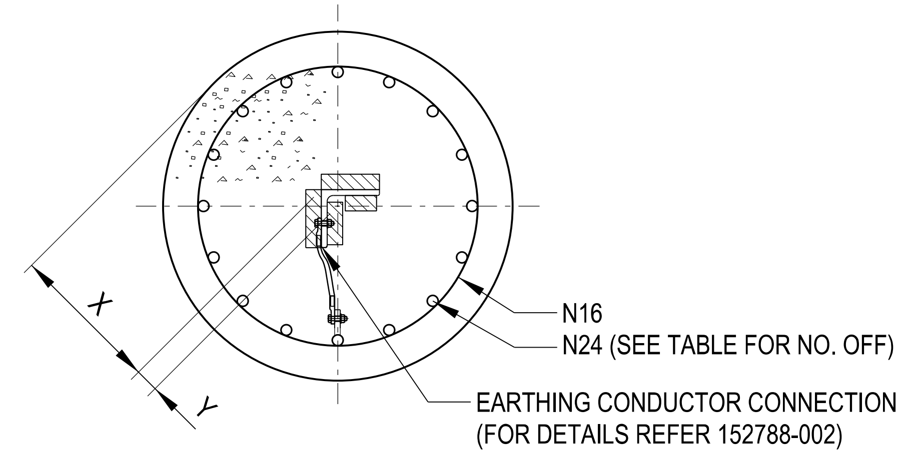
NOT TO SCALE



	LENGTH (mm)
S	1800
B	1050 MIN

BORED UNDER-CUT FOUNDATION
NOT TO SCALE

STUB SIZE	X	Y
L180	451	74
L200	445	80



TYPICAL COLUMN CROSS SECTION
NOT TO SCALE

GEOTECHNICAL REQUIREMENTS

1. THIS FOUNDATION TYPE IS APPLICABLE ONLY TO SITES WITH STIFF OR STRONGER COHESIVE SOILS AS PER TABLE BELOW, CEMENTED SANDS, DENSE OR STRONGER NON-COHESIVE SOILS AND/OR ROCK OF LESS THAN LOW MASS STRENGTH THAT CAN BE UNDER-CUT.

GEOTECHNICAL PROPERTIES OF CLAY - MINIMUM REQUIREMENT		
DEPTH (m)	GROUND CONDITION	Cu (kPa)
0m - 5m	STIFF CLAY	75
>5m	VERY STIFF CLAY	137

2. WHERE LOWER STRENGTH MATERIALS, EXPANSIVE SOILS AND/OR SATURATED CONDITIONS ARE ENCOUNTERED, OR LINERS REQUIRED TO FACILITATE BORING, CONTACT THE DESIGNER FOR AN ALTERNATIVE DESIGN.
3. GEOTECHNICAL MATERIAL AND STRENGTH CLASSIFICATION SHALL BE IN ACCORDANCE WITH AS 1726.
4. EACH INDIVIDUAL FOOTING SHALL BE COMPLETED WITHIN 48 HOURS OF BORING. FOR LONGER DURATIONS, CONTACT THE DESIGNER FOR AN ALTERNATIVE DESIGN.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL FOUNDATION CONSTRUCTION ISSUES. THE CONTRACTOR SHALL ALLOW FOR BORING IN SOIL WITH COBBLE/BOULDER AND ROCK OF LESS THAN LOW MASS STRENGTH.
6. IF BORED FOUNDATION IS ABANDONED, THE NEW POSITION SHALL NOT BE CLOSER THAN 3.0 METRES MEASURED BETWEEN THE HOLES EDGES.
7. EARTHWORKS SHALL COMPLY WITH POWERLINK TRANSMISSION LINES SPECIFICATION.
8. DEWATERING IS PERMITTED ONLY IF ITS APPLICATION WILL NOT DETERIORATE THE SOIL PROPERTIES. RPEQ SHALL APPROVE THE DEWATERING PROCEDURE.
9. THE DESIGN PRINCIPLES ARE BASED ON AS/NZS 7000.

CONCRETE NOTES

C1. ALL CONCRETE WORK SHALL CONFORM TO AS 3600 "CONCRETE STRUCTURES" AND POWERLINK SPECIFICATION.
C2. CONCRETE TO BE S32, MINIMUM CONCRETE COVER TO BE 75mm.
C3. ALL REINFORCEMENT SHALL CONFORM WITH AS/NZS 4671 "STEEL REINFORCING MATERIAL" AND SHALL BE DESIGNATED AS FOLLOWS:
  a. R - PLAIN ROUND BAR, STRENGTH GRADE 250 MPa, NORMAL DUCTILITY (e.g. R10 DESIGNATES R250N10)
  b. N - DEFORMED RIBBED BARS, STRENGTH GRADE 500 MPa, NORMAL DUCTILITY (e.g. N24 DESIGNATES D500N24)
C4. CONCRETE VOLUMES ARE INDICATIVE ONLY.
C5. DIMENSIONS ARE IN MILLIMETRES U.N.O.

TOWER LEVELS	COLUMN HEIGHTS	D	D1	D2	H	COLUMN REINFORCING			STUB SIZE	VOLUME OF CONCRETE m^3 REFER NOTE C4
						LONGITUDINAL	STIRRUPS N16 SPIRALS			
-10 TO -5	500 - 1500	6100	1050	2100	1050	12 - N24	UPPER	@ 300 CENTRE	L 180x180x18 GR 350	7.40
							LOWER	@ 360 CENTRE		
-4 TO +22	500 - 1500	6400	1050	2100	1050	16 - N24	UPPER	@ 250 CENTRE	L 200x200x20 GR 350	7.70
							LOWER	@ 360 CENTRE		

PRELIMINARY
NOT FOR CONSTRUCTION
DATE: 06/12/2024

CHECKED		DESIGNED	
DRAWN		DESIGN CHKD	
ORIGIN	TLD	APPROVED	
CIRCULATION			

Powerlink QUEENSLAND

275kV DOUBLE CIRCUIT STEEL TOWER
STRUCTURE TYPE D2S2V1
INTERNATIONAL STEEL
BORED UNDER-CUT FOUNDATION

LOCATION	CONT/ORDER	PROJECT	DRG CLASS
HLHD		-	A2

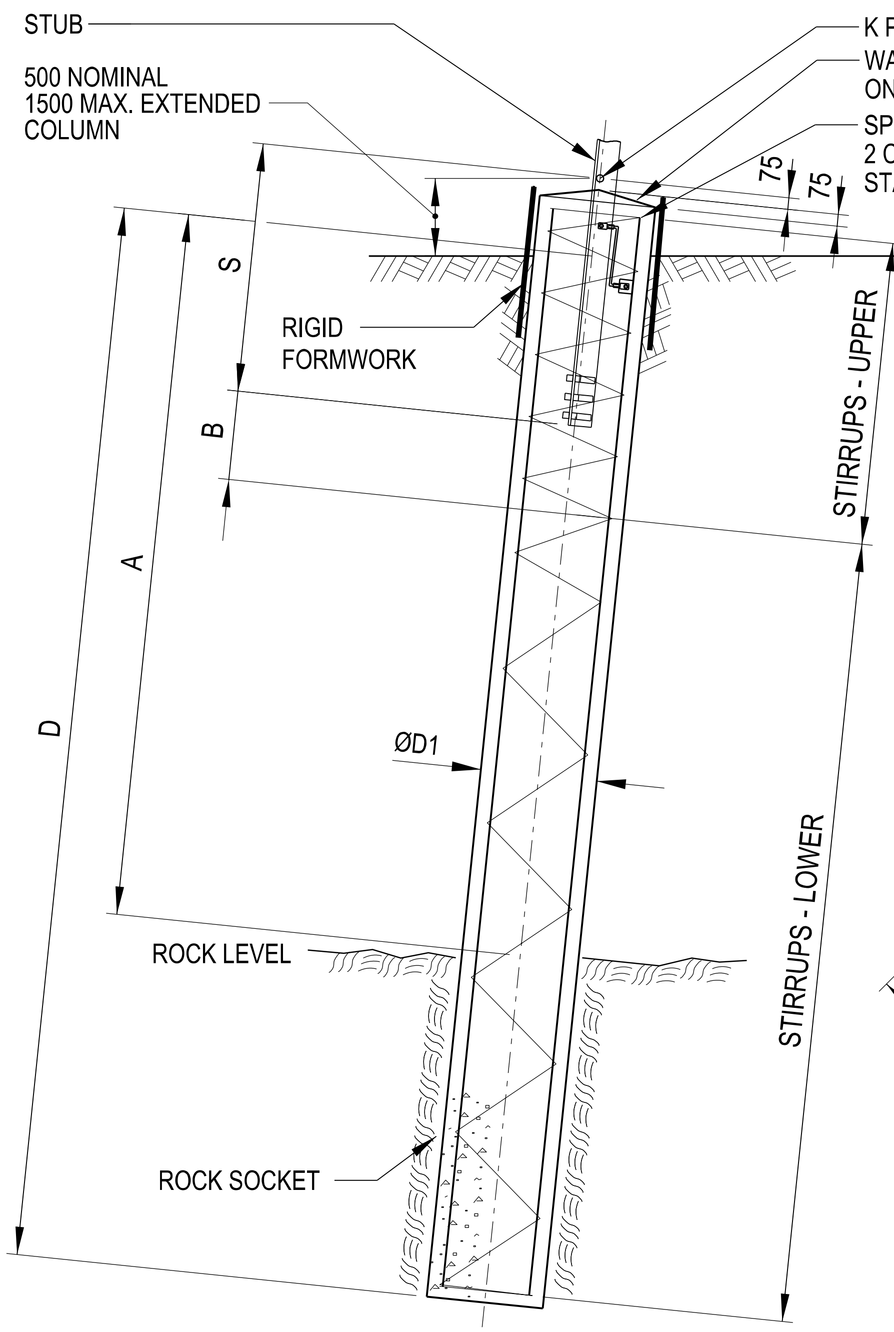
A3 -H-159777-011

NEXT SHEET 012

A

ORIGINAL ISSUE DATE : -

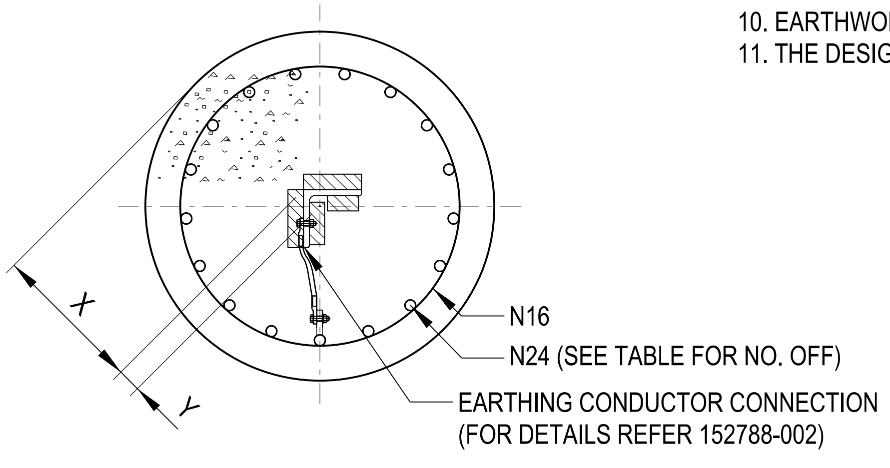
CAD 283x394



BORED AND SOCKETED FOUNDATION
NOT TO SCALE

	LENGTH (mm)
S	1800
B	1050 MIN

STUB SIZE	X	Y
L180	451	74
L200	445	80



TYPICAL COLUMN CROSS SECTION
NOT TO SCALE

GEOTECHNICAL REQUIREMENTS

1. THIS FOUNDATION TYPE IS APPLICABLE ONLY TO SITES WITH UNDERLYING ROCK OF A MINIMUM LOW MASS STRENGTH.

ULTIMATE LIMIT STATE PARAMETERS - MINIMUM REQUIREMENTS	
ROCK TYPE	SHAFT ADHESION, fs (kPa)
LOW MASS STRENGTH ROCK	300
MEDIUM / HIGH MASS STRENGTH ROCK	800

2. WHERE EXPANSIVE SOILS AND/OR SATURATED CONDITIONS ARE ENCOUNTERED, OR LINERS REQUIRED TO FACILITATE BORING, CONTACT THE DESIGNER FOR AN ALTERNATIVE DESIGN.
3. UNDERLYING ROCK SHALL BE CONTINUOUS AND ROCK LAYERS ARE NOT SUITABLE.
4. IN HARD ROCK PEPPERING AND/OR BLASTING MAY BE REQUIRED TO COMPLETE THE FOUNDATION.
5. THE ROCK SOCKET SIDEWALLS SHALL BE FREE OF CRUSHED/SMEARED ROCK AND HAVE INTERNAL SURFACE REAMED TO ACHIEVE A GROOVE SPIRAL OVER ROCK SOCKET.
6. WHERE THE DEPTH ABOVE THE ROCK LEVEL IS GREATER THAN 3 METRES, EACH INDIVIDUAL FOOTING SHALL BE COMPLETED WITHIN 48 HOURS OF BORING. FOR LONGER DURATIONS CONTACT THE DESIGN ENGINEER FOR ALTERNATIVE DESIGN.
7. GEOTECHNICAL MATERIAL AND STRENGTH CLASSIFICATION SHALL BE IN ACCORDANCE WITH AS 1726.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL FOUNDATION CONSTRUCTION ISSUES. THE CONTRACTOR SHALL ALLOW FOR BORING IN OVERLYING SOIL WITH COBBLE AND ROCK LAYERS OF LESS THAN LOW MASS STRENGTH.
9. IF THE FOUNDATION IS ABANDONED, THE NEW POSITION SHALL NOT BE CLOSER THAN 3.0 METRES MEASURED BETWEEN THE HOLES EDGES.
10. EARTHWORKS SHALL COMPLY WITH POWERLINK TRANSMISSION LINES SPECIFICATION.
11. THE DESIGN PRINCIPLES ARE BASED ON AS/NZS 7000.

	-10 To -5				-4 To -22			
ROCK MASS STRENGTH	LOW		MEDIUM / HIGH		LOW		MEDIUM / HIGH	
A	D	VOLUME OF CONCRETE m^3 REFER NOTE C4	D	VOLUME OF CONCRETE m^3 REFER NOTE C4	D	VOLUME OF CONCRETE m^3 REFER NOTE C4	D	VOLUME OF CONCRETE m^3 REFER NOTE C4
0	4000	3.89	3800	3.76	4400	4.28	4300	4.14
300	4000	3.91	3900	3.80	4500	4.29	4300	4.17
600	4100	3.94	4000	3.85	4500	4.33	4400	4.23
900	4100	3.98	4000	3.91	4500	4.36	4500	4.29
1200	4200	4.04	4100	3.97	4600	4.42	4500	4.35
1500	4200	4.09	4200	4.04	4700	4.47	4600	4.41
1800	4300	4.16	4300	4.12	4700	4.53	4700	4.49
2100	4400	4.23	4400	4.20	4800	4.6	4800	4.55
2400	4500	4.30	4400	4.28	4900	4.67	4900	4.64
2700	4600	4.38	4500	4.36	5000	4.77	5000	4.73
3000	4700	4.47	4700	4.46	5200	4.97	5100	4.81
3300	4900	4.63	4800	4.55	5500	5.18	5200	4.90
3600	5100	4.85	4900	4.65	5700	5.4	5300	5.00
3900	5300	5.04	5000	4.75	6000	5.59	5400	5.09
4200	5600	5.26	5300	4.98	6200	5.81	5500	5.20
4500	5800	5.48	5600	5.24	6500	6.03	5600	5.29
4800	6000	5.66	5900	5.50	6700	6.25	5900	5.50
5100	6300	5.89	6200	5.76	7000	6.46	6200	5.76
5400	6500	6.10	6500	6.02	7200	6.66	6500	6.02
5700	6800	6.30	6800	6.28	7400	6.87	6800	6.28
6000	7100	6.54	7100	6.54	7700	7.1	7100	6.54
6300	7400	6.80	7400	6.80	7900	7.3	7400	6.80
6600	7700	7.06	7700	7.06	8100	7.48	7700	7.06
6900	8000	7.32	8000	7.32	8400	7.73	8000	7.32
7200	8300	7.58	8300	7.58	8700	7.92	8300	7.58
7500	8600	7.84	8600	7.84	8900	8.12	8600	7.84
7800	8900	8.10	8900	8.10	9200	8.36	8900	8.10
8100	9200	8.36	9200	8.36	9400	8.58	9200	8.36
8400	9500	8.62	9500	8.62	9700	8.8	9500	8.62
8700	9800	8.88	9800	8.88	9900	9.01	9800	8.88

CONCRETE NOTES

C1. ALL CONCRETE WORK SHALL CONFORM TO AS 3600 "CONCRETE STRUCTURES" AND POWERLINK SPECIFICATION.
C2. CONCRETE TO BE S32 TO THE POWERLINK SPECIFICATION, MINIMUM CONCRETE COVER TO BE 75mm.
C3. ALL REINFORCEMENT SHALL CONFORM WITH AS/NZS 4671 "STEEL REINFORCING MATERIAL" AND SHALL BE DESIGNATED AS FOLLOWS:
a. R - PLAIN ROUND BAR, STRENGTH GRADE 250 MPa, NORMAL DUCTILITY (e.g. R10 DESIGNATES R250N10)
b. N - DEFORMED RIBBED BARS, STRENGTH GRADE 500 MPa, NORMAL DUCTILITY (e.g. N24 DESIGNATES D500N24)
C4. CONCRETE VOLUMES ARE INDICATIVE ONLY.
C5. DIMENSIONS ARE IN MILLIMETRES U.N.O.

TOWER LEVELS	COLUMN HEIGHTS	D1	COLUMN REINFORCING			STUB SIZE
			LONGITUDINAL	STIRRUPS N16 SPIRAL		
-10 TO -5	500 - 1500	1050	13 - N24	UPPER	@ 300 CENTRE	L 180x180x18 GR 350
				LOWER	@ 360 CENTRE	
-4 TO +22	500 - 1500	1050	17 - N24	UPPER	@ 250 CENTRE	L 200x200x20 GR 350
				LOWER	@ 360 CENTRE	

PRELIMINARY
NOT FOR CONSTRUCTION
DATE: 06/12/2024

ORIGINAL ISSUE -
DATE :
A

CHECKED		DESIGNED	
DRAWN		DESIGN CHKD	
ORIGIN	TLD	APPROVED	
CIRCULATION			

Powerlink QUEENSLAND

275kV DOUBLE CIRCUIT STEEL TOWER
STRUCTURE TYPE D2S2V1
INTERNATIONAL STEEL
BORED AND SOCKETED FOUNDATION

LOCATION	CONT'ORDER	PROJECT	DRG CLASS
HLHD		-	A2

A3 -H-159777-012

NEXT SHEET 013

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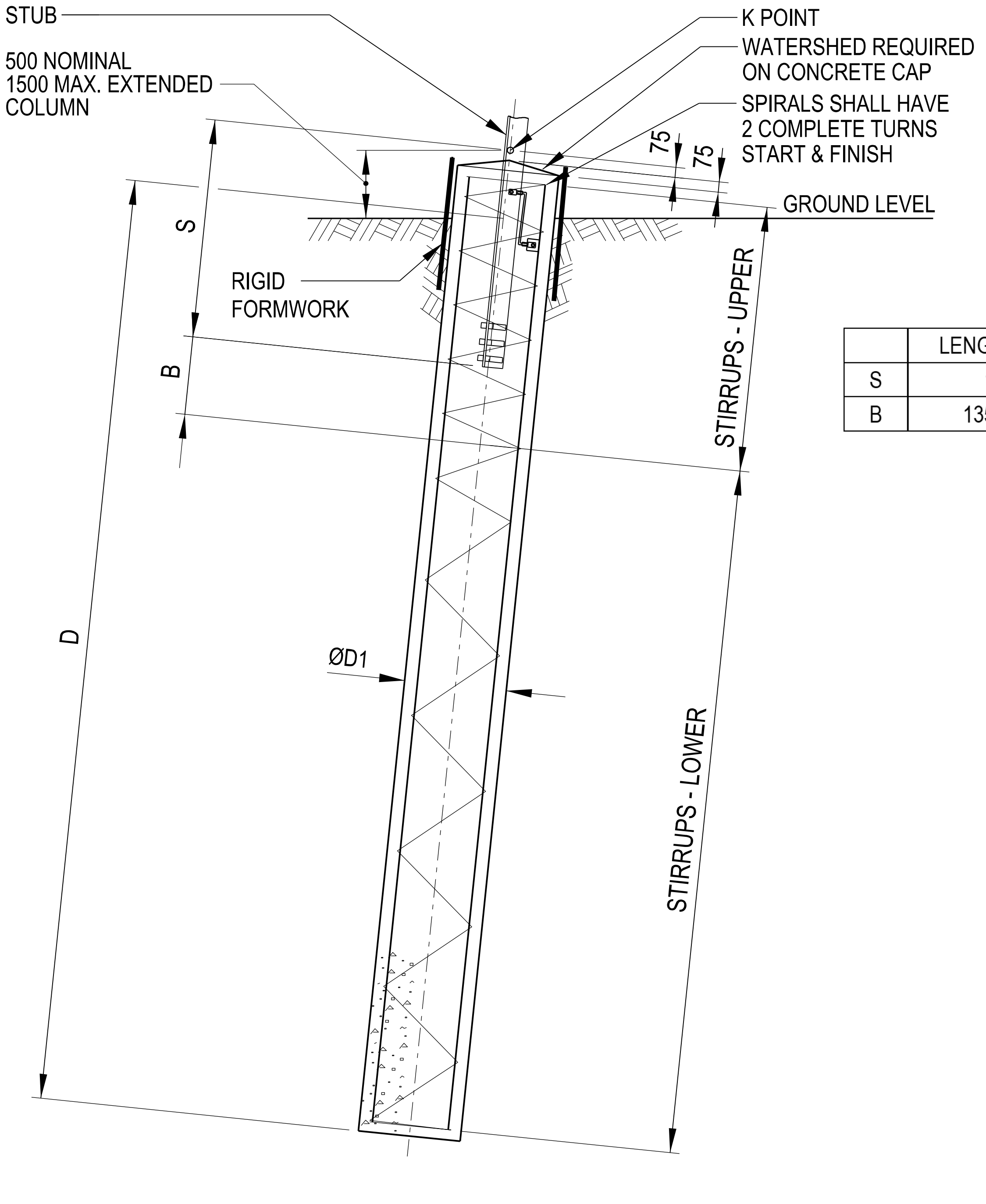
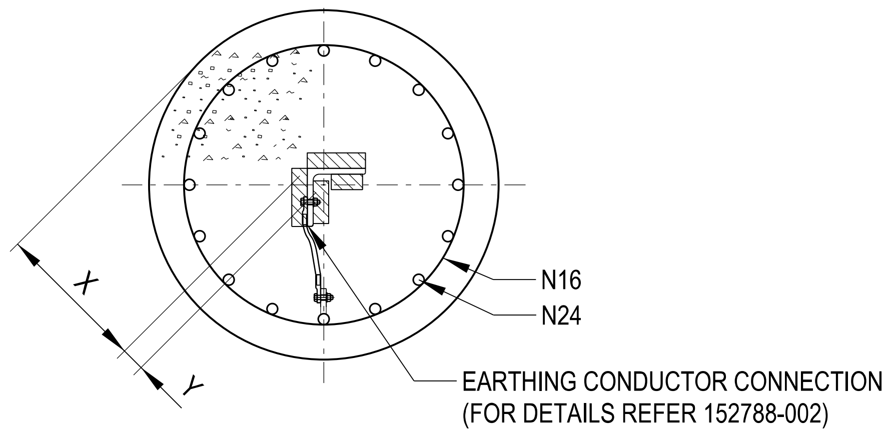
CAD 283x394



	LENGTH (mm)
S	1800
B	1350 MIN

BORED STRAIGHT SIDE FOUNDATION
NOT TO SCALE

STUB SIZE	X	Y
L180	601	74
L200	595	80



TYPICAL COLUMN CROSS SECTION
NOT TO SCALE

TOWER LEVELS	COLUMN HEIGHTS	D	D1	COLUMN REINFORCING			STUB SIZE	VOLUME OF CONCRETE m^3 REFER NOTE C4
				LONGITUDINAL	STIRRUPS N16 SPIRALS			
-10 TO -5	500 - 1500	8000	1350	16- N24	UPPER	@ 300 CENTRES	L 180x180x18 GR 350	12.20
					LOWER	@ 330 CENTRES		
-4 TO +22	500 - 1500	9700	1350	16- N24	UPPER	@ 290 CENTRES	L 200x200x20 GR 350	14.50
					LOWER	@ 330 CENTRES		

GEOTECHNICAL REQUIREMENTS

1. THIS FOUNDATION TYPE IS APPLICABLE ONLY TO SITES WITH DENSE OR STRONGER NON-COHESIVE SOILS, CEMENTED SANDS, AND/OR ROCK OF LESS THAN LOW MASS STRENGTH THAT CANNOT BE UNDER-CUT.
2. WHERE LOWER STRENGTH MATERIALS, EXPANSIVE SOILS AND/OR SATURATED CONDITIONS ARE ENCOUNTERED, OR LINERS REQUIRED TO FACILITATE BORING, CONTACT THE DESIGNER FOR AN ALTERNATIVE DESIGN.
3. GEOTECHNICAL MATERIAL AND STRENGTH CLASSIFICATION SHALL BE IN ACCORDANCE WITH AS 1726.
4. EACH INDIVIDUAL FOOTING SHALL BE COMPLETED WITHIN 48 HOURS OF BORING. FOR LONGER DURATIONS, CONTACT THE DESIGNER FOR AN ALTERNATIVE DESIGN.
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C5. DIMENSIONS ARE IN MILLIMETRES U.N.O.

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CHECKED		DESIGNED	
DRAWN		DESIGN CHKD	
ORIGIN	TLD	APPROVED	
CIRCULATION			

Powerlink QUEENSLAND

275kV DOUBLE CIRCUIT STEEL TOWER
STRUCTURE TYPE D2S2V1
INTERNATIONAL STEEL
BORED STRAIGHT SIDE FOUNDATION

LOCATION	CONT/ORDER	PROJECT	DRG CLASS
HLHD		-	A2

A3 -H-159777-013

NEXT SHEET 014

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Level 1, 369 Ann Street Brisbane
PO Box 10703 Brisbane Adelaide Street Qld 4000
07 3225 0200

Level 5, 93 Mitchell Street Darwin
GPO Box 43348 Casuarina NT 0811
08 8911 0060

wrm@wrmwater.com.au
wrmwater.com.au

ABN 96 107 404 544