



COPPERSTRING 2.0

CopperString 2.0

Hazards, health and safety

Volume 2 Chapter 17



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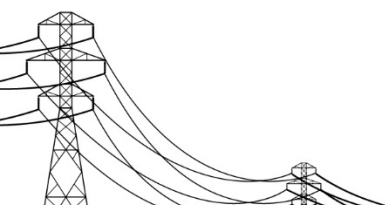
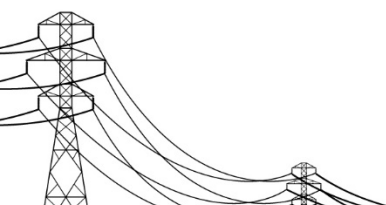


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17. Hazards, health and safety

17.1 Introduction

17.1.1 Project overview

The CopperString 2.0 Project (the Project) involves the construction and operation of approximately 1,060 km of extra high voltage overhead electricity transmission line that would extend from Mount Isa to the Powerlink transmission network, via a new connection point near Woodstock, south of Townsville.

The Project involves construction of seven new substations at Woodstock, Hughenden, Dajarra Road (Cloncurry), Mount Isa, Selwyn, Cannington Mine and Phosphate Hill Mine.

The CopperString transmission network is divided into the following eight sections as shown in Figure 17-1:

1. Woodstock Substation
2. Renewable Energy Hub
3. CopperString Core
4. Mount Isa Augmentation
5. Southern Connection
6. Cannington Connection
7. Phosphate Hill Connection
8. Kennedy Connection (option).

17.1.2 Objectives

This chapter of the Environmental Impact Statement (EIS) aims to ensure that the construction and operation of the project:

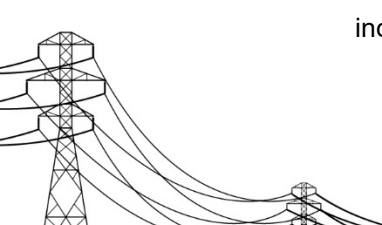
- Avoids, minimises, manages or mitigates the risk of, and the adverse impacts from, natural and human-made natural hazards to protect people and property.
- Enhances the community's resilience to natural hazards.
- Is located, designed and constructed to minimise health and safety risks to communities and individuals, and adverse effects on the environment.

17.1.3 Purpose of chapter

This chapter provides an assessment of the potential risks to people and property that may result from the construction, operation and decommissioning phases of the Project. The assessment is intended to meet the requirements of the Terms of Reference for the Project outlined in Volume 3 Appendix A Terms of reference with cross-reference table.

This chapter specifically identifies potential hazards and risks to people and property associated with each stage of the Project including, but not limited to:

- Identification of potential hazards, accidents, spillages, fire, and abnormal events that may occur during all stages of the Project, including possible frequency of occurrence.
- Identification of all hazardous substances to be used, stored, processed or produced, including the rate of usage.



- Potential hazards posed by wildlife interactions, natural events and implications related to climate change, including the cumulative impact of a number of natural hazards occurring at one time.
- Identification of how the Project may potentially affect hazards away from the Project area (for example, changing flooding characteristics).

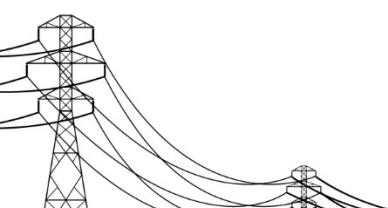
Risks are assessed through a determination of the likelihood of identified hazards and the potential consequence of the hazard occurring, with an overall risk rating determined for each hazard.

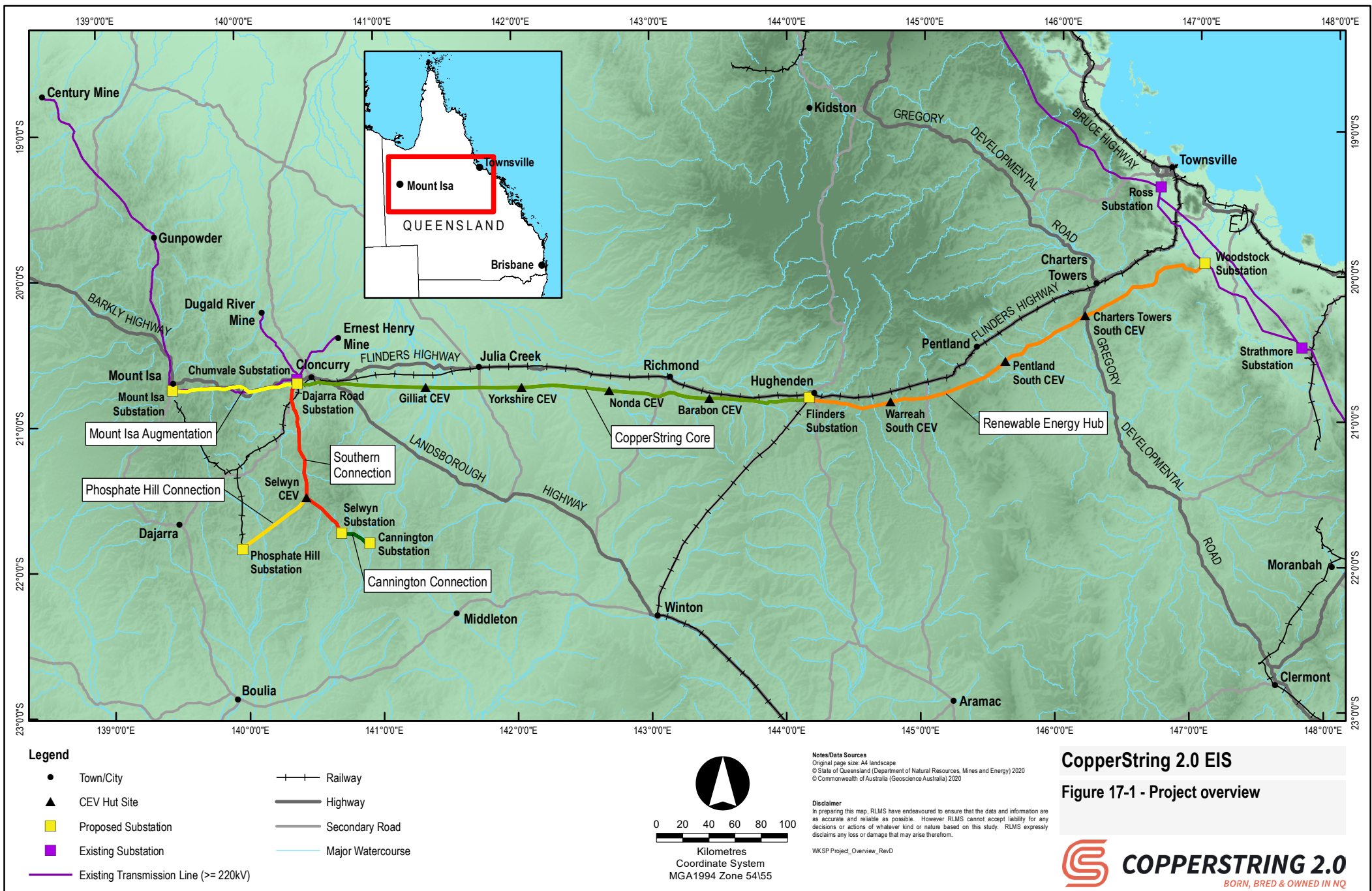
Management and mitigation strategies to minimise the impacts of the Project on the health and safety of people, property, and the environment are also discussed in this chapter.

1.1.4 Defined terms

The following key terms are used throughout this chapter:

- ‘The Project’ – means the CopperString 2.0 EIS Project
- ‘CuString’ – means CuString Pty Ltd, the proponent
- ‘Corridor selection’ – means the baseline investigation corridor of the transmission line (a nominal 1,060 km long corridor). The corridor selection is 120 m wide from Woodstock to Dajarra Road, and 60 m wide from Dajarra Road to Mount Isa, Dajarra Road to Selwyn, and Selwyn to Phosphate Hill and Cannington. The 4 km long section of the corridor selection from Dajarra Road Substation to Chumvale Substation is 60 m wide and a 3 km long section from Dajarra Road Substation to the Dugald River 220 kV overhead line is 80 m wide.
- ‘Study area’ – means the study area defined specifically for this chapter of the EIS, included in Section 17.2.3.
- ‘Project area’ – means the 120 m, 80 m or 60 m wide easement and associated infrastructure including laydown areas, substations, CEV huts, access tracks, brake and winch sites, and construction camps (including components located off-easement).





17.2 Methodology

17.2.1 Preliminary hazard analysis

This hazard assessment is based on a Preliminary Hazard Analysis (PHA), which identifies potential hazards and risks associated with the Project. The purpose of the PHA is to conduct a high-level identification and evaluation of relevant hazards and risks associated with the Project. This allows potentially significant risk exposures to be efficiently identified and prioritised for further, more detailed analysis. The risk information collected during the PHA is not intended to provide a definitive, quantitative measure of risk, rather it is used for guiding and structuring detailed consideration of significant risk issues where such analysis is warranted.

The methodology employed for the PHA included:

- A review of the hazards identified during the CopperString 1.0 Project in 2010 to assess their relevance to the current Project
- A review of relevant Commonwealth, state and local regulatory frameworks
- A review of relevant standards and guidelines
- Identification of sensitive receptors
- A review of the Project activities throughout construction, operation and decommissioning
- A review of hazardous substances that will be used during all phases of the Project
- A review of natural hazards that pose a risk to the Project or that may be influenced by the Project
- Evaluation of the risk associated with each hazard using a qualitative risk assessment approach
- Development of proposed mitigation measures
- Review of residual risk with mitigation measures in place
- Development of a risk management plan, particularly Emergency Response Planning procedures.

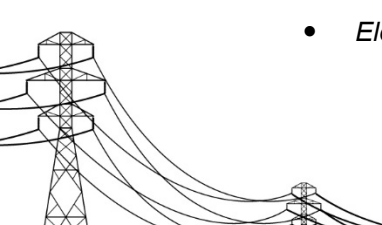
Consultation with emergency services (refer Volume 2 Chapter 14 Social) was carried out to develop proposed integrated Emergency Response Planning procedures.

The results of the PHA are presented in the form of a risk register, which is presented in Table 17-7. Hazards are given a risk rating based on the risk assessment criteria in section 17.2.5 before mitigation and management measures are implemented. The risk rating is then re-evaluated after mitigation and management measures are implemented to determine if the risk can be lowered.

17.2.2 Legislative context and standards

Several key regulatory requirements and standards, codes and guidelines are applicable to the Project. Key legislation relevant to the risk assessment includes:

- *Work Health and Safety Act 2011*, current as 18 March 2019
- *Work Health and Safety Regulation 2011*, current as 1 July 2019
- *Electricity Act 1994*
- *Electricity Regulation 2006*
- *Electrical Safety Act 2002*

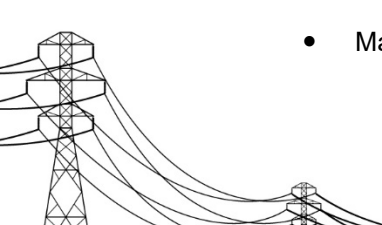




- *Electrical Safety Regulation 2013*
- *Explosives Act 1999*
- *Transport Infrastructure Act 1994*
- *Dangerous Goods Safety Management Act 2001*

In addition, the following policies, standards and codes of practice are in effect in Queensland and are likely to be applicable to the Project:

- Queensland Government 2018, State Planning Policy - state interest guidance material, Natural hazards, risk and resilience – Bushfire
- Queensland Government 2017, State Planning Policy - state interest guidance material, Natural hazards, risk and resilience – Flood
- Standards Australia AS/NZS ISO 31000:2018 Risk Management Guidelines
- Electricity safety codes of practice 2020 – Working near overhead and underground electric lines
- Electrical safety code of practice 2013 - Managing electrical risks in the workplace
- Electrical safety code of practice 2020 - Working near overhead and underground electric lines
- Electricity safety codes of practice 2020 – Works
- National Electricity Network Safety Code (Energy Networks Association (ENA) DOC 001-2019)
- National guidelines for prevention of unauthorised access to electricity infrastructure (ENA_DOC_015-2006)
- Guideline for the Fire Protection of Electricity Substations (ENA DOC 018-2015)
- Land Management Guidelines (ENA 019-2014)
- ENA Guidelines for Safe Vegetation Management (ENA DOC 023-2009)
- EG-0 Power System Earthing Guide Part 1: Management Principles (ENA DOC 025-2010)
- ENA National Guideline for Mobile Plant Earthing (ENA DOC 031-2011)
- Vegetation Risk Management for Overhead Electricity Networks – Guideline (ENA DOC 038-2018)
- National Guidelines for Manual Reclosing of High Voltage Electrical Apparatus Following a Fault Operation (Manual Reclose Guidelines) (ENA DOC 042-2018)
- Substation Earthing Guide (ENA EG1-2006)
- National guidelines for safe approach distances to electrical and mechanical apparatus (ENA NENS 04-2006)
- National guidelines for the selection, use and maintenance of personal protective equipment (PPE) for electrical arc hazards (ENA NENS 09-2014)
- National guidelines for aerial surveillance of overhead electricity networks (ENA NENS 08-2006)
- Australian Dangerous Goods Code Edition 7.6, 2018
- Confined spaces Code of Practice 2011
- Managing risks of hazardous chemicals in the workplace Code of Practice 2018



- Managing risks of plant in the workplace Code of Practice 2018
- Safe design of structures Code of Practice 2018
- Traffic management for construction or maintenance work Code of Practice 2008
- Standards Australia, Australian Standard AS 1940:2004, The storage and handling of flammable and combustible liquids
- Standards Australia, Australian Standard AS 2067:2016, Substations and high voltage installations exceeding 1 kV a.c.
- Standards Australia, Australian Standard AS 5804 (Series) High-voltage live working
- Standards Australia, Australian Standard AS 5577–2013, Electricity network safety management systems
- Standards Australia, Australian Standard AS 5804 series 2010, High-voltage live working
- Australian/New Zealand Standard AS/NZS 7000:2016, Overhead line design
- Australian/New Zealand Standard AS/NZS 45001:2018, Occupational health and safety management systems – requirements with guidance for use
- Australian/New Zealand Standard AS/NZS 4853:2012, Electrical hazard on metallic pipelines
- ICNIRP HEALTH PHYSICS 99(6):818-836; 2010, Guidelines for limiting exposure to static and time-varying electric and magnetic, fields (as directed by ARPANSA)

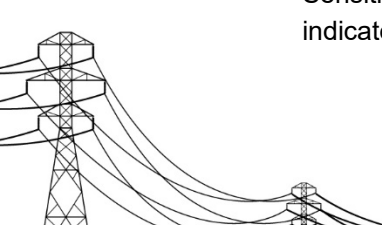
CuString will comply with the above legislation and applicable codes of practice for all activities associated with the Project. This includes those listed above and any other relevant work health and safety regulations.

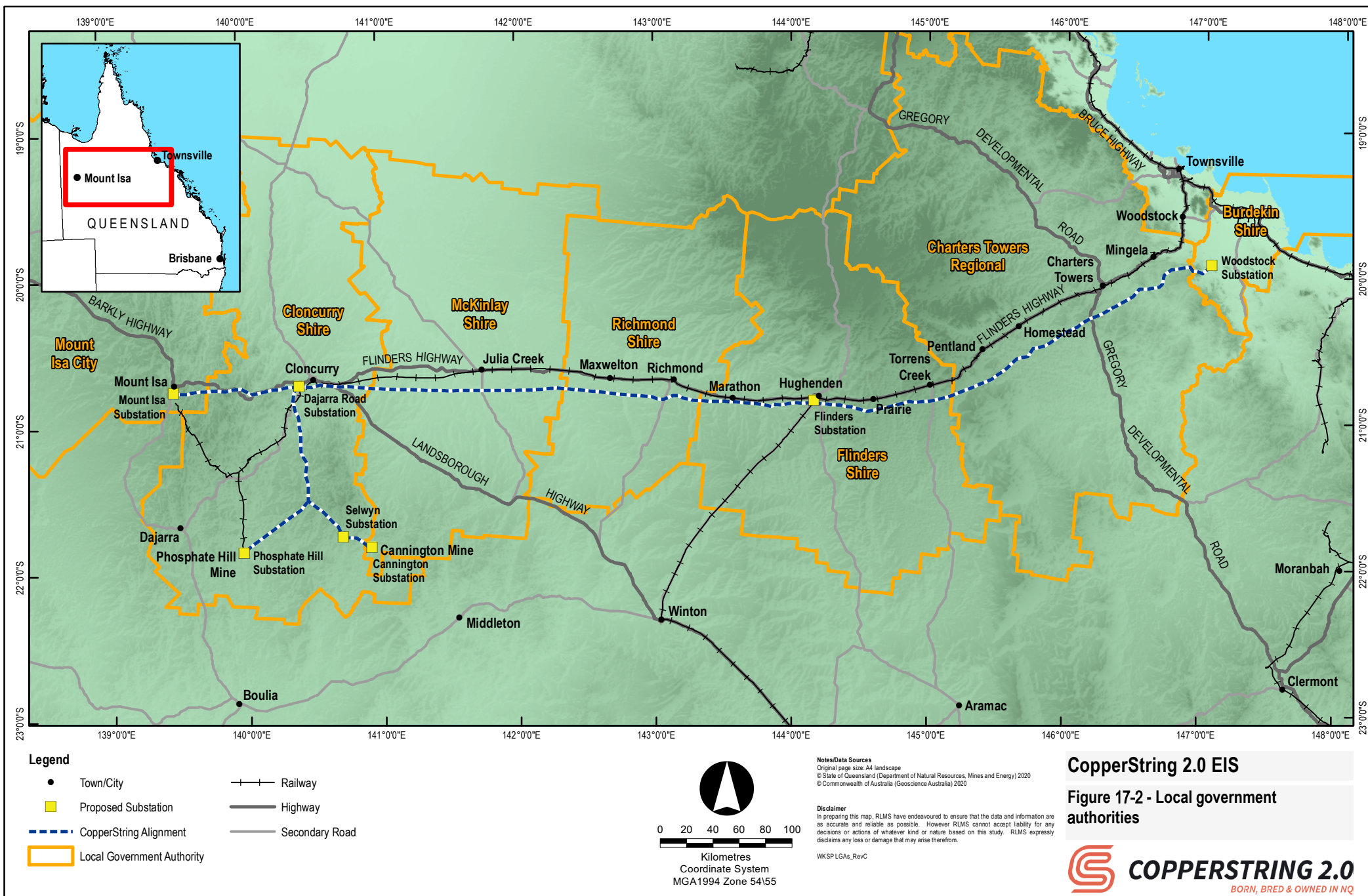
17.2.3 Study area

The study area for the hazard, health and safety assessment includes localities that have the potential to be directly or indirectly affected by the Project. This includes people and property as follows:

- The Project area, including properties on which temporary construction camps will be located
- Substations at Woodstock, Hughenden, Dajarra Road, Mount Isa, Selwyn, Cannington Mine and Phosphate Hill Mine
- Land use and infrastructure on properties intersected by the alignment
- Users of major transport infrastructure within the following local government areas (LGAs):
 - Townsville City Council
 - Burdekin Shire Council
 - Charters Towers Regional Council
 - Flinders Shire Council
 - Richmond Shire Council
 - McKinlay Shire Council
 - Cloncurry Shire Council
 - Mount Isa City Council.

Sensitive receptors for this assessment are described in section 17.3 of this report. Figure 17-2 indicates the LGAs that may potentially be impacted by the Project.





17.2.4 Data sources

This hazard, health and safety assessment draws on the findings of other assessments conducted as part of the Project EIS, including:

- Volume 1 Chapter 2 Project description
- Volume 2 Chapter 5 Land
- Volume 2 Chapter 6 Geology and soils
- Volume 2 Chapter 7 Flora and fauna
- Volume 2 Chapter 9 Water resources and water quality
- Volume 2 Chapter 10 Air and greenhouse gas
- Volume 2 Chapter 11 Noise and vibration
- Volume 2 Chapter 12 Waste management
- Volume 2 Chapter 13 Transport
- Volume 2 Chapter 14 Social.

The assessment has also relied on relevant publicly available data from government agencies such as:

- Bureau of Meteorology (BOM)
- Geosciences Australia
- Australian Transport Safety Bureau (ATSB)
- National Pollutant Inventory (NPI)

Data from these sources provides a thorough understanding of relevant contextual factors, such as:

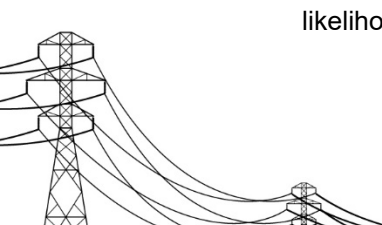
- The overall Project objectives and justification
- Project design considerations
- Indicative construction and operating methods
- Potential sources of energy associated with the Project (a proxy for hazards)
- The natural and man-made environmental setting of the Project.

17.2.5 Risk assessment criteria

In accordance with the requirements of AS/NZS ISO 13000:2018 Risk management – Principles and guidelines, a qualitative risk assessment of all hazards was performed and a comprehensive risk register prepared (refer to Table 17-7). The risk assessment undertaken during the CopperString 1.0 Project in 2010 was reviewed. A desktop study was then undertaken to assess previously identified hazards as well as any newly identified hazards.

The risk assessment was carried out using a standard risk matrix, where a risk scenario is applied to each hazard and is then evaluated in terms of the likelihood of occurrence and the potential consequences.

The likelihood of occurrence table (Table 17-1) has been adopted from the Queensland Emergency Risk Management Framework (QERMF) Risk Assessment Process Handbook (Queensland Fire and Emergency Services, 2018) and is used to identify the most credible likelihood of an event occurring, based on historical data. The table provides rankings based on



the frequency and severity of hazards using the past 50 years of meteorological and geological observations and can also be applied to anthropogenic hazards.

Table 17-1 Likelihood of occurrence

Historical Likelihood	Likelihood	Definition
Has occurred 3 or more times in the last year or at least each year over the last 5 years	Almost certain	Almost certain to occur in most cases
Has occurred twice in the last 5 years	Likely	Likely chance of occurring in most cases
Has occurred twice in the last 10 years	Possible	Might occur in most cases
May occur, and has occurred once in the last 20 years	Unlikely	Not expected to occur in most cases
May only occur in exceptional circumstances or has occurred only once in the last 50 years or more	Rare	Will only occur in exceptional circumstances and has not occurred in most cases

The level of consequence (Table 17-2) is also adapted from the QERMF Risk Assessment Process Handbook and provides an assessment of what the anticipated impact of the hazard would be, either directly or indirectly. The consequence definitions in Table 17-2 relate to four categories - financial and economic, health and safety of people, community and social, and the environment. These categories relate to the requirements of the terms of reference to assess potential risk to people and property. The consequence ascribed to each risk was based on a reasonably foreseeable worst-case event in order to ensure potentially high consequence risks were captured for future consideration. By combining the likelihood of occurrence (Table 17-1) and consequence (Table 17-2), an overall risk rating can be applied to each hazard (refer to Table 17-3).

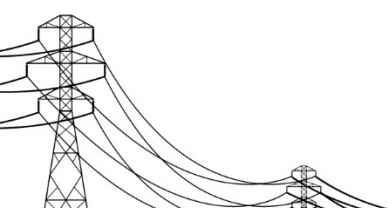
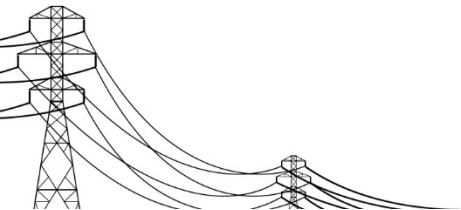
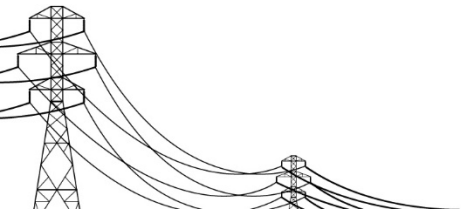


Table 17-2 Consequence definitions

Consequence	Definition			
	Financial & Economic	Health and safety of people	Community and social	Environmental
Insignificant	Short term disruption to economic activity and/or loss of assets within an industry or sector.	No reported injuries to emergency services.	The community's social connectedness is disrupted, such that the reprioritisation and/or reallocation of existing resources is required to return the community to functioning effectively, with no permanent dispersal. There is no or minor damage to objects of cultural significance.	No damage to ecosystems at any level. Inconsequential damage to environmental values of interest.
Minor	Short term decline of economic activity (less than one year) and/or government revenues from industries (e.g. mining, agriculture, tourism). Minor damage to an industry and/or damage to an asset that requires the reallocation of budget for recovery, resulting in short term disruption (less than one year).	Several injuries requiring treatment at the scene (e.g. minor injuries and abrasions, requiring less urgent medical attention).	The community's social connectedness is damaged, such that the community requires some external resources to return to functioning effectively, with no permanent dispersal. Repairable damage to objects of cultural significance.	Minor damage to ecosystems and species recognised at the local or regional level. Minor damage to environmental values of interest.



Consequence	Definition			
	Financial & Economic	Health and safety of people	Community and social	Environmental
Moderate	Medium term decline of economic activity (12 months or more) or government revenues from industries. Impairment of an industry and/or damage to an asset that requires State Government financial assistance resulting in medium term (12 months or more). The recovery from loss of essential infrastructure is simple but requires financial assistance beyond the allocated budget.	A fatality and several critical injuries (e.g. those with an injury that requires immediate treatment and could be potentially life threatening) requiring local hospitalisation	The community's social connectedness is broken, such that the community requires significant external resources to return to functioning effectively with some permanent dispersal. Permanent damage to some objects of cultural significance, impacts beyond cultural and emotional capacity in some parts of the community.	Minor damage to ecosystems or species recognised at a state level. Significant loss or impairment of an ecosystem or species recognised at a local or regional level. Significant damage to environmental values of interest



Consequence	Definition			
	Financial & Economic	Health and safety of people	Community and social	Environmental
Major	Longer term decline of economic activity (e.g. several years) or government revenues from industries. Significant structural adjustment of an industry and/or significant damage to an asset that requires Federal and State Government financial assistance.	Several fatalities with multiple critical injuries requiring immediate evacuation and hospitalisation. These injuries would include several imminent life-threatening injuries requiring time critical treatment.	The community's social connectedness is significantly broken, such that extraordinary external resources are required to return to functioning effectively, with significant permanent dispersal. Reduced quality of life within the community, significant loss or damage to most objects of cultural significance, impacts beyond cultural and emotional capacity in large parts of the community.	Minor damage to ecosystems or species recognised at a national level. Significant loss or impairment of an ecosystem or species recognised at the state level. Severe damage to or loss of an ecosystem or species recognised at a local or regional level Severe damage to environmental values of interest.
Catastrophic	Permanent decline of economic activity or government revenues from industries. Loss or failure of an industry and/or loss of asset as a direct result of emergency event that requires Federal and State Government financial assistance.	Multiple fatalities and critical injuries (life threatening or with significant irreversible effects) requiring evacuation to hospital and specialised care.	The community's social connectedness is irreparably broken, such that the community ceases to function effectively, breaks down and disperse in its entirety. Widespread loss of objects of cultural significance, impacts beyond cultural and emotional capacity across all parts of the community.	Permanent destruction of an ecosystem or species recognised at the local, regional, state or national level. Severe damage or loss of an ecosystem or species recognised at state and national level. Significant loss or impairment of an ecosystem or species at the national level. Permanent destruction of environmental values of interest.

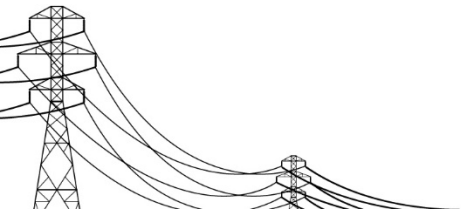
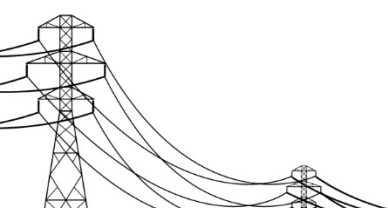


Table 17-3 Overall risk rating

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	High

Risks are prioritised according to the overall risk rating. Where a rating of low or medium is received, the risk can generally be accepted and monitored with minor mitigation measures. Hazards with an overall risk rating of extreme or high require additional mitigation measures that must be prioritised for implementation to reduce the level of risk to as low as reasonably practicable. Project hazards with an overall risk rating of high or extreme were subject to a detailed risk analysis (refer to section 17.4.2)



17.3 Existing environment

17.3.1 Land

17.3.1.1 Land use

The Project area is expected to directly impact on 130 land parcels, which are mainly freehold and leasehold. Additional land parcels will be impacted by the construction of access tracks. A list of properties directly impacted by the Project is included in Volume 3 Appendix F Real property descriptions of impacted land parcels. Sensitive receptors have been identified in section 17.3.8 of this report.

The predominant land uses on the impacted land parcels are rural grazing and cattle breeding. Other land uses include conservation and natural environments.

There are a number of small towns and regional cities within the corridor selection including:

- Charters Towers
- Pentland
- Torrens Creek
- Prairie
- Hughenden
- Richmond
- Maxwellton
- Julia Creek
- Cloncurry
- Mount Isa

The Project area also traverses five mining leases and includes end-user substations at Cannington Mine, Phosphate Hill Mine and Mount Isa Mines.

Detailed information regarding land use is presented in Volume 2 Chapter 5 Land.

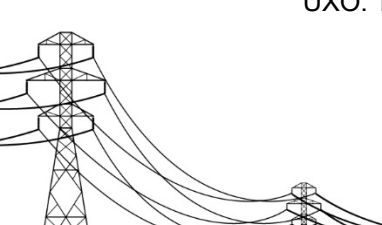
17.3.1.2 Contaminated land

There are no properties listed on the Contaminated Land Register within the corridor selection however the Environmental Management Register lists several properties that are at risk of becoming contaminated due to Notifiable Activities. Notifiable Activities are defined in the *Environmental Protection Act 1994* as activities that have the potential to cause land contamination, such as service stations, cattle dips, tanneries, wood treatment sites, landfills, fuel storage and refuse tips.

A list of properties on the Environmental Management Register is included in Table 5-9 in Volume 2 Chapter 5 Land.

Unexploded ordnance (UXO) are ammunitions such as artillery shells, mortar bombs and grenades that have not exploded when used. UXO pose a risk to health and safety as they may detonate if disturbed and may also release hazardous chemicals into the environment. UXO are mainly found in Queensland on land formerly used by Australian and Allied Defence Forces for live firing of explosive ordnance, particularly during World War II.

Seven properties within the corridor selection have been identified as potentially containing UXO. These properties are located east of Charters Towers.



17.3.2 Watercourse and infrastructure crossings

The corridor selection crosses a range of watercourses and existing infrastructure as summarised in Table 17-4.

Table 17-4 Watercourse and infrastructure crossings

Infrastructure	Number of crossings
Road crossings	
State-controlled roads	14
Local government roads	35
Railway crossings	
Railway crossings	3
Transmission line crossings (not including SWER lines)	
220 kV	4
66 kV	8
33 kV	2
19.1 kV	29
11 kV	2
Pipeline crossings	
Gas pipeline crossings	2
Watercourse crossing	
Total watercourse crossings	62
Major watercourse crossings	29

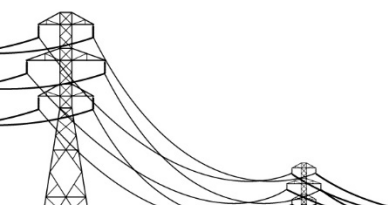
Rivers that require crossing are included in Figure 17-1 and are listed below:

- Burdekin River
- Campaspe River
- Cape River
- Gilliat River
- Fullarton River
- Williams River
- Cloncurry River
- Corella River.

Watercourse and waterway crossings are defined in Volume 2 Chapter 9 Water resources and water quality.

A summary of rail and road corridor crossings is provided in Volume 3 Appendix G Intersecting road and rail infrastructure crossings.

No new rail crossings are proposed for the access tracks. Where access tracks are required to cross a railway line, existing operational crossings will be utilised.



17.3.3 Project related access and transport

Major roads are an important means of access to the transmission line easement for construction and maintenance activities. They are also a constraint to cross when constructing a transmission line because of the need to maintain the use of the road and to protect the users of the road during construction.

It is expected that there will be an increase of traffic on highways and local roads during the construction phase of the Project. It is envisaged that transmission tower steel and components will be transported from Townsville to construction lay-down areas by Type 2 road trains along the Flinders or Barkly Highways or by rail along the Mount Isa Rail Line.

Transportation of over mass and over dimension loads, such as construction machinery and specialised equipment, will be transported from the Port of Townsville on low loaders with escort vehicles.

Hazardous substances will be transported by road from Townsville via the Flinders and Barkly Highways and local roads. An inventory of hazardous substances that are likely to be used for the Project, including their quantities, is included in Table 17-21.

Concrete used in tower and substation foundations will be supplied to the construction sites for each construction zone from several existing or mobile concrete batching plants.

The construction workforce will be deployed on a fly-in fly-out (FIFO) or bus-in bus-out (BIBO) basis, with Townsville as the FIFO/BIBO hub servicing the construction camps at Woodstock, Charters Towers and Pentland, via chartered buses, and Hughenden, Richmond, Julia Creek, Cloncurry, Mount Isa and Selwyn Substation via chartered flights.

There will be light vehicle movements at the construction camps, including food transport, linen laundering, fuel supplies, waste management contractors and maintenance servicemen. Transport of workforce personnel from construction camps to worksites will be via a mixed fleet of 4WD vehicles, buses or other transport modes. Standard contractor training will include the safe use of 4WD vehicles. Private construction worker vehicles will not be permitted to access the transmission line easement unless there is an overwhelming need.

Most watercourses along the corridor selection flow intermittently or are ephemeral. As construction works in these areas are generally programmed for the dry season, it is expected that most watercourses will be dry when crossed. Where this is not the case, and for larger water crossings, the access to transmission tower sites will use only existing crossings and no new watercourse crossings will be constructed, unless for safety reasons.

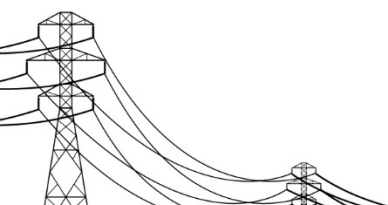
During operational and maintenance phases of the Project, helicopters will be used during the wet season in circumstances where there are road closures limiting access to infrastructure or where there are faults on the transmission line.

Where riparian zones contain vegetation that is at risk of significant disturbance from manual line stringing, conductor draw lines and optical ground wire (OPGW) stringing activities will be performed with helicopters.

17.3.4 Topography, geology and soils

17.3.4.1 Topography

The corridor selection traverses six different bioregions, that are characterised by broad, landscape-scale natural features and environmental processes that influence the functions of ecosystems. Topography in the corridor selection is highly complex. Landforms range from the undulating granite country in the Einasleigh Uplands in the east, to flat, gently undulating plains



crossed by braided channels in the Gulf Plain. Further west, the Northwest Highlands contains sharp ridges and rocky outcrops.

17.3.4.2 Geology

Geology across the corridor selection is highly complex and has been described in Volume 2 Chapter 6 Geology and soils.

Geology ranges from granite and volcanic rocks in the Einasleigh Uplands region to alluvial and colluvial plains associated with large river systems, south-east of Charters Towers.

The Gulf Plains comprises sedimentary rocks, including relatively young sandstone, muddy sandstone and limestone that formed within a vast marine basin.

The Northwest Highlands contains complex geology with relatively low, steep-sided ridges and hills comprising metamorphic rocks intruded by mafic to felsic igneous rocks. Flat land between the ridges may comprise ancient colluvium, intermixed clay, sand, gravel and cobbles, partially reworked by river action.

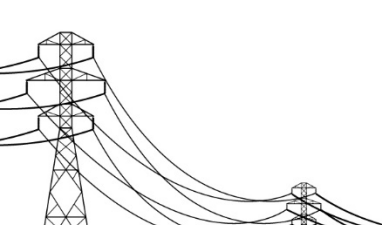
Faulting has been mapped (Geological Survey of Queensland - 1:250,000 Geological Mapping) in areas of basement rock outcrop, particularly in the Northwest Highlands and Einasleigh Uplands areas. Whilst potential for seismic activity in this region is documented as a rare event, any movement is likely to be concentrated around major, regional faults.

Further information regarding faulting is included in Volume 2 Chapter 6 Geology and soils.

17.3.4.3 Soils

A variety of soil types are present across the corridor selection and are detailed in Volume 2 Chapter 6 Geology and soils. Soil erodibility is variable and is based on physical and chemical properties of the soils. Sodic and dispersive soils found in the Einasleigh Uplands and Gulf Plains bioregions are highly prone to water erosion and substantial areas of sheet, rill and gully erosion have been identified in these areas.

Gully erosion is particularly widespread throughout the Einasleigh Uplands, with gully depths of generally one metre or less, due to shallow bedrock. Aerial imagery has shown that extensive rill and gully networks radiate from river anabranches in the Gulf Plains and gully and incised networks can also be found along the steep sides of plateaux and ridge escarpments in the Northwest Highlands.



17.3.5 Climate

17.3.5.1 Climatic zones

The areas traversed by the corridor selection experience a range of climatic conditions that can be defined according to the following three climatic zones:

- Coastal lowlands
- Great Dividing Range
- The inland zone, consisting of:
 - Flinders River Catchment
 - Mount Isa zone.

These zones have been defined to assist in the description of the climatic conditions that may affect the management of the Project and generally complement the bioregions traversed by the corridor selection and are further described in Volume 1 Chapter 3 Site description and climate.

Coastal lowlands

This climatic zone lies between the Woodstock Substation in the east and the Great Dividing Range. The climate in this zone is characterised by data from the Townsville Aero monitoring station and the Ayr Department of Primary Industries Research Centre.

The coastal lowlands experience a tropical climate, typified by monsoonal summers that are generally hot, wet and humid with afternoon sea breezes. Southeast trade winds characterise the winter months with fine weather and relatively cooler nights.

On average, the coastal lowlands receive approximately 1,000 mm of rainfall with most falling in summer months. The coastal lowlands zone is likely to be affected by more intense storms and tropical cyclone events, which may lead to localised flooding, storm surges or damage to infrastructure.

Great Dividing Range

Westward from the coastal lowlands the corridor selection rises and crosses the Great Dividing Range. The influence of the elevated range on climate is characterised by data from the Woolshed and Charters Towers Airport monitoring stations. The western margin of the range is represented by the Hughenden Airport monitoring data.

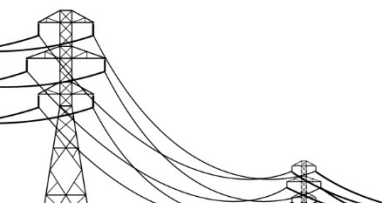
This area is very similar to the coastal lowlands although the elevation (>500 m at the Woolshed monitoring site) results in reduced temperature, and higher relative humidity averages.

Inland zone

The inland zone can be further divided into the Flinders River Catchment and the Mount Isa zones.

The Flinders River Catchment is characterised by undulating plains within the Flinders River Catchment, and may experience seasonal flooding. Climatic conditions are determined by monitoring conducted at Hughenden Airport in the east, Richmond Post Office and Julia Creek Airport in the middle section, and Cloncurry Airport in the west.

Generally the inland sections are characterised by hotter maximum temperatures, lower relative humidity and reduced rainfall comparative to the coastal lowlands. During summer months the temperature can exceed 40 degrees on a number of days.



This Mount Isa zone commences west of Cloncurry and extends across the remainder of the corridor selection from Dajarra Road Substation to Mount Isa. The climate data is represented by the monitoring records from the Mount Isa Aero monitoring station.

The Mount Isa zone has a higher elevation than the Flinders River Catchment, which tends to slightly reduce maximum temperatures. The Mount Isa zone consists of rugged hills and undulating valleys.

The wet season in the inland zones usually brings 75 percent of the annual rainfall however annual rainfall can vary significantly, with less than 250 mm in one year and greater than 500 mm the following year.

High evaporation rates or a failure of the wet season in the inland zones may cause severe strain on the available surface water supplies and may lead to fires, dust and general land degradation. Subsequent summer rains lead to soil erosion and, in severe events, localised or widespread flooding.

17.3.5.2 Climate extremes and natural hazards

Seasonal conditions and climate extremes constitute natural hazards that may impact on the Project. Climatic extremes and natural hazards that are experienced in the climate zones identified for the Project include extended periods of extreme temperatures, drought, storm events, cyclones, flooding, bushfire, and, to a lesser extent, earthquakes. Climate extremes and natural hazards are summarised in the following sections.

Drought

Drought is defined as consecutive years of below average rainfall. Within the Project area significant years of drought have included periods between:

- 1985 – 1989
- 1992 – 1996
- 2001 – 2006
- 2013 – 2019.

There are records of longer periods where below average rainfall was recorded, and although not every one of these years is dry there was a drying trend across these years. Periods of drought are typically associated with increased evaporation (especially during summer months). The inland climatic zone exhibits high rainfall variability and with approximately 75 percent of the rainfall falling in the summer, a wet season failure can result in severe water shortages.

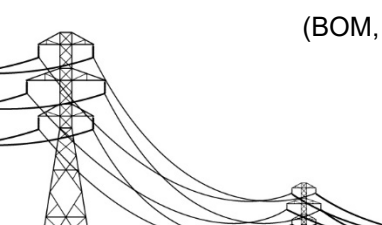
Storm events

Storms may be expected in the Project area between October and April. These events can bring heavy rain, locally strong winds, hail and lightning. There is some risk to the Project infrastructure and operational or construction activities from storm events.

Additionally, storm events may result in short term localised flooding along access tracks and construction areas including temporary construction camps.

Lightning

Lightning is a natural hazard that could impact Project infrastructure, particularly transmission line infrastructure once constructed. It is also a hazard to construction and operational/maintenance workers and others outdoors. Thunder is the sound caused by the electrical discharge of lightning, therefore thunderstorms are always associated with lightning (BOM, 2020). Thunderstorm data recorded from weather stations between 1990 and 1999



indicate there is a higher risk of lightning activity in the Mount Isa zone, with an annual average of 40-50 thunderstorm days, compared to the Coastal Lowlands zone, which had an annual average of 15-20 thunderstorm days.

Cyclones

Tropical cyclones are low pressure systems that form over warm tropical waters, typically when the sea surface temperature is above 26.5 degrees. Tropical cyclones can bring destructive winds, heavy rainfall and storm surges. The Australian cyclone season officially runs from November to April. Reliable tropical cyclone data has been recorded since the 1970s and shows that on average around 11 cyclones form in the Australian region each season. Not all cyclones cross the coast.

Risks associated with tropical cyclones are greatest in coastal areas, as cyclones quickly degrade into rain depressions after crossing the coast and winds become less destructive. However the impacts of cyclones can be experienced deep into the interior of Queensland, as the rains associated with cyclones can result in significant widespread flooding, which can isolate communities for extended periods. Much of the Project area experienced such an event in late January and early February 2019. During this event tropical low TL-13U was the principal system associated with a long-lived and disastrous monsoon event that brought unprecedented rainfall and flooding to parts of north-west Queensland and Townsville (BOM, 2020a).

Storm surges are not a risk for the Project as the nearest site of Project infrastructure (Woodstock Substation) is located approximately 50 km from the coast.

Floods

The corridor selection traverses several large catchment areas and crosses at least 35 major waterways that drain a portion of these catchment areas. The five major river systems and associated catchments include:

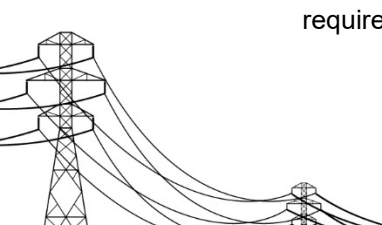
- Burdekin River
- Flinders River
- Cooper Creek
- Leichhardt River
- Georgina River.

The inland zone of the CopperString selection (between the Great Dividing Range and Mount Isa) is predominantly flat with wide floodplains. The corridor selection traverses approximately 185 km of floodplain. Transmission towers will be constructed across this zone at a spacing of 400 to 500 m, depending on topography and conductor clearance requirements.

The flat terrain in the inland zone tends to result in sheet flooding during significant rain events in the wet season. Floods may spread over thousands of square kilometres and last several weeks.

In the coastal areas east of the Great Dividing Range the riverine systems are shorter and stream flow is faster. Flood peaks are generally shorter although these can last several days. Localised flooding may occur during storms and cyclonic events (including storm surges). A number of flood mitigation works (such as dams) have occurred to reduce flood impacts on population centres.

Flash floods may occur on any stream or waterway, generally as a result of high intensity rainfall associated with a storm of defined rain event. These floods pose a localised hazard that requires site specific consideration.



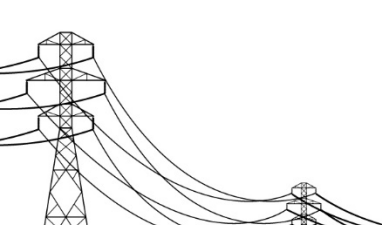
The potential for flooding within the Project area and flood plain management is further addressed in Volume 2 Chapter 9 Water resources and water quality.

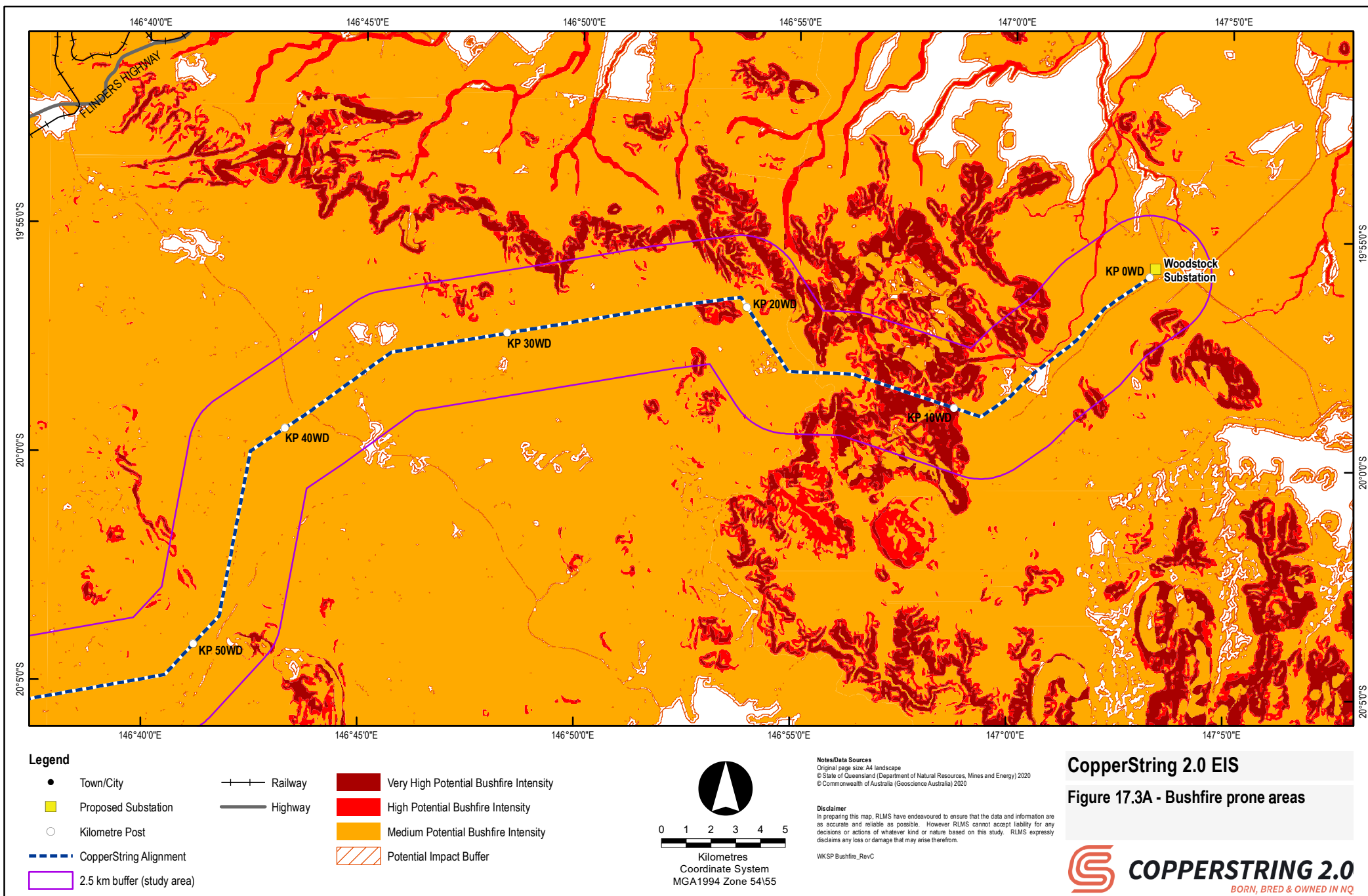
Bushfire

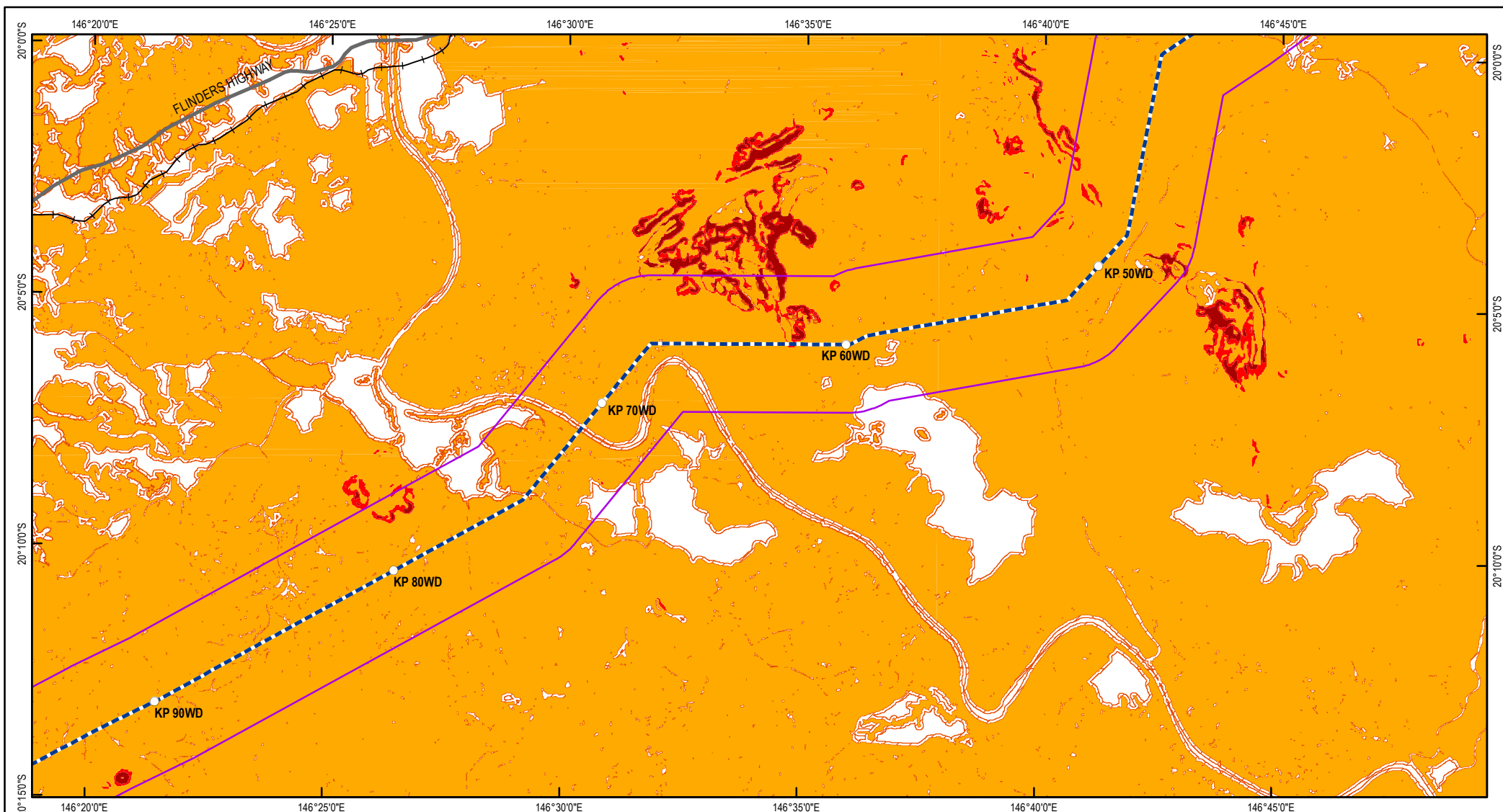
Bushfires can occur at any time of the year in Australia however the peak bushfire season for north Queensland is during the dry season, generally throughout winter and spring, when temperatures are higher and fuel loads are dry. Bushfire conditions are influenced by a combination of climate systems but in most cases are driven by hot, dry winds blowing from central Australia. The end of the fire season in north Queensland is determined by the onset of moister conditions, sometimes as the results of a tropical cyclone developing near the Queensland coast.

Bushfire prone areas are mapped by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in conjunction with the Queensland Fire and Emergency Services (QFES). Bushfire hazard is highest in the Renewable Energy Hub, Mount Isa Augmentation, Southern Connection and Cannington Connection sections of the corridor selection. The QSpatial Bushfire Prone Area (CSIRO 2015) indicates these sections are mostly mapped, as having a medium potential bushfire intensity, with some small areas of high and very-high potential bushfire intensity. The CopperString Core and Phosphate Hill Connection are generally not in bushfire prone areas; there are some small areas that are mapped as medium potential bushfire intensity however these are associated with riparian zones.

Identified bushfire prone areas are illustrated in Figure 17-3.

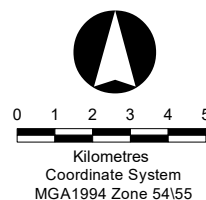






Legend

- | | | |
|----------------------------|---------------|--|
| ● Town/City | —+—+— Railway | Very High Potential Bushfire Intensity |
| ○ Kilometre Post | — Highway | High Potential Bushfire Intensity |
| --- CopperString Alignment | | Medium Potential Bushfire Intensity |
| 2.5 km buffer (study area) | | Potential Impact Buffer |



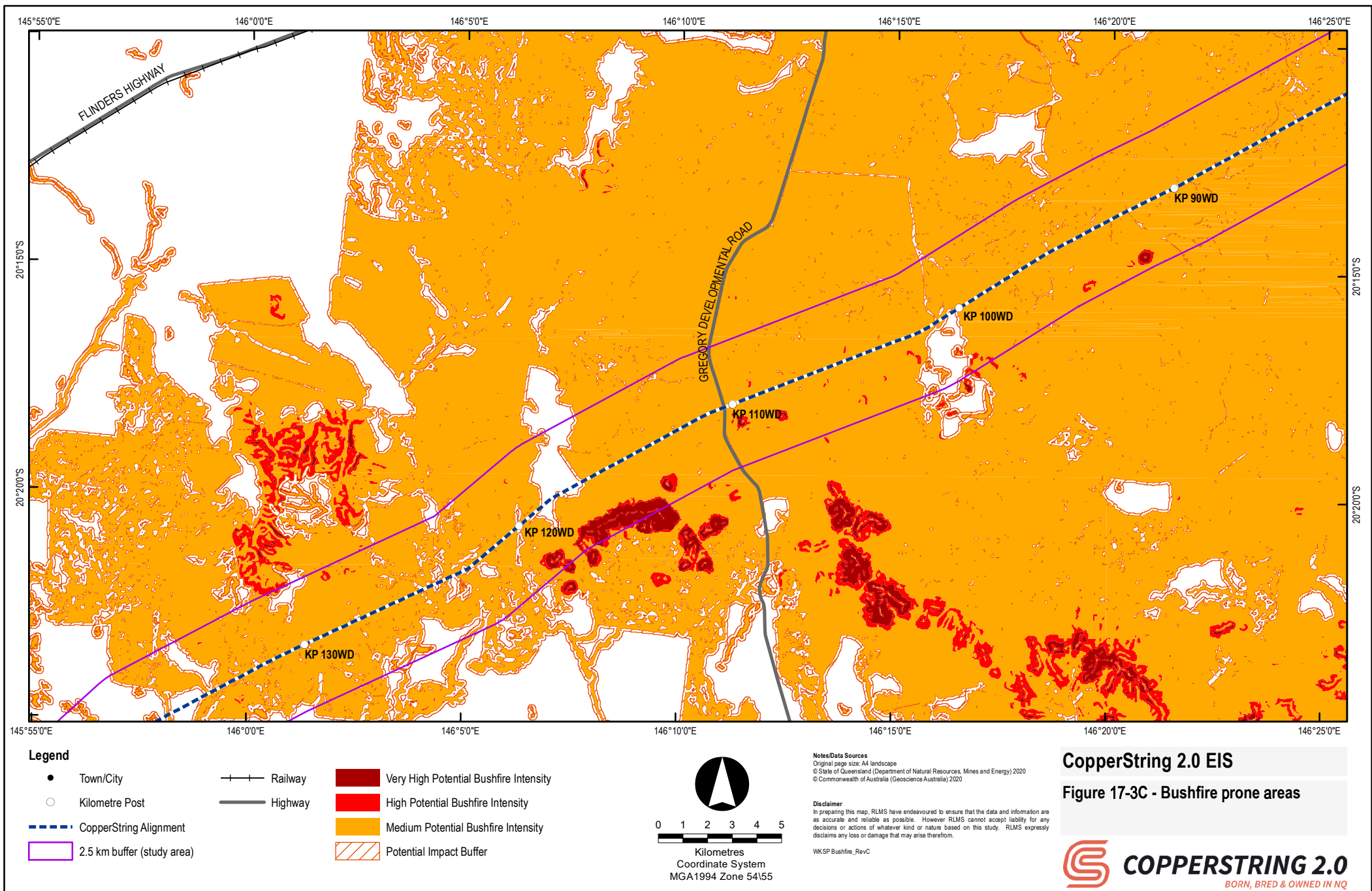
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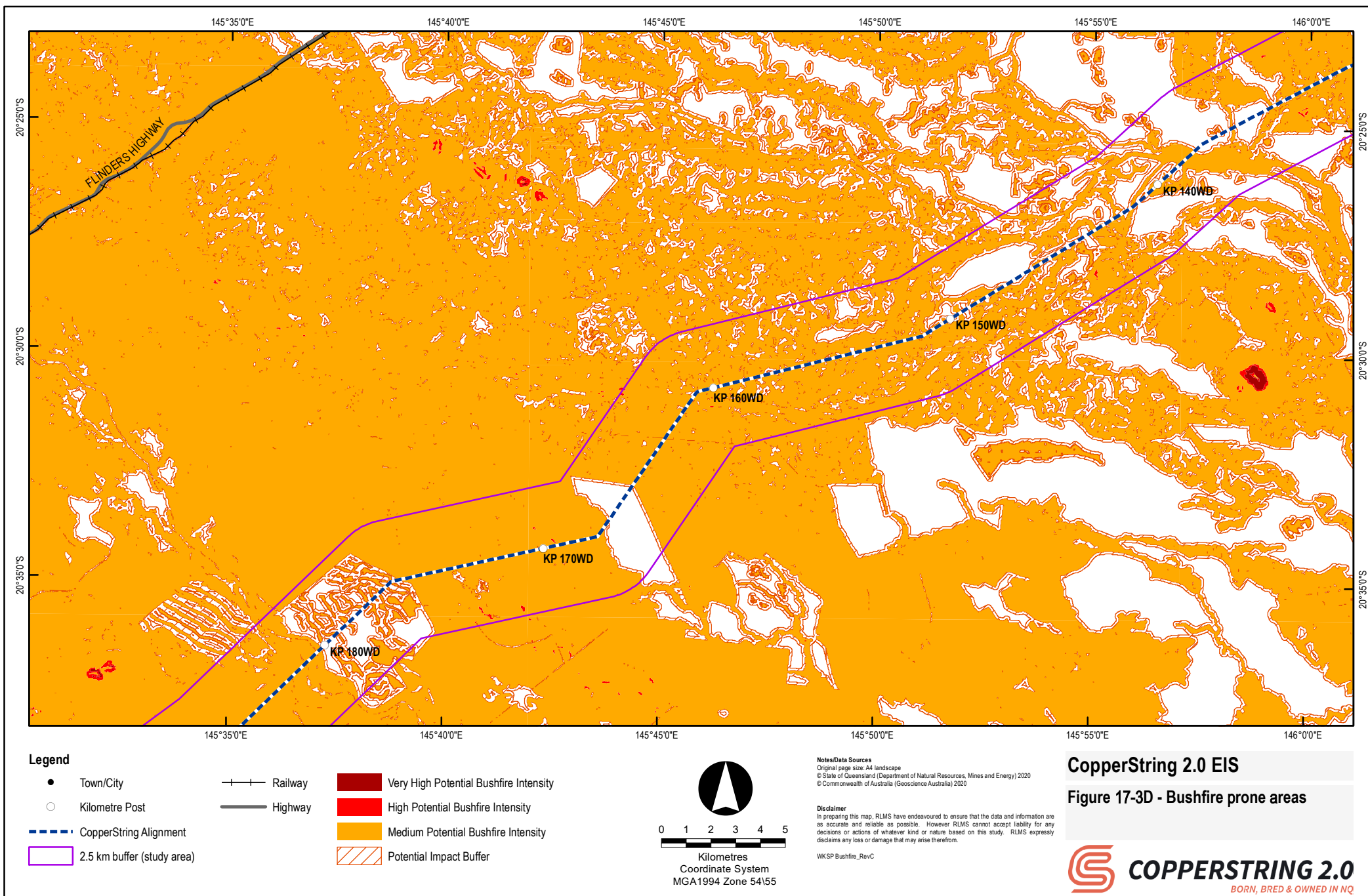
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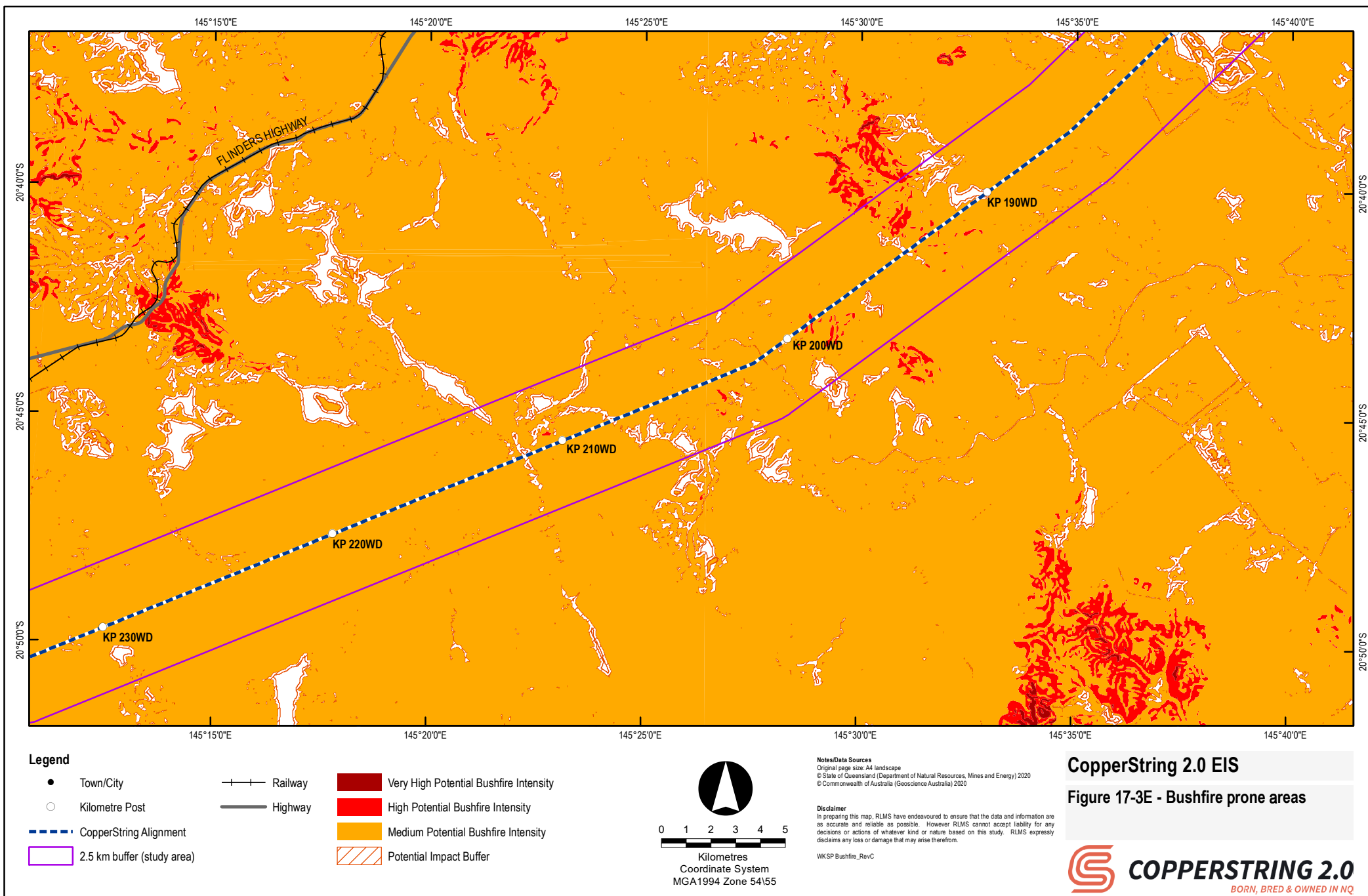
WKSP Bushfire_RevC

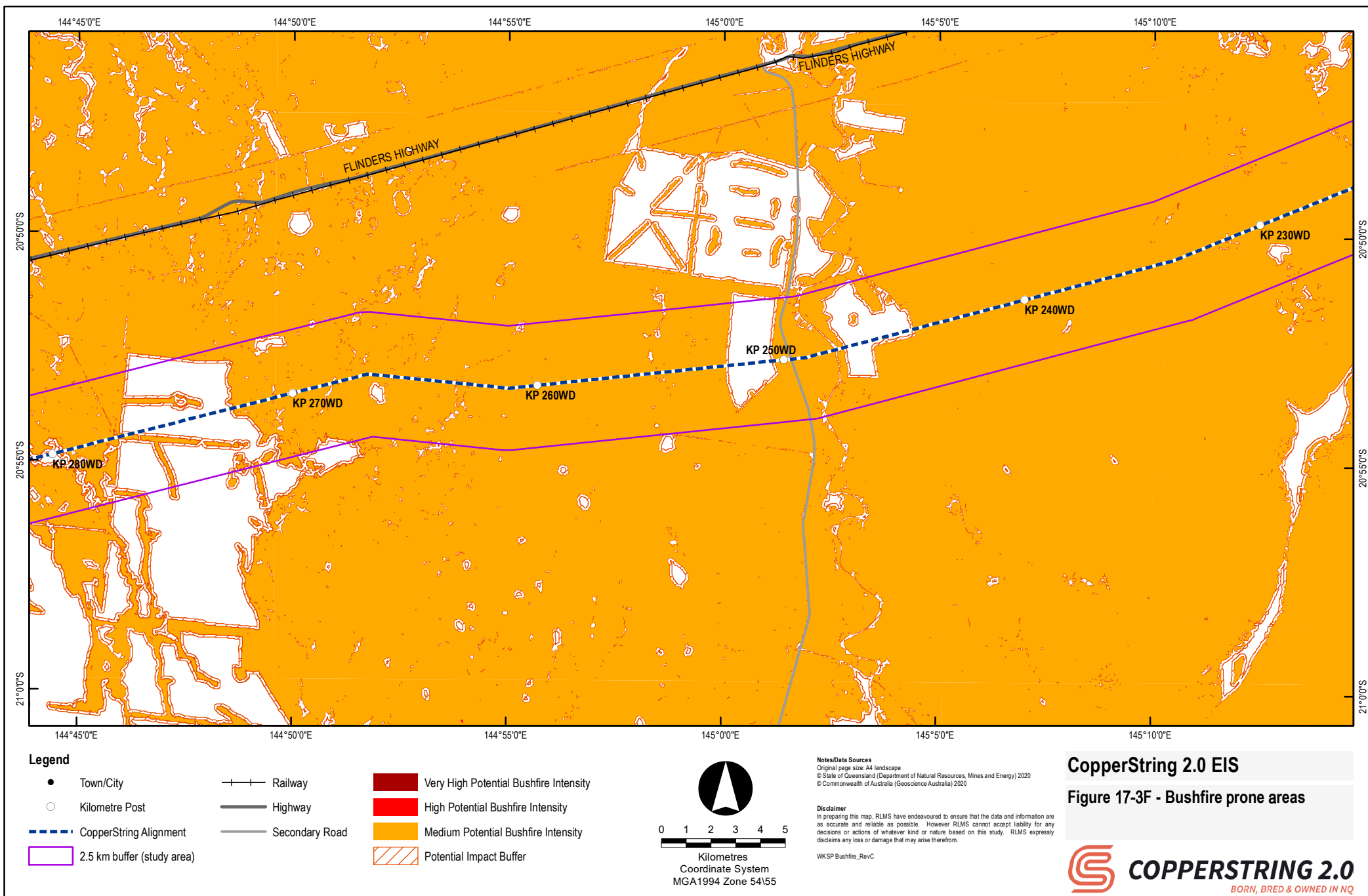
CopperString 2.0 EIS

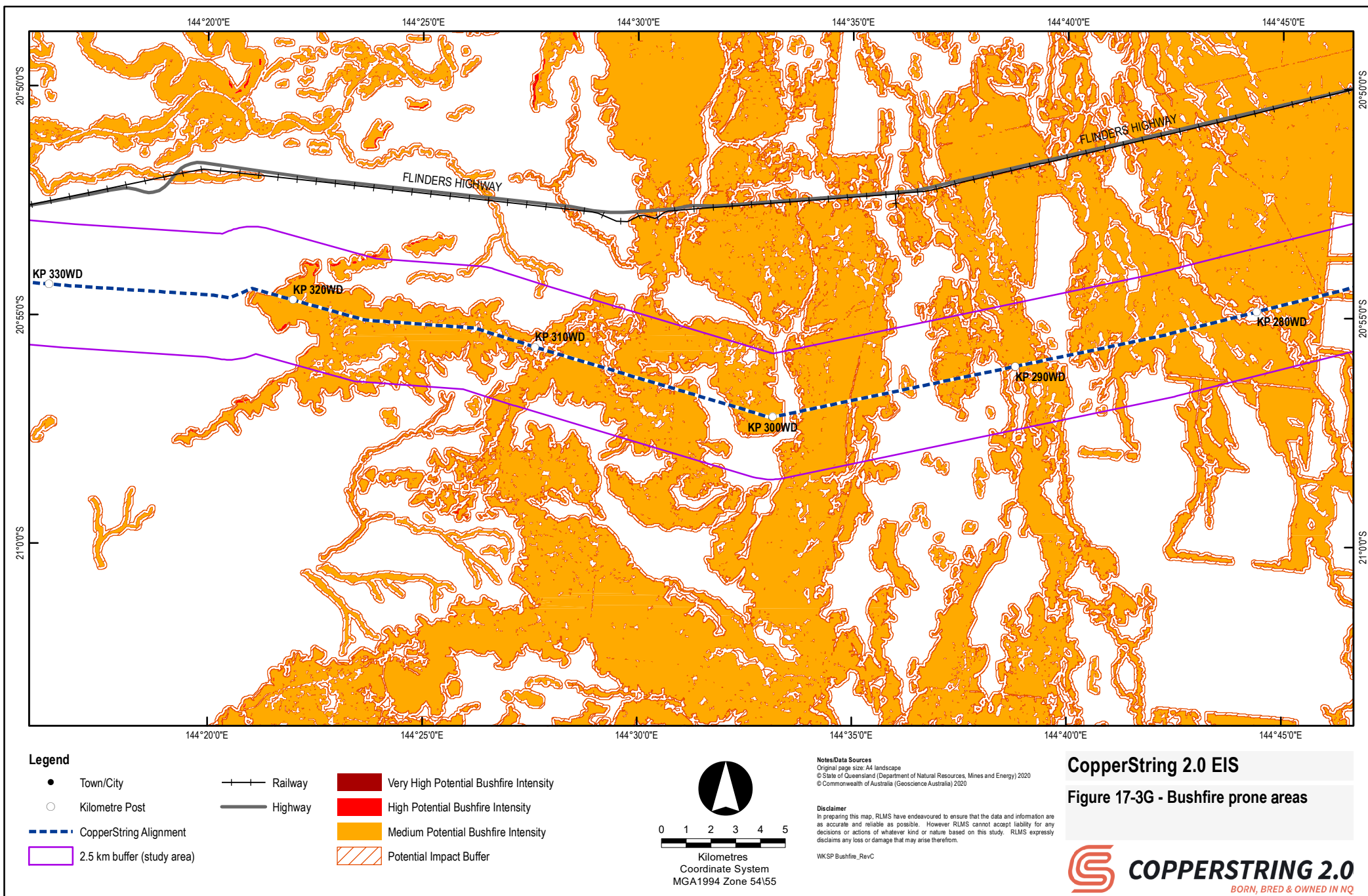
Figure 17-3B - Bushfire prone areas

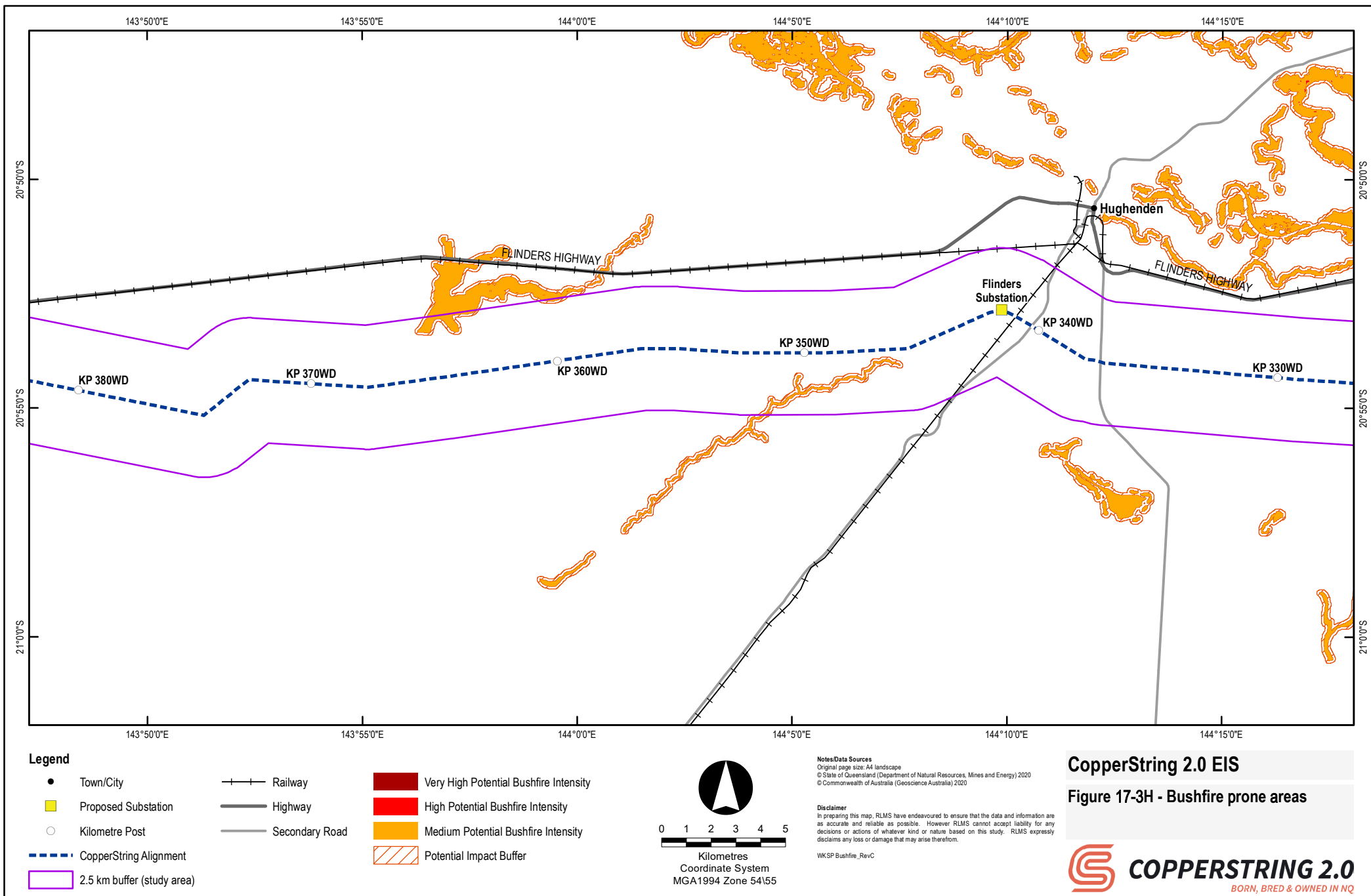


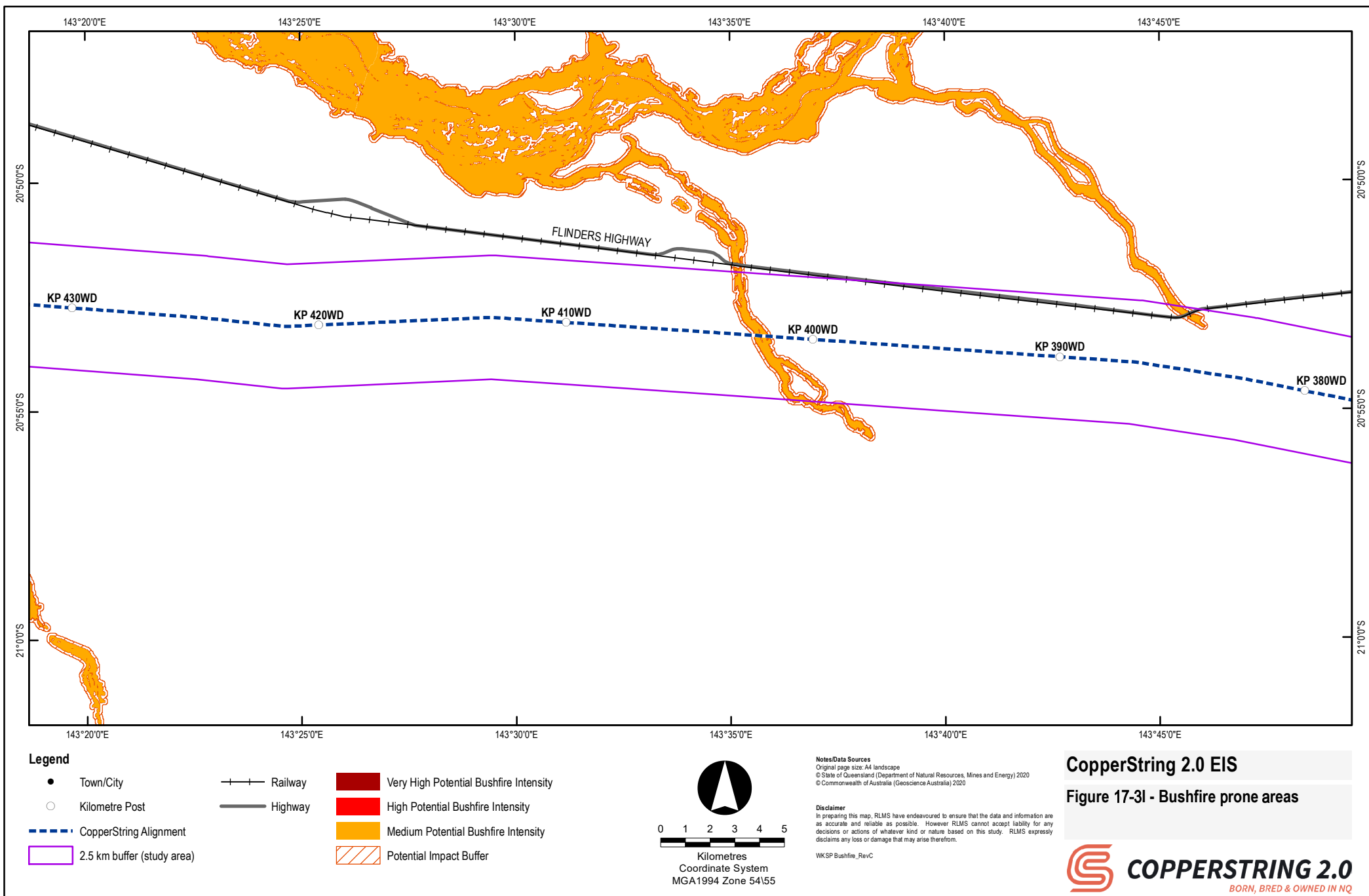


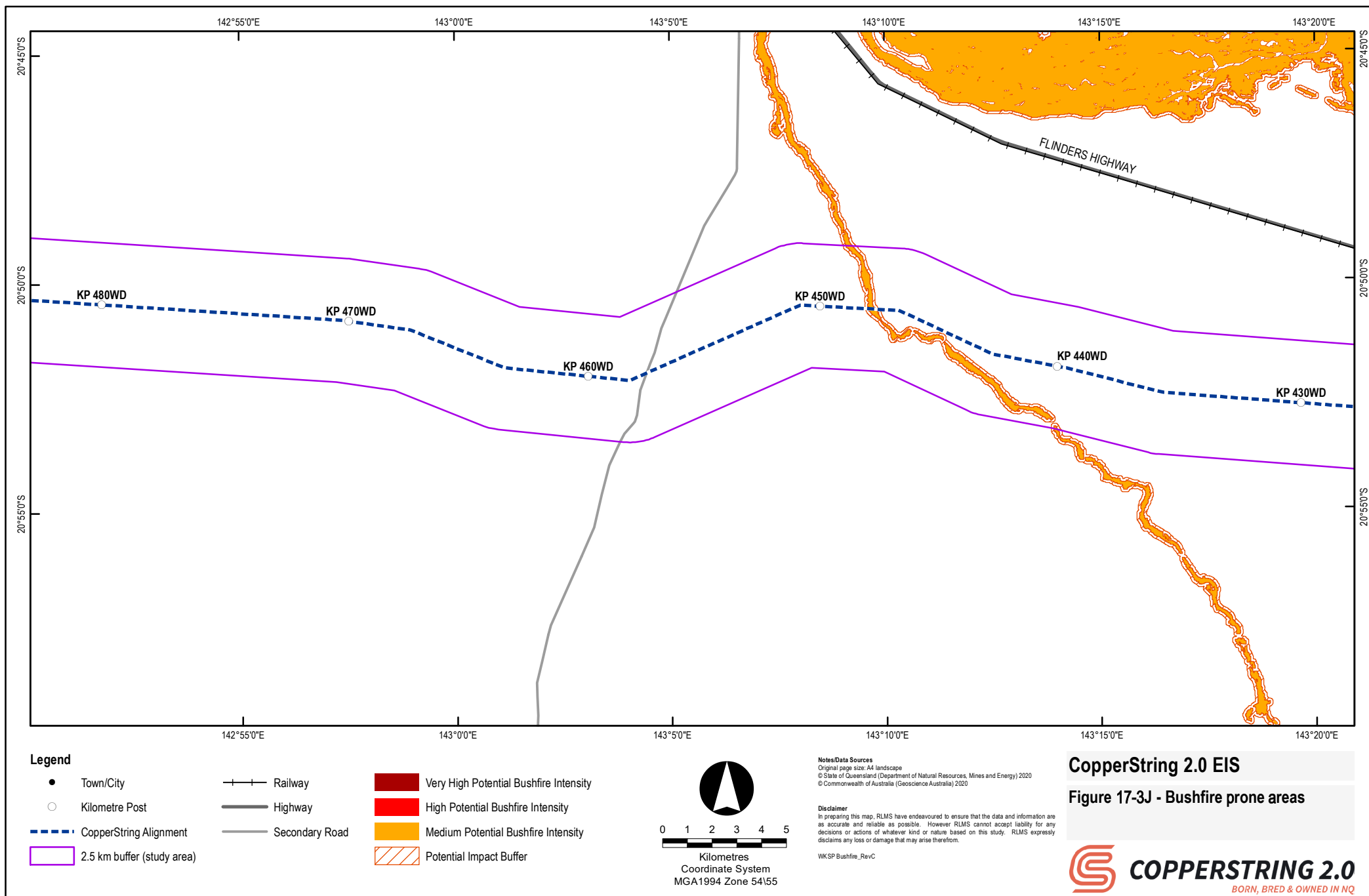


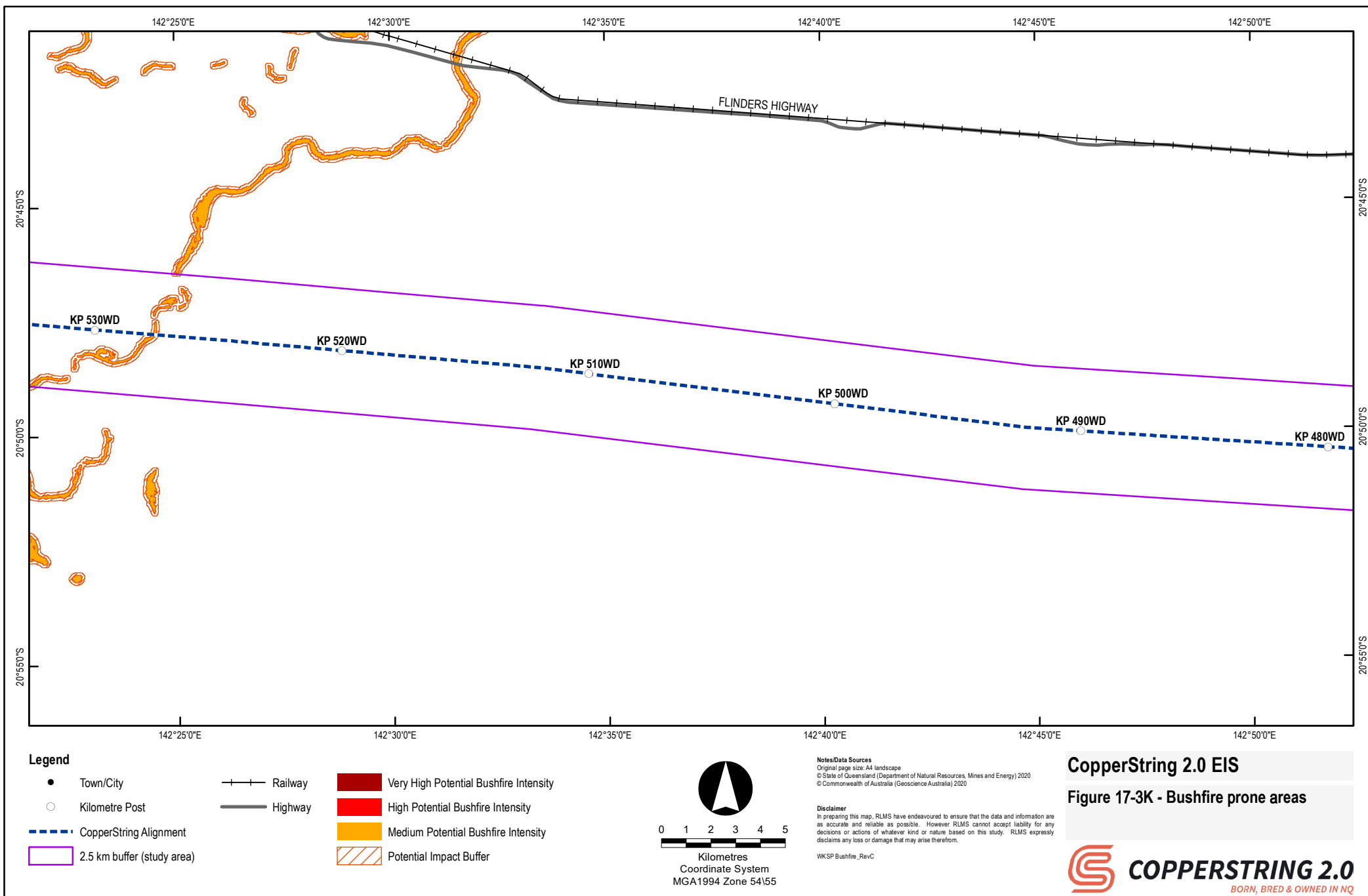


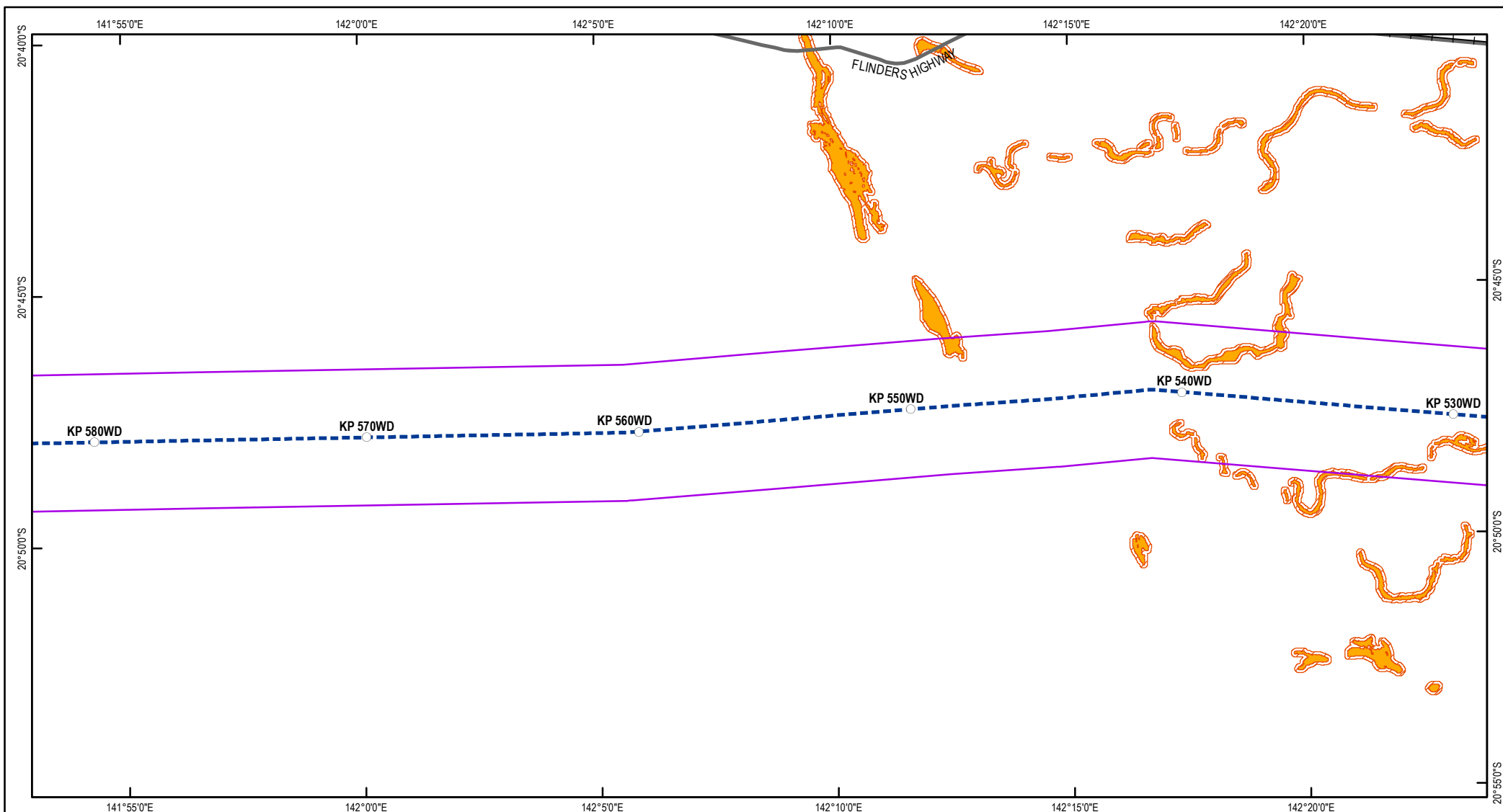






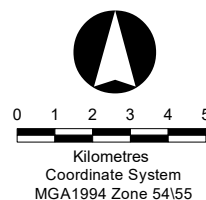






Legend

- Town/City
- Kilometre Post
- CopperString Alignment
- 2.5 km buffer (study area)
- Railway
- Highway
- Very High Potential Bushfire Intensity
- High Potential Bushfire Intensity
- Medium Potential Bushfire Intensity
- ▨ Potential Impact Buffer



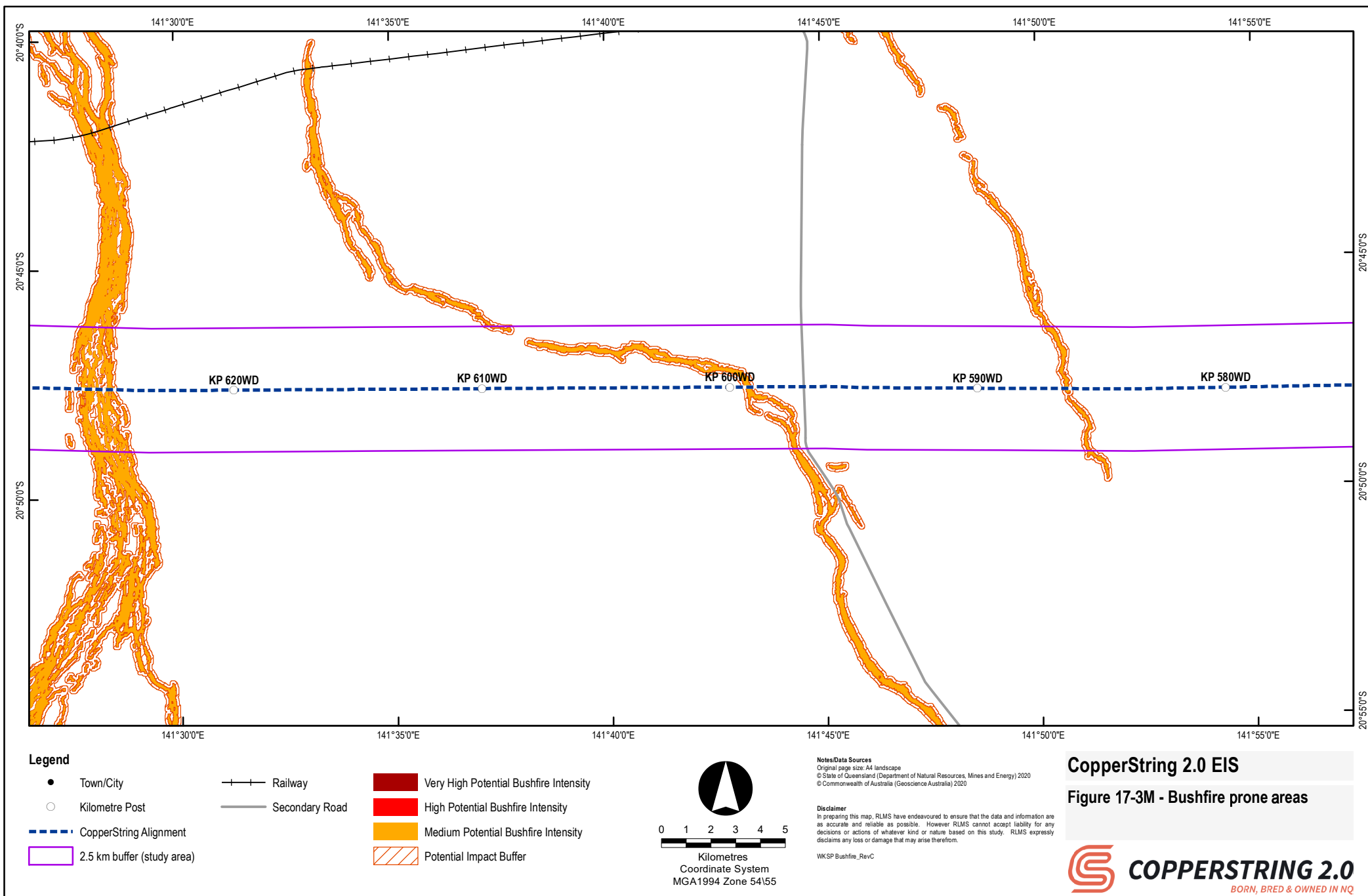
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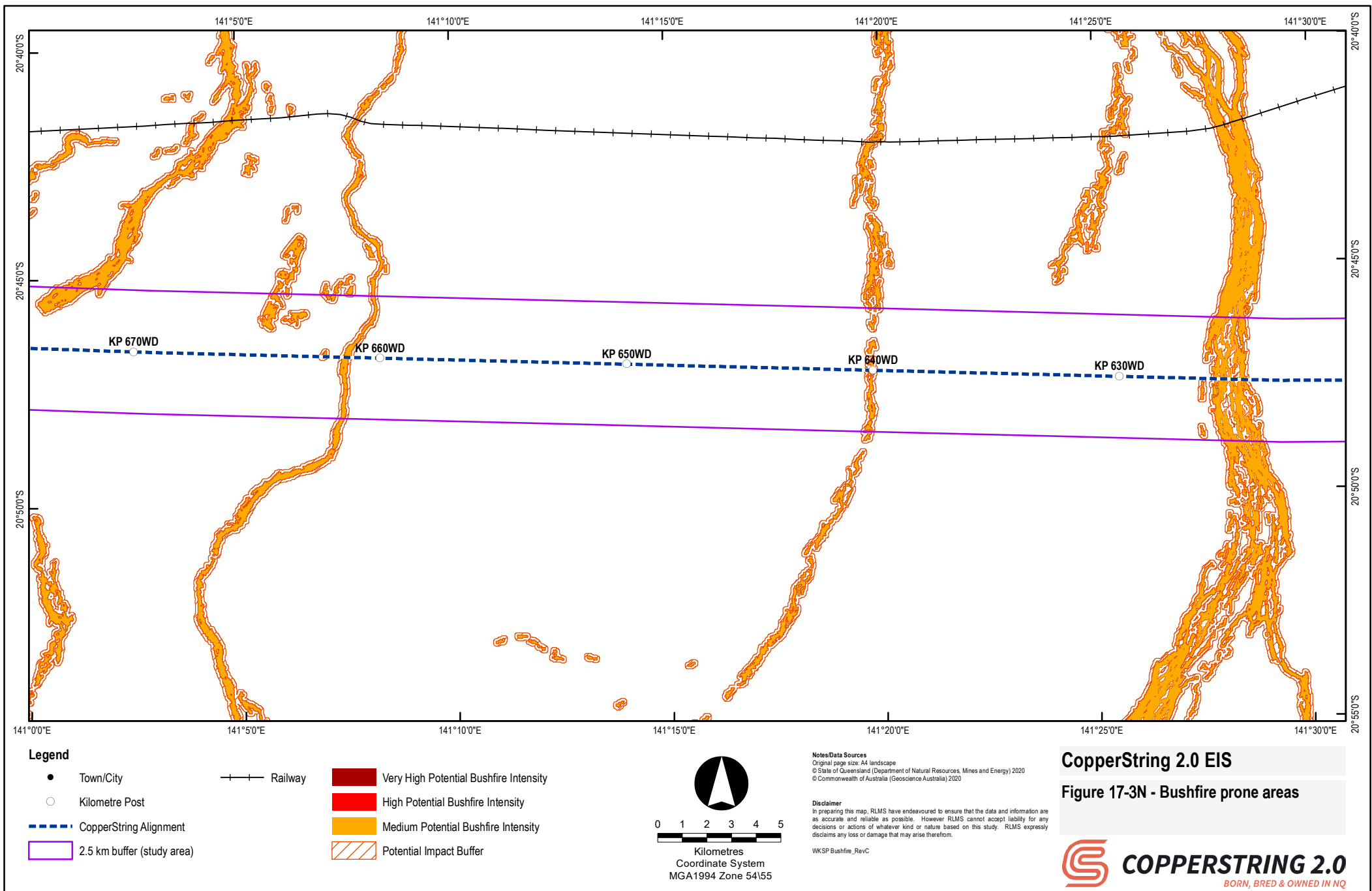
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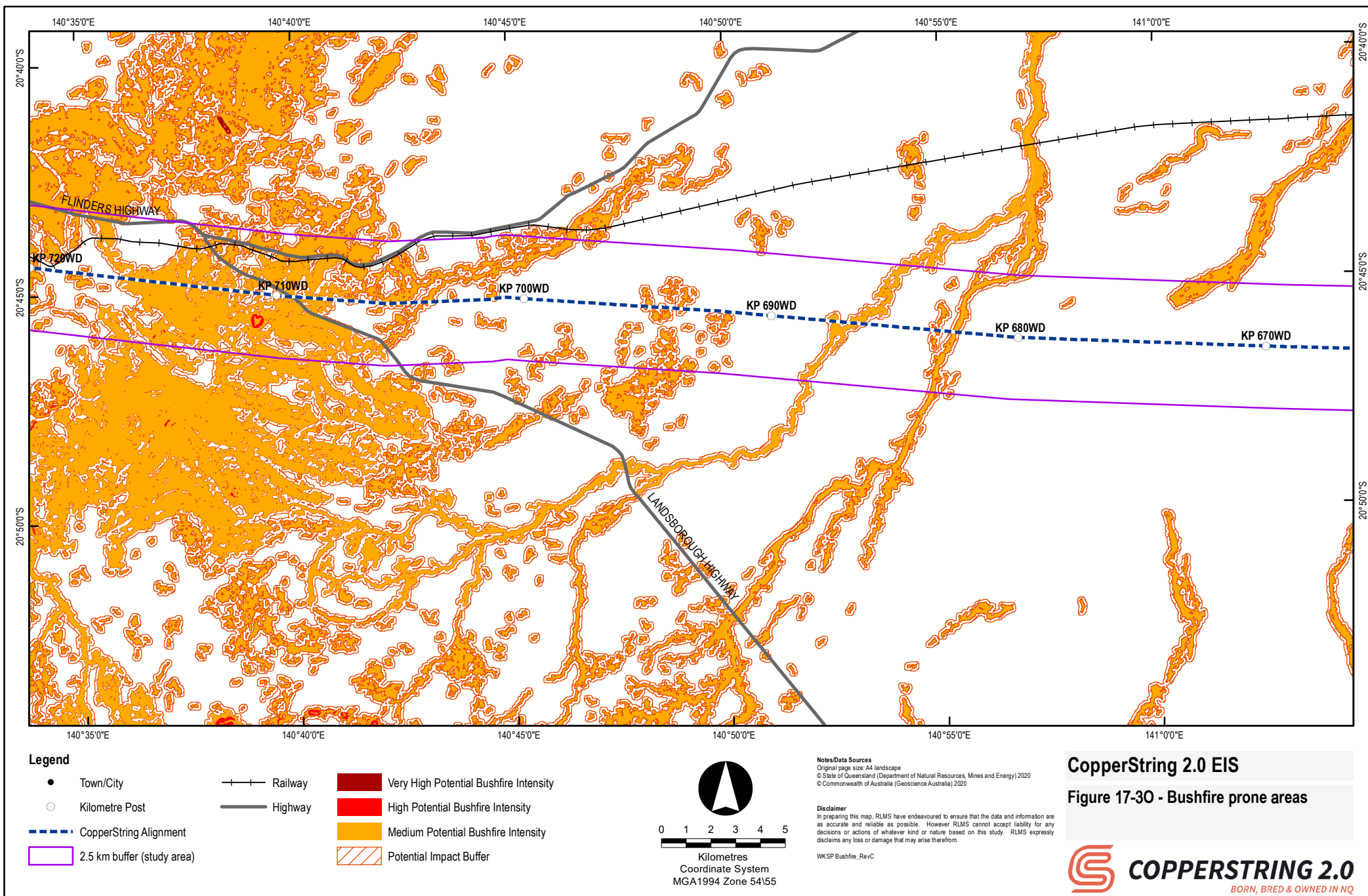
WKSP Bushfire_RevC

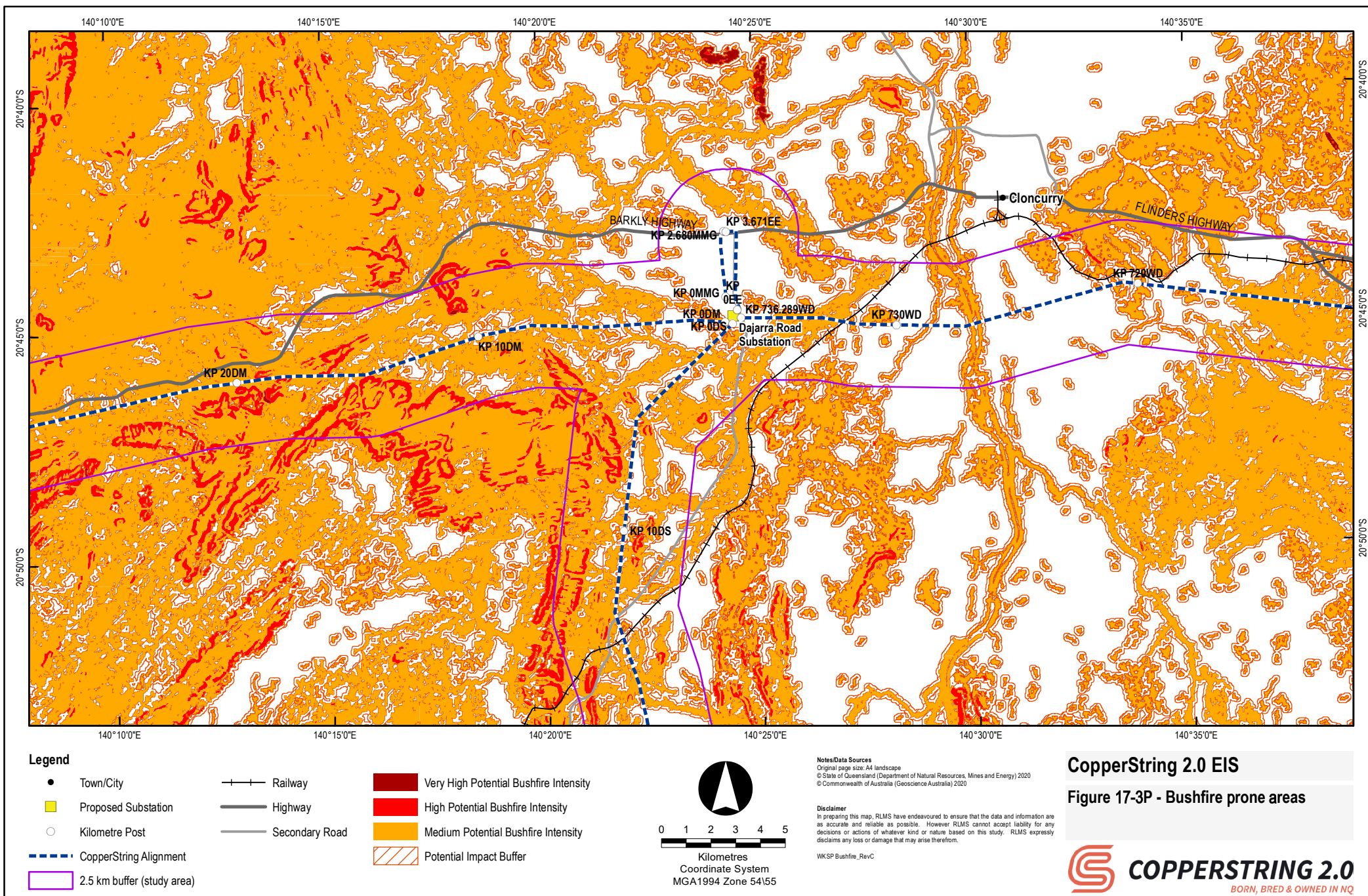
CopperString 2.0 EIS

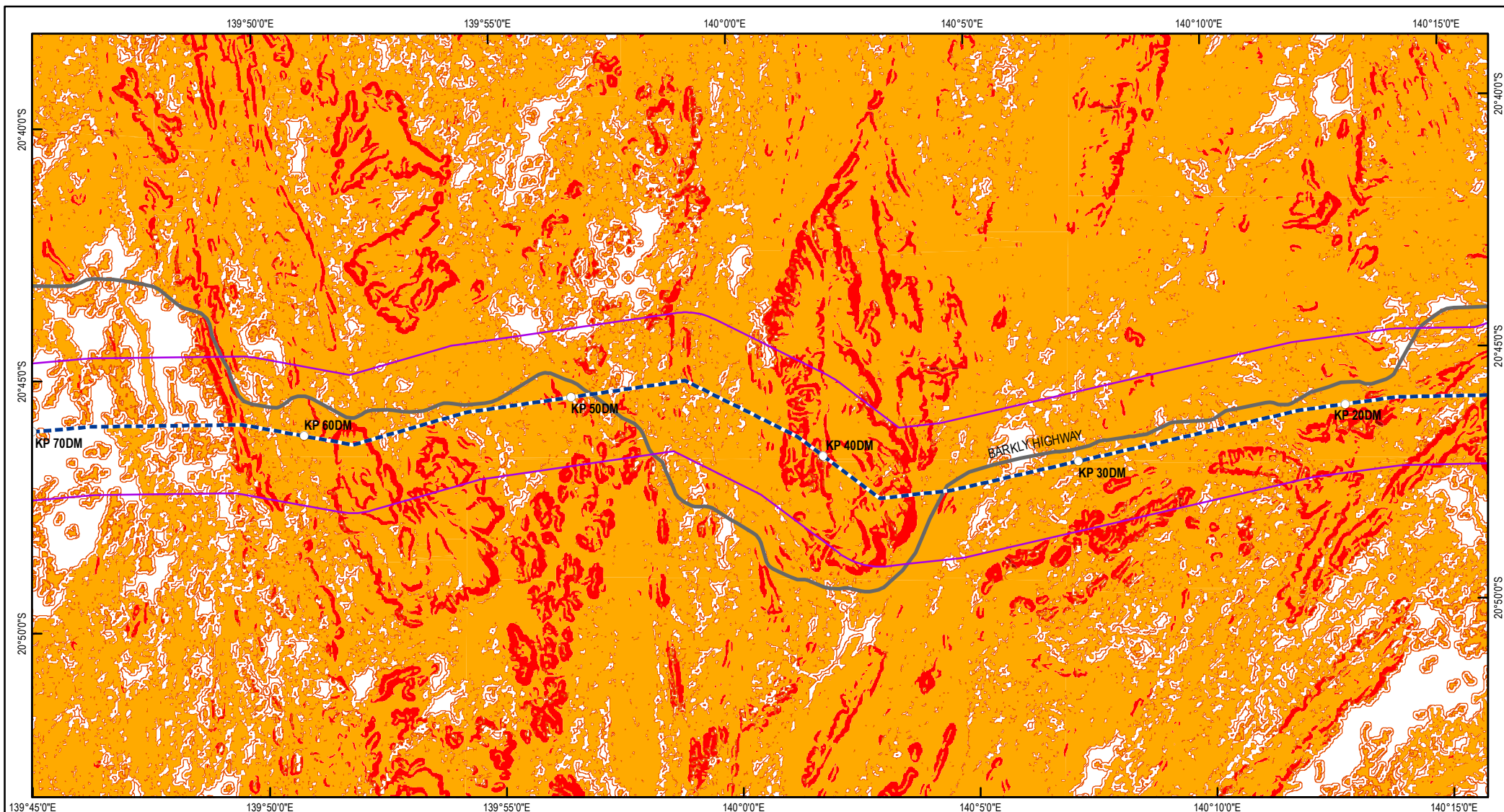
Figure 17.3L - Bushfire prone areas





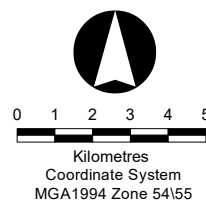






Legend

- Town/City
- Kilometre Post
- CopperString Alignment
- 2.5 km buffer (study area)
- Highway
- Very High Potential Bushfire Intensity
- High Potential Bushfire Intensity
- Medium Potential Bushfire Intensity
- ▨ Potential Impact Buffer



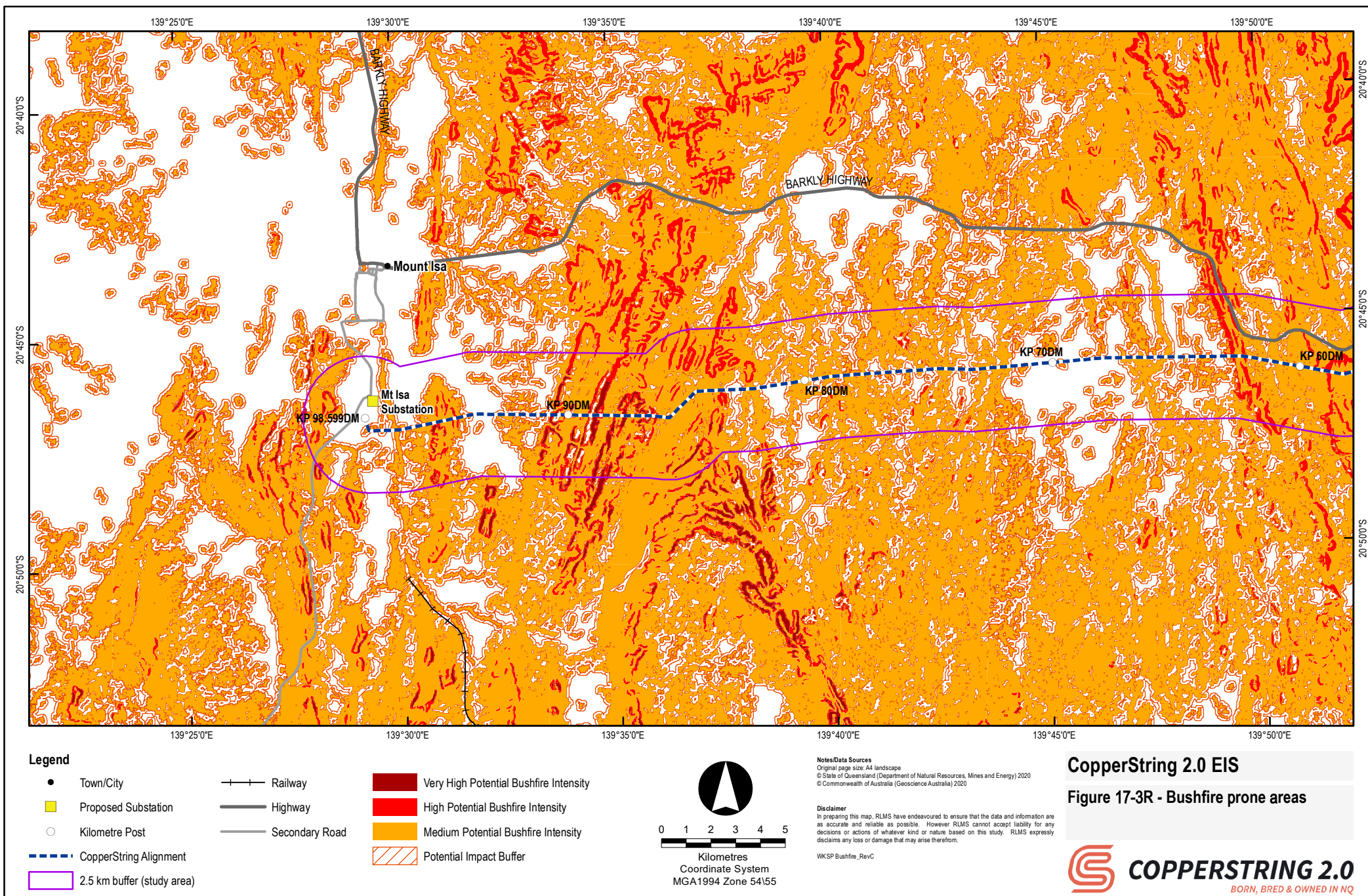
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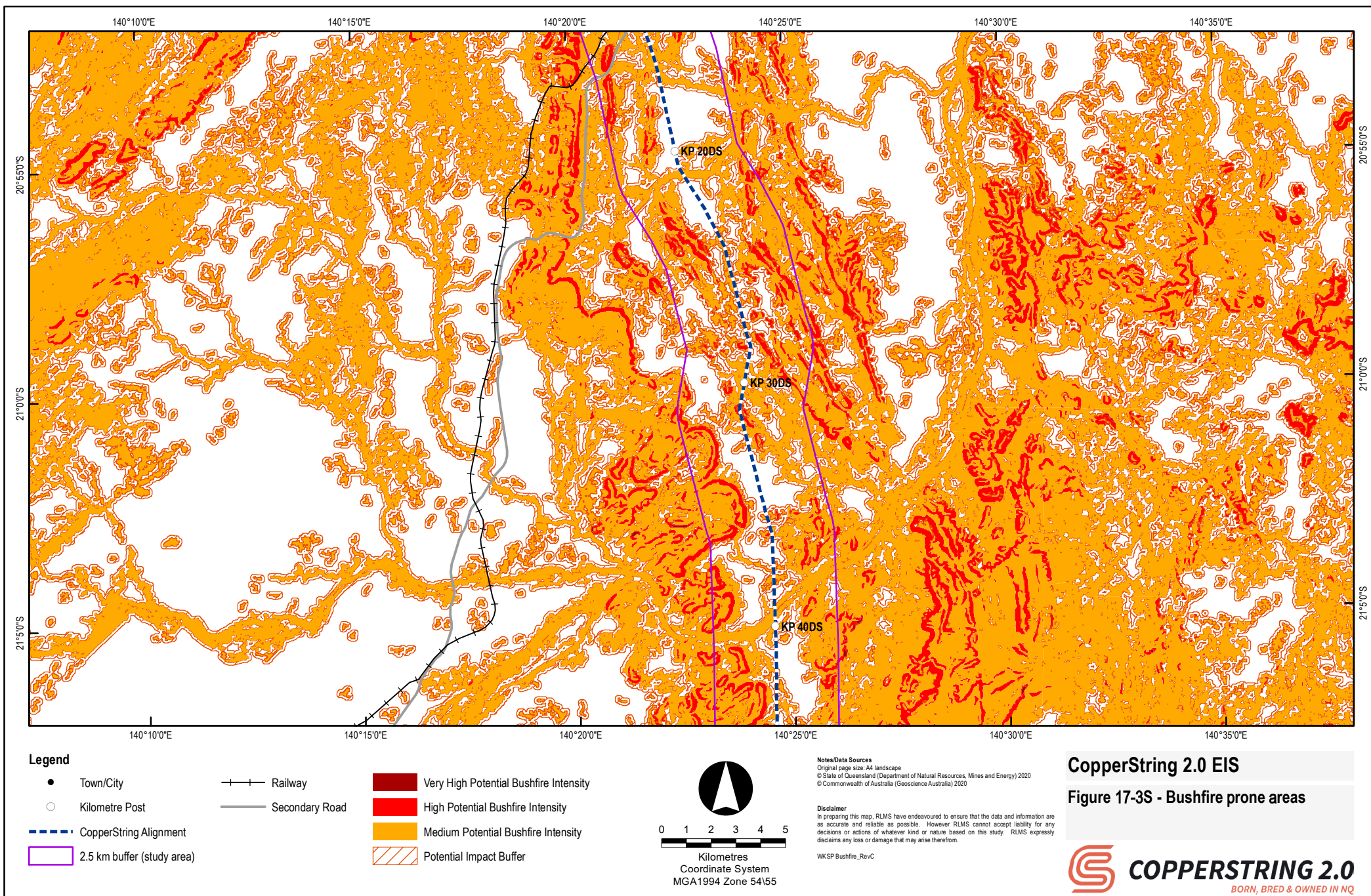
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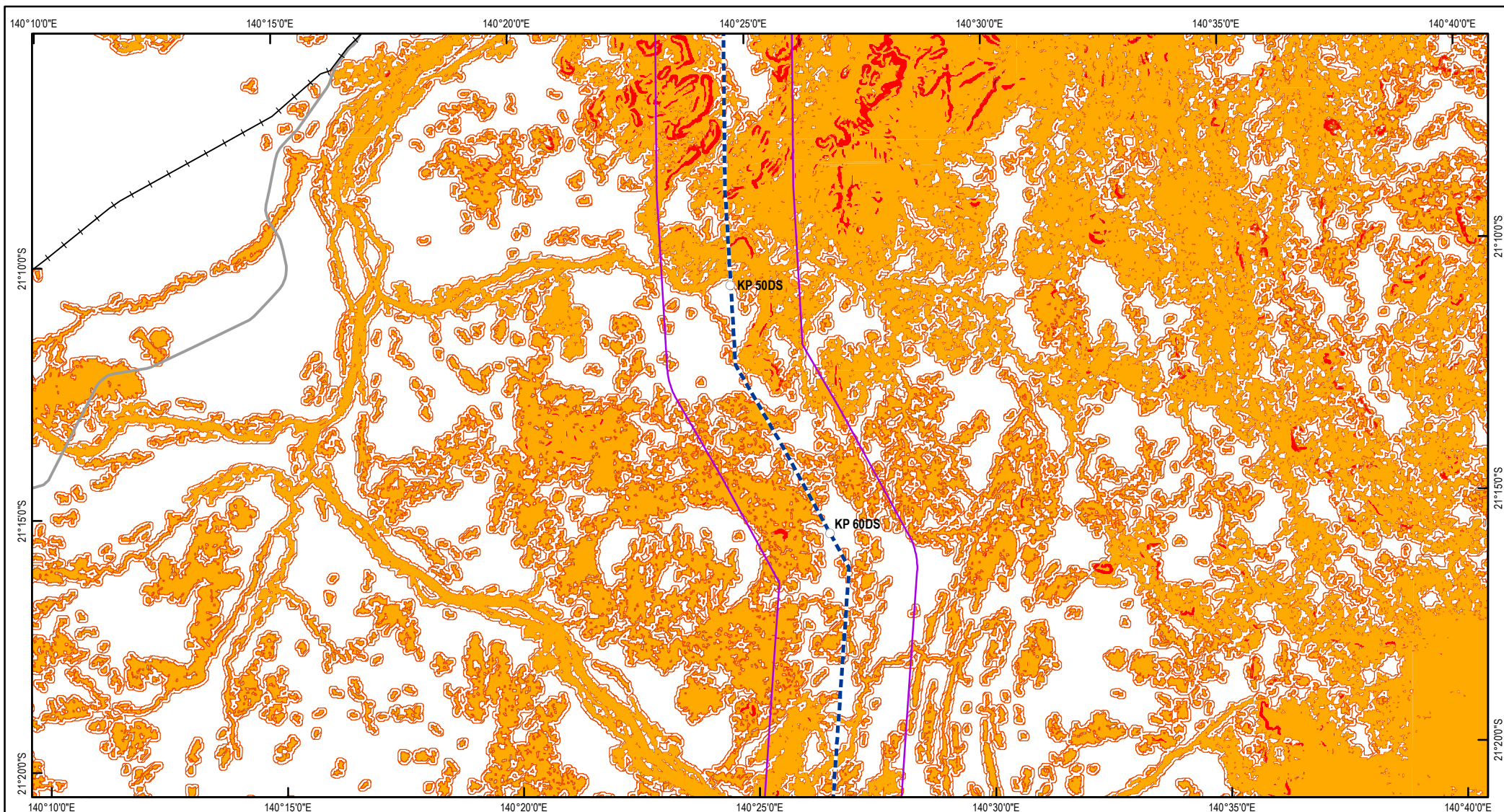
WKSP Bushfire_RevC

CopperString 2.0 EIS

Figure 17-3Q - Bushfire prone areas

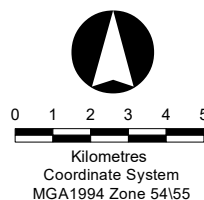






Legend

- Town/City
- Kilometre Post
- CopperString Alignment
- 2.5 km buffer (study area)
- Railway
- Secondary Road
- Very High Potential Bushfire Intensity
- High Potential Bushfire Intensity
- Medium Potential Bushfire Intensity
- ▨ Potential Impact Buffer



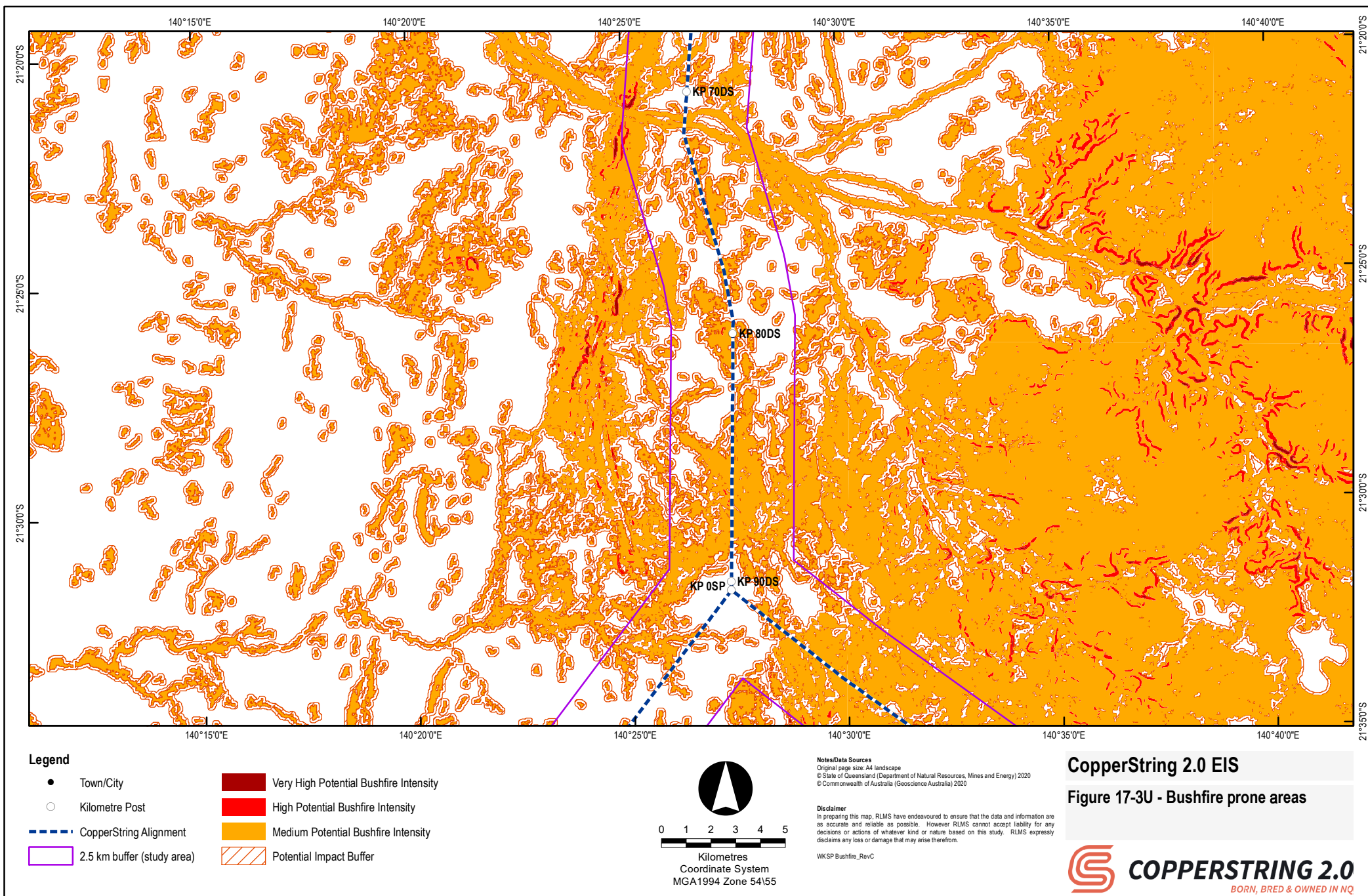
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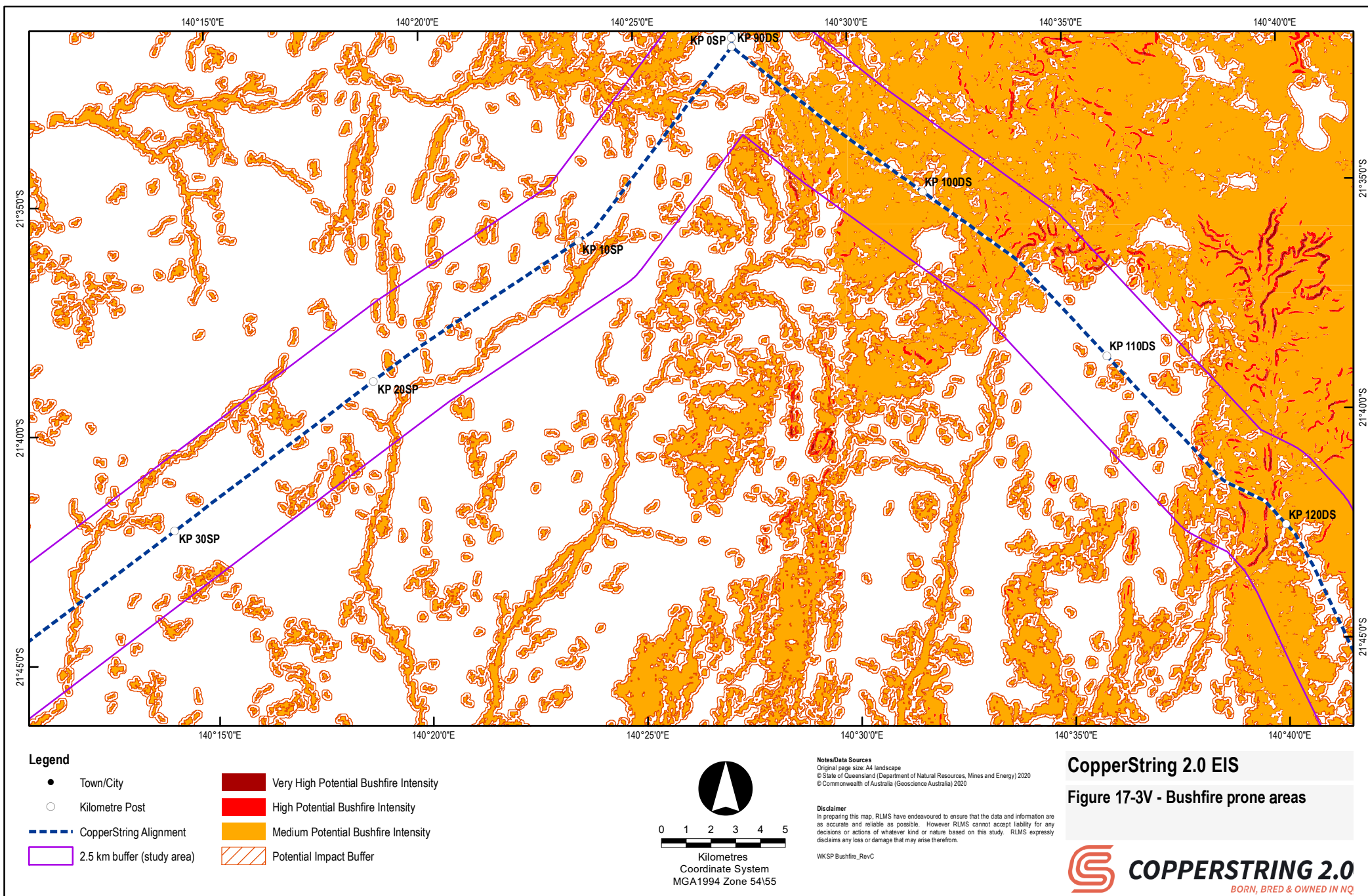
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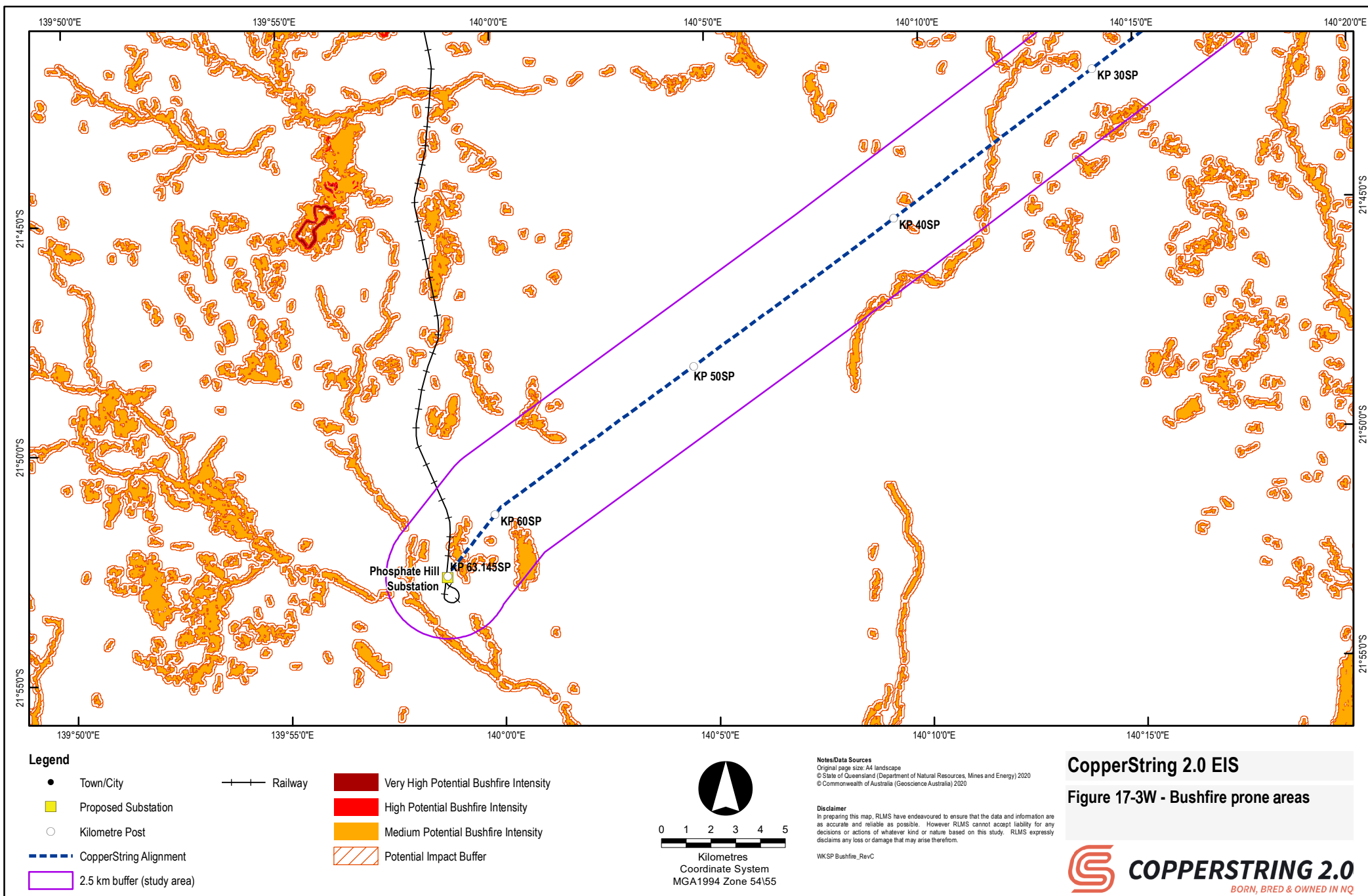
WKSP Bushfire_RevC

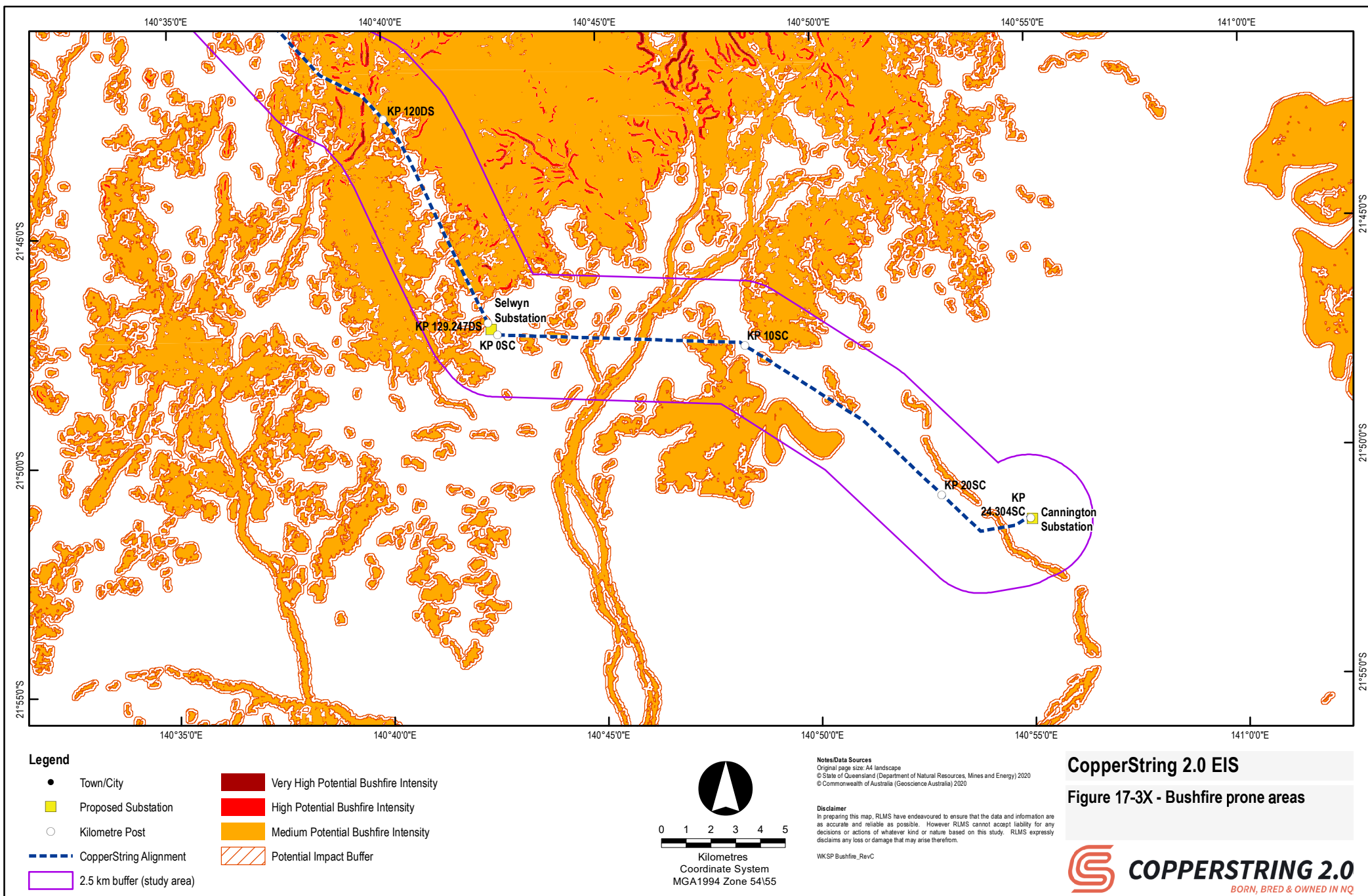
CopperString 2.0 EIS

Figure 17-3T - Bushfire prone areas









Earthquakes

Earthquakes are sudden movements within geographical faults and can cause strong and destructive ground shaking up to tens or even hundreds of kilometres from an earthquake epicentre.

The University of Queensland Seismological Observatory has undertaken mapping of earthquakes in Queensland with Richter magnitudes greater than two for the period 1866 to June 2000. Most data has been collected since 1977, when seismographs were installed around the state's largest dams. The data indicates that the areas of highest recorded seismicity in Queensland are along the east coast and inshore areas, particularly between Brisbane and Gladstone and between Mackay and Cairns.

A number of earthquakes have been recorded in the vicinity of Townsville and Charters Towers, particularly around the Burdekin Falls Dam area between 1977 and 2000. The largest earthquake recorded in that region had a magnitude of six however the earthquake occurred more than 50 km from the Project corridor selection. Older historical earthquake data from Geosciences Australia (2020) shows 10 earthquakes within 50 km of the corridor selection, including a 5.7 magnitude event in 1913, and two earthquakes of <3 magnitude within 50 km of Mount Isa. Seismic activity is rare in the inland region.

Fewer seismographs and lower population density in Queensland means that the true seismicity in Queensland may be higher than what is mapped in comparison to other eastern states of Australia (University of Queensland, 2020). Predicting earthquakes with a level of certainty is not possible. While the risk of earthquake in the Project area is low, it cannot be dismissed.

Climate change

Climate change is influencing the frequency and severity of hazardous climate-related events such as cyclones, storms and bushfires in Australia, including influencing temperature, environmental moisture, weather patterns and fuel conditions.

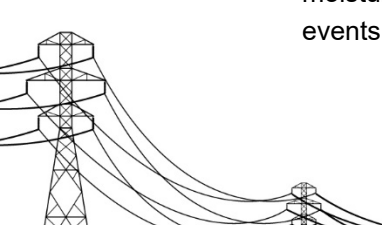
There have been significant changes observed in recent decades towards more dangerous bushfire weather conditions for various regions of Australia, in particular more extreme conditions during summer in Eastern areas and an earlier start to the bushfire season, with dangerous weather conditions occurring earlier in spring than they did in previous years.

Recently a number of devastating fire events have occurred in Australia associated with extreme pyroconvection (where bushfires cause their own storms, including thunderstorm development within a fire plume). Research indicates that over the past 40 years, south-eastern Australia has experienced an increase in the number of high pyroconvection risk days in summer (Earth Systems and Climate Change Hub, 2019). Whilst the data for north Queensland and north-west Queensland indicates that high pyroconvection risk days have generally remained the same or decreased over the past 40 years, there are some areas around the CopperString Core and Renewable Energy Hub sections that have experienced an increase in the number of high pyroconvection risk days.

There is some indication that climate change could influence the risk of ignition from dry-lightning (i.e. Lightning that occurs without significant rainfall) however the modelling of this phenomenon is presently uncertain.

General bushfire weather conditions are projected to increase in severity in future years for many regions of Australia, due to more extreme heat events.

Climate change is also influencing extreme rainfall events. The warmer atmosphere holds more moisture, which increases the risk of heavier downpours. It is predicted that extreme rainfall events are likely to worsen (Climate Council, 2019). Extreme rainfall events can have adverse



impacts to human health through risk to life from flash flooding, contamination of drinking water and food, difficulty accessing health services, and increases in mosquito borne diseases. The economic impacts of heavy rainfall can also be devastating.

Natural hazards can have a cumulative impact when two or more events are experienced at the same time. Increases in monsoonal rainfall in northern Australia have resulted in increased fuel growth in recent decades, which is a key factor influencing fire danger.

17.3.6 Health and safety

This section describes social values of communities in the Project area, in relation to the health and safety of residents, the workforce and other relevant stakeholders.

17.3.6.1 Description of public health and safety community values

The communities near the CopperString transmission network have strong rural identities, which promote a progressive and innovative attitude towards development, whilst maintaining and creating community prosperity. This is achieved by promoting employment opportunities compatible with social and environmental values. Local councils aim to promote themselves as being community orientated and creating a high-quality lifestyle for residents and visitors.

Communities across the region come together for local events such as rodeos, racing events and sporting and cultural activities, including festivals. These events are important to locals, contributing to their sense of identity and the overall health and wellbeing of communities.

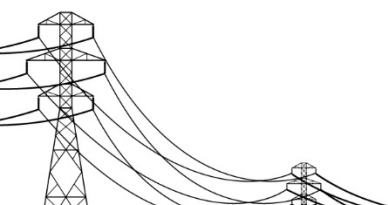
Discussions with relevant local councils have indicated that key challenges for the region include management of issues relating to community development, human services, housing for people living in the area, and population change.

The North Queensland Regional Plan 2020 covers LGAs including Burdekin, Charters Towers and Townsville. It has been prepared to support the established and emerging industries in the region and to address changes expected to occur within the region. The major goals of the North Queensland Regional Plan 2020 are:

- North Queensland be a leading economy in regional Australia
- The region maintains a rich and healthy natural environment
- To create liveable, sustainable and resilient communities that promote living in the tropics
- Infrastructure networks support a safe, connected and efficient North Queensland.

The regional policies aimed at achieving the above outcomes that relate to the health and safety values of the region are summarised below:

- Ensure existing and new industrial areas remain appropriately buffered from incompatible land uses and that the functionality of connecting infrastructure corridors is protected
- Protect the biodiversity and ecological integrity of strategic environmental areas from incompatible development
- Protect and enhance the biodiversity and ecological integrity of regional biodiversity corridors and regional biodiversity values to optimise biodiversity conservation outcomes
- Protect regional landscape values and functions to sustainably manage and provide social, environmental, cultural and economic benefits to the region
- Provide opportunities for the co-location of environmentally sensitive commercial, recreational and community activities in and around strategic environmental areas and the regional biodiversity network



- Identify and manage priority rehabilitation areas within riparian and wetland areas to enhance biodiversity values and ecological functionality and improve water quality
- Incorporate regular reviews and updating of climate change scenarios and modelling into planning for future growth
- Minimise the region's vulnerability to natural hazards through disaster risk management planning and adaptation strategies.

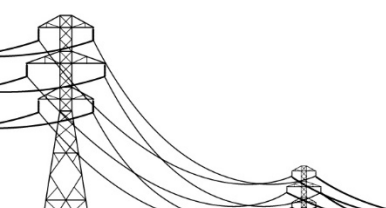
The North West Regional Plan 2010 applies to the LGAs of Mount Isa, Cloncurry, McKinlay, Richmond and Hughenden. It proposes a range of policies to achieve its vision and desired outcomes for the region, under the following topic areas:

- Natural Environment – *'A region where the natural environment is resilient to the impacts of climate change and one which is well-managed to maintain its rich biodiversity, ecological processes, water resources and scenic amenity'*
- Natural Resources – *'The economic, environmental, social and cultural values of the region's natural resources are recognised and managed to enhance regional prosperity and maintain ecological sustainability'*
- Strong Communities – *'A region that has safe, healthy and prosperous communities with a vibrant civic culture, a strong sense of identity and place, social equality and access to services'*
- Urban Development – *'A progressive region where diversity and quality of life are sustained through high-quality built environments'*

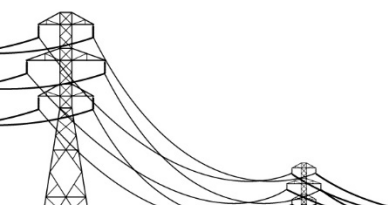
The planning principles and guidelines from the above topics that are relevant to the health and safety values of the region are summarised in Table 17-5. These principles and guidelines are required to be reflected in any plans, policies and codes being prepared by or amended by the Queensland Government or local governments in the north-west region.

Table 17-5 North West regional planning strategies and policies

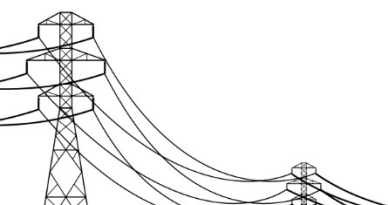
Strategies	Land use policies
Natural environment – air and noise emissions	
• Investigate collaborative models involving community, industry and government to oversee the collection of base-line data and recommend long-term management options for integrating mining and town-based activities	• Development that generates air and acoustic emissions must be adequately separated, designed, constructed and operated to avoid impacts of emissions on sensitive land uses.



Strategies	Land use policies
Natural resources – water management and use	
• Support the use of a range of mechanisms to protect, conserve, enhance and restore the environmental, social and economic values of river systems, groundwater and wetlands • Eliminate point source wastewater discharge of pollutants into water where practicable • Manage reused or recycled water in accordance with best practice environmental management principles to protect or enhance environmental values and meet water quality objectives • Actively involve Traditional Owners in water planning and management as part of collaborative management forums and regimes operating in the region or through on-site practices on country • Promote the development and implementation of water efficient technologies and management strategies for industrial, agricultural and private purposes • Implement the Great Artesian Basin Sustainability Initiative, as identified in the Blueprint for the Bush program • Improve catchment management to maintain water quality and the health of the Lake Eyre Basin and the lower Gulf of Carpentaria river catchments • Investigate the benefits and impacts of mosaic irrigation • Facilitate mapping of land and soil resources at a fine scale to facilitate more detailed planning for irrigation.	• Plan, design, construct and operate development in accordance with best practice environmental management principles that meet water quality objectives • Consider the impacts of developments on the water quality and health of rivers and streams flowing into the lower Gulf of Carpentaria and the Lake Eyre Basin • Adopt demand management principles for the planning, design and construction of water infrastructure • Incorporate industry best practice water saving methods and technology in all development • Incorporate water sensitive urban design principles in urban areas. • Avoid clearing native vegetation or development within a waterway, wetland, riparian area or flood plain through the use of appropriate setbacks and buffer zones, and where unavoidable mitigate through best practice design, rehabilitation and management.

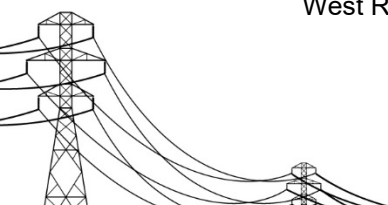


Strategies	Land use policies
Strong communities – social planning and social infrastructure	
• Implement social infrastructure auditing to more clearly identify needs • Identify mitigation and management strategies to address the social impacts of large-scale development projects • Encourage communities to collaboratively participate in community planning and developing social capacity • Encourage partnerships between governments and private organisations to identify and provide essential community facilities • Identify protocols for the sharing of mining workforce information between the mining sector and government • Identify specific social impact assessment protocols and criteria to reflect ongoing needs of the community, utilising existing frameworks • Better utilisation of the findings of social impact assessments in social research and policy and program development to assist local and state government in guiding future development decisions and strategic planning for resource communities.	• Use best available demographic information to identify existing and future community infrastructure needs.
Strong communities – social services	
• Identify critical community service needs and priorities • Reduce duplication and increase efficiency of services through a coordinated network between social service providers • Continue to build a strong partnership approach to crime prevention between police, different levels of government and community groups in the region, including programs targeting at risk youth • Review adequacy of crisis and short-term accommodation and support programs and improve service provision to reduce homelessness within the region.	N/A



Strategies	Land use policies
Strong communities – promote health and wellbeing	
• Provide health services in a way that is consistent with agreed universal service obligations • Give consumers the opportunity to be actively involved in the planning of health services to ensure these services are responsive to community needs and culturally sensitive to all community sectors • Deliver health services through effective partnership arrangements between all agencies who contribute to health outcomes for communities • Provide and locate health services along a continuum from preventative to primary health care, acute, rehabilitative and extended care in accordance with the intent of the regional activity centres network • Attract, retain and support skilled health professionals in the region • Continue to provide ongoing training to the medical and nursing staff who work within the region • Investigate and support opportunities for the cross-skilling of health professionals.	• Include provisions and design guidelines for walking tracks, pathways, cycle tracks, open space and recreational areas • Consider crime prevention through environmental design principles • Developments incorporate measures to provide shade for public walkways, sporting and recreation facilities, playground and public open space • The location of health infrastructure and services is consistent with the intent of the regional activity centres network.
Urban development – hazard mitigation	
• Encourage and support a coordinated regional approach to disaster management between all levels of government, industry and community • Minimise adverse economic, social, infrastructure and environmental impacts through effective emergency services and disaster management strategies • Attract and retain emergency service volunteers to improve the effectiveness of voluntary emergency service providers such as the Rural Fire Brigades and the State Emergency Service • Identify long-term disaster resilience strategies in regional infrastructure planning and development.	• Identify natural hazard areas in planning schemes, taking into account the compounding effects of climate change • Exclude development within areas likely to be subject to factors that threaten lives, property or the environment • Minimise the potential adverse impacts of hazardous and high impact industries through the use of buffers and sensitive land use planning • Address the needs of emergency services and disaster management in development through inclusion in planning schemes • Integrate risk reduction strategies into development policies in order to mitigate or adapt to natural hazards including the compounding effects of climate change.

These policies and strategies assist in defining the values of the community and to determine factors that may affect human health, public safety and quality of life. In particular the North West Regional Plan implements land use policies in order to protect:



- Sensitive land uses from air and noise emissions
- Water resources and water quality
- Community and social infrastructure
- Social and health services
- Lives, property or the environment from natural hazards.

On a sub-regional level the health and safety values primarily relate to the land use of individual land parcels. Land tenure that is intersected by the proposed transmission network is generally large freehold and leasehold land used for primary production. Safety concerns of landholders relate to aerial work that is common practice for mustering of cattle. This risk is further considered in section 17.4.8

17.3.7 Environmentally sensitive receptors

Volume 2 Chapter 7 Flora and fauna, and Volume 3 Appendix P Ecological assessment have identified that the Project is expected to cause localised losses of habitat during the construction phase, predominantly due to clearing for access tracks, transmission line towers, and operational vegetation clearance zones for transmission line conductors. The Project will also cause temporary disturbance of wildlife through construction light, noise, vibration and increased vehicle movements.

During the operational phase, the project will be largely benign for most environmental matters. Nevertheless, the project will pose an ongoing operational risk of collision for a small number of low-flying bird and bat species and collision with maintenance vehicles.

A total of 82 watercourses would be intersected by the Project, which include a variety of aquatic environments included lotic and lentic systems, artificial dams, floodplain depressions and ephemeral creeks.

The majority of the riverine wetlands observed within the study area are ephemeral and comprised of braided sandy channels with the majority of wetlands associated with the major river systems that maintain more permanent water. In the western section of the alignment, seasonal wetlands occur within the Canal Creek, Torrens Creek, Sadowa Creek and Williams River

17.3.8 Sensitive receptors

A sensitive receptor is a place where environmental nuisance issues, such as noise, dust, light, and odour, may be experienced. Types of sensitive receptors include, but are not limited to, educational and childcare facilities, hospitals, aged care homes, sporting clubs and residences.

For the studies undertaken for the EIS in relation to air quality, and noise and vibration impacts, sensitive receptors within two kilometres of the centre line of the corridor selection or substation sites were considered. The basis for this was the two-kilometre buffer used in the initial noise assessments undertaken in the CopperString 1.0 Project EIS in 2010. The review identified 57 sensitive receptors, shown in Table 17-6, with 55 of these being residential premises, one place of recreation and one workplace.

A review of potentially affected sensitive receptors along the corridor selection indicates that 46 of the 57 identified sensitive receptors are greater than 750 m from the proposed transmission line. The exceptions to this include sensitive receptors 45-55, which are existing workers accommodation located between approximately 150 m and 350 m of the existing Mount Isa power stations and electrical substations. The sensitive receptors are shown in Figure 17-4.

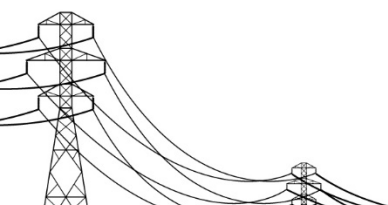
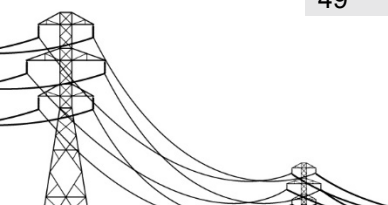


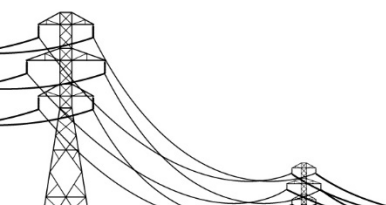
Table 17-6 Sensitive receptors

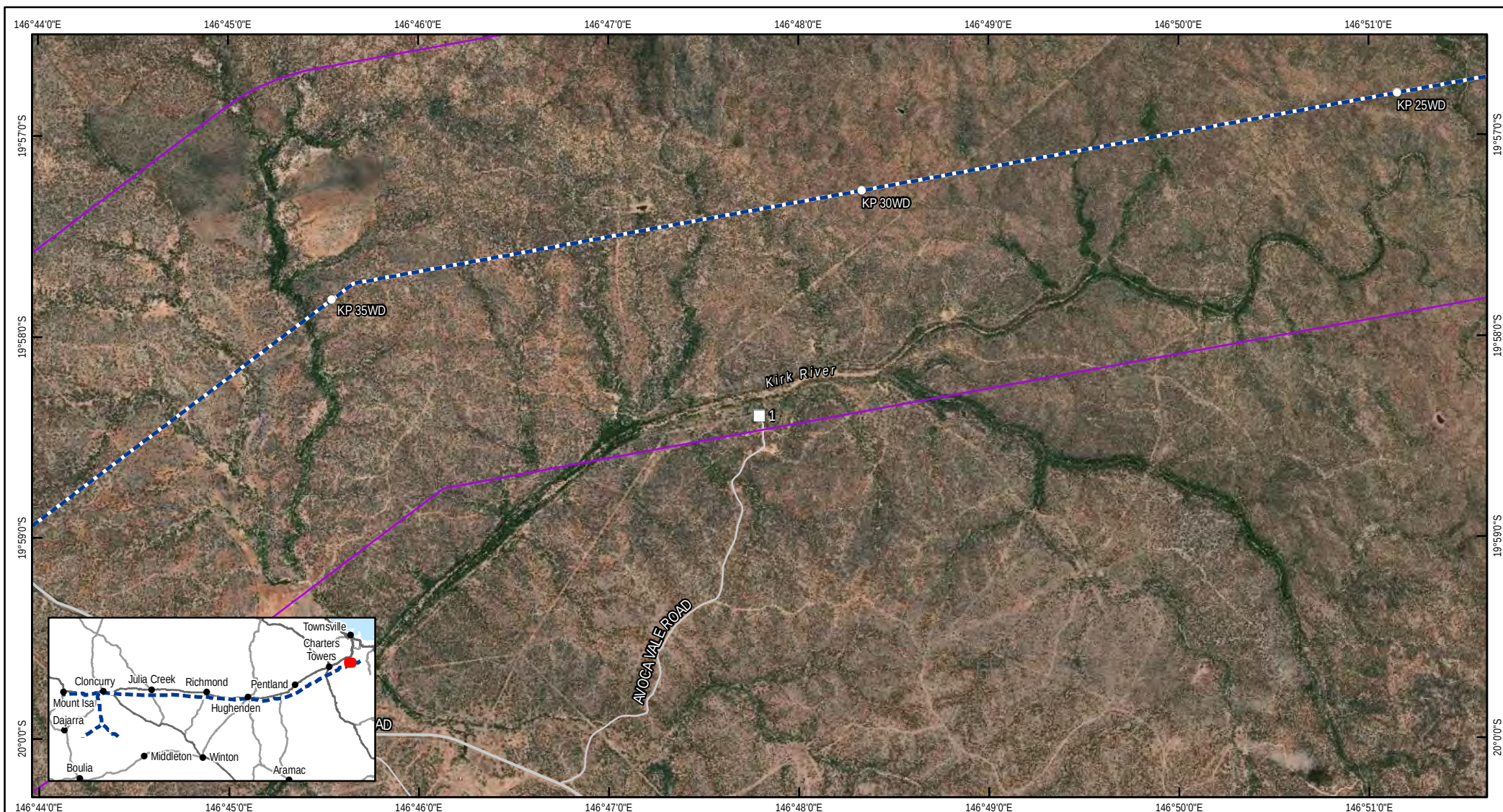
Residential (unless otherwise noted)	Approximate distance from transmission line (m)	Coordinates (GDA94 Zones 54-55) (m)	
		Easting	Northing
1	1,866	478,715	7,791,461
2	782	470,070	7,787,999
3	1,739	465,442	7,781,419
4	962	422,731	7,759,354
5	1,743	421,973	7,759,802
6	1,848	354,040	7,720,974
7	1,958	205,273	7,686,069
8	1,549	196,358	7,684,976
9	1,177	768,786	7,686,785
10	1,799	739,942	7,691,521
11	1,695	716,251	7,693,234
12	1,815	700,852	7,691,947
13	1,894	654,981	7,700,778
14	1,893	629,778	7,698,952
15	1,910	613,729	7,697,966
16	1,903	613,659	7,697,973
17	1,876	453,691	7,704,669
18	1,827	448,434	7,707,124
19	1,020	448,214	7,706,232
20	1,732	447,910	7,706,889
21	1,995	343,827	7,702,956
22	882	343,770	7,701,816
23	1,898	343,674	7,702,941
24	1,617	343,671	7,699,317
25	1,585	343,652	7,699,349
26	1,602	343,642	7,699,332
27	1,590	343,618	7,699,344
28	1,667	343,617	7,699,266
29	1,431	343,559	7,702,420
30	1,357	343,550	7,702,320
31	1,933	343,530	7,703,081
32	1,833	343,524	7,702,968
33	1,431	343,497	7,702,481
34	1,723	343,459	7,702,879
35	1,475	343,457	7,702,573
36	1,370	343,455	7,702,437
37	1,578	343,397	7,702,746
38	1,790	343,360	7,703,014
39	747	343,079	7,701,931
40	914	343,051	7,702,178
41	783	343,051	7,702,011
42	1,151	343,043	7,702,459
43	990	343,028	7,702,282
44	1,315	342,994	7,702,659
45	309	342,944	7,701,240
46	311	342,920	7,701,241
47	318	342,891	7,701,248
48	296	342,866	7,701,243
49	271	342,839	7,701,244



Residential (unless otherwise noted)	Approximate distance from transmission line (m)	Coordinates (GDA94 Zones 54-55) (m)	
		Easting	Northing
50	250	342,815	7,701,245
51	222	342,787	7,701,245
52 (Mica Creek Power Station)	305	342,771	7,701,611
53	199	342,763	7,701,244
54	174	342,737	7,701,249
55	145	342,707	7,701,246
56	1,878	341,786	7,703,158
57(Mt Isa Golf Club)	1,862	341,713	7,703,107

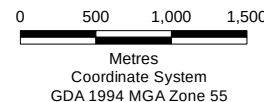
Note: Receptors 1-9 in MGA94 Zone 55, remainder in MGA94 Zone 54





Legend

- Sensitive Receptor within 2km
- Kilometre Post
- CopperString Alignment
- 2 km buffer
- Railway
- Highway
- Secondary Road
- Local Connector Road
- Street



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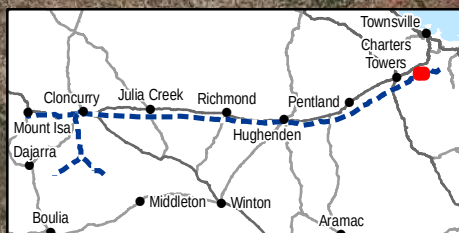
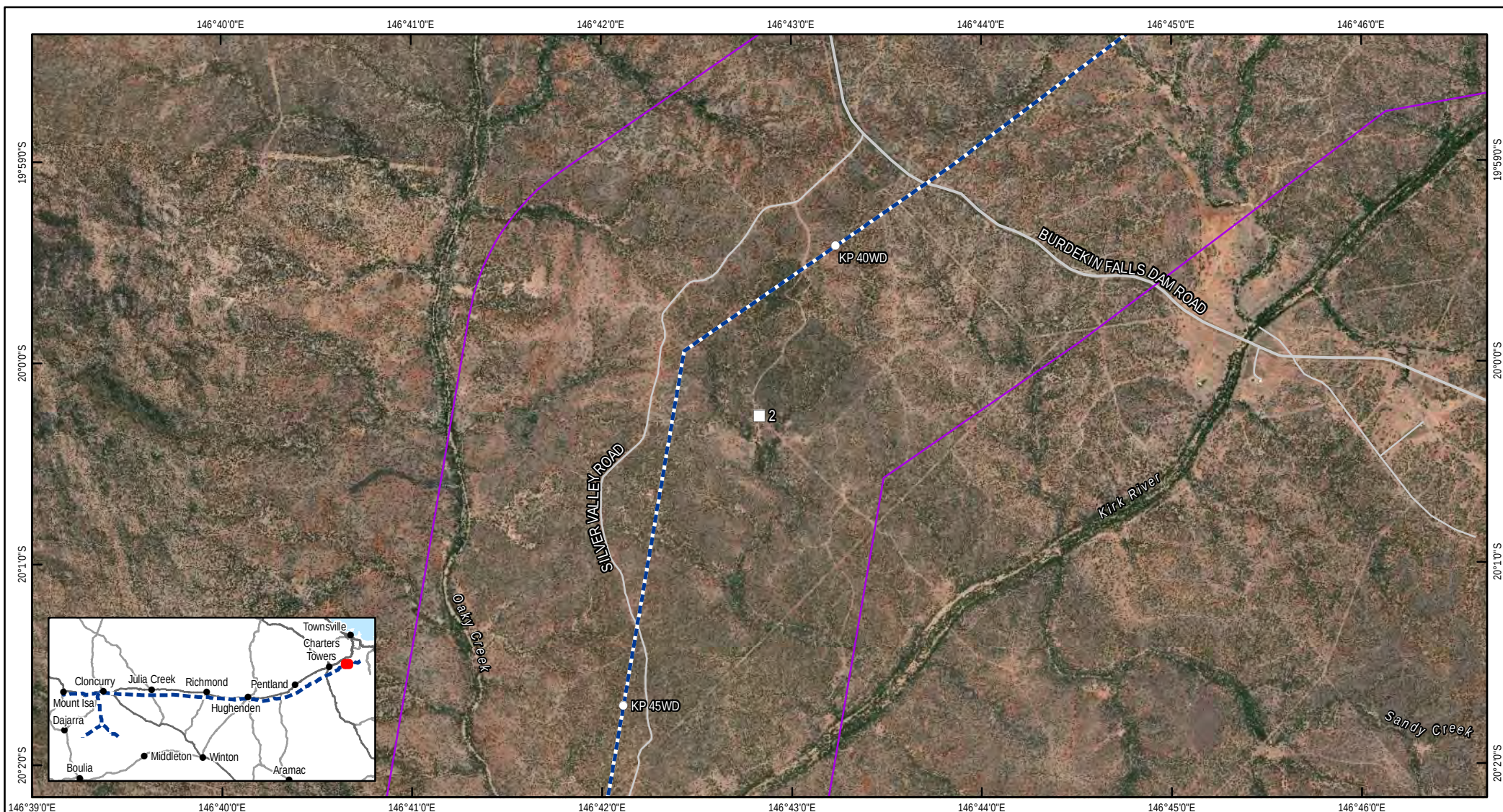
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WKSP Sensitive_Receptors_RevE

CopperString 2.0 EIS

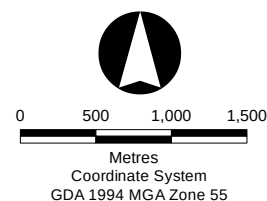
Figure 17-4A - Sensitive receptors





Legend

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|--|-------------------------------|--|----------------------|
| | Sensitive Receptor within 2km | | Railway |
| | Kilometre Post | | Highway |
| | CopperString Alignment | | Secondary Road |
| | 2 km buffer | | Local Connector Road |
| | | | Street |



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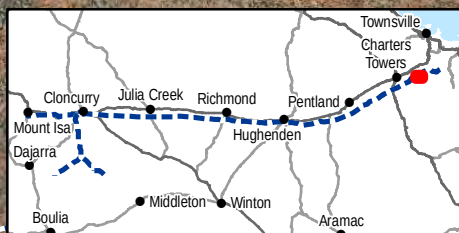
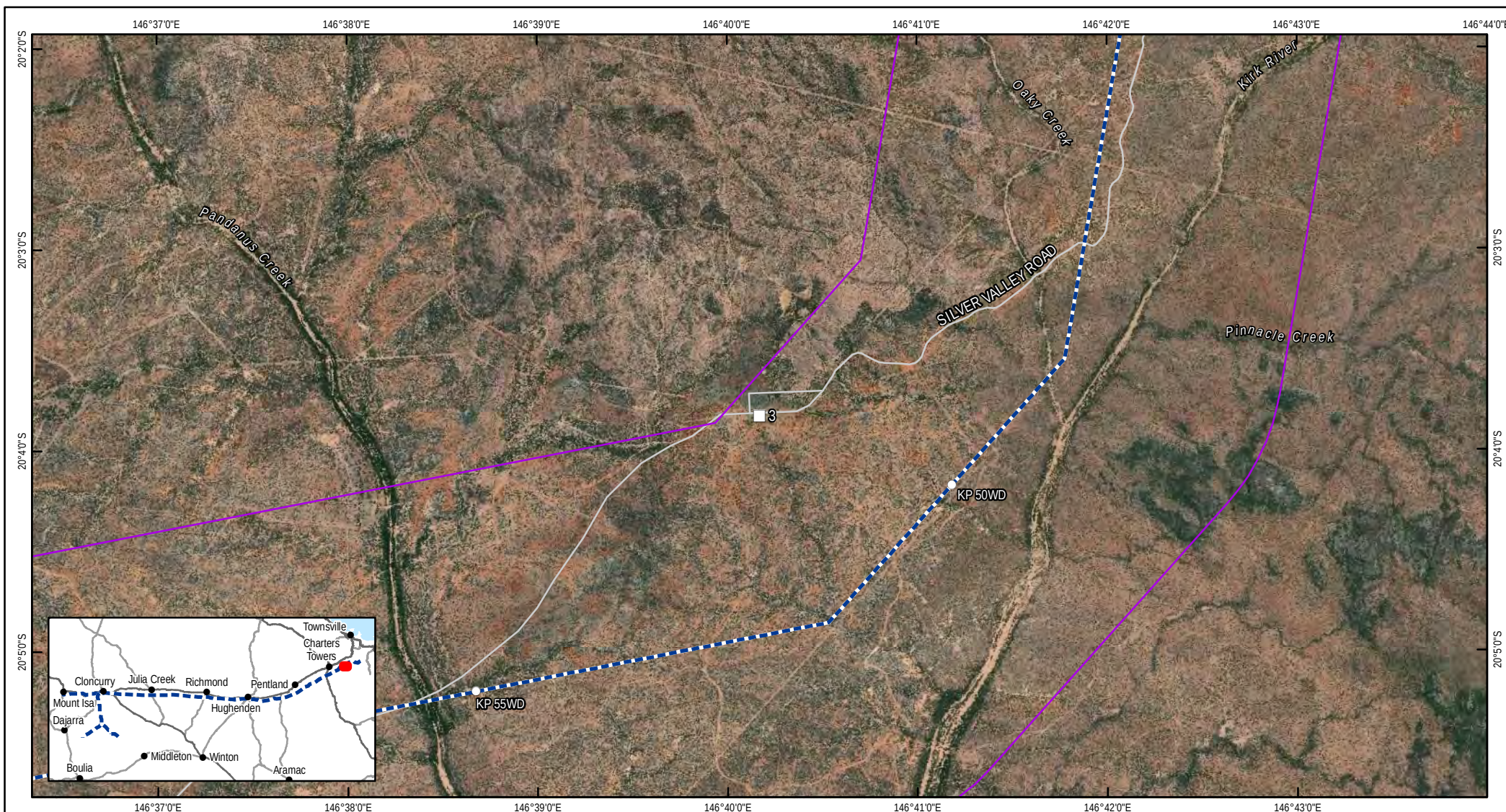
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WKSP Sensitive_Receptors_RevE

CopperString 2.0 EIS

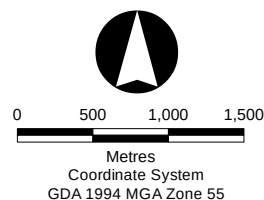
Figure 17-4B - Sensitive receptors





Legend

- | | | | |
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| | Sensitive Receptor within 2km | | Railway |
| | Kilometre Post | | Highway |
| | CopperString Alignment | | Secondary Road |
| | 2 km buffer | | Local Connector Road |
| | | | Street |



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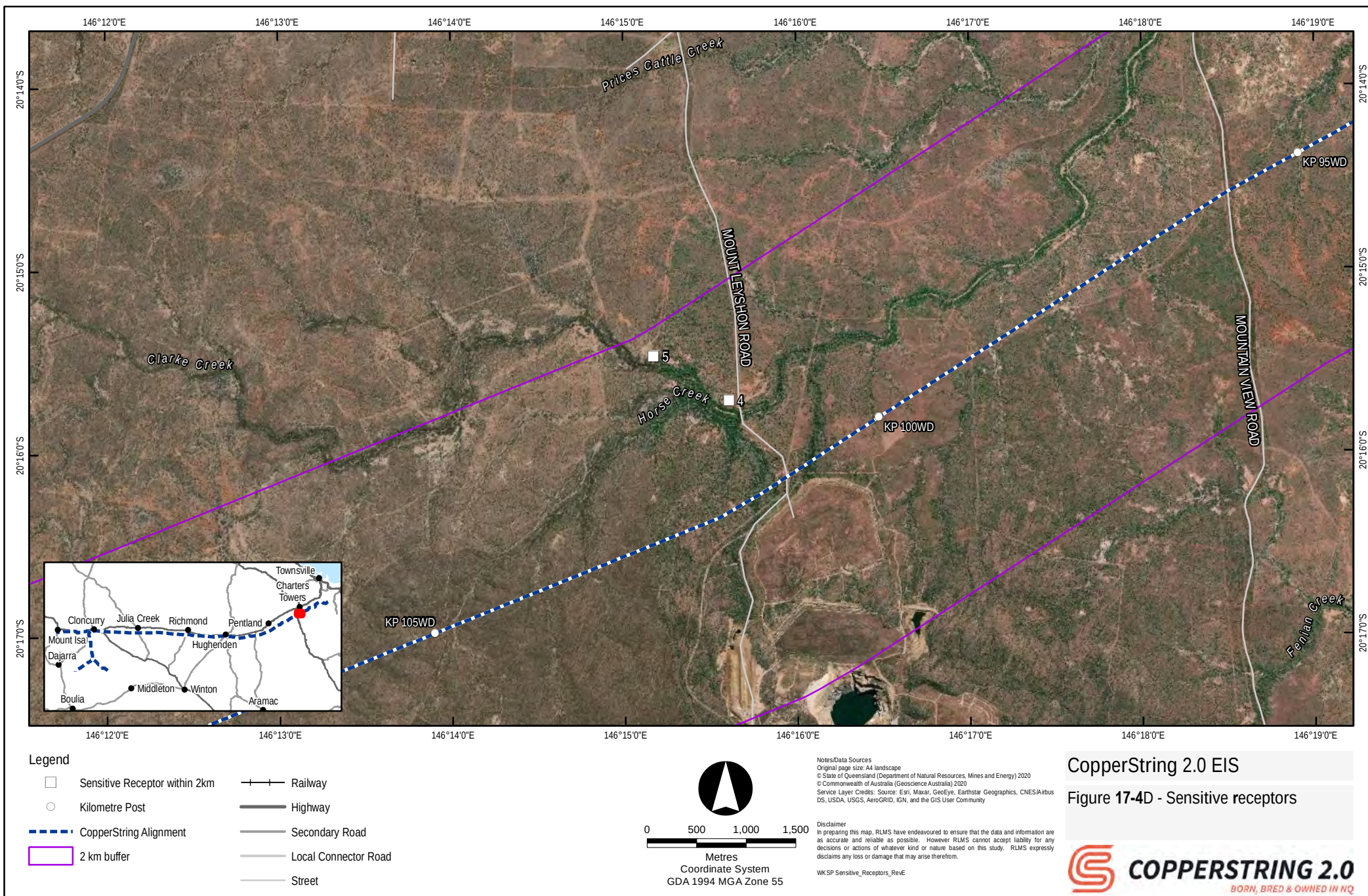
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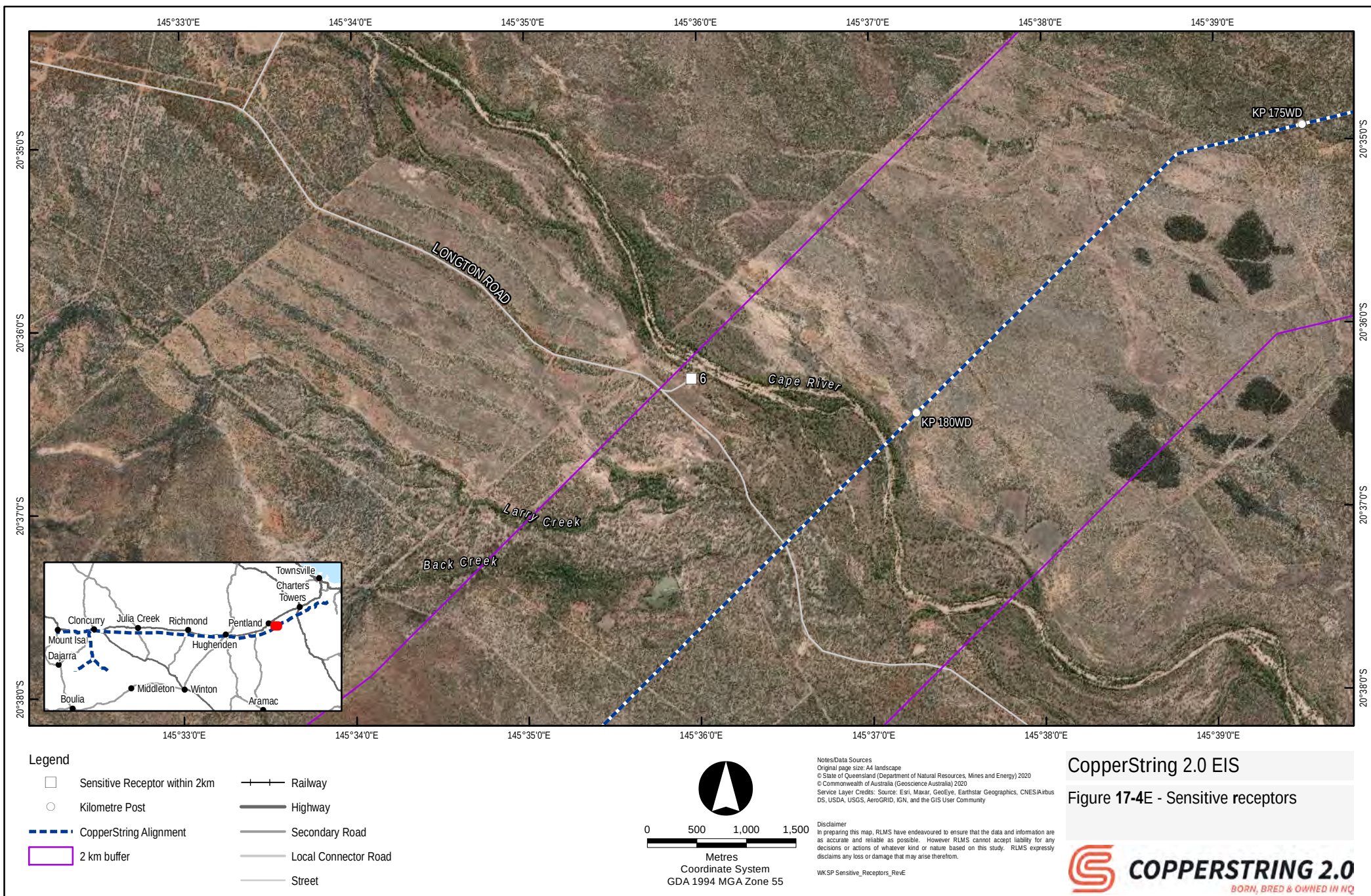
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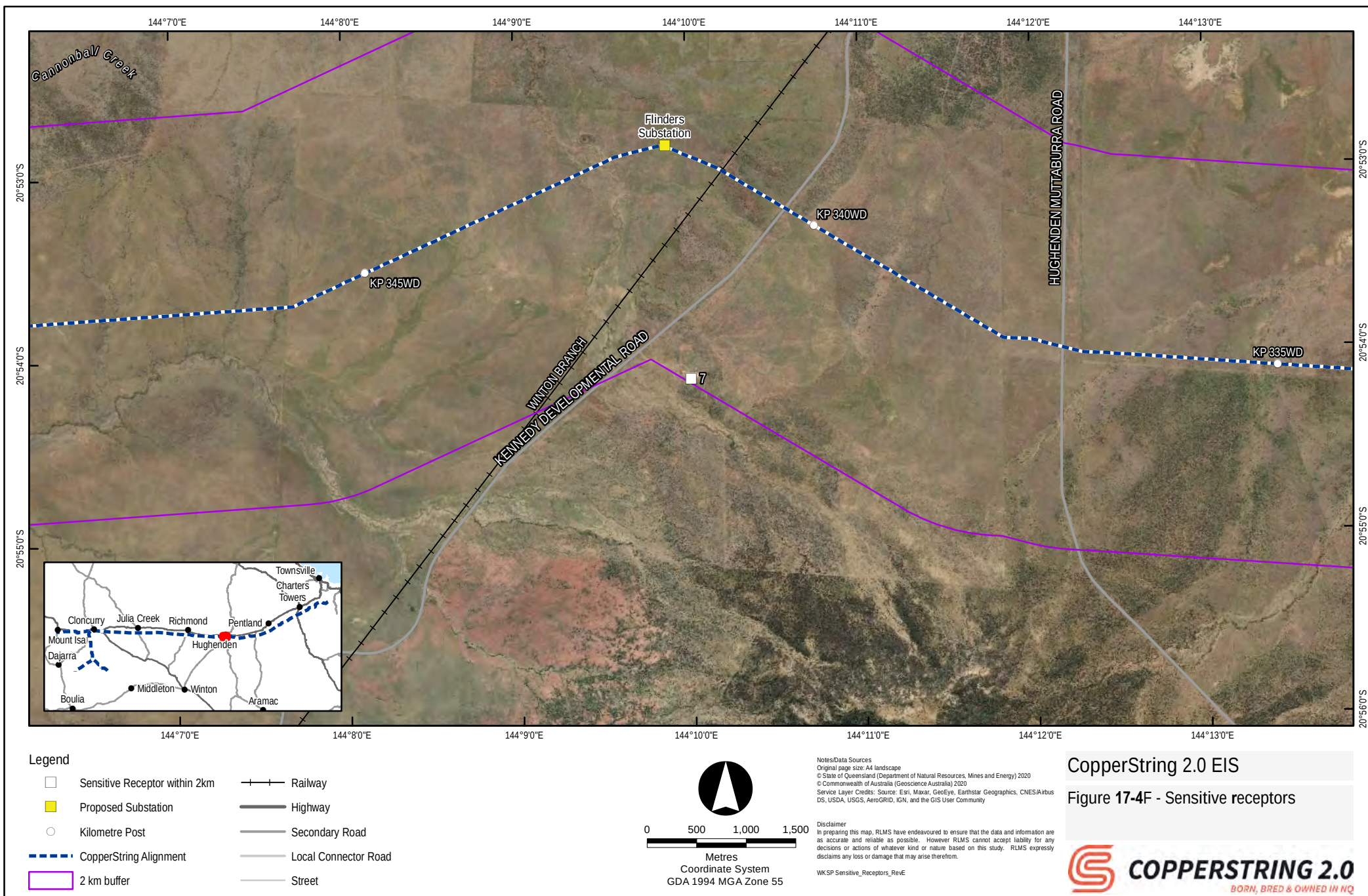
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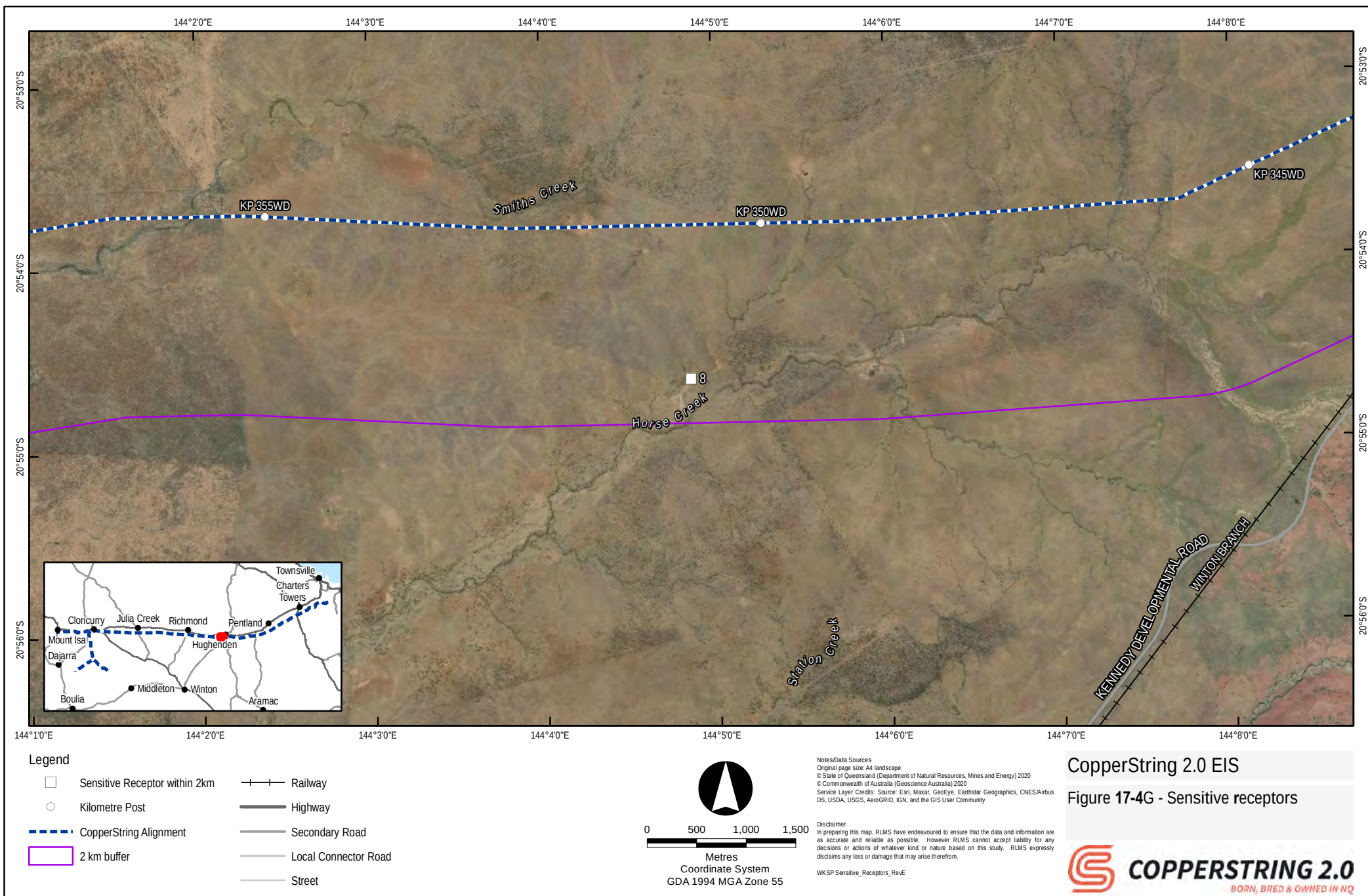
Figure 17-4C - Sensitive receptors

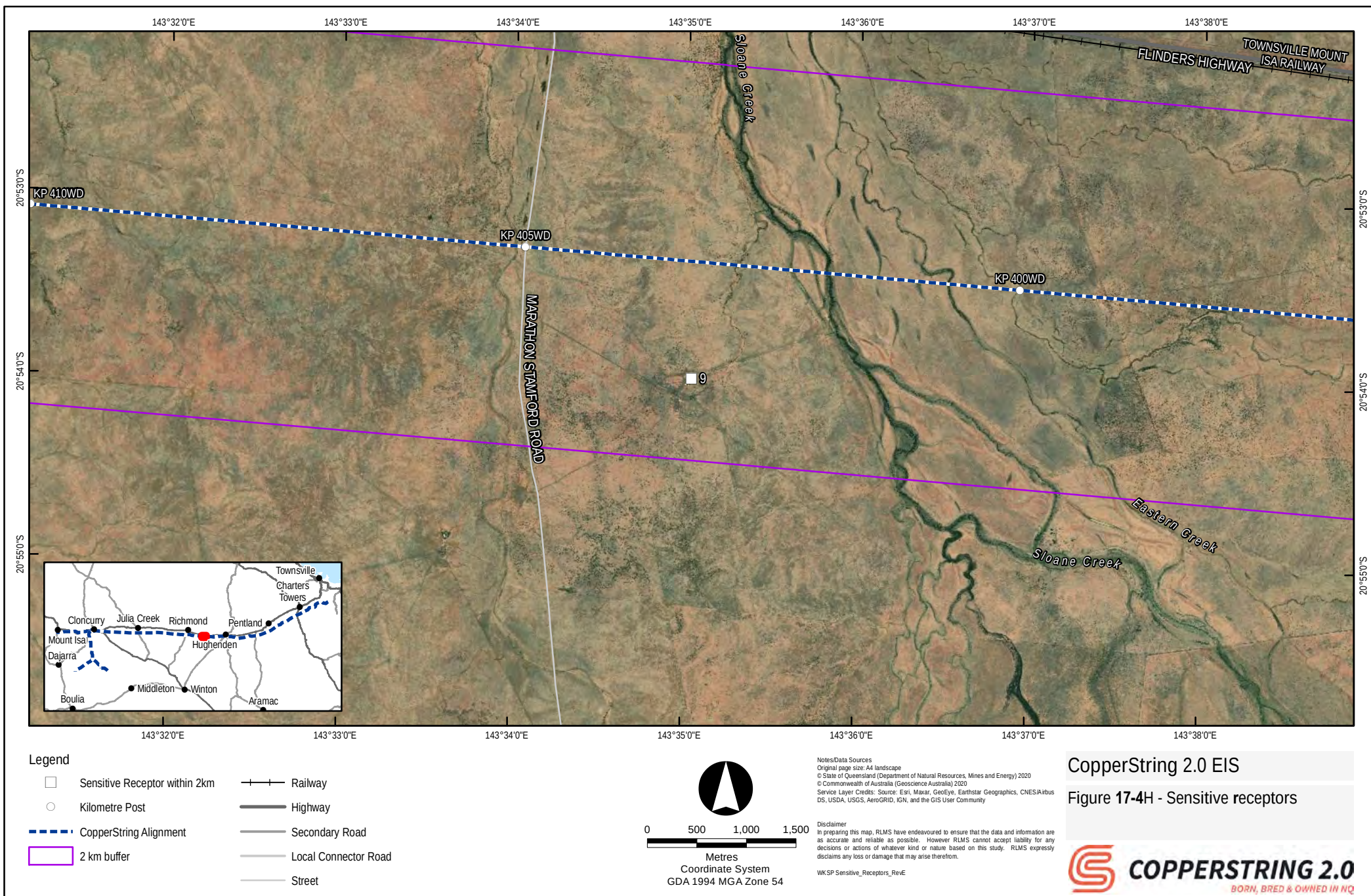


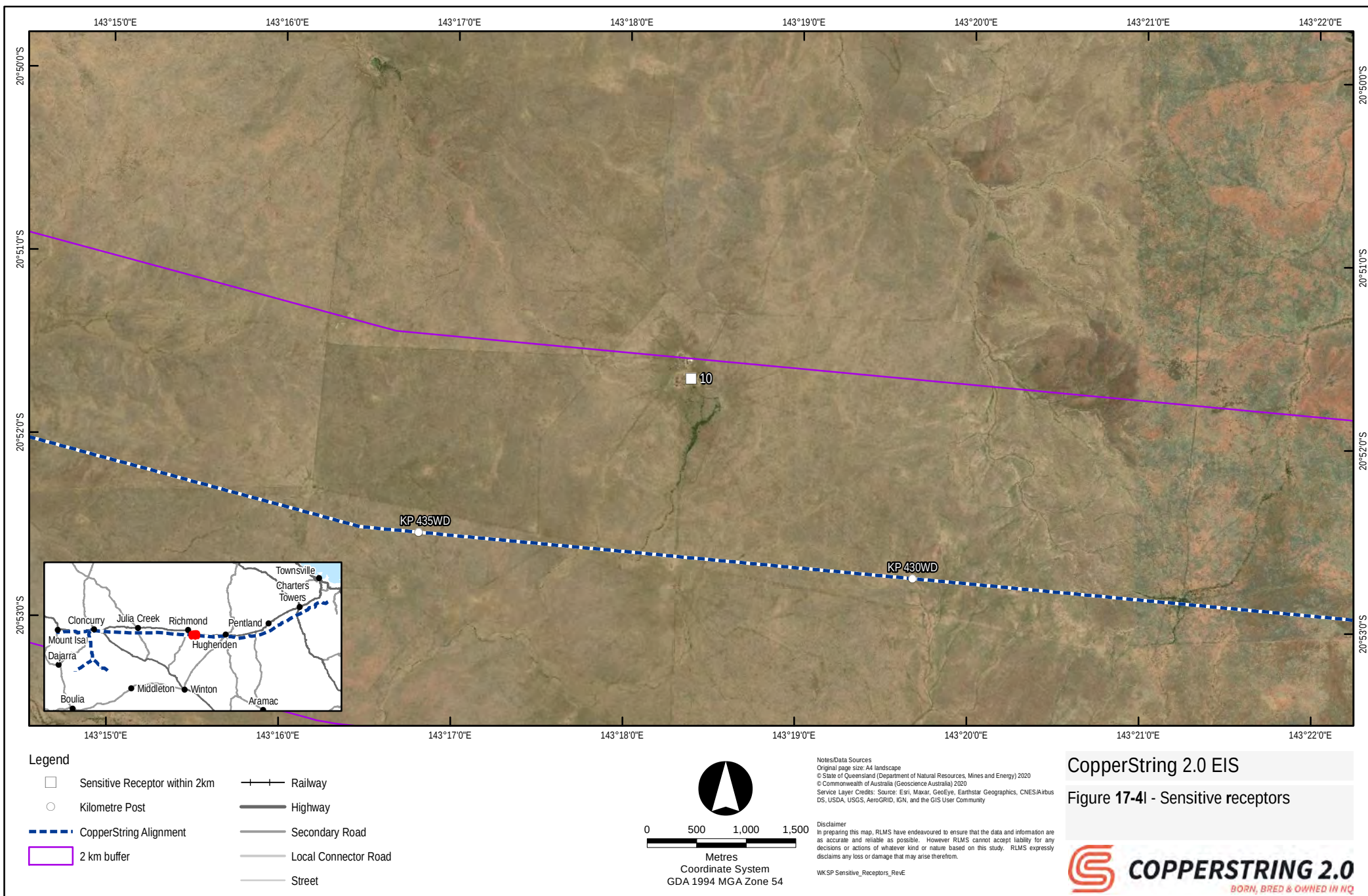


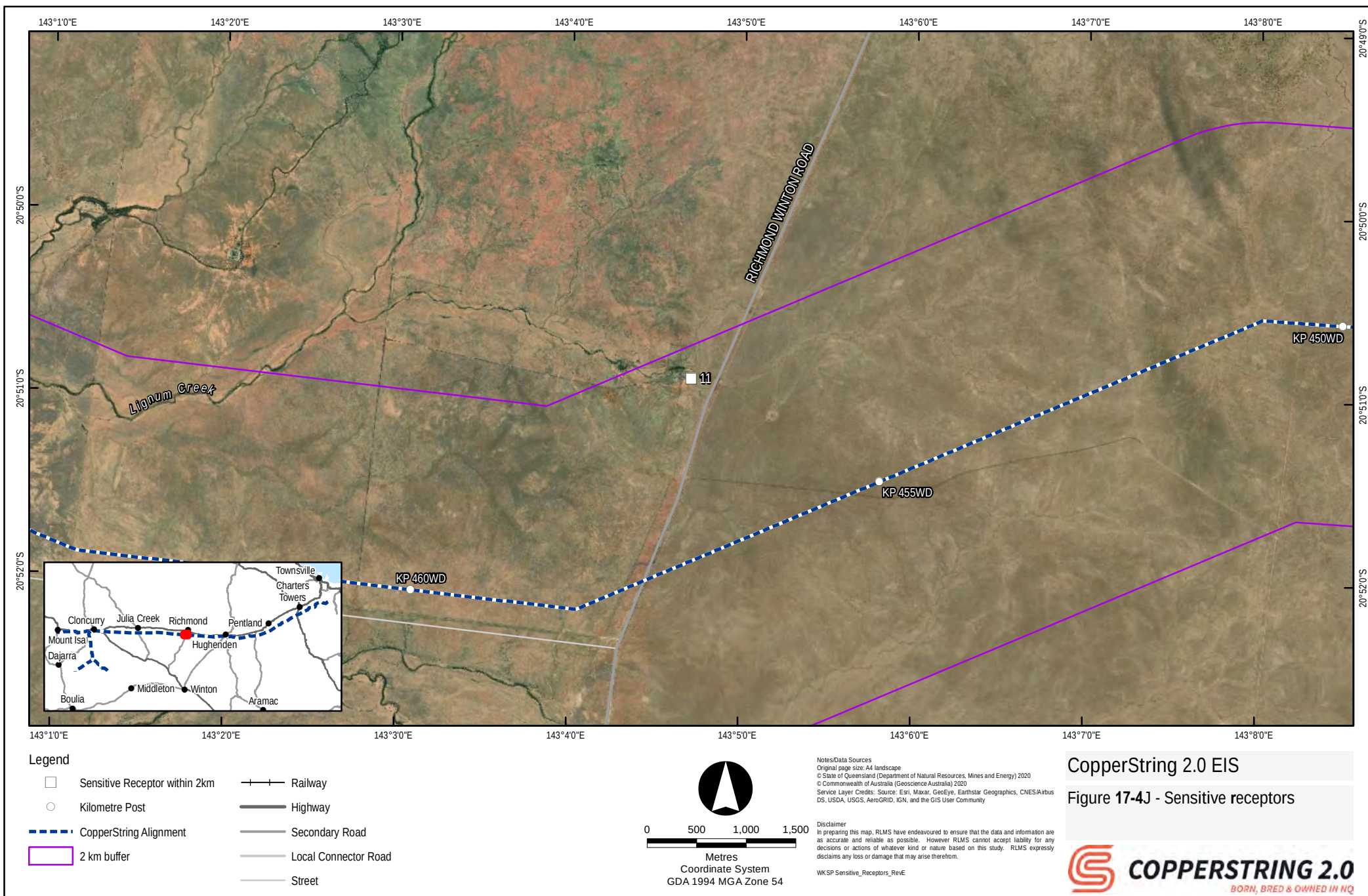


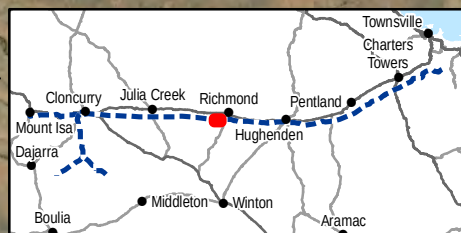
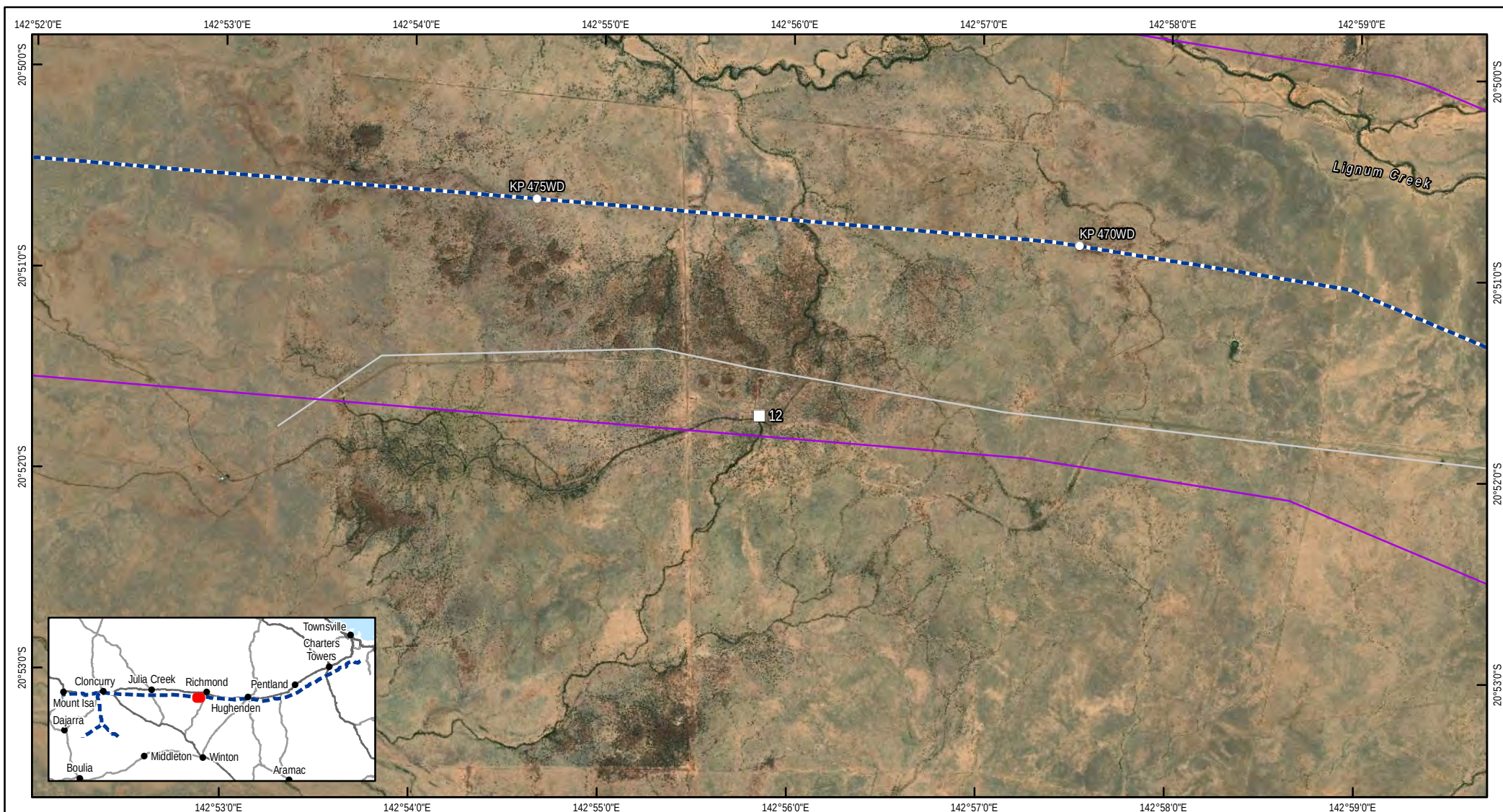






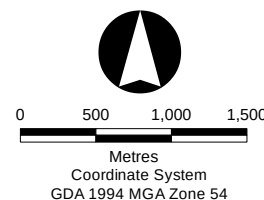






Legend

- Sensitive Receptor within 2km
- Kilometre Post
- CopperString Alignment
- 2 km buffer
- Railway
- Highway
- Secondary Road
- Local Connector Road
- Street



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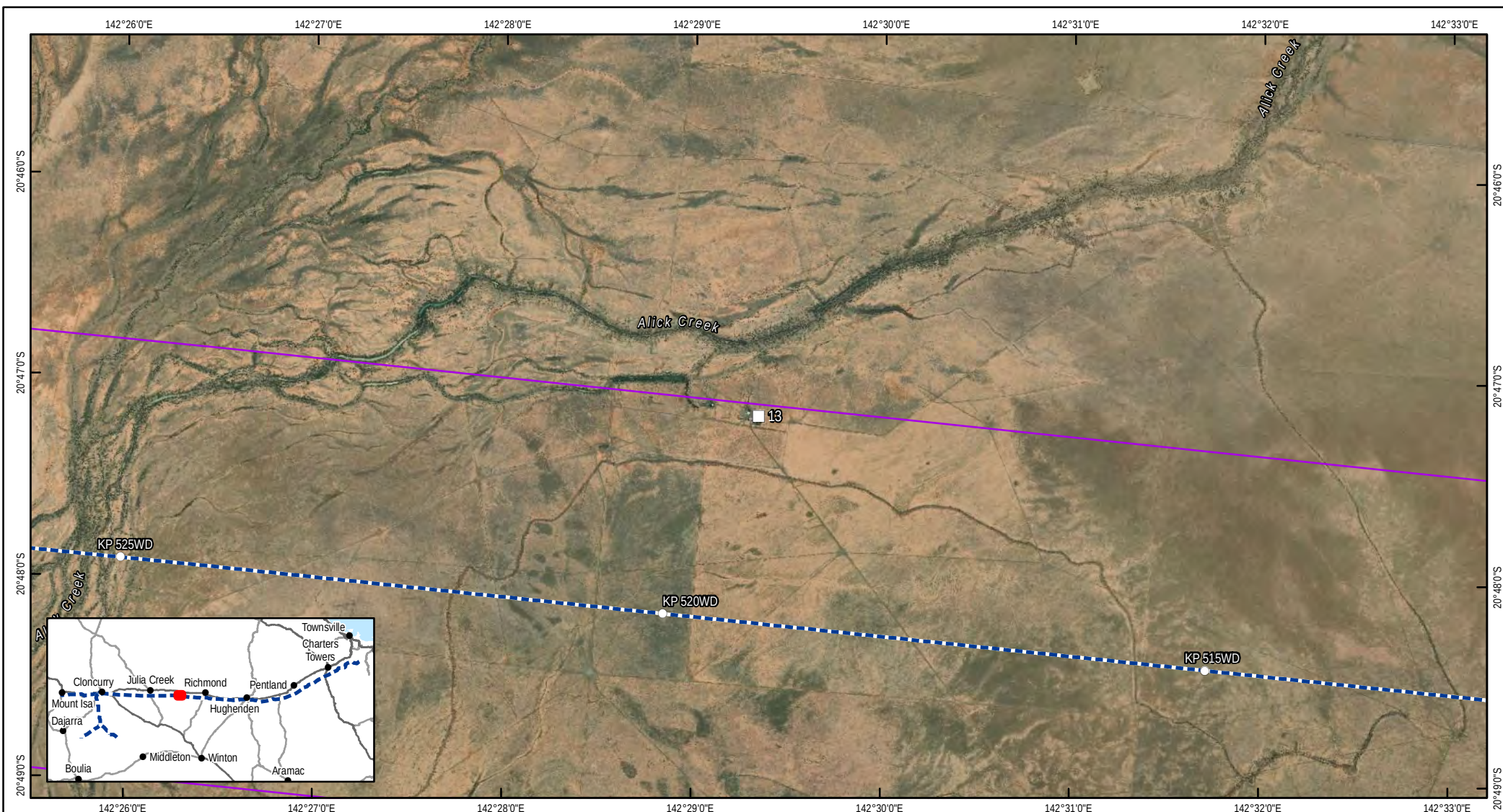
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WKSP Sensitive_Receptors_RevE

CopperString 2.0 EIS

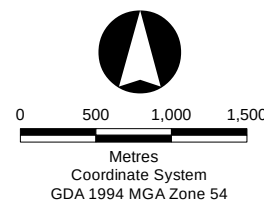
Figure 17-4K - Sensitive receptors





Legend

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|--|-------------------------------|--|----------------------|
| | Sensitive Receptor within 2km | | Railway |
| | Kilometre Post | | Highway |
| | CopperString Alignment | | Secondary Road |
| | 2 km buffer | | Local Connector Road |
| | | | Street |



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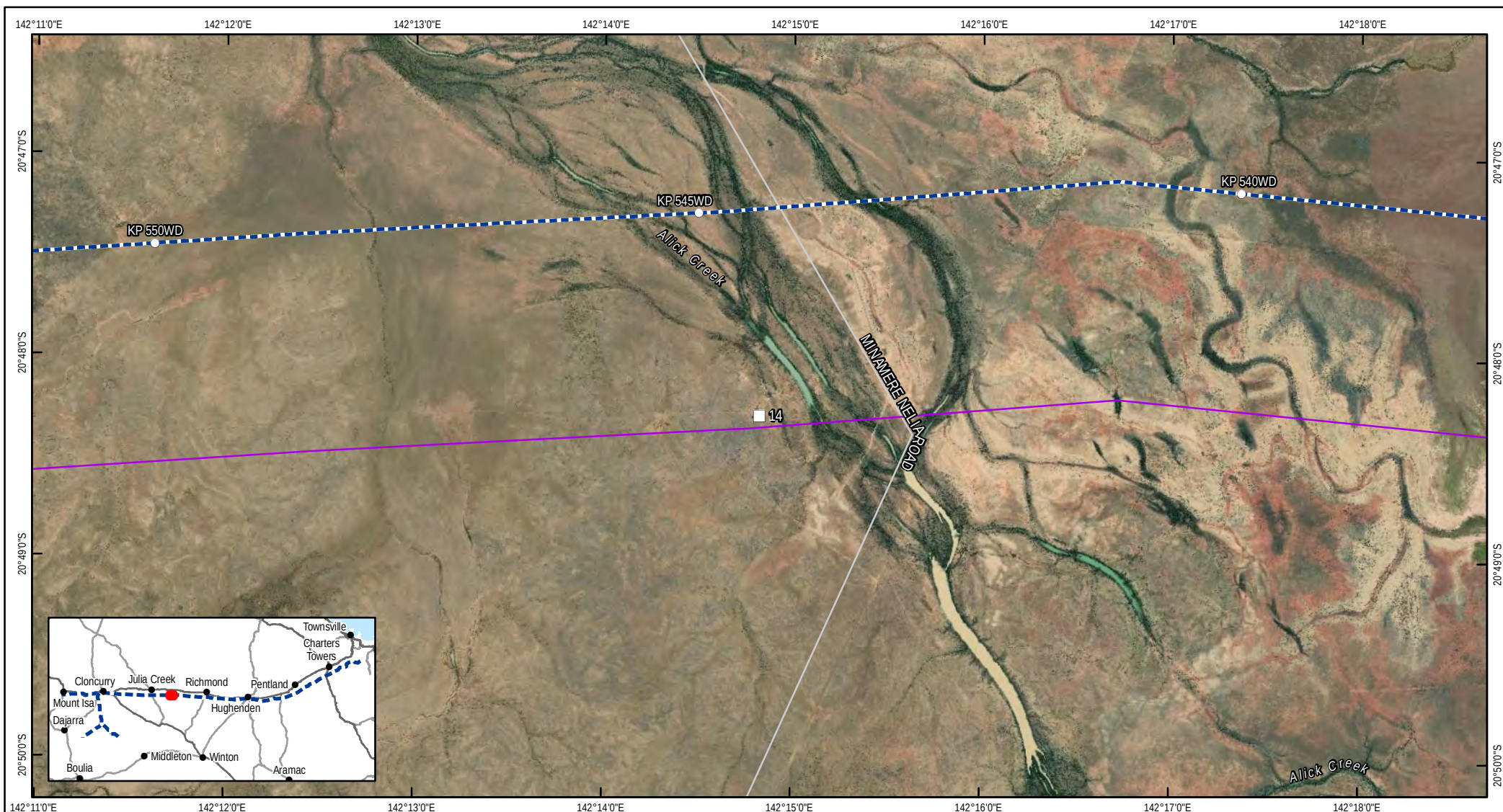
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WKSP Sensitive_Receptors_RevE

CopperString 2.0 EIS

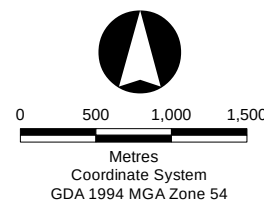
Figure 17-4L - Sensitive receptors





Legend

- Sensitive Receptor within 2km
- Kilometre Post
- CopperString Alignment
- 2 km buffer
- Railway
- Highway
- Secondary Road
- Local Connector Road
- Street



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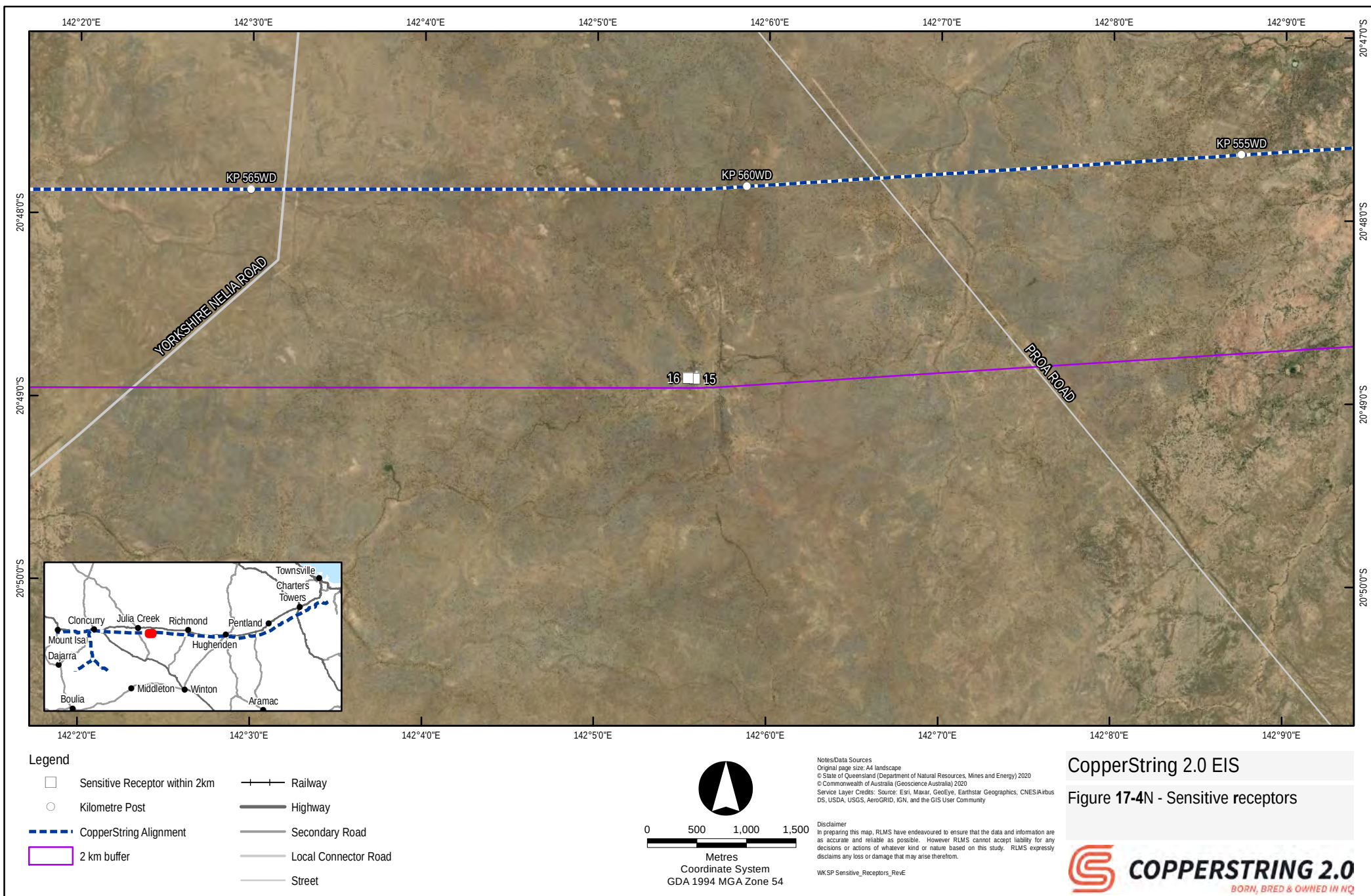
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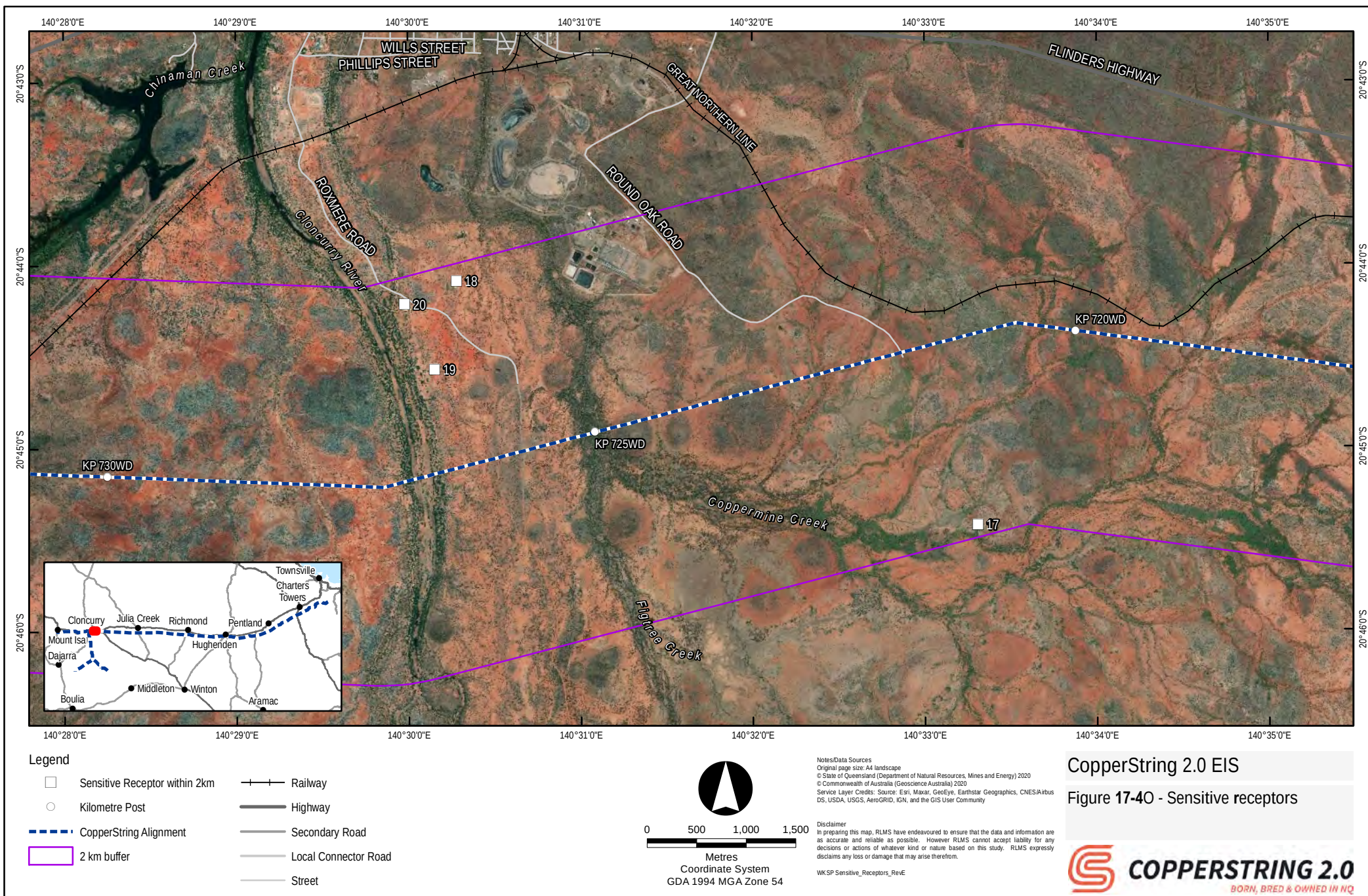
WKSP Sensitive_Receptors_RevE

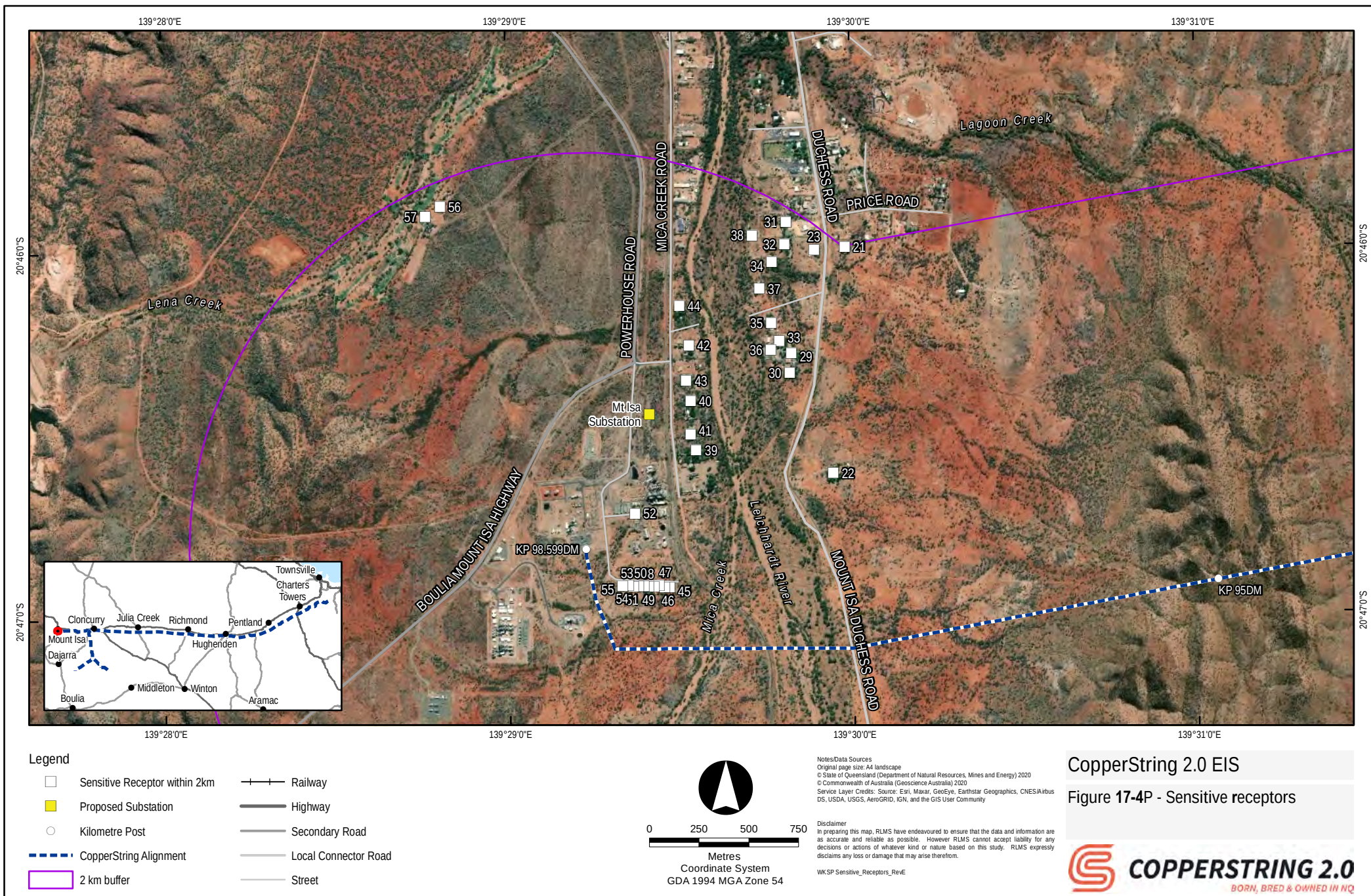
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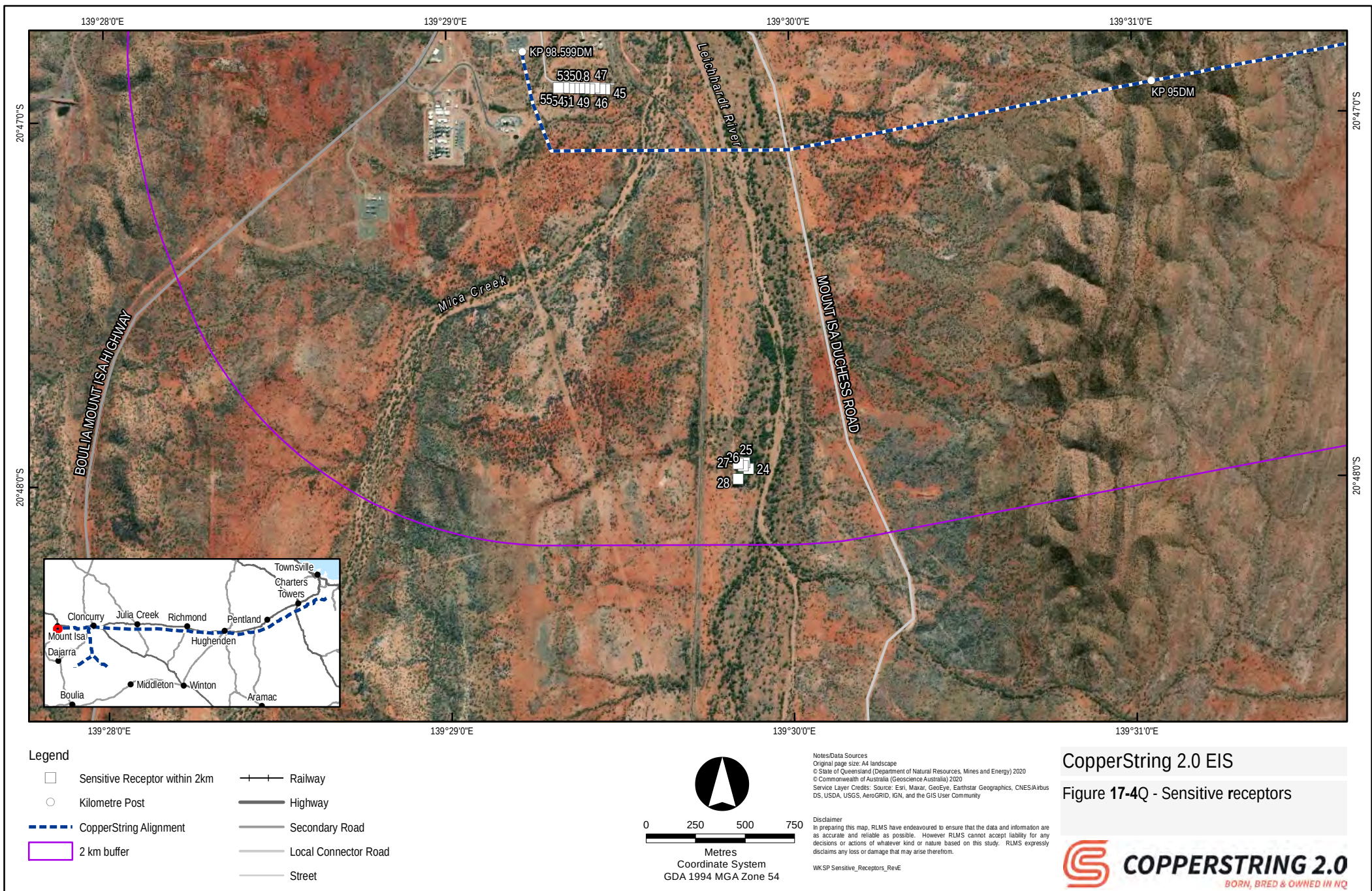
Figure 17-4M - Sensitive receptors











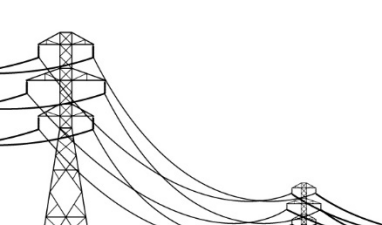
Although elevated noise and dust levels can be expected at locations close to the works areas during construction, works areas will be at setback distances and as such, sensitive receptors affected by construction of access tracks or the use of access tracks during operation and maintenance activities were not assessed. Noise generated from use of access tracks during operation and maintenance activities is considered to be not perceptible.

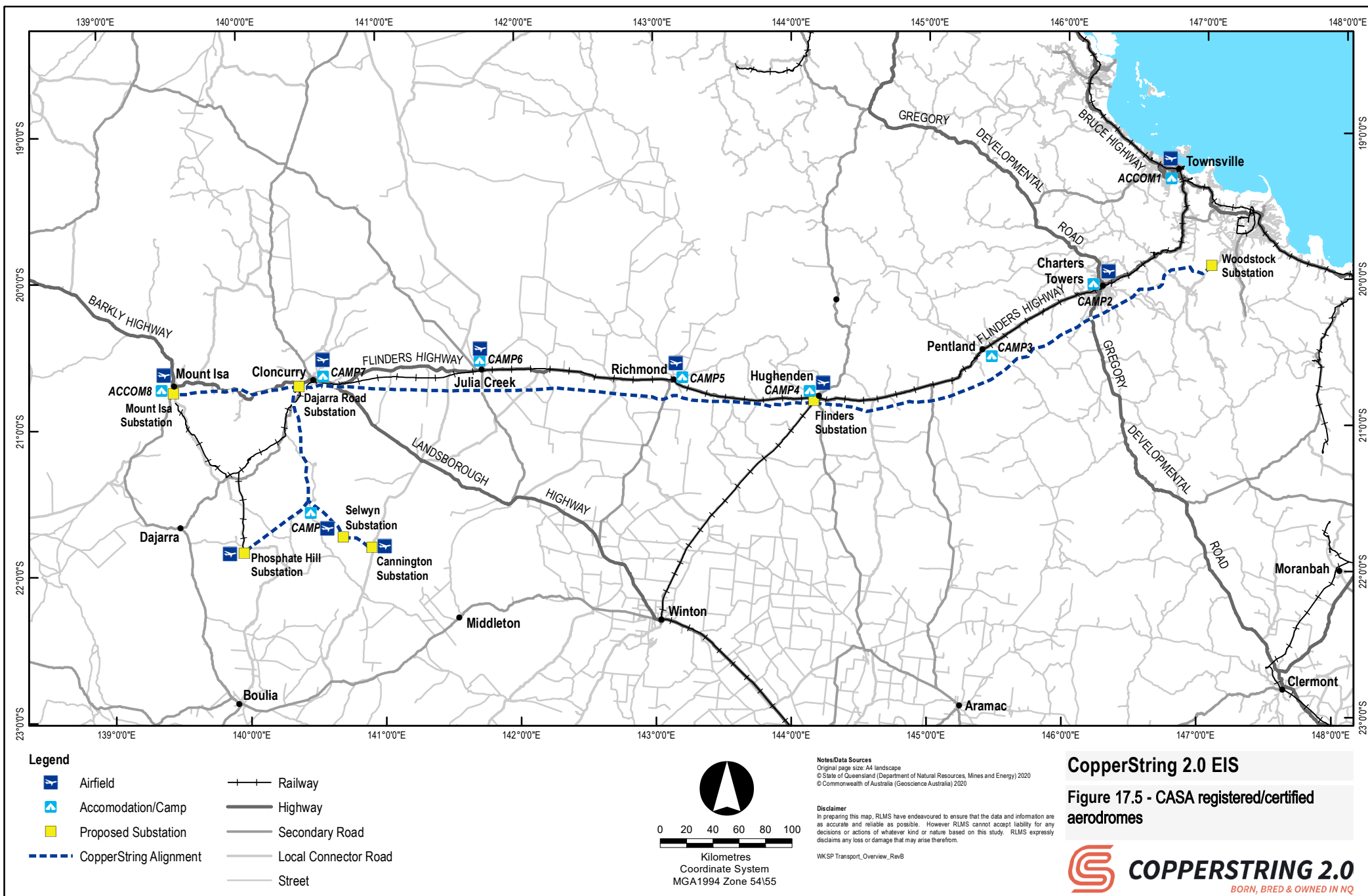
Other potentially affected sensitive receptors include public services and utilities such as education or childcare facilities, Queensland Health facilities, or a Civil Aviation Safety Authority (CASA) certified/registered aerodrome. All identified education, childcare and health facilities are located outside the 2 km buffer established for assessment of sensitive receptors and are not expected to be impacted by hazards associated with the Project.

There are eight certified/registered aerodromes within 25 km of the corridor selection. The nearest certified aerodrome is Trepell, located within the corridor selection. This is a private aerodrome owned by South32 that services Cannington Mine. There are also numerous aircraft landing strips on properties adjacent to the Project area, including the Mount Dore airstrip, which is located close to the Southern Connection.

Locations of CASA certified/registered aerodromes and the Mount Dore airstrip are shown in Figure 17-5.

In addition, the proposed transmission line infrastructure may impact on aerial work of light aircraft, such as heli-mustering, carried out by landholders. Further analysis of the risk presented to aerial work from the Project is provided in section 17.4.8.

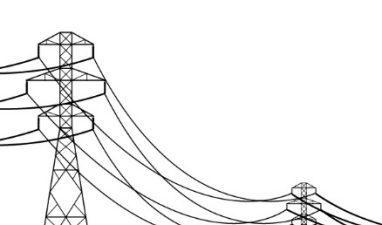




17.3.9 Recommendations

The following recommendations have been made as a result of the existing environment review, in relation to hazards, health and safety:

- A large number of waterways will be traversed by the corridor selection. Design should ensure that water resources are not impacted and that safety around existing watercourse infrastructure is maintained.
- A Road Use Management Plan (RUMP) should be prepared to address the increase of traffic on local roads and highways during construction. These should include, but not be limited to, details about movements of heavy vehicles, transport of construction workers, and details regarding access to transmission line easements
- The placement of towers should consider topographical features and the underlying geological structure so that the integrity of infrastructure and safety of people and the environment isn't compromised
- An erosion and sediment control plan should be developed to manage impacts from soil disturbance, including dust minimisation and control measures
- Design of the transmission line infrastructure should consider climate extremes and may need to be varied for different sections of the alignment (for example, cyclone ratings in coastal lowland sections)
- Due to the high risk of flooding in the wet season, it is recommended that construction is only undertaken during the dry season
- The Project is generally located in remote, rural areas however public health and safety and the community values of local communities should be maintained. Any impacts on public health and safety and community values associated with the construction phase of the Project should be assessed.
- The Project should consider the medical and emergency services available in each town and their capacity to deal with the needs of the construction camps, which will house up to 350 people. Consideration should be given as to whether CuString will need its own medical staff at construction camps.
- The operation of the Project should be considered, with particular attention to the potential impacts of electric and magnetic fields (EMF) from extra high voltage transmission lines
- The majority of the 57 identified residential sensitive receptors are greater than 750 m from the proposed transmission line, with the exception of 11 sensitive receptors located within 350 m of the existing Mica Creek Power Station at Mount Isa. It is recommended that wind speed and wind direction forecasts are considered daily and included in daily pre-start meetings during the construction phase.
- Additional sensitive receptors may be located in proximity of the off-easement access tracks. Noise and vibration, and air quality mitigation measures must be considered during construction, operation and maintenance of off-easement access tracks as they would for the easement.



17.4 Hazard assessment and mitigation measures

17.4.1 Design Response

The corridor selection has been designed with consideration of a range of matters including:

- Current farm infrastructure that may be intersected by the corridor
- Environmental constraints including revisions to 'of concern' ecosystems
- Avoidance of sensitive ecological areas
- Identified cultural heritage place and any buffers around these places.

Existing watercourse crossings will be used for construction of the Project as much as practicable. Where riparian zones contain vegetation that is at risk of significant disturbance from manual line stringing, conductor draw lines and OPGW stringing activities will be performed with helicopters.

A Transport Impact Assessment has been undertaken to assess the impact on local roads and highways (refer to Volume 3 Appendix X Transport impact assessment). A RUMP will be prepared by the Construction Contractor to address the potential impacts of traffic on local roads and highways during construction. The RUMP will be developed in consultation with relevant authorities, such as the Department of Transport and Main Roads, Queensland Rail and local governments.

A Concept Erosion and Sediment and Control Plan has been developed to manage impacts from soils disturbance (refer to Volume 3 Appendix S Concept erosion and sediment control plan).

Project infrastructure will be designed to withstand natural hazards. For example where solar array frames are used for CEV huts, they will be rated for local wind or cyclone conditions.

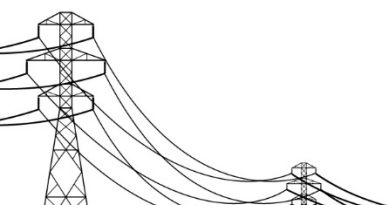
The construction program is structured so that where possible, peak construction activities in areas susceptible to flooding are programmed to occur outside of the wet season. The RUMP will also address wet weather aspects associated with the use of unsealed access tracks, stop work conditions, transport agency consultation on weather events and road use conditions, and formalised wet weather access arrangements with private landholders.

A study on the effects of EMF was undertaken in 2010 and has been reviewed as part of this assessment. Section 17.4.11 addresses EMF. The full study is included in Volume 3 Appendix AC Electro-magnetic field specialist study.

Construction environmental management plans should consider public health and safety with reference to applicable policies outlines in the North Queensland Regional Plan 2020 and the North West Regional Plan 2010.

During construction, wind speed and direction forecasts will be checked daily and communicated during daily pre-start meetings. In the event of high risk winds, a visual inspection of the construction zone will be conducted to check for visible dust and its potential impact on sensitive receptors. Dust control measures will be included in the erosion and sediment control plan and construction activities may be limited until such time as wind speed and/or direction no longer pose a threat to air quality.

Additionally, lightning activity should be monitored throughout the day during the wet season or when there are indications of storm activity in other times of the year. In the event of high risk lightning activity during construction, works may be limited to avoid risk to construction workers.



17.4.2 Overview of hazard identification

Project hazards are those that may affect the Project itself, as well as Project activities and hazardous substances that pose a risk to the health and safety of people and property. The Preliminary Hazard Analysis is based on hazards potentially arising from the Project components and activities as described in Volume 1 Chapter 2 Project description.

Hazard identification focuses on unplanned events that may result in impacts on identified sensitive receptors and property. The hazard identification process applied to the Project assumes compliance with regulatory requirements and does not consider deliberate exposure of hazards, for example, planned releases of pollutants.

The key hazards identified through the PHA are described in Table 17-7.

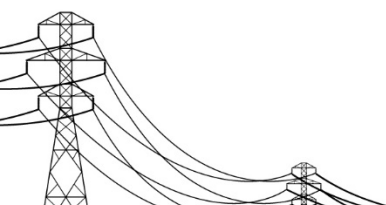
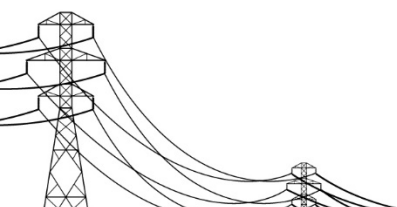


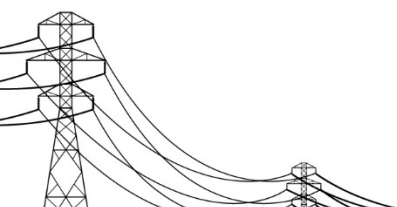
Table 17-7 Hazard and risk assessment

Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Traffic/transport (road)										
Traffic accident such as rollover or collision with another vehicle, wildlife or a stationary object (tree/pole/ pedestrian), resulting in physical damage to vehicle occupants.	Construction Operation Decommissioning	Possible	Major	Health & Safety of People	High	A RUMP will be developed in consultation with the Department of Transport and Main Roads (DTMR) and LGAs. A specific RUMP will be developed for oversized loads. Only use designated travel routes eg. Approved DTMR routes through townships for heavy vehicles, no off-road/track short cuts etc. Safety induction to staff and contract workers which will include awareness regarding traffic rules. Standard contractor training will include 4WD training Remote area first aid training for everyone travelling in (not just driving) vehicles. Implementation of fatigue and alcohol and other drugs management strategies. Consider using light vehicles with high ANCAP ratings and heavy vehicles with high Euro NCAP ratings (ie. vehicles fitted safety technologies such as with forward collision avoidance) Vehicle pre-start checks	Incorporate vehicle accident response in Emergency Response Plan. Develop the plan in conjunction with emergency services. Notify emergency services of any accidents. First aid kits and remote area communications equipment in all Project related vehicles	Unlikely	Major	High
Traffic accident, such as vehicle colliding with a pedestrian, resulting in physical damage to pedestrian	Construction Operation Decommissioning	Possible	Major	Health & Safety of People	High	A RUMP will be developed in consultation with DTMR and LGAs. Consider using light vehicles with high ANCAP ratings and heavy vehicles with high Euro NCAP rating, ie. Vehicles fitted with safety technologies such as forward collision avoidance. Safety induction to staff and contract workers which will include awareness regarding traffic rules. Remote area first aid training for everyone travelling in (not just driving) vehicles. RUMP for Project sites eg. camps, laydown areas, tower sites, brake and tension sites, line sections being strung, etc Use of high visibility clothing in zones shared by pedestrians and vehicles	Emergency Response Plan First aid kits and remote area communications equipment in all Project related vehicles.	Unlikely	Major	High

Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Damage to public road ways (i.e. From heavy equipment movement)	Construction Operation (major maintenance) Decommissioning	Unlikely	Minor	Financial & Economic Community & Social	Low	RUMP	RUMP that includes baseline surveys and ongoing road network monitoring with mitigative and corrective actions	Rare	Minor	Low
Aircraft										
Helicopter accident during stringing of draw lines/earth wires or refuelling	Construction Operation (maintenance) Decommissioning	Unlikely	Major	Health & Safety of People	High	Safe Work Method Statement (SWMS) Use qualified helicopter contractors with helicopters appropriately rated and fitted out for line stringing Fatigue management plans Change management plans		Rare	Major	Medium
Aircraft crash (transport of personnel)	Construction	Unlikely	Catastrophic	Health & Safety of People	High	Use of qualified and reputable aircraft charters/operators	Disaster Management Plan	Rare	Catastrophic	High
Power lines and towers										
Person or animal contact with live dropped transmission lines	Operation	Possible	Major	Health & Safety of People	High	Transmission line protection systems designed to operate reliably under the prospective fault levels, including high impedance fault conditions, with indication and alarming of disabled and/or malfunctioning protection and trip systems Community and landholder education Scheduled maintenance plan for protection systems Change management system triggering protection studies on significant changes in network parameters.	Disaster Management Plan Processes and procedures responding to maloperation of protection systems Reactive Maintenance Plan for protection systems	Unlikely	Major	High
Person contact with live dropped transmission lines (Ergon or Powerlink)	Construction Operation Decommissioning	Possible	Major	Health & Safety of People	High	SWMS	Emergency Response Plan	Unlikely	Major	High
Activities of others on easement resulting in fatality, such as electrocution following breach of high voltage clearance boundaries	Operation	Possible	Major	Health & Safety of People	High	Community and landholder education Develop a guide line to work near transmission power lines.	Disaster Management Plan	Unlikely	Major	High



Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Hazardous step and touch potentials present on tower structures result in injury to people or animals	Operation	Unlikely	Major	Health & Safety of People	High	Design specifications and installation standards for insulation and earthing systems, including appropriate soil resistivity tests for design Transmission line protection system designed to operate reliably under the prospective fault levels, including high impedance fault conditions, with indication and alarming of disabled and/or malfunctioning protection and trip systems. Provide duplicate primary and back up protection system for transmission line faults. Schedule maintenance plans for insulator integrity, protection systems and earthing systems SWMS	Processes and procedures responding to maloperation of protection systems Reactive maintenance plans for insulator integrity	Rare	Major	Medium
Hazardous step and touch potentials present on tower structures result in injury to people (Ergon or Powerlink lines)	Construction Decommissioning	Unlikely	Major	Health & Safety of People	High	SWMS Earthing system design towers and substations according to Australian standards to reduce the fatality risks.	Emergency Response Plan	Rare	Major	Medium
Vehicle interaction with transmission lines (includes haul trucks and other heavy earth moving equipment where lines pass over mining leases, cranes working on structures such as bore pumps beside easements)	Operation	Possible	Major	Health & Safety of People	High	Visible warning signage in high trafficked areas Maintain project GIS and make data available to public through Energy Queensland "Look Up and Live" web based GIS and Queensland Spatial databases Safety in design reviews		Unlikely	Major	High
Vehicle interaction with transmission lines (Ergon or Powerlink)	Construction Decommissioning	Possible	Major	Health & Safety of People	High	Consultation with Ergon Energy or Powerlink to review risk, they may install line markers where appropriate. Installation of appropriate height restriction indicators and devices at high risk areas and traffic controls at roads and tracks under power lines SWMS	Emergency Response Plan	Unlikely	Major	High

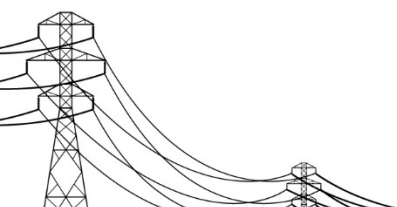


Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Aircraft interaction with transmission towers when lines are not connected	Construction Decommissioning	Possible	Major	Health & Safety of People	High	Transmission towers fitted with warning lights in high risk areas Education of local aviators, airport operator certificate holders and landholders on the location of transmission lines Maintain project GIS and make data available to public through Energy Queensland "Look Up and Live" web based GIS and Queensland Spatial databases Application of CASA and RAAF requirements including "AC 139-08 Reporting of tall structures"	Disaster Management Plan	Unlikely	Major	High
Aircraft interaction with transmission lines – wire strike risk, particularly where transmission lines cross valleys and in vicinity of aerodromes where aerial mustering is carried out	Construction Operation Decommissioning	Possible	Major	Health & Safety of People	High	Transmission line identification markers installed in high risk areas Education of local aviators, airport operator certificate holders and landholders on the location of transmission lines including installation of line markers on request from land owners Continue consultation with landholders regarding location of transmission lines and potential impacts to existing infrastructure – shifting of cattle yards may be appropriate in some instances Licensed contractors used for line inspection	Disaster Management Plan	Unlikely	Major	High
Aircraft interaction with power lines (Ergon or Powerlink)	Construction Decommissioning	Possible	Major	Health & Safety of People	High	Consult with Ergon and Powerlink SWMS	Emergency Response Plan	Unlikely	Major	High
Unauthorised people accessing or tampering with towers	Operation	Rare	Moderate	Health & Safety of People	Low	Warning signage Installation of anti-climbing safety barriers Maintenance plans for the above safety features	Emergency Response Plan	Rare	Moderate	Low

Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Tower collapse	Operation	Rare	Moderate	Financial & Economic Community & Social	Low	Tower design specifications include appropriate wind speed ratings. Sparse geotechnical surveys for design of a range of standard footings, based on soil/rock type under dry and flood conditions where appropriate. Engineering design and analysis of tower structural steelwork and foundation designs including destructive testing of towers and foundation pull-out. In field analysis and interpretation of soil/rock conditions for selection of footings at each foundation Preventative maintenance plans for tower structural integrity.	Disaster Management Plan	Rare	Minor	Low
Electrical interactions with third party services (e.g. Pipelines, railway, Ergon Energy distribution and Powerlink transmission lines)	Operation	Possible	Major	Health & Safety of People Community & Social	High	Safety in design review Detailed assessment of the Earth Potential Rise (EPR) and low frequency induction risk on pipelines according to AS/NZS 4853 Asset management strategies Ongoing monitoring Consultation with affected parties	Disaster Management Plan	Unlikely	Major	High
Interactions with third party services (eg. pipelines, railway, Ergon Energy distribution and Powerlink transmission lines)	Construction Decommissioning	Possible	Major	Health & Safety of People	High	Use of “dial-before-dig” and “look-up-and-live” Consultation with entities operating third party services SWMS	Emergency Response Plan	Unlikely	Major	High
Increased EMF in vicinity of energised electrical infrastructure	Operation	Likely	Insignificant – EMF levels will comply with the International Commission for Non-Ionising Radiation Protection (ICNIRP)	Health & Safety of People Community & Social	Medium	Safety in design reviews		Possible	Insignificant	Low

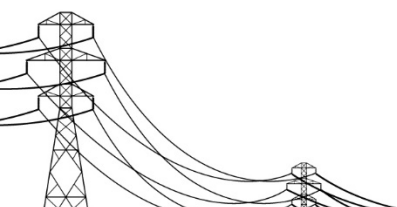
Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
EMF from third party services such as interfaces at Ergon Energy and Powerlink plant, mobile phone repeater stations that might be mounted on transmission structures	Construction Decommissioning	Likely	Minor (assuming people at risk don't have pacemakers – probably wouldn't if this was their main field of work)	Health & Safety of People Community & Social	Medium	Consultation with entities operating third party services SWMS	Emergency Response Plan	Possible	Insignificant	Low
Hazardous step and touch potentials around and within existing (non-CuString) substations under line/equipment fault conditions	Construction Decommissioning	Unlikely	Major	Health & Safety of People Community & Social	High	Consultation with operators of third party substations SWMS	Emergency Response Plan	Rare	Major	Medium
Electrocution during transmission line maintenance	Operation	Possible	Major	Health & Safety of People Community & Social	High	Safety in design reviews SWMS Work undertaken by competent and authorised personnel		Unlikely	Major	High
Electrocution during substation maintenance	Operation	Possible	Major	Health & Safety of People Community & Social	High	Safety in design reviews SWMS Work undertaken by competent and authorised personnel		Unlikely	Major	High
Substations										
Injury during unauthorised access to substation	Construction Operation Decommissioning	Unlikely	Moderate	Health & Safety of People	Medium	Education, awareness and training Tiered substation security systems including intruder alarm system, CCTV, security lighting etc. Layering of fencing as appropriate for the hazards Safety signage Housekeeping – site appearance and on-site storage that does not entice theft and vandalism –vegetation screening etc.		Rare	Moderate	Low

Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Hazardous step and touch potentials around and within substations under line/equipment fault conditions	Operation	Unlikely	Major	Health & Safety of People Community & Social	High	Acquiring enough land for substation to ensure appropriate protected areas, sterile zones and clearance zones in regards to electrical interactions that could bypass touch and step potential controls (transfer of potential, etc) Design specifications and installation standards for insulation and earthing systems, including appropriate soil resistivity tests for design. Transmission line and plant protection system designed to operate reliably under the prospective fault levels, including high impedance faults conditions with indication and alarming of disabled and/or malfunctioning protection and trip systems Scheduled maintenance plans for equipment integrity, protection systems and earthing systems		Rare	Major	Medium
Construction sites and construction camps										
Injury to third party due to unauthorised access to construction site	Construction Operation Decommissioning	Unlikely	Moderate	Health & Safety of People	Medium	Security patrols (of substation sites) Fencing and signage advising of safety Access roads fenced to restrict non-authorised access Protection at open excavations		Rare	Moderate	Low
Injury to third party due to interaction with an open excavation/civil works (e.g. Vehicle accident into excavation)	Construction Operation Decommissioning	Unlikely	Major	Health & Safety of People	High	Fencing and signage advising of safety Access roads fenced to restrict public access Protection at open excavations		Rare	Major	Medium
General workplace accidents	Construction Operation Decommissioning	Likely	Insignificant	Health & Safety of People	Medium	Safety Management Plan		Unlikely	Insignificant	Low
Contact with contaminated land, water or unexploded ordnance	Construction Operation Decommissioning	Unlikely	Moderate	Health & Safety of People	Medium	Register and mapping of sites SWMS Environmental Management Plan (EMP)	Emergency Response Plan	Rare	Moderate	Low
Contact with contaminated water or sewage water at construction camps	Construction	Unlikely	Moderate	Health & Safety of People	Medium	Safety Management Plan		Rare	Moderate	Low



Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Release of waste water, including wash down water from concrete batch plants/trucks	Construction	Possible	Minor	Environmental Health & Safety of People	Low	Adhere to code of practice for concrete batching industry CEMP SWMS	Emergency Response Plan	Unlikely	Minor	Low
Fire										
Fire on site (including construction camps)	Construction Operation Decommissioning	Unlikely	Moderate	Health & Safety of People	Medium	Portable fire extinguishers Hot work permits and procedures Mobile watering tanks Dangerous goods restrictions. Management of ignition e.g. smoking	Emergency Response Plan (construction and decommissioning) Disaster Management Plan (operation)	Rare	Moderate	Low
Fire involving flammable substances at construction camp or laydown areas	Construction	Possible	Moderate	Health & Safety of People	Medium	Fire hydrants Signage Storage and handling of flammable substances in accordance with SDS Physical separation of dangerous goods	Emergency Response Plan	Unlikely	Moderate	Medium
Fire in control buildings	Construction Operation Decommissioning	Possible	Minor	Health & Safety of People	Medium	Fire detection system Fire protected cabling Fire separation between panels Gas suppression system	Emergency Response Plan (construction and decommissioning) Disaster Management Plan (operation)	Unlikely	Minor	Low
Transformer fire or explosion affecting people or environment	Construction (commissioning) Operation	Possible	Major	Health & Safety of People Community & Social Financial & Economic Environmental	High	Design to include appropriate prevention, detection and control systems for fires in oil compartments, including handling of released oil. Safety in design reviews. Maintenance plans (scheduled and reactive) for oil compartments and fire detection and control systems, including systems for control of oil releases	Emergency Response Plan (construction) Disaster Management Plan (operation)	Unlikely	Major	High

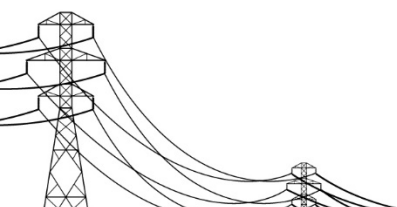
Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Bushfire ignited by arc or spark from transmission line (high impedance and/or transient faults – broken/downed conductor, vegetation, line clash, flashover))	Operation (including commissioning phase)	Possible	Major	Health & Safety of People Community & Social Financial & Economic Environmental	High	Transmission line protection systems designed to operate reliably under the prospective fault levels, including high impedance fault conditions, with indication and alarming of disabled and/or malfunctioning protection and trip systems Community and landholder education Design and integrity of transmission network Continuous control centre network monitoring Schedule maintenance plans for protection systems Schedule maintenance plans for fuel management and vegetation control in easements	Emergency Response Plan (Commissioning) Disaster Management Plan, including critical spare materials and equipment to minimise disruption (operation)	Unlikely	Major	High
Bushfire in vegetation off-easement causing damage to transmission infrastructure resulting in blackout.	Operation	Possible	Major	Health & Safety of People Community & Social Financial & Economic Environmental	High	Transmission line protection systems designed to operate reliably under the prospective fault levels, including high impedance fault conditions, with indication and alarming of disabled and/or malfunctioning protection and trip systems Community and landholder education Design and integrity of transmission network Continuous control centre network monitoring Schedule maintenance plans for protection systems Schedule maintenance plans for fuel management and vegetation control in easements	Disaster Management Plan, including critical spare materials and equipment to minimise disruption (operation)	Unlikely	Major	High
Explosives										
Blasting accident or misfire	Construction	Unlikely	Moderate	Health & Safety of people	Medium	Safety Management Plan SWMS Personnel qualified in use and handling of explosives Safe blast design, incorporating access control and evacuation warnings	Emergency Response Plan	Rare	Moderate	Low
Fly rock and seismic activity from 3 rd party blasting eg. mine sites that easement passes over	Construction Operation Decommissioning	Unlikely	Moderate	Health & Safety of people Financial & Economic	Medium	Consultation and communication with relevant 3 rd parties to develop appropriate safe work procedures	Emergency Response Plan (construction) Disaster Management Plan (operation)	Rare	Moderate	Low



Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Uncovering of UXO	Construction	Rare	Moderate	Health & Safety of people	Low	Safety Management Plan Include the following: - Stop work - Prevent contact or disturbance of the object - Immediately advise Environment Manager and Queensland Police Service to arrange assessment and removal	Emergency Response Plan	Rare	Moderate	Low
Floods										
Flooding of construction camp/site/laydown area	Construction	Possible – if construction is carried out during regional wet season (e.g. Monsoon/cyclones.)	Minor	Financial & Economic	Medium	Flood studies for site selection of temporary construction infrastructure and project infrastructure Appropriate construction scheduling	Emergency Response Plan	Unlikely	Minor	Low
Vehicle trapped/washed away by flood waters	Construction Operation Decommissioning	Possible – if construction is carried out during regional wet season	Major. Injury or death of worker/s. Loss of vehicle.	Health & Safety of People Financial & Economic Community & Social	High	Appropriate construction scheduling Training and awareness of driving in wet/flood conditions	Emergency Response Plan	Unlikely	Major	High
Flooding and inundation of tower sites	Operation	Likely – during wet season	Minor	Financial & Economic Environmental	Medium	Appropriate design of footings and surface finish (drainage profile, surfacing material, etc) in flood prone areas Seasonal access restrictions as appropriate for regions such as black soil plains	Use appropriate transport methods for access in regions with seasonal access restrictions – helicopters during wet season on black soil country	Possible	Minor	Medium
Flooding and inundation of substation sites	Operation	Possible – during wet season	Minor	Financial & Economic	Medium	Flood studies for site selection of substations	Disaster Management Plan	Rare	Minor	Low
Cyclones										
Disruption to power supply	Operation	Likely	Moderate	Community & Social Financial & Economic	High	Development of critical spares inventories and response procedures Scheduled routine maintenance for vegetation clearances and access tracks	Disaster Management Plan	Likely	Minor	Medium

Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Hazardous substances										
Hazardous substance spill/leak during transport or manual handling	Construction Operation Decommissioning	Possible	Moderate	Health & Safety of People Community & Social Financial & Economic Environmental	Medium	Local roads used to transport hazardous substances are sealed, and access roads to laydown yard, construction camps and concrete batching plants will be gravel compacted. Yards, camps and concrete batching areas will all be hardstand. Safety induction to staff and contract workers will include awareness regarding traffic rules. All appropriate vehicles conform to ADG Code. Regular vehicle safety inspections. Implement fatigue and alcohol management strategies. Consider using light vehicles with high ANCAP ratings and using heavy vehicles with high Euro NCAP ratings (ie. Vehicles fitted with forward collision avoidance technology). First aid, spill response and fire-fighting equipment will be available on applicable vehicles. Transportation for diesel for construction is expected to be via B-double tankers in compliance with Australian Code for Transport of Dangerous Goods by Road and Rail. Portable petroleum-product fuel containers will comply with the requirements under AS/NZS 2906:2001 Fuel containers- Portable – Plastic and metal. Mobile fuel trucks of 12,000 L capacity used to fuel onsite equipment will be fitted with automatic shutoff valves and comply with the requirements of the ADG Code.	Emergency Response Plan to include hazardous substance spills response measures. Containment and immediate clean-up of spills. Removal of contaminated soils and sediments and rehabilitation or damaged vegetation. Sampling as required depending on the extent of spill. Use licenced contractor for removal and disposal of spilled and clean-up material. Notify emergency services in case of spills on public roads. Notification to Department of Environment and Science (DES) as required under approval conditions.	Unlikely	Moderate	Medium
Hazardous substance contact (skin/eyes/ingestion etc)	Construction Operation Decommissioning	Possible	Minor	Health & Safety of People	Medium	Inductions and training on safe handling of hazardous substances SDS available First aid, spill response equipment available and all people accessing the site trained to use them PPE available.	Emergency Response Plan Provide immediate first aid to the victim. Transport to hospital for further medical attention if required.	Unlikely	Minor	Low

Hazard	Stage of works	Likelihood of occurrence	Consequence	Consequence type	Overall Risk	Preventative measures	Responsive measures	Residual risk		
								L	C	Risk
Wildlife and livestock										
Wildlife hazards such as snakebite	Construction Operation Decommissioning	Possible	Moderate	Health & Safety of People	Medium	Fauna spotter/catchers present on site during vegetation management activities, when snake-related incidents are expected to be highest. Provide adequate warning signs in areas with potential for presence of snakes Provide adequate illumination if working at night. Wear adequate PPE. First aid kits with snake (compression) bandages – personnel to be trained in snake bite response	Emergency Response Plan Provide immediate first aid to the victim. Transport to hospital for further medical attention. Conduct site specific inductions for all personnel to be aware of wildlife hazards. Use alert systems and notification posters to keep personnel aware of changes to hazards. Ensure the availability of first aid officers on site to treat potential injuries.	Rare	Moderate	Low
Unplanned impacts on endangered, vulnerable or near threatened species or habitat	Construction Operation Decommissioning	Unlikely	Minor	Community & Social Environmental	Low	EMP ESWMS Maintenance of Project GIS and use of that data in work plans Buffer distances in environmentally sensitive areas Hazard mapping showing sensitive areas to be avoided Signage of sensitive areas	Disaster Management Plan	Rare	Minor	Low
New or increased infestation of weeds resulting from unsuitable land management	Construction Operation Decommissioning	Possible	Minor	Community & Social Environmental	Medium	Adhere to pest management procedures outlined in Volume 3 Appendix Q Framework Environmental Management Plan. Vehicle wash-down facilities. Restricted access. Weed Management Plan Maintenance of Project GIS Ongoing rehabilitation management to include weed control.		Unlikely	Minor	Low
Third party assets										
Damage to third party assets or loss or production to mining connections due to power supply, faults or failures	Construction Operation Decommissioning	Unlikely	Minor	Financial & Economic Community & Social	Low	Consultation with customers NEM registration of sheddable loads Customers critical system would have back up power supplies, including local generation Design of network includes power quality and reliability requirements for regulated customer connections	Disaster Management Plan	Rare	Minor	Low



17.4.3 Detailed risk analysis

This section provides a more detailed discussion and analysis of the key risks identified in the PHA. Further analysis will allow an objective judgement to be made regarding the tolerability of the identified risk exposures, by considering the level of risk in more detail, and the effectiveness of the risk controls to be implemented. The detailed risk analysis also considers the proximity of the Project to sensitive receptors identified in section 17.3.8.

Quantitative analysis of risks was completed where:

- Reliable and accurate data was available to enable quantitative measure of consequence and likelihood to be determined with a reasonable level of confidence
- There was objective criterion against which a calculated risk level could be evaluated.

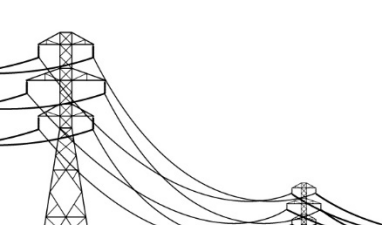
In other instances where a quantitative analysis would be academic, qualitative and semi-quantitative measures are appropriate and have been used to evaluate the acceptability of identified risks, based on the control strategies which will be put in place to manage them. Further, similar risk issues which are experienced and tolerated elsewhere in the community have been considered.

Some of the risks and management strategies identified in the PHA are described more thoroughly in other sections of the EIS, including:

- Volume 1 Chapter 3 Site description and climate
- Volume 2 Chapter 5 Land
- Volume 2 Chapter 6 Geology and soils
- Volume 2 Chapter 7 Flora and fauna
- Volume 2 Chapter 9 Water resources and water quality
- Volume 2 Chapter 13 Transport

The risk analysis determined that the level of residual risk, after the proposed control and mitigation strategies are implemented, are considered acceptable, based upon the following factors:

- Risks are similar to those currently considered tolerable by the community.
- The Project will be designed, constructed, and operated under comprehensive regulatory requirements of the electricity transmission industry in Australia, much of which addresses the well-understood inherent safety risks and system reliability considerations.
- The proposed design makes use of operational technology and construction methods which are proven and standard for the industry.
- The environmental setting of the Project is favourable, with adequate separation achieved between the assets and potential sensitive receptors and sensitive land uses, which minimises the risk exposure from localised hazard events, such as transformer fires or explosions.
- The more regional risk to people and property associated with bushfire is similarly mitigated through the available separation, but additional features such as the low to moderate inherent bushfire risk and planned vegetation management process further reduces the risk.



17.4.4 Risk acceptance criteria

To evaluate the level of off-site risk associated with the CopperString 1.0 Project, the New South Wales Department of Planning's Hazardous Industry Planning Advisory Paper Number 4 (HIPAP 4): Risk Criteria for Land Use Safety Planning 2011 was consulted. The risk criteria in HIPAP 4 are commonly referenced and utilised by Queensland Government agencies and have been developed to provide a sound basis for compatible land use safety planning.

The HIPAP 4 criteria provide suggested quantitative measures of individual risk at land uses adjacent to industrial developments, which would generally be considered acceptable and are presented in Table 17-8. These proposed levels of risk are generally below existing levels of risk already being experienced by the community.

Table 17-8 Individual fatality risk criteria

Land use	HIPAP fatality risk criteria (risk in a million per year)	
	Suggested risk tolerance	Numerical value
Hospitals, schools, childcare facilities and old age housing	0.5	$0.5 \times 10^{-6}/\text{yr}$
Residential developments and places of continuous occupancy, such as hotels and tourist resorts	1	$1.0 \times 10^{-6}/\text{yr}$
Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres	5	$5.0 \times 10^{-6}/\text{yr}$
Sporting complexes or active open space areas	10	$10.0 \times 10^{-6}/\text{yr}$
Industrial	50	$50.0 \times 10^{-6}/\text{yr}$

Risk tolerance criteria regarding toxic hazards are also presented in HIPAP 4, but as no such hazards were identified in relation to the Project, they were not considered further.

Information regarding the proximity of the Project to public sensitive receptors, including education and health facilities is detailed in section 17.3.8.

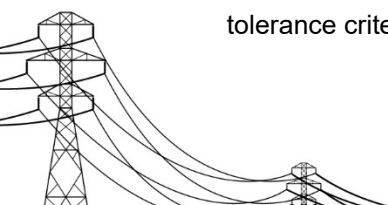
17.4.5 Substation transformer fire and explosion

17.4.5.1 Potential impacts

The substation transformers are one of the few components of the Project that have the potential for a sudden and severe release of energy. Quantitative analysis of the consequence and likelihood of transformer overpressure and pool fire risks were completed in 2010 as reliable and accurate data was available, in conjunction with an objective criterion from HIPAP 4. This data is expected to be unchanged for the Project.

Transformer overpressure analysis undertaken in 2010 concluded that explosion scenarios evaluated do not represent a significant risk of fatality at or beyond the site boundary. HIPAP 4 also presents injury risk criteria for off-site exposures, but these are only relevant if the facility is bordered by a residential area or other sensitive land use (e.g. school or health care facility). There are no such land uses within the potential injury effect zones of the modelled transformer explosion scenarios.

With respect to potential on-site impacts, the individual fatality risk is conservatively estimated at less than 9×10^{-6} per year. There is not a defined risk tolerance criterion for on-site safety risks, but it is worth noting that the estimated exposure is five times less than the HIPAP 4 risk tolerance criteria for a neighbouring industrial facility.



Regarding transformer pool fires, it can be concluded that the scenarios evaluated do not represent a significant risk of fatality at or beyond the site boundary, as HIPAP 4 injury risk criteria for off-site exposures are only relevant if the facility is bordered by a residential area or other sensitive land use.

With respect to potential on-site impacts of transformer pool fires, the individual fatality risk is again conservatively estimated at less than 9×10^{-6} per year, on the basis that no more than three transformers contribute to the individual fatality risk at any one location within the respective substation sites. In fact, a more accurate estimate would be significantly lower than this value as it is not sufficient that a person is simply within the facility, but they would actually need to be within a much smaller thermal radiation effect zone.

Furthermore, the injury impacts of thermal radiation are much more time dependent than explosion impacts, which are essentially instantaneous. Therefore, unless a person is exposed to very severe thermal radiation (i.e. close to the source) or is incapacitated in some way, it is highly likely that they would be able to escape severe injury by moving a distance of a few tens of metres.

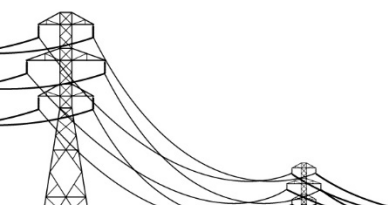
It was also concluded that there is not a significant risk of a transformer fire leading to a bushfire. Research into Queensland's bushfire history indicates that over the period from 1900 to 2006, 12 fatalities have resulted from bushfires in Queensland from all causes. There is insufficient data to provide a conclusive estimate of the individual fatality risk specifically attributable to electricity transmission, but a 2008 report by the Australian Institute of Criminology suggests that approximately 3 percent of known bushfire causes in Queensland are the result of electrical ignition (Bryant, 2008). This figure however, covers a large number of potential 'electrical' causes of which electricity transmission is only one portion. For all 'electrical' causes the average bushfire fatality rate, assuming 100 percent of the exposure is in rural areas, has been estimated at 6.6×10^{-9} fatalities per person year, on the basis that the probability of fatality is independent of the cause of a bushfire.

On the basis that the majority of the corridor selection passes through areas with a low to moderate inherent bushfire risk, with some small areas of high to very-high bushfire risk, it is reasonable to conclude that the local risk would not be grossly disproportionate to the average state value, which is approximately 100 times less than the most conservative risk tolerance criterion from HIPAP 4. Further information regarding natural hazards, including bushfires, is discussed in 17.4.8.

A comparison of the Project against the HIPAP 4 Land Use Criteria is presented in Table 17-9. Of the land uses adjacent to the Project area (refer to Volume 2 Chapter 5 Land), none occur within the potential injury effect zones of the modelled transformer explosion scenarios.

Table 17-9 HIPAP 4 risk criteria

Land use	HIPAP fatality risk criteria (risk in a million per year)		Conforms to risk criteria
	Suggested risk tolerance	Numerical value	
Hospitals, schools, childcare facilities and old age housing	0.5	$0.5 \times 10^{-6}/\text{yr}$	All transmission network sites deemed acceptable since there are no structure of this definition with the $0.5 \times 10^{-6}/\text{yr}$ contour.



Land use	HIPAP fatality risk criteria (risk in a million per year)		Conforms to risk criteria
	Suggested risk tolerance	Numerical value	
Residential developments and places of continuous occupancy, such as hotels and tourist resorts	1	$1.0 \times 10^{-6}/\text{yr}$	All transmission network sites deemed acceptable since there are no structures of this definition with the $1.0 \times 10^{-6}/\text{yr}$ contour.
Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres	5	$5.0 \times 10^{-6}/\text{yr}$	All transmission network sites deemed acceptable since there are no structures of this definition within the $5.0 \times 10^{-6}/\text{yr}$ contour.
Sporting complexes or active open space areas	10	$10.0 \times 10^{-6}/\text{yr}$	All transmission network sites deemed acceptable since there are no structures of this definition within the $10.0 \times 10^{-6}/\text{yr}$ contour.
Industrial	50	$50.0 \times 10^{-6}/\text{yr}$	All transmission network sites deemed acceptable since there are no structures of this definition within the $50.0 \times 10^{-6}/\text{yr}$ contour.

Source: HIPAP 4, 2008

17.4.5.2 Mitigation and management

The electrical industry has developed and published a number of standards to try and eliminate/mitigate the risk of transformer fire and/or explosion.

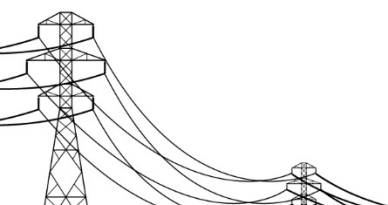
17.4.6 Electrical interactions

17.4.6.1 Potential impacts

Indirect hazards

Electrical interactions between transmission systems and other conductive structures can be of three principle kinds, as follows:

- Capacitive coupling**
 Capacitive coupling occurs in the immediate vicinity of the overhead power lines when other aboveground conductive structures, such as pipelines are well insulated from the ground. The influence of capacitive coupling occurs in both normal and fault conditions. The charging current and the magnitude of the voltage present depends mainly on the line voltage and the distance from the overhead line.
- Inductive coupling**
 Inductive coupling (low frequency induction (LFI)) Alternating current on the transmission line may induce a longitudinal voltage in an adjacent metallic object, such as an



aboveground or underground pipeline, causing it to act as the secondary of an air-cored transformer. The magnitude of induced voltage depends on several variables:

- Distance to the transmission line – coupling is inversely proportional to the distance
- The voltage induced is proportional to the exposure length
- The current in each phase conductor. Phase conductors are typically reasonably balanced under load conditions and unbalanced under fault conditions, but any unbalanced current condition will lead to inductive coupling
- Mutual impedance between phase conductors and the adjacent metallic object
- Shielding effect of HV cable earth screens, overhead earth wires and other earthed structures.

LFI events can happen during power system faults and during normal operation. As power system line to earth faults create large currents, the resultant induced voltage is much higher than during normal operating conditions. The two cases are separate since the contact probability is very different due to the likelihood of an earth fault event.

- **Conductive coupling**

Conductive coupling (due to Earth Potential Rise (EPR)) is a phenomenon occurring when currents of large magnitude enter the earth (such as during a substation fault, high-voltage network fault or during lightning strikes creating a fault). In such instances, the transmission tower earthing system (including tower footing) and the surrounding soil will undergo a rise in electrical potential.

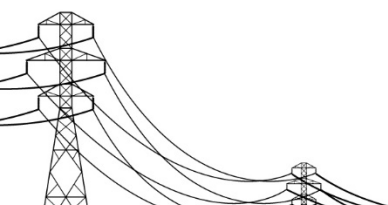
An EPR event can be hazardous to both personnel and equipment. The soil has resistance, known as soil resistivity, which develops an electrical potential gradient, or voltage drop, along the path of the fault current in the soil.

The EPR is the product of earth impedance, and the current that flows through that impedance. During power system faults, the transmission line is automatically switched off by protection systems. According to National Electrical Rules, the maximum allowable fault clearing time for a 330 kV system is 100 to 120 milliseconds depending on where the fault is within the network, and for a 220 kV system it is 120 to 220 milliseconds (Australian Energy Market Commission, 2020).

A person is at risk during one of the coupling modes when two or more points of their body are in contact with surfaces at different potentials. The difference in potential is referred to as the touch voltage. Depending on the touch voltage level, what the person is wearing (insulating value which is related to rating and condition), skin resistivity (skin being wet or dry and if there is any skin damage) and current path through the body (whether it is through the heart). This may cause a current greater than the ventricular fibrillation current (depending on the exposure time and the cycle the heart was in when the event occurred) to flow through their heart, or possibly cardiac paralysis if the current is high enough. The ventricular fibrillation current is the amount of electrical current needed to cause cardiac arrest from which recovery will not spontaneously occur.

Direct hazards

In addition to these electrical interactions there is also the possibility of hazards created by direct contact between energised electrical lines and conductive structures. This may be when an energised electrical line falls and directly contacts conductive infrastructure or a conductive object contacts an intact energised electrical line, such as a rural worker moving sections of metallic irrigation pipe contacts a power line or a crane slewing into power lines.



Fatality risk assessment criteria during power system faults

EPR and LFI (during faults) hazards on humans are mitigated based on probabilistic assessment according to ENA EG 0 guide and to comply with AS/NZS 7000, AS 2067 and AS/NZS 4853 standards.

The probability of fatality, or $P(f)$, is the product of the following:

- The probability that a person will be present and in contact with an item at the same time that the item is affected by a power system fault. This is defined as the probability of coincidence, or $P(\text{coinc})$.
- The probability that the heart will enter ventricular fibrillation due to contact with an external voltage (due to above described coupling modes) is the probability of fibrillation or $P(\text{fib})$.

The main purpose of hazard mitigation is to maintain the likelihood of a fatality occurring, to within societally acceptable limits.

According to ENA EG 0 the fatality risks are categorised in to three regions for individual risks and social risks. They are, low or tolerable region, as low as reasonably achievable (ALARA) region and intolerable region.

Individual fatality risk criteria regions are defined as follows:

- **Low or tolerable region** where probability of fatality per year is less than 10^{-6} – Mitigation is based on the risk generally acceptable, however, risk treatment may be applied if the cost is low and/or a normally expected practice.
- **ALARA Region** where probability of fatality per year is between 10^{-4} & 10^{-6} - Mitigation is based on reducing the risk profile whenever possible, and only accept the residual risk on the basis of a risk cost benefit analysis. The use of the ALARA principle is clearly intended to form a key part of the Due Diligence process embodied in ENA EG 0 guide. The ALARA principle that requires a designer and asset owner to reduce the risk profile whenever possible provides a consistent yet practical means for managing earthing system of the HV asset (Substations, Transmission Line and other utility assets).
- **Intolerable Region** where the probability of fatality per year is more than 10^{-4} - The risk profile must be reduced.

ENA EG 0 provides the guidance to calculate the social fatality risk criteria based on the number of people simultaneously exposed to the hazard. Figure 17-6, which is reproduced from Figure 5-7 of ENA EG 0 provides social fatality risk criteria regions. The “X” axis provide the number of fatalities (N) and “Y” axis gives the frequency of N or more fatalities.

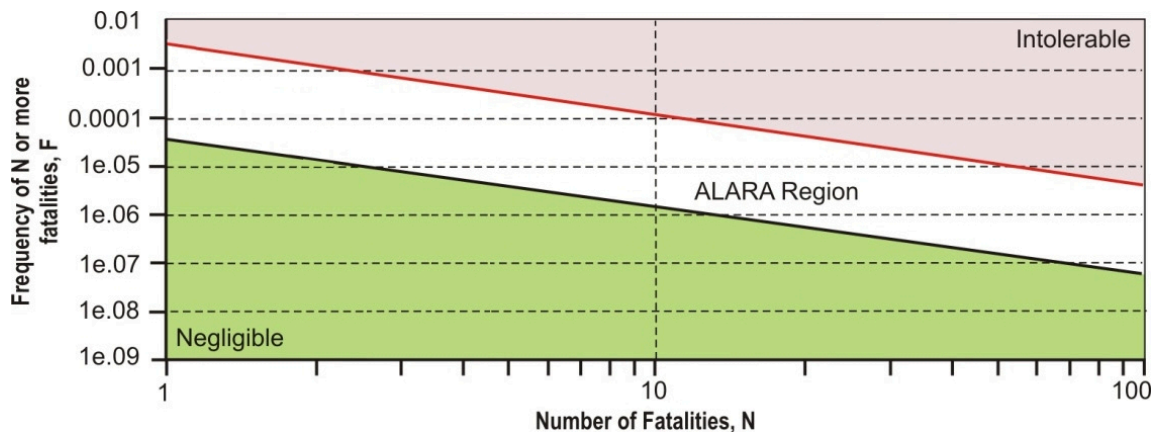
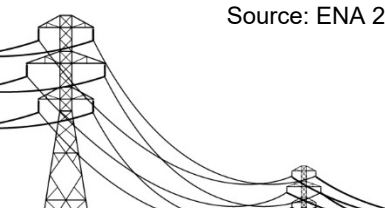


Figure 17-6 Social fatality risk criteria regions

Source: ENA 2010



The following shall be noted when assessing the specific risk in the Project due to coupling modes.

- If the assets are in rural areas where the probability of coincidence will be less than 10^{-6} , then the probability of fatality will be less than 10^{-6} automatically. The power assets (excluding the transmission towers) can be considered as “remote” and no additional mitigations are required.
- Based on ENA EG 0 guidance, Australian standards AS/NZS 7000, AS/NZS 4853 and AS 2067 provide case study scenarios to obtain the touch voltage limits, where the probability of fatality is less than 10^{-6} . If the case study scenario matches the assessing situation, the limits derived in the standards can be used. For scenarios based on electrical interference with third party infrastructure it is important to engage with the asset owner.

The following key hazard areas identified in proximity to the transmission network are outlined in the following sections:

- Railway lines
- Overhead electricity lines
- Pipelines
- Water bores.

17.4.6.2 Railway lines

Railway lines crossed by the Project are shown in Table 17-10.

Table 17-10 Railway lines crossed by Project

Railway line	KP where crossed
Mount Isa Line (Cloncurry to Flynn)	727.7WD
Mount Isa Line (Flynn to Mount Isa)	97.8DM
Mount Isa Line (Cloncurry to Flynn)	14.3DC

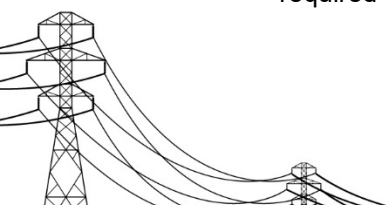
The following risks are applicable near railway lines:

- Earth potential rise risk from nearby transmission tower or substation earthing systems.
- Capacitive coupling during maintenance of the rail lines, however, this is a highly unlikely event in the corridor selection.
- Conductors falling on to the tracks
- Inductive coupling is almost no risk at the crossing. However, required to assess the parallel sections of the transmission line with the rail corridor.
- Direct contact during maintenance.

EPR Hazards

EPR due to fault current (grid current) flowing in the nearby transmission line tower footing/earth can create following hazards

- Equipment damage - damaging signalling and communication equipment associated with rails.
- Fatal, to workers maintaining rail equipment. There can be high probability that the most of the locations are “remote”. However, transfer voltage via continuous metallic structures required to assess.



Hazards due to conductors falling on to the tracks

Fallen conductors can rise EPR around the metal objects touching the fallen live conductors. These can be metallic objects such as rails, fences, galvanised steel toughing. Hazards are:

- Damaging signalling and communication equipment associated with track monitoring and possession systems that are hazardous,
- Fatal, to workers maintaining rail equipment.

The risk of occurrence of this event is very low with modern construction practice and design tolerances use.

Hazards due to direct contact during maintenance

Direct contact will create the following hazards:

- Damage to plant and equipment that is in contact with the overhead line,
- Fatality or serious harm to workers in contact with plant and equipment that is in contact with the overhead line.

Mitigation and management

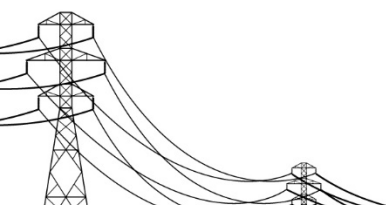
Consultation with rail entities should be undertaken to negotiate design requirements and mitigation measures to control hazards associated with electrical interaction.

17.4.6.3 Overhead electricity lines

As higher voltage lines require larger clearances, they are typically installed at a higher elevation than lower voltage lines. Overhead lines are commonly installed with uninsulated conductors, in fact covered conductors are only available for the lower voltage conductors (including the lower range of high voltage conductors). The risk and probability of pole/tower and conductor failure is considered during overhead line design to ensure a reasonable and practical design. Industry standards are used to ensure that safe clearances are provided between conductors at different voltage as well as clearance to ground and adjacent structures. Table 17-11 shows the existing high voltage overhead lines within the Project corridor selection.

Table 17-11 Existing high voltage transmission lines within Project corridor selection

Voltage	Count	Location of transmission line crossings
11 kV	2	Dajarra Road to Mount Isa KP40-41DM, KP97-98DM



Voltage	Count	Location of transmission line crossings
19.1 kV	28	Woodstock to Dajarra Road KP39-40WD, KP45-46WD, KP93-94WD, KP96-97WD, KP184-185WD, KP277-278WD, KP297-298WD, KP334-335WD, KP342-343WD, KP389-390WD, KP404-405WD, KP422-423WD, KP449-450WD, KP477-478WD, KP518-519WD, KP543-544WD, KP567-568WD, KP589-590WD, KP595-596WD, KP630-631WD, KP662-663WD, KP702-703WD, KP724-725WD Dajarra Road to Selwyn KP0-1DM, KP0-1DS, KP15-16DS, KP69-70DS Selwyn to Cannington KP22-23DC Dajarra Road to Mount Isa KP0-1DM
33 kV	2	Woodstock to Dajarra Road KP380-381WD, KP407-408WD
66 kV	8	Woodstock to Dajarra Road KP46-47WD, KP68-69WD, KP101-102WD, KP341-342WD Dajarra Road to Mount Isa KP35-36DM, KP49-50DM Dajarra Road to Chumvale KP3-4EECL, KP2-3MMG
220 kV	2	Dajarra Road to Mount Isa KP37-38DM, KP54-55DM, KP98-99DM Dajarra Road to Chumvale KP2-3MMG
Total	42	

Mitigation and management

Consultation with Ergon Energy should be undertaken to negotiate design requirements and mitigation measures to control hazards associated with electrical interactions, including replacement of the sections of lower voltage overhead lines at proposed crossings with underground cabling, or alternatively during stringing, install frames taller than the power lines being crossed over, on each side of the existing power line to prevent contact if the line being strung falls.

Construction and maintenance work will be conducted in line with the principles of the Electrical Safety Regulations and Codes of Practice.

17.4.6.4 Pipelines

The transmission network will be located in relatively close proximity to a number of buried, steel high-pressure gas transmission lines (Table 17-12).

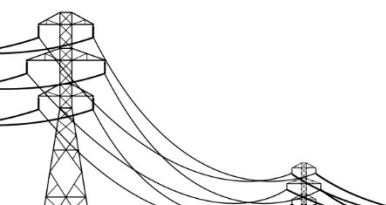


Table 17-12 Pipelines in proximity to Project

Pipeline	Owner/operator	Licence	Approximate distance from transmission line infrastructure
Carpentaria pipeline	APA Group	PL41	300 m from KP 98.599DM near Mount Isa Substation
Mount Isa meter station to Mica Creek Power Station	CS Energy Mica Creek Pty Ltd	PL49	140 m from Mount Isa Substation
Mica Creek Meter Station (including Diamantina Power Station lateral)	APA Group	PL50	380 m from KP 98.599DM near Mount Isa Substation
Mt Isa lateral	APA Group	PL51	185 m from Mount Isa Substation
Northern Gas Pipeline Project	Jemena	PL2015	420 m from KP 98DM
Carpentaria pipeline to Phosphate Hill	Southern Cross Fertilisers Pty Ltd	PL54	500 m from Phosphate Hill Substation
Carpentaria pipeline to Cannington	APT Pipelines (Qld) Pty Ltd	PL42	The corridor selection crosses this pipeline between KP 23SC and KP 24SC near Cannington Substation
North Queensland pipeline	North Queensland Pipeline No 1 Pty Ltd	PL89	370 m from Woodstock Substation

The following risks are applicable near pipelines:

- Earth potential rise risk from nearby transmission tower and substation earthing systems.
- Low frequency inducing during faults
- Low frequency induction (LFI) during steady state.

EPR hazards

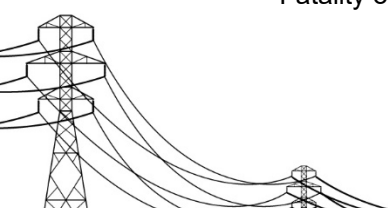
EPR events can create the following hazards.

- Equipment damage - damaging cathodic protection (CP) equipment, insulation flanges.
- Fatality or serious harm to workers, valve operators, CP test point operators, etc.

LFI hazard during power system faults

LFI can occur in pipelines that run parallel, and in close proximity, to transmission lines. Power system faults generate large fault currents which are rapidly cleared. Note that such faults produce both LFI and EPR hazards. LFI events can create following hazards.

- Equipment damage - damaging cathodic protection (CP) equipment, insulation flanges
- Fatality or serious harm to workers, valve operators, CP test point operators, etc.



LFI hazard during normal operation

The current flowing through the transmission line during normal operation can produce LFI in pipelines parallel, and in close proximity, to the transmission line. These voltages are of a lower magnitude than voltages generated during faults, but of much longer duration.

Longer term LFI conditions event can create following hazards:

- AC corrosion hazard to the pipeline
- Fatality or serious harm to workers, valve operators, CP test point operators, etc.

Mitigation and management

Crossing of the gas pipelines by the transmission line is not a significant constraint. It is not anticipated that there will be any significant interaction between the Project and these gas pipelines.

Capacitive coupling is not directly relevant to the Project, as the pipelines with which there may be some interaction are buried.

Inductive coupling is not directly relevant as no areas of extended parallel routing have been identified with respect to the Project's electricity transmission lines and third party buried pipelines.

Should a hazardous conductive coupling situation arise, there is a potential for someone who comes into contact with the pipeline to receive an electric shock. Under adverse conditions this could be fatal. Those most likely to be at risk would be personnel conducting maintenance on the pipeline, such as at valve stations, meters or cathodic protection test points.

It is considered very unlikely that more than one person would be injured in such an event, particularly due to the extremely short exposure period until the fault-induced charge is dissipated to the earth.

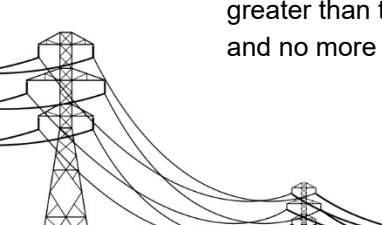
In addition to the electrical interactions of the transmission system on pipelines there are also hazards associated with electrical interactions from pipeline systems on transmission systems. Pipelines are commonly fitted with passive or active cathodic protection systems. The current flows involved in conductive coupling can accelerate corrosion of pipeline or transmission assets leading to hazardous scenarios such as gas leaks/explosion or failure of transmission structures or line support elements.

The probability of an induced current situation caused by conductive coupling is highly dependent on such factors as the proximity of transmission system structures to buried pipelines, the nature of the pipeline coating and the ground in which it is buried. The risk exposure will be taken into account during the detailed design process (safety in design review), in which the final location of transmission towers will be determined with respect to minimising the potential electromagnetic interaction.

Although at this stage of the Project the risk cannot be quantified, the issue is well recognised and the regulatory and engineering controls are available to provide an adequate level of control.

Consultation with pipeline owners should be undertaken to obtain the pipeline data including contact scenarios and to negotiate design requirements and mitigation measures to control hazards associated with electrical interaction.

It should be noted that the first pass risk assessment in accordance with AS/NZS 4853 shall be undertaken to determine the risk levels. If the distance to the pipe from the transmission tower is greater than the distance listed in AS/NZS 4853 tables 4.4 and 4.5, the risk level is negligible and no more mitigation is required.



If the first pass assessment is a fail, calculations are required to obtain the pipeline voltages and further assess the risks based on contact scenarios. If the risks are less than the limits (both for equipment and humans) no action is required. If the risks are above the limits, earthing design will be required to the transmission line and pipelines.

17.4.6.5 Water bores

There are a number of water bores in close proximity to the corridor selection, some of which are deep sub-artesian and artesian bores. In addition to the hazard scenarios presented in Section 17.4.6.4 on pipelines, the bores themselves require ongoing maintenance that may require the use of cranes and drill rigs in close proximity to the overhead transmission lines.

Mitigation and management

Consultation with property owners should be undertaken to negotiate mitigation measures to control hazards associated with steel structures and risk management practices to be implemented during maintenance activities.

17.4.7 Workforce health and safety

17.4.7.1 Potential impacts

CuString is committed to providing a safe and healthy workplace for the workforce during all phases of the Project. Health and safety issues will be taken into account during the design phase by way of risk assessments and safety in design reviews. This will ensure that the design takes into account any prescribed methods of preventing or minimising workers exposure to risk. The process will continue after the design phase in the implementation of safety management systems and associated audits.

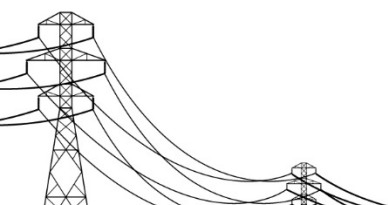
Safety will be ensured by utilising proven design, technology and construction methodologies in accordance with industry best practice and the applicable Australian and international codes and standards. The integrity of the equipment will be assured by such measures as specialist construction specifications, quality control and testing/inspection of critical components during the construction phase. The transmission network will be subject to a detailed testing and commissioning plan and a number of performance trials to verify the integrity of the transmission line and substation infrastructure, prior to the operation of the network.

Potential workplace hazards include:

- Exposure to exposed electrified transmission equipment
- Exposure to hazardous materials
- Fire and explosions
- Conducting aerial work
- Vehicle safety
- Natural disasters.

17.4.7.2 Mitigation and management

CuString will develop a structured health and safety management system in accordance with AS 5577-2013: Electricity network safety management systems and AS/NZS 4801-2001: Occupational health and safety management systems, which includes policies, objectives and procedures for ensuring the health and safety of personnel, the community and other associated stakeholders.

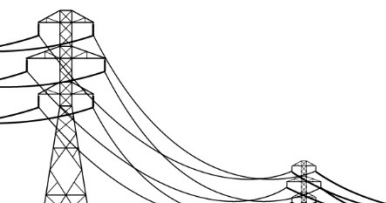


The objectives and targets will be continually reviewed and improved based on monitoring of performance. The monitoring and improvement will ensure that the performance indicators meet any associated health and safety policies, legislative requirements and industry best practice.

Training and health and safety updates will be provided to personnel and contractors where appropriate, through regular toolbox talks. Personnel trained in first aid will be present on site at all times and approximately 20% of the workforce will have formal first aid qualifications.

Mitigation measures for the hazards mentioned above include:

- Development of environmental and safe work methods (ESWMS) in accordance with industry best practice to minimise the risk of exposure to electrified equipment during the operation of the Project. The Queensland Electrical Safety Office and Energy Networks Australia (ENA) have separately published a number of guidelines and codes that will be adopted to minimise the risk to personnel. These include:
 - Australian Standard AS 5804 (Series) High-voltage live working
 - Electrical safety code of practice 2013 - Managing electrical risks in the workplace
 - Electrical safety code of practice 2020 - Working near overhead and underground electric lines
 - Electricity safety codes of practice 2020 – Works
 - National Electricity Network Safety Code (ENA DOC 001-2019)
 - ENA Guidelines for Safe Vegetation Management (ENA DOC 023-2009)
 - ENA National Guideline for Mobile Plant Earthing (ENA DOC 031-2011)
 - Vegetation Risk Management for Overhead Electricity Networks – Guideline (ENA DOC 038-2018)
 - National Guidelines for Manual Reclosing of High Voltage Electrical Apparatus Following a Fault Operation (Manual Reclose Guidelines) (ENA DOC 042-2018)
 - National guidelines for safe approach distances to electrical and mechanical apparatus (ENA NENS 04-2006)
 - National guidelines for the selection, use and maintenance of personal protective equipment (PPE) for electrical arc hazards (ENA NENS 09-2014)
- A register of all hazardous materials will be kept updated including relevant safety data sheets for each substance. Appropriate training will be provided including methods for handling, storage and clean-up of hazardous substance and chemical spills. Applicable PPE will be provided.
- Substations will be designed in accordance with relevant Australian standards for the prevention of fire and explosion hazards. Automatic electrical protection systems and separation distances of transformers from buildings will minimise the risk of explosion or fire (refer to section 17.4.4 for further information).
- All personnel conducting aerial work must have the required accreditations. Specific ESWMS will be developed for each activity involving aerial work. Aerial inspection of the transmission line will be in accordance with the principles of the National guidelines for aerial surveillance of overhead electricity networks (ENA NENS 08-2006).
- Standard policies on vehicle use and driver safety (such as speed limits, seat belt requirements, vehicle maintenance and zero drug and alcohol limits) will be implemented.
- The Emergency Response Plan will include response measures in the event of a natural disaster (refer to section 17.5.4).



17.4.8 Road transport

17.4.8.1 Potential impacts

The Project will generate an increase in traffic, including heavy vehicles, on the major highways and some local roads during the construction phase (refer to Volume 2 Chapter 13 Transport). This increase in traffic poses a hazard to construction personnel as well as other public road users, with a high risk of traffic accidents.

To a lesser extent, there is also a risk of damage to public road infrastructure from heavy vehicle/equipment movements.

17.4.8.2 Mitigation and management

A RUMP will be developed in consultation with DTMR and LGAs. A specific RUMP will be developed for oversized loads.

CuString will implement a number of other measures that will promote road safety including:

- Construction personnel will be transported to and from work sites in four wheel drive vehicles or buses and will not be able to bring private vehicles to work sites unless there is a specific requirement.
- Designated travel routes through townships for heavy vehicles
- Staff and contractor inductions will include traffic safety awareness and traffic rules
- Implementation of fatigue and alcohol management strategies
- First aid kits and emergency communications equipment will be supplied in all Project related vehicles. All Project personnel will have basic first aid training
- CuString will consider using light vehicles fitted with ANCAP ratings and heavy vehicles with high Euro NCAP rating (ie. Vehicles fitted with safety technologies such as forward collision avoidance).

17.4.9 Aircraft

17.4.9.1 Potential impacts

The Aviation Impact Assessment undertaken for the CopperString 1.0 Project in 2010 has been reviewed and updated by Aviation Projects and is included in Volume 3 Appendix Y Assessment of the impact to aviation. Risks involving aircraft may occur either in the vicinity of transmission lines or at aerodromes/aircraft landing areas.

Activities in vicinity of transmission lines

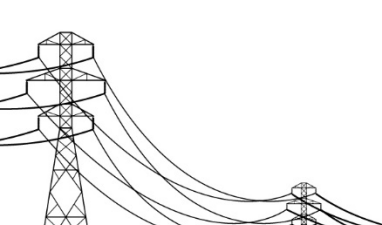
During construction of the Project, helicopters will be used to string conductors. Additionally, helicopter charters may be used to transport construction crews and materials to more remote or difficult to access regions.

During operation, helicopters will be used for regular aerial inspection of transmission lines and accessing transmission lines when required for repair and/or restoration of power.

Helicopter and small fixed wing aircraft mustering is a potential hazard in the project region.

Aircraft conducting power line surveys for CuString and other electricity entities are also an identified hazard.

Some low-level military flying may occur within the vicinity of the Project, especially at the eastern end of the corridor selection.



A search of the Australian Transport Safety Bureau (2020) identified 96 wire-strike accidents and 247 wire-strike incidents between 2009 and 2019. Of the 96 wire-strike accidents, 44 involved aerial agricultural operations, seven involved other aerial work operations, and 45 involved private/business operations.

Operations involving low level flying, which comprises activities such as stock mustering, aerial spraying, surveying and photographic operations, search and rescue and fire control accounted for approximately 439,000 hours of flight time in 2018 in Australia (ATSB, 2020).

Some sections of the transmission line pass over terrain that is undulating and in some areas rugged. This appears to be most obvious in the terrain between Cloncurry and Mount Isa and south to Cannington Mine and Phosphate Hill Mine. It is probable that the final tower placement will be strung across small valleys and in a number of places near Cannington Mine, up individual valleys to lower the costs of construction. Wide spacing between towers, particularly long spans across valleys, is a common factor in fatal low flying aircraft accident.

There are existing overhead electricity transmission lines across the region (refer Table 17-11), the majority of which are at lower voltages than the Project and are thus located lower to the ground. The majority of the overhead transmission lines throughout the region are on the 19.1 kV single wire earth return (SWER) system. SWER systems have a different risk profile not only due to their height but also because the system has a single conductor of significantly smaller size.

Activities at aerodromes

It is envisaged that part of the construction workforce will be employed on a fly-in fly-out (FIFO) basis with personnel flying from Townsville to Hughenden, Richmond, Julia Creek, Cloncurry, and Mount Isa via chartered flights. These locations have existing aerodromes registered or certified with CASA. Additionally, the Mount Dore Airport may be used by construction personnel flying to the Selwyn Substation. Mount Dore Airport is not certified/registered with CASA but is still required to meet CASA requirements.

A number of man-made features such as stock watering points, dams and stock yards are also in close vicinity of the proposed transmission line. These locations are noted as they may be places where aerial stock mustering activity is concentrated. The Project also passes close to a number of small property airstrips that may be used by smaller private and charter aircraft as well as emergency services such as the Royal Flying Doctor Service. Consultation with landholders has occurred on the proposed transmission line alignment and will continue with reference to potential impacts to existing infrastructure.

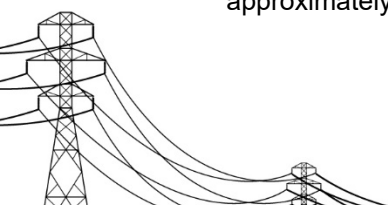
Due to the consequence of an aircraft crash, use of aircraft is considered to have an extreme risk.

17.4.9.2 Mitigation and management

Helicopter stringing activities will be undertaken essentially within the easement, which is separated from buildings and other sensitive receptors.

All substation sites, with the exception of Mount Isa, Cannington and Phosphate Hill incorporate an unsealed helicopter landing area.

The nearest CASA certified/registered aerodrome is Trepell Aerodrome, located within the corridor selection. This aerodrome is owned by South32 and services Cannington Mine. The corridor selection minimises impact to the operation of the aerodrome by traversing land parallel to the landing strip and not encroaching on the flight path of aircraft. All other certified/registered aerodromes are greater than 5 km from the corridor selection. The Mount Dore Airport is located approximately 8 km from the Cannington Connection. The tower structures are not expected to



breach any associated obstacle limitation surfaces or exclusion zones of any certified/registered facility.

A number of preventative measures are suggested below to reduce the risks associated with aircraft interactions with power lines. The residual risk remains high however this is indicative of the consequence remaining as 'major', whilst the likelihood of the risk scenarios can be reduced to 'unlikely'. The general residual risk of a wire strike remains for all low flying aerial activities and therefore the suggested mitigation treatments will never be totally effective.

Notwithstanding, the Commonwealth *Civil Aviation Safety Regulations 1998* places the responsibility on the air operator and pilot to ensure that hazards are properly identified and avoided.

Transmission line safety has been a priority in the planning and design of the Project and CuString is committed to undertaking further consultation with landholders regarding the safety of aerial work operations. The prevention of aircraft contact with the transmission line infrastructure will incorporate:

- Ongoing landholder consultation during detailed design phase on the location of the transmission lines.
- Utilisation of transmission line identification markers in areas of aircraft use, in accordance with AS 3891.1-2008.
- Complying with CASA constraints on the erection of tall structures in the vicinity of aerodromes.
- Recording of the transmission line on navigation mapping in conjunction with CASA, Air Services Australia and Royal Australian Air Force – Aeronautical Information Service.
- Ensuring personnel conducting Project related aerial activities are accredited to do so and operate in accordance with ESWMS and fatigue management plans under the Operational Safety Management System.
- Encouraging private aircraft operators to conduct fixed wing aerial mustering in accordance with the risk treatments identified in the Aerial Mustering Sector Risk Profile (CASA 2015).

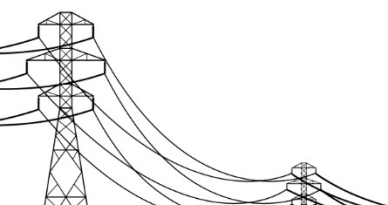
Controls such as conductor delineation and tower lighting may be considered on a case-by-case basis and in consultation with individual landholders.

17.4.10 Transmission lines, towers and substations

17.4.10.1 Potential impacts

Potential hazards associated with the transmission line infrastructure are related to the construction, operational and decommissioning phases of the Project. High risk hazards that have been identified include:

- Person or animal contact with live dropped transmission lines (including existing Ergon Energy or Powerlink lines).
- Unauthorised breach of high voltage clearance boundaries.
- Hazardous step and touch potentials on tower structures.
- Hazardous step and touch potentials on substations.
- Electrocution during substation or transmission line maintenance.
- Vehicle interactions with transmission lines.
- Vehicle interactions with towers.



- Bushfire ignited by arc or spark from transmission lines.

17.4.10.2 Mitigation and management

Due to the remote locations of the transmission line infrastructure, the risks associated with the identified hazards are low. Where risks have scored high in the risk assessment (Table 17-7) the overall risk is generally attributed to a major consequence however the likelihood of occurrence remains unlikely or rare.

Transmission line infrastructure will be designed and installed according to legislative requirements and will be subject to safety in design reviews. Transmission lines will be fitted with protection systems and communications systems that are designed to identify and isolate faults. Only appropriately qualified and experienced personnel will be involved with the construction and maintenance of transmission line infrastructure.

The transmission line infrastructure will be constructed within easements as described in Table 17-13.

Table 17-13 Transmission line easement description

Transmission Line Section	Approximate Distance (km)	Voltage (kV)	Easement width (m)
Renewable Energy Hub	342	330	120
CopperString Core	395	330	120
Dajarra Road Connection for Ernest Henry and Chumvale Substation	4	220	60
Dajarra Road Connection for Dugald River	3	220	80
Mount Isa Augmentation	99	220	60
Southern Connection	129	220	60
Cannington Connection	24	220	60
Phosphate Hill Connection	63	220	60

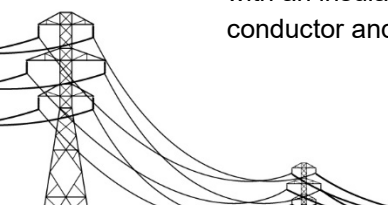
Access tracks will be required for both the construction and ongoing maintenance of the transmission line infrastructure. Access tracks will generally be contained within the easement however where terrain, environmentally or culturally sensitive areas or water crossings do not permit this, the access track may be located outside of the easement, with spur tracks linking the main access track to each transmission tower site. In vegetated areas, existing cleared paths will be utilised where possible so that clearing by the Project is kept to a minimum.

It is intended to utilise the existing road network and private access tracks, though some new tracks will be required to provide access for construction and maintenance teams.

The access tracks for the Project will be constructed to a standard suitable for dry weather use for 4WDs under speed restrictions. They will be of a suitable width to allow the safe movement, including turning, or construction and maintenance equipment and vehicles.

Access to easements will generally be restricted to construction/maintenance personnel and landholders. Transmission towers will have anti-climbing safety barriers installed and warning signage to prevent unauthorised access. Substations will be fenced with appropriate warning signage. CEV huts will have local alarms activated by motion sensors to deter trespassers.

Each transmission line circuit will consist of three phase conductors (or possibly groups of sub-conductors) and an OPGW. Each individual phase corridor is attached to the transmission tower with an insulator and a cross arm. The OPGW consists of a fibre optic cable shielded by a conductor and is used for both lightning protection and communications.



Transmission towers will be designed to maintain a mid-span clearance of the power line above local terrain in compliance with Queensland legislation. Nominal transmission tower heights and distances between transmission towers are described in Table 17-14.

Table 17-14 Transmission tower physical description

Transmission line route	Minimum height (m)	Maximum height (m)	Typical spacing (m)
Renewable Energy Hub	60	81	450-500
CopperString Core	60	81	450-500
Mount Isa Augmentation	55	76	400-450
Southern Connection	55	76	400-450
Cannington Connection	49	70	400-450
Phosphate Hill Connection	49	70	400-450

Transmission tower heights will vary from location to location depending on the topography of each specific location. Likewise the distance between transmission towers will vary depending on the topography and conductor clearance required in particular areas of the easement.

The final transmission tower sites will be determined after careful consideration of all physical constraints such as sensitive environmental areas, rock/soil types, significant watercourse/infrastructure crossings, existing land use and amenity. The transmission towers will be sited to make the best use of available terrain providing both sound foundations whilst minimising impacts to the environment and adjacent land uses.

An Emergency Response Plan will be developed by the Construction Contractor to manage incidents associated with hazards that directly involve or impact Project personnel during construction.

A Disaster Management Plan will be developed to manage operational responses to risks associated with hazards that have a broader impact such as bushfires and flashovers.

17.4.11 Construction camps

17.4.11.1 Potential impacts

It is anticipated that 750 people will be employed during the construction of the Project. Temporary construction camps will house the majority of these workers.

The Project route will be segmented into eight or more construction zones, each serviced by a central camp and project office. Preliminary camp locations have been identified as detailed in Table 17-15. These accommodation numbers represent a nominal maximum and there will be parts of the project period in each section where the workforce is substantially less.

Where appropriate worker accommodation facilities already exist (e.g. Richmond's Big Wheel, Richmond's Mud Hut or Mount Isa's Irish Club), workers may be accommodated in these facilities.

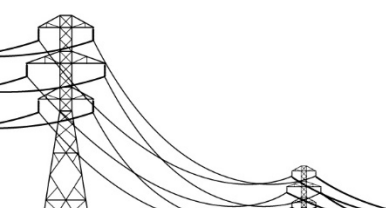


Table 17-15 Indicative workforce accommodation for the construction zones

Transmission Network Section	Construction zone	Length (km)	Location of accommodation	Capacity (beds)
Woodstock Substation	Woodstock	n/a	Options under consideration within the Townsville City LGA (within 1 hour of travel to Mingela and the Woodstock Substation)	350
Renewable Energy Hub	Woodstock	31	As above	Incl. above
	Charters Towers	72	Charters Towers	350
	Pentland	139	Pentland	350
	Hughenden	94 47	Hughenden	350
CopperString Core	Richmond	134	Richmond	350
	Julia Creek	147	Julia Creek	350
	Cloncurry	118 50	Cloncurry	350
	Mount Isa	50	Mount Isa	250
Southern Connection	Cloncurry	50	Cloncurry	Incl. above
	Selwyn	40	Selwyn Substation	250
Cannington Connection	Cannington	57		
Phosphate Hill Connection	Phosphate Hill	60		

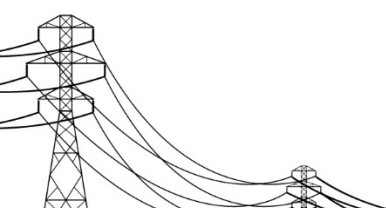
Potential hazards associated with construction camps include impacts of sewage and water supply and fires initiated from activities within the camps.

17.4.11.2 Mitigation and management

Construction workforce camps will be located near major towns in order to utilise existing services, including water supply, electricity and sewage services. This arrangement will also reduce the negative impact of pressure on existing accommodation resources in the region while providing benefit to local supply services. Construction camps will only be used during construction of the Project and will be decommissioned at the end of the construction program.

Package sewage treatment plants may be used to treat sewage at construction camps. STPs will be operated and managed in accordance with operational procedures. Spillages and unplanned events will be managed in accordance with emergency response procedures.

Where wastewater is treated on site, it may be reticulated to a ground area or pumped to an appropriate evaporation pond area, subject to further discussions with regulatory authorities.



17.4.12 Electric and magnetic fields

17.4.12.1 Overview

CuString is mindful of concerns in the community and among some scientists regarding the possibility of adverse health effects from exposure to electric and magnetic fields (EMF).

In 2010, LineTech Consulting Ltd was engaged by CuString to complete a review of available scientific evidence and national and international best practice standards regarding EMF (refer to Volume 3 Appendix AC Electro-magnetic field specialist study).

EMF are part of the natural environment (e.g. static electricity and the Earth's magnetic poles) and can be found in any electrical appliance. Because the use of electricity is so widespread, humans are constantly exposed to electric and magnetic fields. Electricity transmission lines, substations, transformers and other electrical sources such as common domestic and commercial electrical appliances and wiring, all emit extremely low frequency EMF. EMF strength decreases rapidly with distance from the source.

Large electrical power systems rely on the supply of electricity from the generation (or source) to the consumer along overhead transmission, distribution and service lines. In Australia, this is an alternating current (AC) supplied at a frequency of 50 Hertz (Hz). Instead of the relatively constant field associated with static electricity or the Earth's magnetic poles, these AC fields alternate from positive to negative and back at 50 times per second.

At the low frequency of 50 Hz the electric fields and magnetic fields can be studied separately. At higher frequencies, such as that used for television, radio and mobile phone signals, the electric and magnetic fields alternate millions of times a second and cannot exist independently.

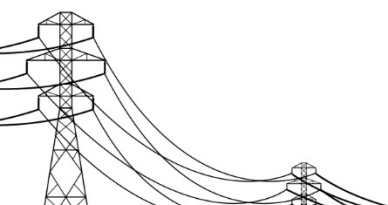
17.4.12.2 Electric fields

Electric field levels strength is measured in volts per metre (V/m). Due to the range of the levels encountered in power system environments, field strength is reported in kilovolts per metre (kV/m). Electric fields are easily shielded or weakened by earthed objects such as shield wires, vegetation and buildings, whereas magnetic fields are not as readily blocked.

17.4.12.3 Magnetic fields

Magnetic fields are commonly measured in tesla (T) or sometimes in gauss (G), and due to the range of levels encountered in typical power system environments, field levels are recorded in microtesla (μT) or milligauss (mG). One mG is equal to 0.1 μT . This assessment will utilise the tesla unit as the standard within the commonly adopted International System of Units.

Magnetic fields found in homes are typically between 0.015 and 2.2 microtesla (μT), depending on what electrical items are in use. Figure 17-7 shows typical magnetic field levels at different locations in the home and in proximity to power lines.



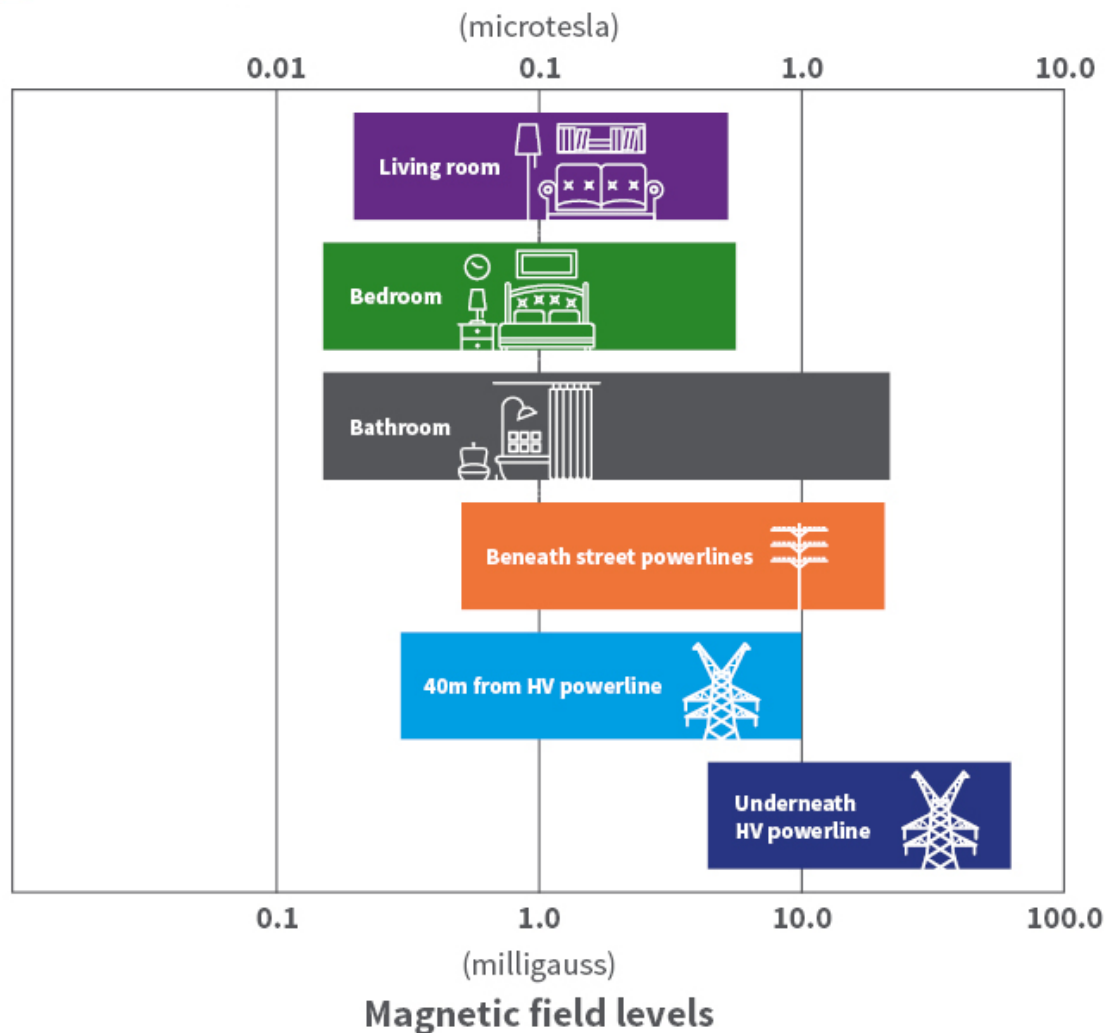


Figure 17-7 Typical magnetic field levels at different locations.

Source: ARPANSA 2019

Magnetic fields are produced by the current flowing (movement of electric charge) along a conductor and as the current changes the magnetic field will change. Electric current is measured in amperes (A) and its magnitude is influenced by the voltage levels used for the electricity network. Magnetic fields are measured by both magnetic field strength (MFS) and magnetic field density (MFD).

17.4.12.4 EMF health and safety concerns

The effects of EMF on human health have been subject to extensive research over many decades. According to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA, 2019), the majority of research indicates that extremely low frequency (1 Hz to 100 Hz) EMF exposure normally encountered in the environment, including in the vicinity of transmission lines, does not pose a risk to human health. However there are some population studies that have reported a possible association between prolonged exposures to extremely low frequency magnetic fields, at levels below the exposure limits but higher than what is typically encountered, and increased rates of childhood leukaemia. Based on this limited evidence, the International Agency for Research on Cancer has classified extremely low frequency (3 Hz to 3,000 Hz) magnetic fields as possibly carcinogenic to humans. It is not known how magnetic fields could cause childhood leukaemia and overall the research has not confirmed these results.

ARPANSA (2019) states that,

“On balance, the evidence related to childhood leukaemia is not strong however people should be aware of the issue in order to make informed decisions.”

For homes near high voltage transmission lines, the magnetic field exposure will vary according to the amount of current carried by the transmission line and the distance of the home from the transmission line. Generally, homes that are more than 50 m from high voltage transmission lines are not expected to have higher than typical magnetic fields. For substations and transformers, the magnetic fields at distances of five to 10 m away are generally similar to typical background levels in a home.

The sensitive receptors identified in Table 17-6 indicate that the closest home to the Project infrastructure is 145 m away (receptor R55).

17.4.12.5 EMF effects on animal life

Extensive studies have been carried out on the effects of EMF on agricultural holdings, with some studies far exceeding permissible electric field strength limits. Such studies typically involve the comparison of an exposed group versus a control group and the energisation and de-energisation of a line for some period of time.

In general, studies of animal reproductive performance, behaviour, milk production, meat production, health and navigation have found minimal or no effects of EMF. The literature published to date has shown little evidence of adverse effects of EMF from overhead transmission lines on farm animals and wildlife. Experience from electric utilities and results from research show in general that electric fields from overhead transmission lines do not affect behaviour or health of livestock. Livestock of all kinds often rest or feed underneath transmission lines.

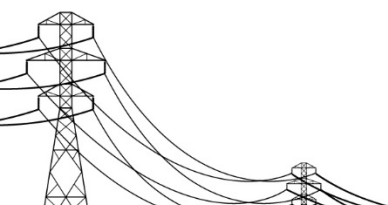
The LineTech Consulting report references a number of studies on the effects of EMF on cattle, including one where no effects on cattle fertility were noted in pilot studies of 36 herds, during which artificial insemination was applied.

A larger study involving 106 farms in Sweden did not show cows to have decreased fertility. On average, they were exposed to 400 kV lines for more than 15 days per year and to maximum electric fields of 5 kV/m on some of the farms (DOE, 1989; Algers et. al, 1981; Hennichs, 1982; Algers and Hultgren, 1987 cited in LineTech Consulting, 2010). Similarly no evidence was found in a 27 month study that involved examining the potential impacts on immune function of sheep (Hefeneider et. al., 2001 cited in LineTech Consulting, 2010).

Cattle behaviour was studied seasonally near a 1200 kV prototype transmission line over a five year period with a 12 kV/m maximum electric field created by the transmission infrastructure. Animals showed no reluctance to graze or drink underneath the transmission line. Statistical analysis of data from the first two years of the study indicated that the cattle spent somewhat more time near the line when de-energised. This finding could not conclusively be related to the transmission line (DOE 1989; Rogers et. al., 1982 cited in LineTech Consulting, 2010).

The National Livestock Identification System, which is the Australian scheme for the identification and tracking of livestock, utilises tags that are read by external readers. This system is unlikely to be affected by the EMF of the Project as these devices operate at a frequency that should not be impacted by the low frequency EMF emitted by the transmission lines.

Although not generally reported by beekeepers, studies have shown transmission line electric fields can affect honey bee colonies. The effects can include micro-shocks experienced by the bees whilst inside the hive, and there is evidence that bees may have reduced aversive learning and increased aggression levels from extremely low frequency EMF (Shepherd et al., 2019).



In keeping with the precautionary principle, it is recommended that bee hives be placed outside the transmission line easement. Should bee hives be placed inside the easement, CuString will provide advice of suitable techniques to shield the bees, while in the hive, from the transmission line electric field.

Effects of EMF on wildlife are subtle and difficult to identify. Based on studies with laboratory animals, wildlife may be able to detect electric fields through such means as hair stimulation. Research has not shown these fields to adversely affect wildlife behaviour or health.

17.4.12.6 EMF effects on vegetation

The effect of electric fields on plants has been studied since the eighteenth century, mainly due to an interest in the possible use of electricity to increase crop yield. High frequency EMF may provide an environmental stimulus that evokes specific responses in plants. Studies have shown that damage of leaf tips occurs at fairly high electric field levels at locations very close to the transmission line. Trees growing this close to the transmission line would fall within the region where pruning is required to conform to legislative safety requirements for easement management. At field levels outside the easement, where tall trees are more likely to be found, the electric field levels will be low enough not to cause any leaf tip damage.

The EMF levels typical of a transmission line environment, and the legislative requirements for vegetation management within the easement, mean EMF from the Project is unlikely to affect vegetation in terms of growth, germination and crop production.

17.4.12.7 Relevant standards and guidelines

The International commission on Non-ionizing Radiation Protection (ICNIRP) published the Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up to 300 GHz) in 1998 and this was revised in 2010 with the frequency range changed to 1 Hz to 100 kHz. The revised guidelines reduce the limits of exposure to flat maximums applicable to continuous exposure and short-time exposure limits were deleted. ARPANSA recommends the ICNIRP guidelines.

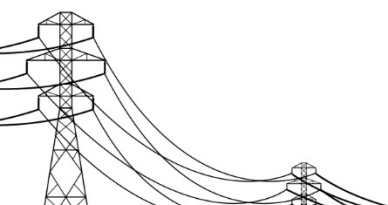
Table 17-16 includes a summary of the ICNIRP exposure limits. The standard recommends a precautionary approach to exposures due to research into EMF and links to childhood leukaemia (discussed above).

Table 17-16 EMF exposure limits

Group	Electric field limits	Magnetic field limits
General public	5 kV/m	200 μ T
Occupational workforce (those likely to be exposed to EMF as part of their occupation)	10 kV/m	1,000 μ T for 24 hours a day exposure

17.4.12.8 EMF calculations for the Project

EMF levels were calculated for different transmission tower geometries and voltages and for each substation during the CopperString 1.0 EIS process. These results were calculated using SES-Enviro Plus, a Canadian developed program that analyses power line cross-sections to determine line parameters, capacitive and magnetic induction, as well as local electrostatic potentials, gradients and corona parameters, for systems of overhead AC and direct current transmission line conductors.



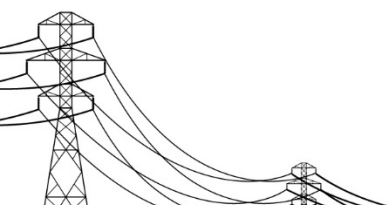
A summary of the electric field strength (EFS), magnetic field strength (MFS) and magnetic field density (MFD) for proposed transmission tower geometries and voltages, is described in Table 17-17.

Table 17-17 Transmission line EMF calculation results (1 m above ground level)

Distance from transmission centreline (m)	EFS (kV/m)	MFS (A/m)	MFD (μT)
Renewable Energy Hub and CopperString Core – 330 kV double circuit twin conductor double earthwire system – modelled at 500 MVA per circuit			
Maximum Value*	4.350	4.741	5.957
30	0.052	0.613	0.77
250	0.003	<0.001	<0.001
330	0.001	<0.001	<0.001
Mount Isa Augmentation – 220 kV double circuit twin conductor/double earthwire system – modelled at 250 MVA per circuit			
Maximum Value*	3.045	7.003	8.801
30	0.036	0.905	1.138
250	0.002	<0.001	<0.001
330	0.001	<0.001	<0.001
Southern Connection – 220 kV double circuit single conductor double earthwire system – modelled at 120 MVA per circuit			
Maximum Value*	3.174	4.932	6.197
30	0.047	0.5	0.629
250	0.001	<0.001	<0.001
330	<0.001	<0.001	<0.001
Cannington Connection and Phosphate Hill Connection – 220 kV single circuit single conductor/double earthwire – modelled at 120 MVA			
Maximum Value*	3.621	10.014	12.583
30	0.339	1.74	2.187
250	0.004	0.02	0.025
330	0.002	0.01	0.013

*Maximum value is lateral distance at which the EFS, MFS and MFD are at the highest value. This distance varies – for EFS the location is at 0 m (centre of tower) and for both MFS and MFD it is offset by a matter of metres.

The above transmission line EMF calculation results are all below the limits identified by the ICNIRP Guidelines in Table 17-16. The maximum EFS calculation occurs on the Renewable Hub and CopperString Core sections of the transmission network, with a calculated EFS level of 4.35 kV/m. This is below both the general public (5 kV/m) and occupational workforce (10 kV/m) limits. Note that the load levels (MVA) used for modelling are the design capacities of the transmission lines (cannot be made any smaller for the distances involved in the project for a



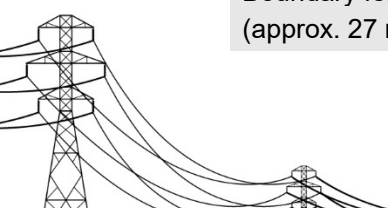
reliable supply system) which are twice or more than the forecast loads for the initial years of operation of the system.

The highest calculated MFD is for the 220 kV single circuit single conductor system, planned to be utilised for the Cannington Connection and Phosphate Hill Connection sections of the transmission network. This was calculated to be a maximum of 12.583 μT , and is below both the general public (200 μT) and the occupational workforce (1,000 μT) limits. This MFD decreases to 2.187 μT at the edge of the easement. The magnetic field at the easement edge would be proportionate to that of the magnetic field of a hair dryer at normal user distance.

For the proposed substation sites, a summary of the EFS, MFS and MFD is described in Table 17-18. The results are described as a maximum value and the value likely to be found at the boundary fence of each substation site. Calculated results have been grouped based on the operating voltages of the different substation systems (i.e. the step-up or step-down voltages).

Table 17-18 Substation EMF results

Distance (m)	EFS (kV/m)	MFS (A/m)	MFD (μT)
Woodstock Substation – 330 kV system – modelled at 500 MVA			
Maximum value	9.186	23.195	29.15
Boundary fence (approx. 28 m)	0.257	1.323	1.663
Woodstock Substation – 275 kV system – modelled at 500 MVA			
Maximum value	8.038	27.676	34.778
Boundary fence (approx. 23 m)	0.441	2.479	3.115
Flinders Substation – 330 kV system – modelled at 500 MVA			
Maximum value	9.186	23.195	29.147
Boundary fence (approx. 20 m)	0.784	2.801	3.52
Dajarra Road Substation – 330 kV system – modelled at 500 MVA			
Maximum value	9.186	23.195	19.147
Boundary fence (approx. 32 m)	0.161	0.961	1.207
Dajarra Road Substation – 220 kV system			
Maximum value	9.154	48.372	62.042
Boundary fence (approx. 18 m)	0.637	5.005	6.29
Mount Isa Substation – 220 kV system – modelled at 350 MVA			
Maximum value	9.154	34.470	43.312
Boundary fence (approx. 17 m)	0.765	3.925	4.933
Mount Isa Substation – 132 kV system – modelled at 350 MVA			
Maximum value	5.212	55.014	69.133
Boundary fence (approx. 27 m)	0.067	1.568	1.971



Distance (m)	EFS (kV/m)	MFS (A/m)	MFD (μT)
Cannington and Phosphate Hill Substations – 220 kV equipment – modelled at 60 MVA			
Maximum value	9.154	5.932	7.456
Boundary fence (approx. 14 m)	1.375	0.986	1.239

Since the study by Linetech Consulting (2010), the Project scope has changed to include an additional new substation at Selwyn. The Selwyn Substation and Chumvale Substation include addition (lower) voltage levels not listed in the table above, therefore their electric field values are also lower. Construction work includes a minimal activities within the Chumvale Substation with the majority of the work being cutting into lines outside of the existing substation.

The above substation site EMF calculation results comply with the ICNIRP Guidelines, as areas of maximum value occur within the substation site area not accessible to the general public. Sites with the greatest EFS results are associated with the 330 kV high voltage equipment at the Woodstock, Flinders and Dajarra Road Substation sites (9.186 kV/m). This value is still below the recommended limit for the occupational workforce (10 kV/m) that may be present at the substation during the operation of the sites for maintenance activities.

The maximum MFD was calculated for the 132 kV high voltage equipment at the Mount Isa Substation (69.133 μT). This value is below both the recommended general public (200 μT) and occupational workforce (1,000 μT) exposure limits under the ICNIRP Guidelines. At the substation boundary fence this value decreases to 1.971 μT. The magnetic field at this boundary fence would be proportionate to that of the magnetic field of a hair dryer at normal user distance.

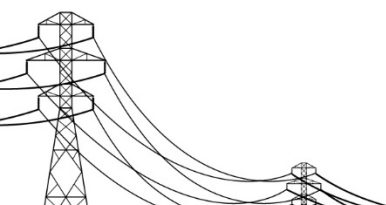
The likely exposure to the public of the calculated EMF levels is further reduced by the likelihood of members of the public being in the vicinity of the substation sites, considering a larger area of land is to be acquired for the substations. Substations will utilise between 9.5 to 31.9 percent of the acquired land, with the exception of the Cannington and Phosphate Hill sites that are to be located on the mining leases of the respective operations.

17.4.12.9 Interference with electronic devices

Electronic devices can potentially be affected by electrical discharges from conductors of the transmission line. This is known as corona discharges and is a consequence of minor discharges to the ionised air surrounding the conductor. As a result there is potential for audible noise and radio interference. The level of interference is subject to the operating voltage of the system. The potential impact of audible noise from corona discharges is further addressed in Volume 2 Chapter 11 Noise and Vibration.

Corona is a significant factor in the design of overhead power lines and it influences the selection of the diameter of the phase conductors, the number of conductors in each phase conductor bundle as well as the conductor clearance to ground. Corona discharge noise is generally only audible under conditions of high humidity, such as during rain or fog.

High voltage transmission lines generate radio interference directly under or within the easement area, as shown in Figure 17-8. This electronic interference may impact on television reception, and the operation of satellite phones, cellular networks and UHF communications as well as internet connections. Good reception cannot be warranted directly below and within the transmission line easement, though transmission line design measures ensure that these services are provided at an acceptable quality outside of the easement area.



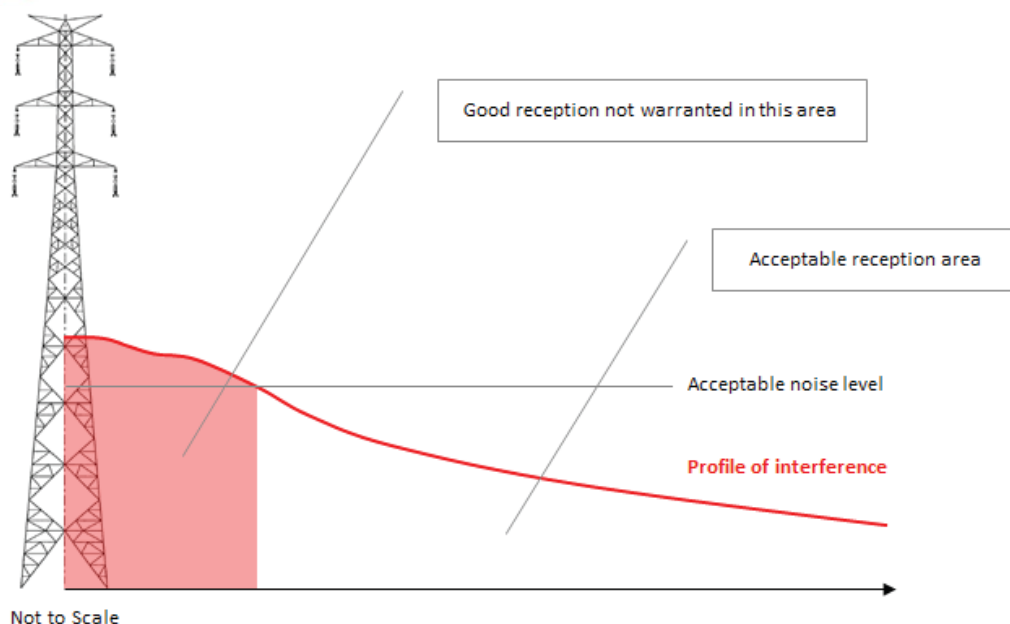


Figure 17-8 Radio and communication interference zone

The radiofrequency spectrum is classified into categories of radiofrequencies that are derived from the International Telecommunication Union. A summary of radiofrequencies for various communication mediums in relation to known frequency ranges is shown in Table 17-19.

Table 17-19 Frequency spectrum

Frequency bandwidth description	Frequency range	Applications
Extremely low frequency	0 to 3 KHz	Distress broadcast
Very low frequency	3 KHz to 30 KHz	Coastal radio
Low frequency	30 KHz to 300 KHz	Long-wave broadcast
Medium frequency	300 KHz to 3,000 KHz	Medium-wave broadcast
High frequency	3 MHz to 30 MHz	Short-wave broadcast
Very high frequency	30 MHz to 300 MHz	Radio and TV
Super band	216 MHz to 600 MHz	Cellular, radio and TV
Ultra-high frequency (UHF)	300 MHz to 3,000 MHz	TV, cellular and satellite
Super high frequencies	3 GHz to 30 GHz	Radar and satellite
Extremely high frequencies	30 GHz to 300 GHz	Satellite and microwaves
Infrared radiation	300 GHz to 420 THz	Optical communications
Visible light	410 THz to 750 THz	Visible light communication
Ultraviolet radiation	1.62 PHz to 30 PHz	High performance liquid chromatography
X-rays	30 PHz to 30 EHx	Medical imaging
Gamma rays	30 EHx to 3,000 EHx	Genetic repair

Television and radio interference

Television interference due to transmission lines is evident when “snowing” or “lines” appear on the television screen. On radios a hiss or crackling sound is evident. The expected radio interference is a subject that is still under research; particularly in the television reception frequency of 47 MHz to 230 MHz range.

For frequencies in the range 0.15 MHz to 3 GHz, the International Electrotechnical Commission (2017) provides guidance for radio noise through the technical report, Radio interference characteristics of overhead power lines and high voltage equipment (CISPR TR 18-1:2017). The scope of this document includes the causes, measurement and effects of radio interference, design aspects in relation to this interference, methods and examples for establishing limits and prediction of tolerable levels of interference from high voltage overhead power lines and associated equipment, to the reception of radio signals and services.

Results for worst-case scenario properties along the proposed transmission line indicate that the radio interference at these properties is below the minimum acceptable noise level to CISPR TR 18-1:2017. The actual calculated radio interference at 250 m from the centre of the easement to the closest residence is 15.11 dB, which is lower than the acceptable reference noise level of 54 dB ($\mu\text{V/m}$).

Results of radio noise calculations are provided in Volume 3 Appendix AC Electro-magnetic field specialist study. The results indicate that when comparing the corridor selection to relevant international standards, the values indicate that the proposed overhead lines do not pose any radio interference violation issues for any nearby habitant.

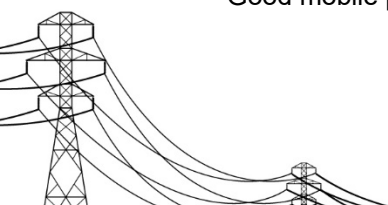
Interference with other electronic devices

Concerns are often raised over the radio interference generated from high voltage overhead transmission lines on multi-band communication device reception (e.g. cellular phones, satellite and internet communications). These devices operate at frequency ranges between 800 MHz and 1.6 GHz. Existing empirical formulas to calculate the rate of lateral attenuation of radio noise at these frequencies are not accurate and research is on-going to derive these formulas. CISPR 18 can be applied to determine the expected rate of lateral attenuation by comparing the change in attenuation from lower to higher frequencies. This assessment has been undertaken for direct distances of 20 m and 100 m from the nearest conductor of a line. The results are summarised in Table 17-20.

Table 17-20 Lateral attenuation of mobile phone reception

Frequency range	Rate of lateral attenuation (log D-x) from the transmission line	
	20 m	100 m
0.15 MHz to 0.40 MHz	0.005	0.0003
0.40 MHz to 1.70 MHz	0.007	0.0005
30 MHz to 100 MHz	0.028	0.0040
100 MHz to 300 MHz	0.050	0.0100
800 MHz to 1.2 GHz	>0.05	

The rate of near field lateral attenuation increases as the frequency increases. Mobile phone frequencies lateral attenuation can be expected to significantly increase, therefore reducing radio noise over short lateral distances. As high frequency radio interference is extremely directional, calculating the expected radio interference is complex and still under research. Good mobile phone reception cannot be warranted immediately under transmission lines.



Modern mobile technology contains frequency shift digital modulation which has error checks. This technology is less susceptible to high frequency radio interference. No negative impact to mobile phone reception is expected beyond the easement of the proposed transmission line.

17.4.12.10 Mitigation and management

When comparing the above results to international guidelines, and comparing the proposed transmission line route, the values indicate that the Project does not pose any EMF issues for any of the proposed transmission line or substation locations.

The primary mitigation measure against possible environmental EMF non-compliance is addressed during the design of the transmission line and substations and in the specification of high voltage equipment such as transformers and fittings. Particular mitigation measures that are to be included in the design of the transmission infrastructure include:

- Balancing the transmission lines voltages by phase transposition
- Designing the transmission network to operate remotely from a central control centre, limiting the occupational exposure to times of repair or maintenance
- Conversion of a horizontal formation to a triangular delta formation to reduce the electromagnetic field of single circuit systems (i.e. Cannington Connection and Phosphate Hill Connection)
- Restricting access to the substation sites by use of security fencing. This would limit the exposure of the general public to higher fields within the substation.

A prudent avoidance assessment was undertaken in accordance with Section 7 of the ENA EMF Management Handbook, January 2016. The intent of the prudent avoidance assessment is to reduce exposure to magnetic fields at no cost, or very low-cost measures, that reduce exposure while not unduly compromising other issues.

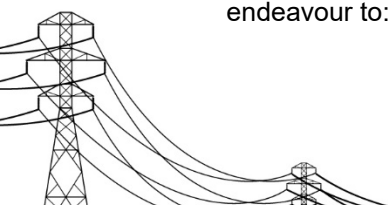
The line route and substation locations have been selected to avoid schools, childcare centres and other places where children congregate, homes, and residential areas.

Based on sections 8 and 9 of the ENA EMF Management Handbook, after prudent avoidance assessment, the following measures have also been adopted:

- 1 m more ground clearance than the minimum requirement in the *Electrical Safety Regulation 2013* under the *Electrical Safety Act 2002* for overhead lines (minimum 9 m for 330 kV and 8.5 m for 220 kV). The extra height of the conductors reduces ground level magnetic field.
- Reducing phase to phase spacing on lines as much as possible consistent with reliability, operational, and safety requirements.
- Diagonal phasing of all double circuit lines (e.g. 330kV and 220kV) which gives minimum magnetic field at ground level.
- Balanced impedance of all transmission lines through the use of transpositions.
- Requirements on loads to ensure high power factor to reduce the total current which generates magnetic fields.

The EMF assessment will be updated during the detailed design phase of the Project, including an updated prudent avoidance assessment, in accordance with the ENA EMF Management Handbook.

As CuString recognises that EMF is an issue of great importance to local communities and nearby residents, as part of the Stakeholder and Community Engagement Plan, CuString will endeavour to:



- Remain up to date with the latest scientific research into possible linkages between EMF and adverse health impacts.
- Liaise closely with the community to ensure they are educated and informed of emerging research and EMF policy development.
- Encourage concerned stakeholders to liaise with independent organisations in relation to EMF and transmission infrastructure (i.e. ARPANSA).

17.4.13 Public health and safety

17.4.13.1 Potential impacts

Safety of the public, workforce and infrastructure are of paramount importance to CuString and emergency planning will be undertaken to prepare for and mitigate impacts that may arise during an emergency. The Emergency Response Plan is further discussed in section 17.5.4.

17.4.13.2 Mitigation and management

From the health and safety values of the community identified above, and assessments conducted for the EIS it has been shown that:

- The potential for impacts to human health from air and noise emissions during the construction and operation of the Project will not present a health concern for surrounding sensitive receptors and communities (refer to Volume 2 Chapter 10 Air and greenhouse gas and Volume 2 Chapter 11 Noise and vibration).
- Any potential impact to surface and groundwater resources and water quality can be effectively mitigated without presenting a significant impact to communities (refer to Volume 2 Chapter 9 Water resources and water quality).
- Potential impacts to social infrastructure can be minimised through the design of the Project and the mitigation measures identified in Volume 2 Chapter 14 Social.
- Emergency situations of safety incidents will be managed through the Emergency Response Plan (section 17.5.4).

17.4.14 Hazardous substances

17.4.14.1 Potential impacts

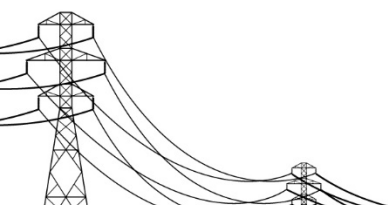
During construction and operation of the Project, a number of hazardous substances will be used, including some that are listed on the Australian Code for the Transport of Dangerous Goods by Road & Rail, Edition 7.6, 2018 (ADG Code). Table 17-21 provides an indicative list of the hazardous substances that will be used, their purpose and approximate quantities to be stored on site. Hazardous substances are described in further detail in the following sections.

Diesel

Diesel is a flammable liquid with a flash point of minimum 61.5°C. Diesel has very low solubility in water and is incompatible with strong oxidising agents. Due to the properties of diesel, there is no risk of a diesel fire or explosion.

Diesel is toxic to plants and animals. Contact with skin and eyes will cause irritation. Inhalation by humans in high concentrations will result in dizziness, headaches, nausea, vomiting, drowsiness or narcosis.

Diesel will be used to fuel mobile equipment and vehicles during construction and operation of the Project and for electricity generation during construction of the Project.



Unleaded petrol

Unleaded petrol is an extremely flammable liquid with a flash point of -40°C.

Unleaded petrol is toxic to plants and animals and may cause long-term adverse effects in the aquatic environment. Contact with skin and eyes will cause irritation. Inhalation of vapours may cause drowsiness and dizziness in humans and ingestion may cause lung damage.

Unleaded petrol will be used to fuel mobile equipment and light vehicles during construction and operation of the Project.

Kerosene or jet fuel

Jet fuel is essentially highly refined kerosene, used in aircraft powered by gas-turbine engines. It is a flammable liquid with a flash point of minimum 38°C.

Kerosene-based hydrocarbons are toxic to plants and animals. Contact with skin and eyes will cause irritation. Inhalation of vapours or ingestion of liquids by humans can cause dizziness, headache and vomiting. Repeated skin exposure may result in dermatitis. A short, one-off exposure to jet fuel is unlikely to result in any long-term effects.

Jet fuel will be used to fuel helicopters during construction and operation of the Project.

Oils

Oils are typically clear amber viscous liquids with a boiling point of 100 to 105°C. Prolonged exposure may irritate eyes and skin and when released into the environment, will absorb to the sediment and soil.

Bioaccumulation is unlikely due to the very low water solubility and therefore bioavailability to aquatic organisms is minimal. Oils are toxic to plants/animals and coating of plants and animals with oil can cause death.

Lubricating oils will mainly be used in moving parts ranging from battery hand tools to vehicle mounted implements and heavy equipment as well as on friction surfaces of tools and components during the construction of the Project.

Hydraulic oils will be used on equipment ranging from portable hydraulic tools to vehicle mounted implements during the construction of the Project.

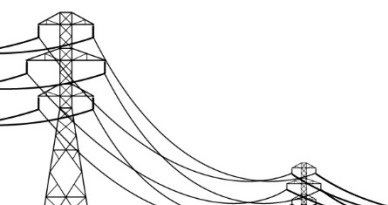
Insulating oils will be used to insulate the live part of transformers during operation of the Project. Insulating oils may be a traditional mineral oil or a more expensive synthetic product with different properties such as a higher flashpoint.

Explosives

Ammonium nitrate emulsion is a mixture of ammonium nitrate, water, a hydrocarbon (may contain diesel) and other non-hazardous additives. It is classified as hazardous according to Safe Work Australia.

Ammonium nitrate is a strong oxidizing agent that can react violently with other incompatible materials. In the event of an uncontrolled detonation it can cause serious injury or death. It should be stored and handled correctly by qualified personnel.

Ammonium nitrate is acidic with a pH of 5.4. It causes irritation to eyes, skin and the respiratory tract and is harmful if swallowed. Spills to the environment can cause toxicity to plants, algal blooms and effect to population balances in the aquatic environment due to the increased availability of nitrogen.



Ammonium nitrate emulsion is not combustible under normal applications and is not considered a fire risk however as it is an oxidising agent, it will support combustion in an existing fire by liberating oxygen, even if smothered. Contact with acids will emit toxic gases.

Ammonium nitrate emulsion will be used as an explosive for construction works at transmission tower sites.

Sulfuric acid

Sulfuric acid is a clear, colourless, oily liquid with a boiling point of 315 to 338°C. It is highly reactive and corrosive.

As sulfuric acid is soluble in water, it can easily contaminate water resources if released. It has moderate short-term and long-term toxicity on aquatic life. Sulfuric acid will cause serious burning to plants and animals. It can severely burn the skin and eyes, even causing third degree burns and blindness.

Sulfuric acid mist can irritate the eyes, nose, throat and lungs in humans.

Sulfuric acid will be used in valve regulated lead acid batteries, used for direct current power supplies to substation control and communications equipment, and in batteries in vehicles used during construction.

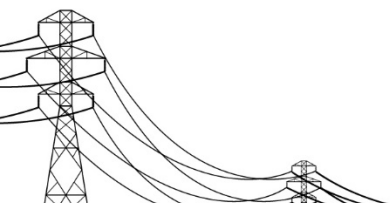
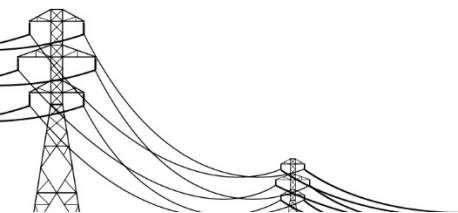
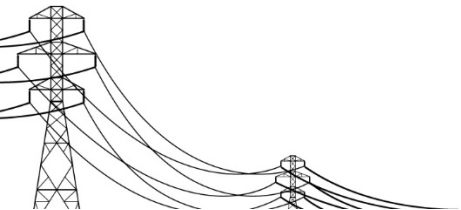


Table 17-21 Hazardous substances inventory

Hazardous substance	Dangerous goods class	Purpose/use	Indicative maximum inventory on site	
			Construction	Operation
Diesel fuel	Class 4 Flammable liquid (hydrocarbon)	Fuel for mobile equipment and electricity generation	4.2 ML - mobile plant and equipment over Project life 2.8 ML - local electricity generation equipment over Project life (depending on construction camp access to existing local supply networks). Smaller quantities (< 1,000 L) may be stored at substation sites for use in stand-by generators.	Local supply points will be utilised where available
Unleaded petrol	Class 3 Flammable liquid (hydrocarbon)	Fuel for mobile equipment and light vehicle fleet	5,000 L at any one location	Local supply points will be utilised where available
Kerosene or jet fuel	Class 3 Flammable liquid (hydrocarbon)	Fuel for helicopters used for stringing operations and ongoing maintenance	5,000 L at mobile refuelling pads/stations	5,000 L at mobile refuelling pads/stations
Lubrication oils (hydraulic oil)	N/A (Environmental/safety concern)	Lubrication of equipment during general maintenance	50 L at any one location (e.g. Vehicle workshop)	N/A
Explosives	Class 5.1 Ammonium Nitrate Emulsion (oxidising agent)	Blasting activities – requirement or extent of activities is to be confirmed during detailed design, as an outcome of detailed tower geotechnical studies	To be determined through detailed design of the Project	N/A



Hazardous substance	Dangerous goods class	Purpose/use	Indicative maximum inventory on site	
			Construction	Operation
Transformer mineral oil	N/A (Environmental/Safety concern)	Insulation of live part of the transformers	N/A	50,000 to 100,000 L per transformer and shunt reactor
Sulfuric acid	Class 8 Corrosive liquid (acid)	Stored within valve regulated lead acid batteries, used for direct current power supplies to substation control and communications equipment.	N/A	200 L per substation
Herbicides	N/A (Environmental/safety concern)	Vegetation management – most vegetation control will occur by mechanical means	N/A	20 L at any one time
Cement powder	N/A (Dust release is an environmental/safety concern)	Used to make concrete		
Concrete admixtures	N/A (Environmental/safety concern)	Used to modify the behaviour of concrete (setting time, plasticity etc.)		
Fly ash	N/A (Dust release is an environmental/safety concern)	Use to make concrete		



17.4.14.2 Mitigation and management

To ensure the Project avoids the release of hazardous materials as a result of a natural hazard event, hazardous substances will be stored and used in accordance with current Australian Standards and industry codes of practice (refer to section 17.2.2). This will include containment measures, such as bunding and fire protection, as specified below. Locations for storage of hazardous substances will also be chosen to avoid release to the environment in the event of an event such as a flood or fire.

Safety Data Sheets (SDS) will be available at appropriate locations where these substances are stored or used.

It is expected that hazardous substances will be transported to construction camps and lay-down areas by road via the roads identified in Volume 2 Chapter 13 Transport.

Most hazardous substances will be required during the construction period of the Project. Procedures for the safe storage and use of hazardous materials and dangerous goods will be included in the CEMP. Where regulatory licences are required, (for example an Environmental Authority for Environmentally Relevant Activity 8: Chemical Storage), compliance with all associated conditions will be managed through the CEMP.

Once construction is complete, the use of significant quantities of hazardous substances will be minimal.

Diesel and unleaded petrol

All bulk diesel and unleaded storage and handling locations will be established in accordance with current Australian Standards and industry codes of practice.

Sites will be organised to minimise the exposure of personnel or buildings to potential fire hazards and appropriate fire protection equipment will be provided at fixed installations. Mobile plants will also be fitted with portable fire extinguishers and spill kits.

Ignition sources will be closely controlled and appropriate personal protective equipment (PPE) will be provided.

Kerosene/jet fuel

Mobile refuelling pads/stations will be provided by the helicopter operator and these will include secondary containment, spill response equipment and fire protection equipment. Refuelling facilities will be located close to the project area to minimise travel distances and fuel usage.

Ignition sources will be closely controlled and appropriate PPE will be provided.

Hydraulic oil

Hydraulic oil will be stored in sealed containers and used in accordance with ESWMS.

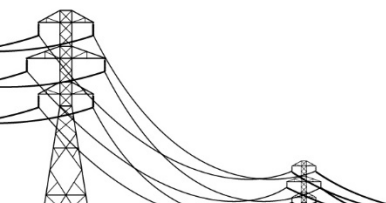
Explosives

Explosives will be stored in accordance with relevant legislation and guidelines.

Only personnel trained in the safe handling and use of explosives will be in contact with explosives.

Transformer oil

Transformer oil will be contained in enclosed transformer tanks and associated radiator fins. Secondary containment will be provided by bunding, drained to interceptor pits to capture potential oil spills.



Sulphuric acid

Sulphuric acid will be stored in suitably designed hazardous goods containers.

Batteries containing sulphuric acid will be housed in suitable enclosures (cabinets, racks or rooms) equipped with suitable spill containment and ventilation. Warning signage and appropriate PPE will be provided.

Batteries will be replaced every 10 years (observing the relevant SDS), protective clothing and all recommended procedures covering disposal.

Herbicides

All personnel handling herbicides will be required to have a current Agricultural Chemicals Distribution Control licence.

Herbicides will be stored in sealed containers in accordance with the applicable SDS and will be used in accordance with ESWMS.

Concrete Admixture

Concrete admixture will be stored in appropriately bunded areas.

Employees will be trained in the correct handling and use of concrete admixture. PPE and spill kits be available.

Cement powder and fly ash

Cement powder and fly ash will be stored in sealed containers. Employees will be trained in correct batching procedures to reduce the potential for dust release.

17.4.15 Natural hazards**17.4.15.1 Potential impacts****Floods**

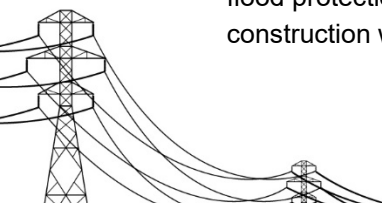
The corridor selection traverses approximately 185 km of floodplains and areas that are subject to flooding events associated with summer monsoonal conditions.

Transmission towers will be constructed across the floodplain zones at a spacing of 400 to 500 m, depending on topography and conductor clearance requirements. No substations or construction camps or other critical infrastructure is planned along this floodplain.

The Burdekin River is by far the largest river system in the study area, with mean annual flow volumes of 4400 GL/yr recorded at Sellheim. The next largest river system is Flinders River with a mean annual flow of 520 GL/yr recorded at Richmond. All other waterways have mean annual flow volumes less than 250 GL/yr.

Most of the major waterways in the study area are ephemeral in nature. For these waterways, flows are only experienced during the wet season which lasts for about four to five months of the year. The remaining seven to eight months of the year these waterways are virtually dry, with minimal flow recorded.

Flood level modelling has not been undertaken during the preparation of this EIS however there are no significant changes in substation locations since flood modelling was undertaken for the CopperString 1.0 Project in 2010. Qualitative assessments based on topography and aerial photography indicate that the proposed construction camps and substations will be located outside of the typical floodplain extents and are therefore likely to have an appropriate level of flood protection. Transmission towers will be constructed within flood prone areas however construction will be undertaken outside the wet season.



In February 2019, North Queensland experienced an unprecedented weather event that caused an extended period of heavy rainfall and flooding across large areas of northern Queensland, with many sites exceeding 1% annual exceedance probability (AEP) for durations of four or more days (BOM, 2019a). Should there be reoccurrence of such an event it is likely that many transmission towers will be inundated, especially those planned on floodplains.

There is a risk of infrastructure associated with the Project being damaged/lost as a result of a flood event. This can indirectly lead to a function loss of the transmission line and associated infrastructure, which would result in a total loss of capacity on the electrical grid and lead to outages in affected communities.

There is also a risk of harm to people during flood events, particularly vehicles being trapped in floodwaters.

Bushfires

Figure 17-3 indicates that the CopperString corridor selection is mostly in an area of low to medium bushfire risk, with some small areas in high to very-high bushfire risk. Bushfires have a high heat output and have historically caused loss of life and significant damage to property.

In the event of bushfires in vegetation outside of the transmission line easement, the flames and heat plume present a risk to the Project as they may cause direct damage or reduce the life of the transmission infrastructure and lead to fire-induced flashovers. This would result in blackouts to Mount Isa, Cloncurry and mines connected to the grid, which could last days. In this scenario there would be no alternative source of electricity supply until the transmission infrastructure can be repaired.

In areas that are not in bushfire prone areas, there is still a risk of grassfire. Grassfires are fast moving and are low to medium intensity. They typically damage crops, livestock and farming infrastructure such as fences.

Wind

The transmission infrastructure is designed to meet applicable wind codes. Transmission infrastructure is at risk of damage when wind speeds exceed those used in the design. Impacts can include structural failure due to wind pressure and impacts from objects flying into transmission infrastructure. These impacts may be experienced during a cyclone or other weather event. The majority of the corridor selection is not at risk from cyclonic winds however there is potential for strong winds throughout the entire corridor selection.

Drought

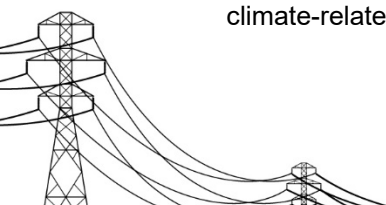
Whilst drought is frequently experienced in much of the Project area, it is unlikely to cause any direct impacts to people or property in association with the Project. Indirect impacts such as the increase in fire risk, due to hot temperatures and dry conditions, may result from drought.

Earthquake

Historical records indicate that earthquake activity is low in the Project area however there have been earthquakes up to magnitudes of six in the region. Although the risk of earthquake is low it cannot be discounted as there are mapped fault lines in the Project area and previous records of seismic activity, particularly in the western section of the corridor selection.

Climate change

Risks from climate change are associated with changes to the frequency and severity of hazardous climate-related events such as cyclones, storms, and bushfires. There is a risk that climate-related impacts could affect the long-term viability of the Project, for example increased



flood levels, higher temperatures and frequent/severe bushfires may impact Project infrastructure.

Lightning

Lightning is a common natural hazard that is likely to be experienced more frequently during the wet season, but may occur at any time throughout the year.

The risks associated with lightning include personal injury/electrocution from direct lightning strike and conductive coupling, which occurs when lightning strikes a transmission structure, or when there is a phase to ground fault (refer 17.4.5).

Cumulative impacts of natural hazards

There are some instances where more than one natural hazard may occur at one time, such as drought and bushfire, or cyclones and floods. There is also a tendency for natural hazards to have an impact on the severity of other natural hazards that follow soon after. For example, the amount of vegetation cover may be significantly reduced during a drought or bushfire, resulting in more severe impacts from a subsequent flood due to a lack of vegetation to slow overland flow and provide soil stability. Conversely a period of high rainfall can increase fuel loads, resulting in more severe bushfires.

The cumulative impacts of a number of natural hazards occurring at one time has the potential to increase risk to people and property, particularly where existing preparation and management plans are insufficient to deal with more than one event.

17.4.15.2 Mitigation and management

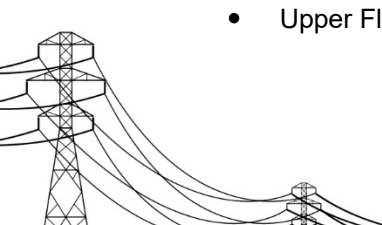
Floods

The construction program is scheduled such that peak construction activities in areas susceptible to flooding are programmed to occur outside of the wet weather period. The Road Use Management Plan will also address wet weather aspects associated with the use of unsealed access tracks, stop work conditions, transport agency consultation on weather events and road use conditions, and formalised wet weather access arrangements with private landholders.

The BOM provides a Flood Warning Service Program to provide an effective flood forecasting and warning service in each Australian state and territory. It provides flood forecasting and warning services for most major rivers in Australia, with the cooperation of other government authorities, such as State Emergency Services (SES), water agencies and local governments. BOM issues a Flood Watch to provide early advice of a developing situation that may lead to flooding. Flood Watch is generally issued up to four days in advance of the expected onset of flooding and may be issued before, during and after rainfall has occurred, depending on flood impact information made available from the local emergency services or state agency (BOM, 2020b).

Flood Watch areas are based on riverine catchments. The areas referred to in Flood Watches that are applicable to the corridor selection are:

- Leichhardt River
- Cloncurry River
- Georgina River and Eyre Creek
- Lower Flinders River
- Upper Flinders River



- Thomson River
- Cape River to Burdekin Falls Dam
- Burdekin River to Burdekin Falls Dam
- Haughton River.

During construction of the Project, the Construction Manager should regularly check BOM weather forecasts and Flood Watch for indications of potential flood hazards. In the event of a Flood Watch being issued for one of the areas listed above, the advice should be followed and flood warnings heeded. All personnel should follow the advice of local emergency services.

Further investigation of flood risks will be undertaken during detailed design of the Project.

Bushfires

Bushfire risk has been considered during concept design, with avoidance of steep terrain and woody vegetation.

The transmission network will include protection system elements for high impedance faults, such as energised lines contacting vegetation and the ground, which reduces the risk of bushfire initiation by transmission line contact.

The Project Emergency Response Plan will include management of hazards and risk of bushfires. This plan will be developed in consultation with the relevant fire and emergency services. The plan will be developed from information sources such as the Bushfire & Natural Hazards Cooperative Research Centre which publishes regular updates on fire season outlook and incorporate recent weather patterns and the climate outlook (BNHCRC, 2020).

Strategies to manage bushfire risk will be developed in line with the State Planning Policy - state interest guidance material, Natural hazards, risk and resilience – Bushfire, and will be outlined in the Emergency Response Plan.

Wind

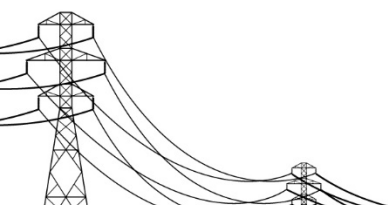
Engineering design of the transmission tower structures and foundations will include the requirements of the Wind Code. Wind Code requirements may differ for different sections of the transmission line, particularly the first 50 km of the Woodstock to Dajarra transmission line section, which is in the cyclone impact zone (refer Figure 17-1). Engineering design controls will have consideration of the foundation size, spacing of towers and individual tower placement in the mitigation of high cyclonic winds for this identified wind hazard zone.

Earthquake

The Project will be designed in accordance with accepted civil engineering practice for the region which includes consideration of managing natural hazards and risks for structures.

Drought

Due to the relatively short period of construction, the impact of drought on construction of the Project is not expected to be significant and can be managed should a drought occur. The direct impact on operations is also low. However, drought is often associated with other climate extremes which can result in a number of other issues that may affect operations including an increased risk of fire, dust storms and land degradation. These issues will be managed through the Emergency Response Plan and Erosion and Sediment Control Plan.



Climate change

As the risks from climate change are associated with increased frequency and severity of other natural hazards, such as cyclones, bushfires and floods, the mitigation and management measures include those designed to manage other natural hazards.

During detailed design, adaptation strategies will be assessed based on long-term climate change projections for the region to minimise the impacts of climate change on the Project. Adaptation strategies will consider the frequency of storms and bushfires, and variations in temperature and increasing flood levels.

An Emergency Response Plan will be developed to address the hazards and risks associated with bushfires. The construction program is scheduled such that peak construction activities in areas susceptible to flooding are programmed to occur outside of the wet weather period.

Lightning

Construction activities will mostly occur outside of the wet season, which will reduce potential exposure to lightning. Lightning activity should be monitored throughout the day during the wet season or when there are indications of storm activity in other times of the year. In the event of high risk lightning activity during construction, works may be limited to avoid risk to construction workers.

Cumulative impacts of natural hazards

An Emergency Response Plan will be developed with appropriate specific emergency response plans for all relevant construction and operational activities. This plan should consider the cumulative impacts of several natural hazards occurring at any one time. An overview of the Emergency Response Plan is provided in Section 17.5.4.

17.4.16 Wildlife and livestock interactions**17.4.16.1 Potential impacts**

The risks to people and property from wildlife and livestock interactions include:

- Construction personnel being involved in vehicle strike with wildlife or livestock
- Construction personnel receiving animal bites/stings
- Wildlife or livestock contact with electricity transmission infrastructure causing damage to infrastructure and/or power outages.

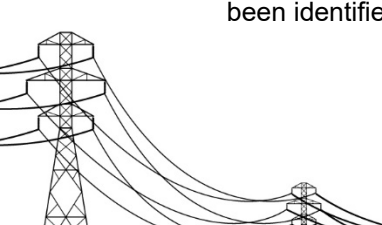
17.4.16.2 Mitigation and management

Construction personnel will undertake inductions that will include information about areas of higher risk of impact with wildlife and livestock, where relevant, and appropriate first aid/response to wildlife or livestock interactions.

Vehicles will be restricted to the relevant highways, roads and construction access tracks and speed limits will be enforced. Only vehicles required for safe, efficient and essential construction activities will be allowed in construction zones.

Fauna spotter/catchers will be present on site during clearing, when snake-related incidents are expected to be highest. Construction personnel will be required to wear suitable clothing and appropriate PPE. First aid kits with compression bandages will be available at all construction sites, construction camps and in construction vehicles.

Fauna friendly anti-climbing barriers will be installed on towers where wildlife interactions have been identified or are likely (e.g. riparian zones).



Potential bird strike areas will be assessed to determine if and where installation of diverters is required.

17.5 Management framework

17.5.1 Risk management plan

The Risk Management Plan associated with the Project will evolve throughout the life of the Project. The key risk management activities, which will be undertaken as the basis of the Risk Management Plan are as follows.

Application of design and construction standards

CuString has identified a comprehensive register of relevant design and construction standards, which will be applied throughout the life of the Project. Many of these standards address safety and environmental risk exposures, as well as operational type risks. The register of these standards will be included in the Risk Management Plan.

Safety in design reviews

The application of design standards will be a key driver of risk management in the design and construction stages. CuString will also conduct detailed Safety in Design Reviews of each major Project component. These reviews are intended to confirm that risk mitigation strategies (safety, environment, operational) are incorporated into the Project design and to identify opportunities for improvement where potential gaps are identified. These reviews are in keeping with the principles of inherent safety, which suggest that risk can be far more effectively managed and mitigated with design treatments, rather than through future administrative controls and retrofits.

Construction safety management plans

Each component of the construction will be delivered in accordance with a specific construction safety management plan, which will be generated on the basis of a construction risk assessment. The risk assessment will involve a cross section of the construction workforce, in accordance with best practice risk management principles. Ongoing supervision will be provided to ensure compliance with the safety management plan.

Construction environmental management plans

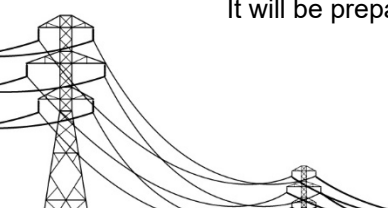
This plan will provide specific environmental management requirements to ensure that works undertaken avoid adverse effects on the environment and surrounding communities. It will be prepared to address the environmental management strategies including performance criteria, management actions, and monitoring, auditing and reporting requirements and to specify areas of responsibility related to the construction phase of the Project.

Construction quality management plans

This plan will ensure that the construction of the Project, including the risk mitigation factors, is delivered in accordance with the prescribed specification. It will include detailed audits and reviews at predetermined hold points in a gated approach.

Operational safety management system

A comprehensive safety management system will be developed for the operational phase of the Project. This will be based on a formal risk assessment process and will drive the development of standard operating procedures and SWMS for regular or routine tasks. It will also define a risk based approach to managing ad-hoc or unusual tasks, in the form of an ESWMS or similar. It will be prepared to address the safety management strategies including performance criteria,



management actions, and monitoring, auditing and reporting requirements and to specify areas of responsibility related to the operational phase of the Project.

Operational environmental management plans

This plan will provide specific environmental management requirements to ensure that operational activities have minimal adverse effects on the environment and surrounding community. It will be prepared to address the environmental management strategies including performance criteria, management actions, and monitoring, auditing and reporting requirements and to specify areas of responsibility related to the operational phase of the Project.

Asset management strategy and plans

A key element of managing all areas of risk is ensuring the operational integrity of the electricity transmission network. An overall asset management strategy will be developed and this will be supported with management plans focusing on such aspects as condition monitoring and preventative maintenance, corrective maintenance, asset replacement and augmentation, change management, etc. Formal policies and standards will be developed based on asset life considerations and standard operating procedures will be developed to ensure that these policies and standards are delivered.

Bushfire management plan

A bushfire management plan will be developed in conjunction with other risk management features, such as asset management strategies and environmental management plans. The plan will consider both network design and operating features relevant to fire prevention, as well as environmental procedures, such as vegetation management, to manage and mitigate the potential consequences of an ignition. This plan will also be linked to the Project's Emergency Response Plan.

Emergency response planning

An overall Emergency Response Plan will be developed detailing such requirements as emergency preparedness, emergency response plans and command and control structures to ensure effective communications during an emergency. This plan will require that appropriate specific emergency response plans are developed for all relevant construction and operational activities. An overview of the Emergency Response Plan is provided in Section 17.5.4.

Stakeholder communications and engagement plan

Formal procedures will be developed to ensure that there are adequate resources to allow ongoing consultation with the community and to respond to community concerns such as network operations issues, environmental issues and outline landholder communication paths. Stakeholder engagement is further discussed in Volume 2 Chapter 14 Social, Volume 3 Appendix C Public consultation report, and Volume 3 Appendix Z Social impact assessment.

17.5.2 Hierarchy of control

The hierarchy of control is a commonly used principle in the management of hazards. It involves a prioritised order of controls from the most effective to the least effective strategies.

The aim of applying the hierarchy of control is to have a combination of control strategies to manage a specific risk and to use the hierarchy to reduce the risk so far as is reasonably practicable.

The hierarchy of control is detailed in Table 17-22.

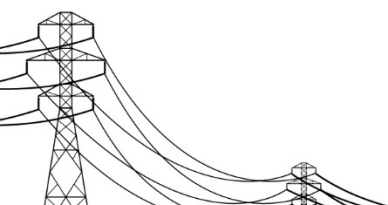


Table 17-22 Hierarchy of control

Control	Definition
Elimination	Remove or avoid the hazard completely
Substitution	Replacing with a safer alternative
Isolation	Separating the hazard from the person, environment or process at risk by isolation, guarding, barricading, alternate duties etc.
Engineering controls	Constructing new devices to reduce the risk
Administrative controls	Promote awareness of hazards e.g. signage, procedures, training etc.
Personal Protective Equipment (PPE)	Considered only when other controls are not practical or to increase personal protection

By undertaking a risk assessment of health and safety during the early stages of the Project, CuString have the ability to implement the hierarchy of control to its fullest extent. During the design stages, control strategies higher in the hierarchy can be applied to eliminate, substitute, isolate or engineer the site, infrastructure and equipment to reduce the risks so far as reasonably practicable.

17.5.3 Incident management

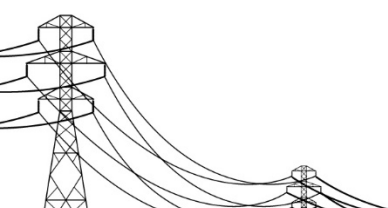
CuString will implement an incident management process to enable:

- Reporting of incidents by any site personnel
- On-going identification of hazards and system deficiencies by any site personnel
- Investigation of all reported incidents to identify hazards and system deficiencies to prevent an incident reoccurring
- Follow up and close-out of identified corrective actions
- Communication of incidents across the organisation and statutory reporting if required
- Use of findings from incident investigations to improve systems, processes and procedures.

17.5.4 Emergency management

CuString will maintain a state of emergency preparedness as a commitment to its workforce, local communities and other relevant stakeholders. While prevention is seen as the primary instrument of avoiding the risks identified in the above risk assessment and throughout the EIS, a detailed Emergency Response Plan will be developed for the Project as part of the Construction Management Plan by the Construction Contractor. The Emergency Response Plan will assist in minimising the severity of any emergency and the damage and disruption that may arise from any emergency. The Emergency Response Plan will include comprehensive emergency response procedures, including evacuation plans for the construction camps.

The Emergency Response Plan will be developed in consultation with the relevant emergency service providers including the Queensland Ambulance Service, Queensland Fire and Emergency Services, Rural Fire Service Queensland, Queensland Disaster Management, local government and other relevant community stakeholders. The Emergency Response Plan will include reference to the State Planning Policy 2017, which includes planning for safety and resilience to hazards, and local government disaster management plans, where appropriate.



The Emergency Response Plan will be based on the following key components:

- An assessment of incidents that may take place and the consequences that would likely occur
- Coordinated planning mechanisms to manage incidents incorporating both on-site and off-site plans to coordinate any required emergency services
- Communication, emergency responsibilities and establishment of a control centre
- Post-emergency procedures including recovery and management plan review
- Training requirements and testing of the management plan to ensure effective and efficient implementation.

The Emergency Response Plan will be developed using current industry standards and will contain specific information regarding the:

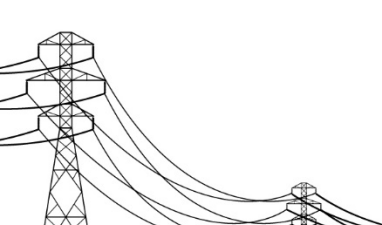
- Emergency organisational structure
- Roles and responsibilities in the event of an incident
- Emergency contact numbers of internal and external emergency managers and providers
- Clear notification protocols and procedures will be detailed (but not limited to) in relation to the following events:
 - Fire from natural events (i.e. Bushfires) and as a result of the Project
 - Explosion of high-voltage substation equipment
 - Medical emergency
 - Missing personnel during the construction of the Project
 - Environmental emergency
 - Natural disasters.

The Emergency Response Plan and emergency response procedures will be communicated to all personnel associated with the Project through inductions and toolbox talks. Copies of the Emergency Response Plan will be kept in prominent workplace locations and will be made available on site during construction.

The Emergency Response Plan will incorporate consideration of the remoteness of some work locations and the limited response capabilities of emergency service providers in those locations. Consultation with relevant emergency service providers will occur prior to construction of the Project to confirm the location and schedule of works. Detailed mapping will outline the locations of access roads and reference to work locations (e.g. Tower numbering). Emergency service providers will be updated on amendments and revision to the management plan, where appropriate.

Where an onsite incident or emergency situation has the potential to extend offsite and impact on surrounding land users, the management plan will have specific notification arrangements in place for contacting neighbouring properties.

A review of the Emergency Response Plan, in line with the adaptive nature of the Project management system, will be conducted on completion of the construction schedule to make certain the emergency situations that may arise from the operation of the Project are taken into account.



17.5.5 Reporting and audits

As part of an effective management system, CuString will implement a monitoring, auditing, review and improvement process that will include:

- Routine inspections of assets
- Routine monitoring of control implementation (for example, workplace observation programs)
- Document control system to enable routine review and update of all standards, procedures and SWMS. A training management system to identify and track training requirements for tasks and of all personnel, including refresher training programs
- A permit to work process to monitor and control specific higher risk activities
- A change management system to assess the impacts of changes made
- A communication strategy to notify all relevant personnel of changes made.
- Regular audits to confirm compliance with the health and safety legislative requirements and company/operations specific processes and procedures. This will also include independent external authorities conducting audits as necessary.

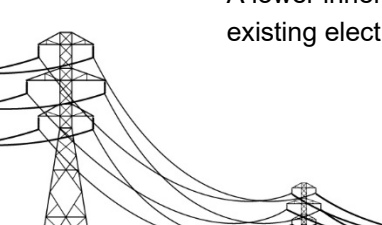
17.6 Conclusion

An evaluation of each potentially significant risk identified in the PHA was conducted and the results of these evaluations suggest that the Project will not present an unacceptable level of risk to people, property or the environment. In appropriate cases this was determined quantitatively through a comparison of calculated risk levels associated with the Project to the generally accepted risk criteria for land use safety planning presented in HIPAP 4. In other cases, where a qualitative or semi-quantitative approach was considered more appropriate, the risk levels were evaluated with respect to the proposed control and mitigation strategies. Further, similar risks which are currently considered tolerable by the community were included.

The risk analysis determined that the risk levels with respect to the proposed control and mitigation strategies were considered acceptable, based upon the following factors:

- Risks are similar to those that are currently considered tolerable by the community
- The Project will be designed, constructed and operated under the comprehensive regulatory environment which exists for the electricity transmission industry in Australia, much of which addresses the well-understood inherent safety risks and system reliability considerations
- The proposed design makes use of operational technology and construction methods which are proven and standard for the industry
- The environmental setting of the Project is favourable, with adequate separation achieved between the assets and potential sensitive receptors and sensitive land uses, which minimises the risk exposure from localised hazard events, such as transformer fires or explosions
- The more regional risk to people and property associated with bushfire is similarly mitigated through the available separation, but additional features such as the low to moderate inherent bushfire risk and planned vegetation management process further reduces the risk.

A lower inherent risk to people and property is anticipated than those experienced by numerous existing electricity transmission and distribution assets elsewhere in Queensland and Australia,



which often co-exist in close proximity to more densely populated and more densely vegetated areas.

This understanding of the inherent risk to people and property of the Project coupled with CuString's commitment to implementing Australian industry standard risk management practices, suggest that the overall risk to people and property is low in the broader electricity transmission industry context.

