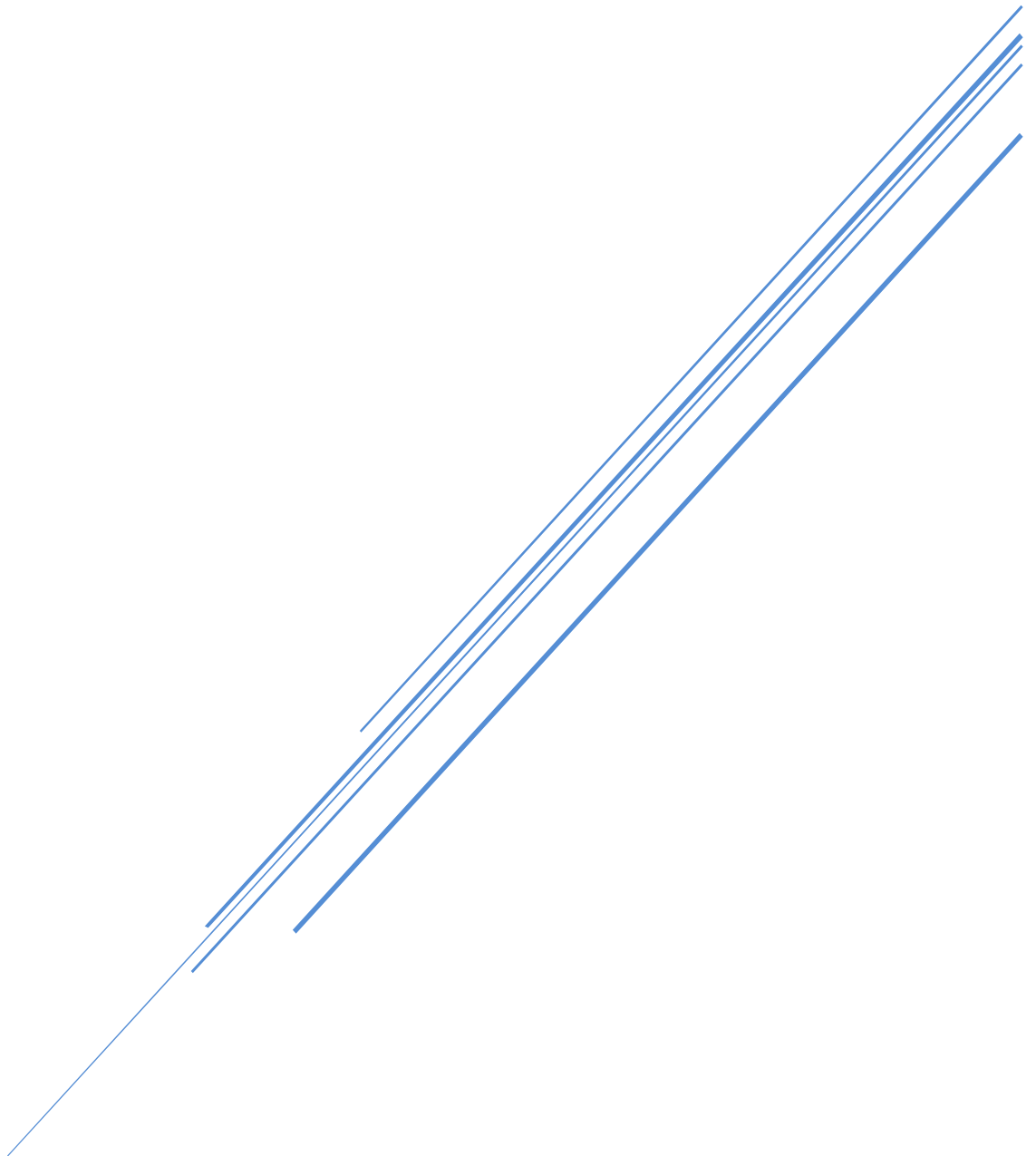


STATEMENT OF ENVIRONMENTAL EFFECTS

Narrabri 3A Solar Farm

1 November 2021



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Attachment A: AHIMS Search Results

Document Details & History

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Client	ITP (Development) Pty Ltd
Author	Allen Grimwood, Director
ABN	Zenith Town Planning Pty Ltd PO Box 591 Moruya NSW 2537 11 624 467 349
Qualifications	Bachelor of Arts (Honours), UNSW Master of Urban & Regional Planning, USyd  Planning Institute Australia
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EXECUTIVE SUMMARY

This Statement of Environmental Effects supports an application to Narrabri Shire Council to develop a solar farm at Lot 102 DP 579423 No 11498 Newell Highway, Narrabri, referred to as the Narrabri Solar Farm. The proponent is ITP (Development) Pty Ltd. The site is located 4.5 kilometres south-west of Narrabri township and occupies 11.32 hectares of the 62 hectare property. The application is for regionally significant development that needs consent and is to be determined by the Northern Regional Planning Panel.

The proposed development comprises the following:

- 12,100 solar modules ranging in height from 1.5 metres to 2.75 metres installed in 140 rows,
- Two 3MW inverter stations each mounted on a 12.2 metre long skid,
- A temporary car parking and materials laydown area,
- A security fence, and
- Perimeter landscaping on the outer side of the security fence.

The site selection process has involved liaison with Narrabri Shire Council officers; identification of environmental and topographical constraints; existence of necessary infrastructure including accessways, power lines and sub-stations; proximity to the settlement of Narrabri to enable supply of power direct to the township; sufficient cleared land area; willingness of the land owner to develop part of the property and enter lease arrangements to facilitate the solar farm; and the availability of solar resources.

Documentation is submitted in accordance with *Schedule 1 Forms Part 1 Development Applications* of the *Environmental Planning and Assessment Regulation 2000*. It is integrated development as a separate approval is required to be issued by Transport for NSW under the *Roads Act 1993* for works on a classified road.

The development is satisfactory to the objects of the *Environmental Planning & Assessment Act 1979* and applicable environmental planning instruments. The land is zoned RU1 Primary Production under *Narrabri LEP 2012*. The development is defined as *electricity generating works* which means a building or place used for the purpose of making or generating electricity. The proposed development of Narrabri Solar Farm is prohibited in zone RU1 but made permissible by provisions of *SEPP (Infrastructure) 2007*.

The proposed development is consistent with the strategic planning framework that applies to the local government area, the site itself and to the development of electricity generating works.

Goals, objectives and actions of the *New England North West Regional Plan 2036*, the *Narrabri Growth Management Strategy*, the *Narrabri Local Strategic Planning Statement 2040* and the *NSW Renewable Energy Action Plan* are satisfied.

Key issues are potential impacts on biodiversity, access to the site and traffic impacts, the effects of flooding and noise emissions, and impacts on cultural heritage, the rural landscape and scenic amenity. The likely impacts of the development have been considered and measures recommended to avoid, minimise or mitigate these impacts.

The solar farm is designed to generate in excess of 12.71GWh of energy annually which will offset almost 8.5 thousand tonnes of CO² equivalent emissions (Sources: *National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Schedule 1)* and Department of the Environment and Energy) and providing enough energy to power about 2,150 NSW homes. Electricity generated by the system will be directed to the settlement via existing electrical infrastructure to contribute to the supply of electricity for use by households and businesses in Narrabri town centre. The solar farm will generate community economic benefits through local employment opportunities during the planning and construction phases as well as maintenance and inspection jobs once operational. The land may continue to be used for agriculture and returned to its current condition once the facility is decommissioned.

The development of the solar farm will assist the transition of our economy from reliance on fossil fuels to renewable sources. It will assist Commonwealth and NSW Governments to achieve targets and objectives relating to emissions and addressing climate change.

1. INTRODUCTION

1.1 Overview

The purpose of this Statement of Environmental Effects is to support an application to Narrabri Shire Council to develop a solar farm at Lot 102 DP 579423 No 11498 Newell Highway, Narrabri, referred to as the Narrabri Solar Farm. The application is for regionally significant development that needs consent and is to be determined by the Northern Regional Planning Panel.

A separate approval is required to be obtained under section 4.46 of the *Environmental Planning and Assessment Act 1979* and is therefore integrated development. Works are proposed along a classified road, therefore, an approval is required to be issued by Transport for NSW under section 138 of the *Roads Act 1993*.

This Statement has been prepared having regard to advice provided by Narrabri Shire Council during a site visit in September 2020. Information has also been sourced from the Council's website, the NSW legislation website, SIX Maps, the website of the Department of Planning, Industry & Environment, the Planning Portal and SEED (Sharing and Enabling Environmental Data). All information referenced in this Statement has been sourced from publicly available documents or websites and from expert reports produced to support the application.

The methodology and findings of expert reports that accompany the application are summarised in this Statement. Further information about these matters should be sought from the original documents.

1.2 Scope of the report

The scope of this report is to describe the location and physical characteristics of the site on which the development is proposed, identify relevant provisions of plans and policies applying to the land, and to discuss any potential environmental impacts of the development and proposed servicing arrangements.

The purpose of this report is to assist Council's assessment of the proposal against the matters for consideration listed in section 4.15 of the *Environmental Planning and Assessment Act 1979*.

This statement is accompanied by the documents listed in Table 1 which support the development application and have been submitted under separate cover. This documentation is submitted in accordance with *Schedule 1 Forms Part 1 Development Applications* of the

Environmental Planning and Assessment Regulation 2000. Summaries of the findings of these studies and reports are provided in this Statement. Reference should be made to these documents for further details and information about methodology, findings and recommendations.

Table 1: Development application documents

Plan/Doc No.	Plan/Doc Title	Prepared by	Issue	Date
NAR3A-G-0100	Narrabri 3A 5MW Solar Farm Development Application	ITP Renewables	-	-
NAR3A-G-0400	Location Plan, Site Plan	ITP Renewables	1	23 /02/21
NAR3A-G-2100	General Arrangement Plan	ITP Renewables	4	01/03/21
NAR3A-G-2200	Site Elevations	ITP Renewables	1	01/03/21
NAR3A-C-4300	Inverter Footing Details	ITP Renewables	1	09/02/21
NAR3A-C-5300	Fencing Detail	ITP Renewables	1	25/01/21
NAR3A-C-5301	Gate Sections	ITP Renewables	1	25/01/21
NAR3A-C-6300	Access Path Details	ITP Renewables	1	01/02/21
NAR3A-E-3400	Nextracker Array Detail	ITP Renewables	1	19/02/21
NAR3A-E-4300	Inverter Station Details	ITP Renewables	1	10/02/21
NAR3A-C-7300	Landscape Details	ITP Renewables	1	12/03/21
MAC180781-14RP1	Noise Assessment	Muller Acoustic Consulting Pty Ltd	-	08/10/20
F8619	Traffic Impact Assessment Report	Price Merrett Consulting	Final	27/09/21
18105488-021-Rev2-Narrabri3A-WaterAssess	Water Assessment	Golder Associates Pty Ltd	-	31/03/21
-	Glare and Glint Assessment	ITP Renewables	1	23/09/20
-	Waste Assessment	ITP Renewables	1	11/09/20
-	Decommissioning Assessment	ITP Renewables	1	11/03/21
-	Biodiversity Inspection Report	Red-Gum Environmental Consulting Pty Ltd	-	12/03/21
2220	Landscape Character and Visual Impact Assessment	Zenith Town Planning Pty Ltd	-	30/03/21

1.3 The proponent

The proponent for the proposed solar farm is ITP (Development) Pty Ltd. ITP (Development) is a private sector organization based in Canberra and Sydney, which was established in 2003. It is part of the IT Power Group which was formed in 1981 in the UK to bring together specialists in renewable energy, energy efficiency and carbon markets. IT Power offers expertise in renewable energy and energy efficiency, including research, development and implementation, managing and reviewing government incentive programs, high level policy analysis (including carbon markets), engineering design and project management.

1.4 Justification

Solar energy is energy created by the heat and light of the sun. Solar power is produced when this energy is converted into electricity or used to heat air, water, or other substances. Australia has the highest average solar radiation per square metre of any continent in the world. Despite uncertainty regarding energy policy, the Commonwealth and NSW Governments have recognized the need to supplement energy derived from fossil fuels with energy generated from renewable sources. Alternative energy supply may be sourced from solar photovoltaic, geo-thermal, solar thermal, wave and tidal action, and wind.

The development of solar photovoltaic power is well underway in NSW and across Australia. This growth in the local solar PV sector continues to provide a significant boost for Australia's regional economy with renewable infrastructure development estimated to create upwards of 2,300 direct jobs plus indirect employment.

According to the Australian Renewable Energy Agency (ARENA), the deployment of household solar PV that generates about 5 kW is expected to continue and at the same time an increase in rooftop solar PV installations on commercial premises generating around (10-100 kW) is expected. Large scale solar PV is also rapidly expanding in Australia with several solar farms being constructed that will have the capacity to generate over 50MW. The proposed solar farm aims to fill the gap in the mid-sized plants. It will generate 5MW of AC power and contribute to renewable energy supply to supplement electricity generation from coal, oil and gas.

The proposed development is in accordance with relevant objects of the *Environmental Planning and Assessment Act 1979* in that it will assist to generate power to be distributed to the residents of NSW thereby promoting the social and economic welfare of the community in a manner that manages and conserves natural resources. The Narrabri Solar Farm will further the goals of sustainability, and the orderly and economic use of land.

1.5 Electromagnetic radiation

The information presented in this section has been sourced from the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). It includes a description of the type of electromagnetic radiation that may be produced by the generation and distribution of electricity.

The generation, distribution and use of electricity can produce extremely low frequency (ELF) electromagnetic fields (EMF) from electrically charged particles. The electric field is produced by the voltage whereas the magnetic field is produced by the current. The strength of the electric field is measured in units of volts per metre whilst the strength of the magnetic field is expressed in units of tesla (T), microtesla (μT), gauss (G) or milligauss (mG).

ELF EMF is produced by both natural and artificial sources. Naturally occurring ELF EMF is associated with atmospheric processes such as ionospheric currents, thunderstorms and lightning. Artificial sources are the dominant sources of ELF EMF and are usually associated with the generation, distribution and use of electricity at the frequency of 50 or 60 Hz. The widespread use of electricity means that people are exposed to ELF electric and magnetic fields in the home, in the environment and in the workplace.

According to the Australian Radiation Protection and Nuclear Safety Agency, which maintains continual oversight of emerging research into the potential health effects of the EMF exposure, there is no established evidence of health effects from exposure to electric and magnetic fields from powerlines, substations, transformers or other electrical sources, regardless of proximity.

2. SITE DESCRIPTION AND CONTEXT

2.1 Description

The site of the proposed Narrabri Solar Farm is described as Lot 102 DP 579423 No. 11498 Newell Highway, Narrabri, NSW. It is located approximately 4.5 kilometres directly south-west of Narrabri township. It is a irregular shape with a total area of 62 hectares.

The location of the site is shown in Figure 1 below.

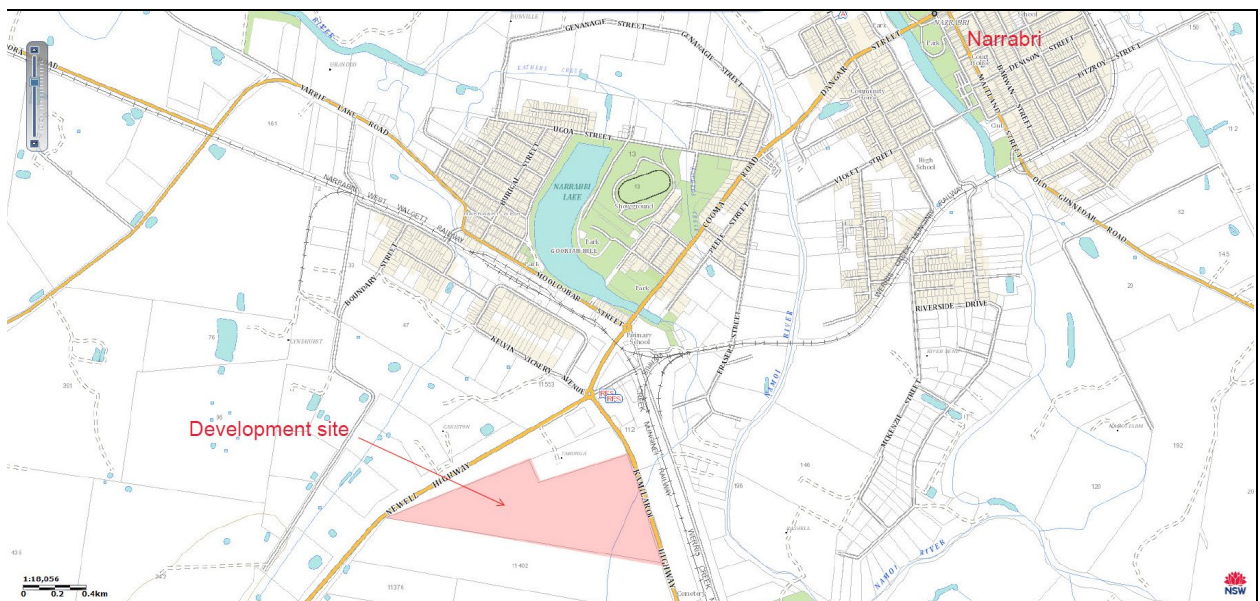


Figure 1: Locality map. Source: SIX Maps, 2020

The site is occupied by a dwelling and a number of farm sheds that are sited at the north-western corner of the property and enclosed within a wire fence. The topography of the site is flat with a very gentle crossfall to the south and west.

The property is farmland and has previously been used for livestock grazing and has been sown with wheat, barley and oats. The land owner is currently considering sowing indigenous food sources on eastern parts of the property. Existing ground vegetation comprises mostly exotic grasses and weeds with some shrubs and trees within the curtilage of the dwelling.

A second order (Strahler classification) watercourse cuts across the property at the south-eastern corner, flowing in a northerly direction for 1.5 kilometres before entering Narrabri Lake. There are no dams on the property.

Current access to the site is by way of an entrance off The Newell Highway which is located approximately half way along the western boundary. The access crosses a property described as Lot 7313 DP 1147165 which is the Newell Highway road reserve. The width of the road reserve is 160 metres at the northern corner of the development site tapering to 10 metres at the south-western corner. The road reserve is vegetated with native species to the edge of the verge with a narrow stretch of grass before the pavement.

2.2 Context

Narrabri local government area is located in the New England and North West region of NSW. It is roughly 13,000 square kilometres in area and includes the administrative centre of Narrabri and the towns of Wee Waa, Bellata and Boggabri. Narrabri township is located approximately at the intersection of the Newell Highway and the Kamilaroi Highway 533 kilometres north-west of Sydney GPO and 576 kilometres south-west of Brisbane GPO. The town is located on the floodplain of the Namoi River. The area has diversified from its traditional agricultural base of grain, cotton, wool, beef and prime lamb production to coal mining and gas extraction and exploration.

Land surrounding the development site is predominantly small acreages and large farm holdings zoned RU1 Primary Production. There are scattered remnant and regrowth native vegetation along road reserves, property boundaries and on distant hillsides. Industrial development is located to the north in zone IN1 General Industrial and north-east along the highways. An aerial image of the site and surrounding land is shown in Figure 2 below which is dated 26 April 2016.



Figure 2: Aerial image. Source: SIX Maps, 2016

Below is an extract from the topographic map for land in the vicinity of Narrabri that shows the location of the settlement, transport infrastructure, dams, cadastre and waterways. Narrabri Airport is located more than 7 kilometres north-west of the site and 3.5 kilometres from the centre of the township.

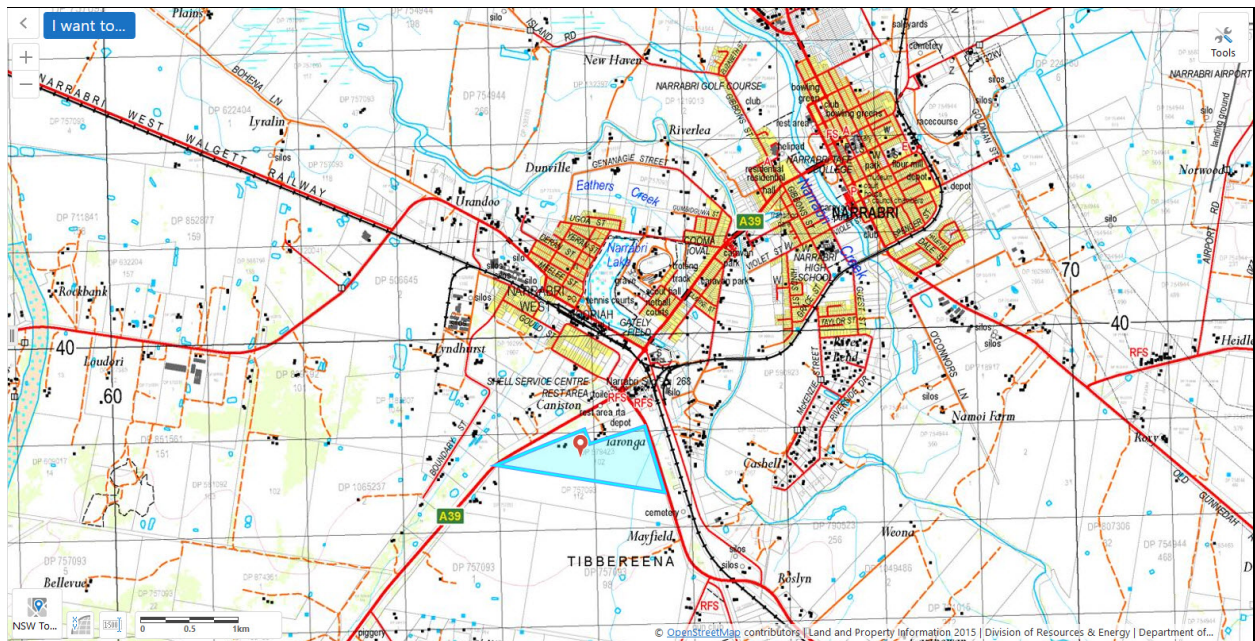


Figure 3: Extract from the topographic map. Source: Land & Property Information 2015

2.3 Climate

Global solar exposure is described by the Australian Bureau of Meteorology as being the total amount of solar energy falling on a horizontal surface. The daily global solar exposure is the total solar energy for a day. Typical values for daily global solar exposure range from 1 to 35 MJ/m² (megajoules per square metre). The values are usually highest in clear sun conditions during the summer, and lowest during winter or very cloudy days.

Global solar exposure coincides with seasons – the longer the daylight hours the greater the solar radiation due to the tilt of the earth during summer months. Rainfall is spread relatively evenly across the year and so does not appear to impact on the level of solar radiation.

Solar exposure estimates are important for a wide range of applications, including for agriculture, power generation and solar heating system design and use. This climatic information sourced from the Australian Bureau of Meteorology indicates that the global solar exposure, or solar radiation, is sufficient to support power generation in the proposed location which benefits from the presence of electricity power lines in the vicinity of the development site.

The map below (Figure 4) shows the average daily hours of sunshine across Australia. Narrabri LGA receives an average of between 8 and 9 hours of sunshine each day.

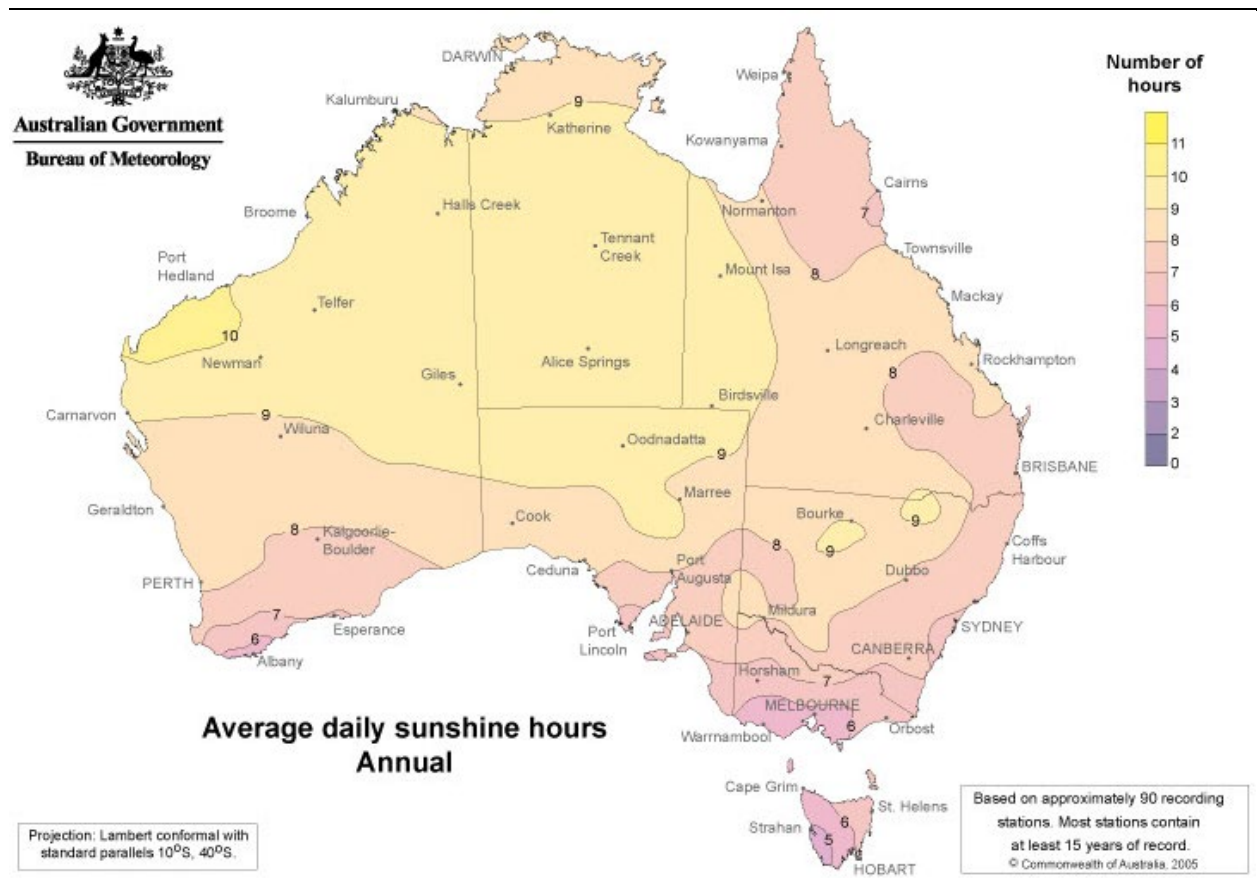


Figure 4: Average daily sunshine hours. Source: Australian Bureau of Meteorology

The mean monthly global solar exposure measured at Narrabri Airport (station number 054038), the closest measuring station to the solar farm, site, is given in Table 2 below. The annual mean daily global exposure for 2020 was 18.4MJ/m². Narrabri LGA receives an average of between 18 and 20 MJ/m² each day.

Table 2: Mean monthly global solar exposure at Narrabri Airport, 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly mean	26.5	20.4	19.1	14.8	12.8	11.3	12.0	14.4	18.6	21.2	27.0	22.9

This data demonstrates that Narrabri LGA receives adequate solar energy to harness and convert to clean electricity and is eminently suitable for the development of a solar photovoltaic farm.

3. DETAILS OF THE PROPOSED DEVELOPMENT

3.1 Overview

The proposed development comprises a solar farm and ancillary facilities with an AC capacity of 5.0MW on approximately 11.32 hectares of the total site. The capital investment value of the solar farm is estimated to be \$6.6 million.

3.2 The array

There are proposed to be 12,100 solar modules installed in 140 rows that are 103 metres long and 2 metres wide running east to west. There is approximately 6.25 metres spacing between each row. The array is proposed to be placed in the lower half of the property adjacent the southern boundary.

Each row of PV modules will rotate to track the sun across the sky from east to west each day. The hub height of each tracker is 1.5 metres with the peak of the modules reaching an approximate height of 2.75 metres when the array is fully tilted to 60 degrees from horizontal, i.e. in the early morning and late evening.

The layout of the solar farm is shown on General Arrangement Plan (Drawing No NAR3A-G-2100).

3.3 Inverters and ancillary items

Two 3MW AC inverter stations and a transformer will be installed at the solar farm. These inverters are to be located within the centre of the array and are each mounted on a 12.2 metre long skid. Each of these inverter stations incorporate high and medium voltage switchgear. Each will connect by way of underground cables to a 22kV feeder to inject power to the electricity grid at the Essential Energy Narrabri 66 Zone Substation. Dial-before-you-dig investigations would be carried out prior to commencing all subsurface work.

3.4 Construction

The mounting system for the PV panels is constructed on piles that are driven into the ground using a vibrating pile driver. The piles will be driven approximately 1.5 to 3.5 metres into the ground, as to be confirmed by a geotechnical and structural engineer.

During construction there is expected to be 50 personnel on site working from 7.00am – 4.00pm Monday to Friday. The construction is expected to take approximately three months. Should it be necessary to carry out work outside these hours then activities would be limited to those generating low noise emissions. Once operational the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 to 3 people.

3.5 Services

Reticulated water and sewer services are not required to be provided to the solar farm as there are no permanent offices or amenities proposed on site. Portaloo's for wastewater disposal (see <https://www.kennards.com.au/site-equipment/showers-toilets.html>) and water supply by way of a portable tank or cart (see <https://www.kennards.com.au/site-equipment/water-tank.html>) are proposed to be installed during the construction phase. Maintenance workers would not be required to remain on site. Cleaning of the PV panels would be carried out on an annual basis to maximise the performance of the system. This is done using water brought into the site and a sponge mop.

3.6 Access and car parking

Proposed access to the development site is off an existing secondary entry to the property off the Newell Highway. This is located at roughly the centre of the western boundary adjacent the main driveway entrance to the dwelling. A 4 metre wide internal road will connect to the centre of the array where the temporary materials laydown and car parking areas are to be located. It is expected that car parking for up to 40 small vehicles will be needed to cater for 50 construction workers at the rate of 0.8 spaces per worker. Traffic generation is given in Table 3 below. It is proposed that heavy vehicles only access the site between 10.00am and 2.00pm.

Table 3: Expected traffic generation

Phase	Description of vehicles and movements
Establishment	6 to 8 light vehicle two-way trips per day by earthworks contractor
	10 to 15 truck and trailer loads to deliver gravel over approximately 2 to 3 days
Construction	33 semi-trailers (maximum 19m length) for delivery of equipment
	12 B-Double trucks (maximum 26m length) for PV module delivery
	40 light vehicle one-way trips for 50 construction workers
	Potential shuttle bus service to and from the site
Commissioning	Light or heavy rigid vehicles (maximum 12 metres length) by electrical contractor

3.7 Landscaping

It is proposed to plant a vegetated screen around the perimeter of the array on the outer side of the security fence. A mix of native shrubs and ground covers that grow to a maximum height of 3 metres have been selected to ensure that overshadowing of panels does not occur. The plants would be spaced 3 metres apart to provide a continuous screen upon maturity.

Land that is disturbed during construction of the solar farm and not to be used for access or other maintenance purposes will be sown with grasses following completion of construction. Planting will also assist to minimise site disturbance and contribute to the rural landscape and character of the immediate area.

Plantings will be maintained and watered by maintenance crew on a regular basis. The planting will be carried out whilst construction takes place to enable use of the hired portable tank or cart that will provide water supply to the site. Construction will take approximately 3 months so regular watering during that period would ensure the establishment of plants. The use of native plants means that watering requirements once established would be minimal and would be done once every 2 or 3 months by the landowner. There would be nil impact on Council's infrastructure and no augmentation of services would be required. Bore water would be sourced to maintain the plants if available, otherwise water may be brought onto the site in tanks fixed to utility trays.

Regular inspections of the site will be carried out to ensure that grassland is managed to reduce the risk of bushfire to surrounding land and to control weeds. Mowing or slashing between rows of PV panels and in the area immediately surrounding the arrays would be carried out as required. Livestock grazing is being trialled elsewhere and may be carried out around and beneath panels in the future.

3.8 Security

The solar farm is to be enclosed within a 1.8 metre high security fence setback 103.2 m from the entrance of the property to the solar farm gate, 3 m from the southern boundary, 234.3 m from the security fence to the south western corner of the lot boundary and approximately 765.1 m from the security fence to Kamilaroi Highway on the eastern boundary. Solar arrays are to be setback 8 metres from the security fence. The proposed fence is to be chain mesh steel topped with three rows of barbed wire giving a total height of 2.3 metres similar to that shown in Plate 1 below.

Security lighting is not proposed to be installed.



Plate 1: Example of security fencing

3.9 Waste management

A *Waste Assessment* of the waste generated during construction and operation of the proposed solar farm has been carried out by ITP Renewables to determine the appropriate means of waste disposal and recycling. The findings of the assessment are summarized below. Reference should be made to the *Waste Assessment* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

The largest amount of waste will be generated during the construction phase and be classified as general solid waste (non-putrescible). Wastes would include wooden pallets, cardboard, plastics, green waste and domestic waste. Construction of a solar farm would not generate any putrescible waste products. Minimal waste would be generated when the farm is operational other than small amounts of replacement parts and packaging required for maintenance and repair works.

Local waste management facilities and capacities are identified in the assessment. Technology for recycling of PV panels is advancing rapidly worldwide and while recycling options currently

exist, they are likely to be more advanced and readily available at the time of decommissioning. Options for recycling of PV panels should be reviewed as the project progresses.

Estimates of waste materials and proposed management arrangements for each phase of the development project are provided in Table 4 below.

Table 4: Estimated waste materials and waste management arrangements

Phase	Waste material	Proposed management
Construction	• Packaging waste such as cardboard, wood pallets, plastic wrap, scrap metal, general waste including approximately 810 wooden pallets and cardboard packing boxes • Concrete waste during setting of footings and mounts • Electric cable waste and cable reels • Plastic pipe offcuts/scrap • Empty drums and containers (minimal quantities) • Minimal used lubricating oil and filters • Unused or spent chemicals	Waste products will be sorted and stored separately in skip bins located in the materials laydown area in accordance with EPA Waste Classification Guidelines. This will facilitate disposal through appropriate waste streams as follows: Recycling: • Steel and scrap metal (recycled) • Timber/cardboard (recycled) • Recyclable plastics Landfill: • General wastes and plastic (other than where recyclable) All recycling and general waste would be collected and taken to off-site waste management facilities for disposal Fluids would be recycled where possible or taken to off-site waste management facilities for disposal
Operational	• Minimal volumes of domestic wastes such as office consumables, paper, plastics and glass • Waste resulting from maintenance or replacement of equipment	All waste materials would be taken to off-site waste management facilities for recycling or disposal

Phase	Waste material	Proposed management
Decommissioning	- PV modules (12,100 panels) and supporting poles and mounts - Glass for panels (250 tonnes) - Silicon for wafers (40 tonnes) - Inverters / transformers / batteries - PV boxes, skids, scrap metal (410 tonnes) - Electrical cables - Fencing - Storage containers (two 20-foot containers)	The solar farm infrastructure would be dismantled into separate waste products such as metals, glass, plastics and concrete. All products would be sorted on site into recyclable and general waste streams in accordance with the EPA Waste Classification Fencing and storage containers would be removed from the site and reused

Waste management should be predicated on the international hierarchy of waste management to avoid/reduce, reuse, recycle, recover, treat and dispose of waste products to avoid or reduce waste materials where possible, and to re-use, recycle and recover the majority of waste materials generated during each of the construction, operational and decommissioning phases.

It is recommended that a waste management plan be developed to provide detailed procedures to manage the waste stream. The plan should contain:

- Strategies to reduce waste during all project phases,
- Recycling, re-use and recovery strategies and opportunities,
- Classification of all waste streams with a tracking register and details,
- On site recycling management,
- Allocation of responsibilities for recycling, re-use and disposal, and
- Reporting and notification procedures if a waste incident occurs and there is a threat to the environment.

3.10 Decommissioning

The expected life of the Narrabri Solar Farm is projected to be 35 years. Upon decommissioning all infrastructure, including cabling and panels and mounting frames including footings and inverters would be disassembled and removed from the site. The bulk of materials that are used in solar panel manufacturing include glass (75%), aluminum (8%), silicon (5%) and copper (1%). There are also small amounts of silver, tin and lead. These materials are recoverable.

Decommissioning will involve:

- Notification of stakeholders (e.g. Essential Energy, Narrabri Shire Council) of proposed de-energisation,
- De-energisation of the solar farm and disconnection of assets,
- Removal of PV modules and associated infrastructure,
- Removal of electrical wiring,
- Remediation of land.

Relevant equipment will be brought to site to facilitate decommissioning, including amenities for site crew for the duration of the works. This equipment may include mobile cranes, excavators, skid steers, loaders, rollers/compactors, pile drivers, telehandlers, skip bins, water carts, temporary shipping containers for storage, site office and site ablution blocks.

Full details of the process are provided in the *Decommissioning Plan* prepared by ITP Renewables. Reference should be made to that report for an explanation of each step in the decommissioning process.

4. STATUTORY FRAMEWORK

4.1 Legislation

4.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment (EPA) Act 1979* is the principal piece of legislation governing the use and development of land in NSW. The objects of the Act are:

- (a) *to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,*
- (b) *to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,*
- (c) *to promote the orderly and economic use and development of land,*
- (d) *to promote the delivery and maintenance of affordable housing,*
- (e) *to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,*
- (f) *to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),*
- (g) *to promote good design and amenity of the built environment,*
- (h) *to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,*
- (i) *to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,*
- (j) *to provide increased opportunity for community participation in environmental planning and assessment.*

The objects of the EPA Act are intended to guide land planning and management. Section 4.15 of the Act lists matters for consideration when assessing and determining an application for development.

4.1.2 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* introduced the *Biodiversity Offsets Scheme* which is used to determine whether the *Biodiversity Assessment Method* is necessary to assess the impacts of a development proposal on threatened species, endangered ecological communities and habitats. Determining whether a *Biodiversity Development Assessment Report* is required under the

Biodiversity Conservation Act 2016 and subsequently whether the *Biodiversity Offsets Scheme* would apply to the proposed works is subject to three steps.

- The first step is to identify whether the site is mapped on the *Biodiversity Values Map*.
- The second step is to estimate whether the extent of native vegetation to be cleared for the proposed development is above the threshold which in this case is 1 hectare.
- The third step is to carry out a test of significance to predict whether impacts on biodiversity are likely to be significant.

Under the *Biodiversity Offsets Scheme* offset obligations may apply whereby the biodiversity assessment finds that the removal of vegetation to facilitate the development will have significant impacts on flora. These offsets are in the form of credit obligations whereby payment is made to a biodiversity conservation fund which enable vegetation removal and provides funds to assist to preserve the same vegetation community elsewhere. Credit obligations also apply to fauna species where particular species are likely to be living in or frequenting the property. These matters are addressed in section 5.1 *Biodiversity* of this Statement.

4.1.3 Water Management Act 2000

The *Water Management Act 2000* includes provisions to control or permit works near a watercourse or stream. Works within specified distances of the top of the bank of a watercourse may necessitate issue of a *controlled activity approval* by the Natural Resources Assessment Regulator. Impacts on surface and groundwaters are addressed in 5.3 *Water resources* of this Statement.

4.1.4 Local Land Services Act 2013

The *Local Land Services Act 2013* regulates the clearing of native vegetation on rural land and where an activity is permitted without Council consent. There are two broad categories of land under the LLS Act - Category 1 (Exempt) land and Category 2 (Regulated, Vulnerable or Sensitive) land which are shown on the [Native Vegetation Regulatory Map](#) .

Clearing may be authorised on Category 1 (Exempt) Land but only where the activity is permitted without consent and when no other permit is required under other legislation. The onus is on the applicant to ensure they are not committing an offense under other legislation. If located on Category 2 (Regulated, Sensitive or Vulnerable) Land, the clearing may be authorised as an Allowable Activity or under the Land Management (native vegetation) Code within the *LLS Act*. If the clearing on Category 2 Land is not an Allowable Activity or is not authorised under the Land Management (native vegetation) Code, the clearing will need to be offset under the Biodiversity Offset Scheme. This means a Biodiversity Development Assessment Report is needed and the

clearing will need to be approved by the Native Vegetation Panel. The LLS Act does not apply to the proposed solar farm as development consent is required to be obtained to enable the works to proceed.

4.1.5 National Parks and Wildlife Act 1994

The objectives of the *National Parks and Wildlife Act 1974* are to conserve and protect habitat, ecosystems, biodiversity, landforms, landscapes and objects, places or features of cultural value in NSW. Under the NPW Act, it is an offence to knowingly harm or desecrate an Aboriginal object. Harm includes destroy, deface or damage an Aboriginal object or Aboriginal Place, and in relation to an object, move the object from the land on which it has been situated. Aboriginal objects include sites, relics or cultural material such as scar trees, middens and ancestral remains.

The NPW Act can also protect areas of land that have no Aboriginal objects, that is, they may have no physical evidence of Aboriginal occupation or use. These areas can be declared 'Aboriginal places' if they have spiritual, natural resource usage, historical, social, educational or other type of significance.

Anyone who exercises due diligence in determining that their actions will not harm Aboriginal objects has a defence against prosecution for the strict liability offence if they later harm an object. The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* provides a process whereby a reasonable determination can be made as to whether or not Aboriginal objects will be harmed by an activity, whether further investigation is warranted and whether the activity requires an application for an Aboriginal Heritage Impact Permit.

4.1.6 Heritage Act 1977

The aims of the *Heritage Act 1977* are to identify, protect and conserve items of State heritage significance. Provisions of the Heritage Act facilitate the establishment of a State Heritage Register for the listing of items of State significance and the preparation of conservation management plans for these items. The Heritage Act also sets out the procedures for the approval of works relating to items listed on the State Heritage Register. Impacts on listed heritage items are addressed in section 5.9 *Heritage* of this Statement.

4.1.7 Noxious Weeds Act 1993

The aims of the *Noxious Weeds Act 1993* are to prevent the establishment, reduce the risk of spread and minimise the extent of noxious within NSW. The extent of noxious weeds and

procedures to eradicate weed infestation from the development site are addressed in section 3. *Details of the proposed development* in this Statement.

4.1.8 Roads Act 1993

Under section 138 of the Roads Act 1993, consent is required to carry out works in, on or over a public road, remove or interfere with a structure, work or tree on a public road or connect a road to a classified road. The consent of Transport for NSW is required in the case of works relating to a classified road. Traffic impacts are addressed in section 5.7 *Traffic* and access of this Statement.

4.1.9 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* aims to protect nationally and internationally important flora, fauna, ecological communities and heritage places. The approval of the Commonwealth Minister for the Environment is required for actions that may have a significant impact on matters of national environmental significance. The *EPBC Act* also requires Commonwealth approval for certain actions on Commonwealth land.

An assessment of the potential impact of the proposed works on any matters of national environmental significance under the *EPBC Act* and the need for referral to the Commonwealth is provided in section 5.1 *Biodiversity* of this Statement.

4.2 State Environmental Planning Policies

4.2.1 State Environmental Planning Policy No 55 – Remediation of Land

SEPP 55 requires Council to consider whether land is contaminated and to determine whether the proposed use is suitable with or without contamination. Council can require an applicant for development to conduct a preliminary investigation and a subsequent more detailed investigation if warranted. Where contamination exists and remediation is necessary, Council must be satisfied that the remediation will take place before the land is used for the proposed purpose. It is noted that should the preliminary investigation identify contamination on the site then the *NSW Contaminated Land Planning Guidelines* apply to subsequent investigations.

4.2.2 State Environmental Planning Policy (Infrastructure) 2007

The aims of *SEPP (Infrastructure) 2007* are to ensure a consistent and flexible planning system to facilitate the delivery of services. The policy identifies environmental assessment categories for types of infrastructure, matters to consider when assessing development adjacent to

infrastructure and provides for consultation with relevant public authorities. The policy applies to the whole of NSW.

SEPP (Infrastructure) contains provisions relating to approval processes and assessment requirements for infrastructure proposals according to the type or sector of infrastructure. It outlines land use zones where types of infrastructure are permissible with or without consent and identifies certain works as exempt and complying development.

Part 3 Division 4 of the policy relates to electricity generating works or solar energy systems. Section 34(7) enables development for the purpose of a solar energy system to be carried out by any person with consent on any land. The proposed development is permitted with consent by *SEPP (Infrastructure) 2007*.

Clause 45 of *SEPP (Infrastructure) 2007* requires the consent authority to consult with the electricity supply authority where development occurs near electricity infrastructure. If an electricity line runs within an easement on or near the development site, Council is to consult Essential Energy prior to determination of the application.

Clause 104 - Traffic-generating development also applies. Schedule 3 triggers a referral to Transport for NSW if the proposed development generates vehicle movements within a specified threshold.

4.2.3 State Environmental Planning Policy (Primary Production and Rural Development) 2019

The aims of *SEPP (Primary Production and Rural Development) 2019* are:

- (a) *to facilitate the orderly economic use and development of lands for primary production,*
- (b) *to reduce land use conflict and sterilisation of rural land by balancing primary production, residential development and the protection of native vegetation, biodiversity and water resources,*
- (c) *to identify State significant agricultural land for the purpose of ensuring the ongoing viability of agriculture on that land, having regard to social, economic and environmental considerations,*
- (d) *to simplify the regulatory process for smaller-scale low risk artificial waterbodies, and routine maintenance of artificial water supply or drainage, in irrigation areas and districts, and for routine and emergency work in irrigation areas and districts,*
- (e) *to encourage sustainable agriculture, including sustainable aquaculture,*
- (f) *to require consideration of the effects of all proposed development in the State on oyster aquaculture,*

- (g) *to identify aquaculture that is to be treated as designated development using a well-defined and concise development assessment regime based on environment risks associated with site and operational factors.*

The policy applies to *State significant agricultural land*, farm dams and other artificial waterbodies, livestock industries and aquaculture. There is no *State significant agricultural land* listed in the schedule to the policy. It is noted that, separately, the Department of Primary Industries are in the process of preparing mapping of *Important Agricultural Land* in NSW to assist decision-making regarding development on rural land.

4.2.4 State Environmental Planning Policy (State and Regional Development) 2011

Development that is state and regionally significant is identified in *SEPP (State and Regional Development) 2011*. Electricity generating works including solar farms which have a capital investment value of more than \$30 million, or a capital investment value of more than \$10 million and are located in an environmentally sensitive area of State significance, are declared state significant development. Private infrastructure, including electricity generating stations, that have a capital investment value of over \$5 million are declared regionally significant and are to be determined by a Regional Planning Panel.

4.2.5 State Environmental Planning Policy (Koala Habitat Protection) 2019

SEPP (Koala Habitat Protection) 2019 commenced on 1 March 2020. This policy aims to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline. The new policy is implemented through the *Koala Habitat Protection Guideline*. The policy lists 123 feed tree species. Schedule 1 lists local government areas to which the policy applies, and for which a koala assessment report is required for development on rural properties greater than 1 hectare in area.

4.3 Local Environmental Plans

4.3.1 Narrabri Local Environmental Plan 2012

The property is zoned RU1 Primary Production under *Narrabri LEP 2012*. The objectives of zone RU1 are:

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*

- *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
- *To minimise the fragmentation and alienation of resource lands.*
- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
- *To allow for non-agricultural land uses that will not restrict the use of other land for agricultural purposes.*

The development is defined as **electricity generating works** which means a building or place used for the purpose of making or generating electricity. This use is prohibited in zone RU1.

The following clauses of *Narrabri LEP 2012* apply to the proposed development:

Clause 6.1 Earthworks

The objective of this clause is to ensure that earthworks for which development consent is required will not have a detrimental impact on environmental functions and processes, neighbouring uses, cultural or heritage items or features of the surrounding land.

Development consent is required for earthworks unless the earthworks are ancillary to development for which development consent has been given. In deciding whether to grant development consent for development involving ancillary earthworks, the consent authority must consider:

- (a) the likely disruption of, or any detrimental effect on, drainage patterns and soil stability in the locality of the development,*
- (b) the effect of the development on the likely future use or redevelopment of the land,*
- (c) the quality of the fill or the soil to be excavated, or both,*
- (d) the effect of the development on the existing and likely amenity of adjoining properties,*
- (e) the source of any fill material and the destination of any excavated material,*
- (f) the likelihood of disturbing relics,*
- (g) the proximity to, and potential for adverse impacts on, any waterway, drinking water catchment or environmentally sensitive area.*
- h) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.*

Earthworks associated with the development comprise minor excavation to 150mm to install road base for accessways, 750mm footings for the inverters and security fence strainer posts, 1,000mm footings for the access gate and 1,500mm to 3,500mm footings for the panel mounting

frames. Cable trenching of 600mm for low voltage cables and 1,200mm deep trenching is also to be carried out.

All of these earthworks are ancillary to the development of a solar farm and are not expected to impact adversely on drainage, future use of the land if the facility is decommissioned, relics, the natural environment or adjoining developments.

Clause 6.2 Flood Planning

The objectives of clause 6.2 are:

- (a) to minimise the flood risk to life and property associated with the use of land,*
- (b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,*
- (c) to avoid significant adverse impacts on flood behaviour and the environment.*

The clause applies to land that is identified on the Flood Planning Map accompanying *Narrabri LEP 2012* as a Flood Planning Area. The site is not mapped as a Flood Planning Area, however, the *Narrabri Flood Study* identified the site as being flood prone and recommended that the Flood Planning Map be amended to include the site within the Flood Planning Area. The planning portal maintained by DPIE erroneously records the site as being a Flood Planning Area.

The matter of flooding is addressed in section 5.3 *Water resources* of this Statement.

Clause 6.5 Essential services

This clause requires a consent authority to be satisfied that any of the following services that are essential for the development are available or that adequate arrangements have been made to make them available when required:

- (a) the supply of water,*
- (b) the supply of electricity,*
- (c) the disposal and management of sewage,*
- (d) stormwater drainage or on-site conservation,*
- (e) suitable vehicular access.*

The supply of reticulated water and sewerage services is not required for the proposed development. However, portaloos for wastewater disposal (see <https://www.kennards.com.au/site-equipment/showers-toilets.html>) and water supply by way

of a portable tank or cart (see <https://www.kennards.com.au/site-equipment/water-tank.html>) are proposed to be installed during the construction phase.

Electrical services are available to the site. Stormwater management is proposed to be addressed by controls recommended in this Statement with full details to be provided with the application for a construction certificate. An existing access off the Newell Highway is proposed to provide access to the site.

There are no draft environmental planning instruments that are on exhibition or have been exhibited but not yet published that apply to the site, or that relate to the proposed development of electricity generating works.

4.4 Development Control Plans

4.4.1 Narrabri Development Control Plan 2000

Narrabri DCP 2000 provides guidance for development, however, the DCP does not contain any provisions that applies to the development of a solar farm. The Industrial Development Code contains a list of suitable plant species which would assist in plant selection for landscape screening surrounding the solar farm

4.5 Land use strategies

4.5.1 New England North West Regional Plan 2036

The *New England North West Regional Plan 2036* was released in August 2017. It establishes a framework for growth over the next 20 years for the New England and North West Region. Narrabri LGA is located at the western edge of the region. Economic opportunities identified in the plan include a focus on renewable energy generation along with agriculture, horticulture, green industries and tourism.

A series of goals, directions and actions are to guide land use planning priorities and decision making. Direction 5 is to *grow New England North West as the renewable energy hub of NSW*. It is noted in the plan that the region receives 19 to 20 megajoules of solar exposure making it the second highest solar penetration region in the state and that a strategic and integrated approach will assist to achieve the NSW Government's goal of carbon neutrality by 2050.

Action 5.2 is to *facilitate appropriate smaller scale renewable energy projects using biowaste, solar, wind, hydro, geothermal or other innovative storage technologies*. In the case of the proposed Narrabri Solar Farm, ITP Development have identified the development site as being suitable in terms of existing power infrastructure to enable connection and proximity to the township of Narrabri in order to directly generate power for use by the local community. This complies with the local government narrative for Narrabri Shire Council to *Identify and promote wind, solar and other renewable energy production opportunities*.

4.5.2 Local Strategic Planning Statement 2040

The purpose of the *Narrabri Shire Local Strategic Planning Statement* is to outline economic, social and environmental land use needs for the next 20 years. The Statement sets out Narrabri Shire's strategic planning actions to achieve identified planning priorities.

Planning Priority 4 of the LSPS is to *Manage and support the transition to renewable energy*. It is noted in the statement that Narrabri Shire can lead the development of renewable energy as it is located within the second highest solar penetration region in NSW. Council's Community Strategic Plan 2018-19 is referenced as encouraging the establishment of a commercial solar power industry in the LGA and that there is widespread community support for renewable energy. Council is committed to proactively managing potential impacts on productive agricultural land and scenic landscapes and to promoting a planning framework that will facilitate the transition to renewables.

4.5.3 Narrabri Growth Management Strategy 2020

The Narrabri Growth Management Strategy (GMS, Strategy) has been prepared to guide growth and development in Narrabri Shire Council over the next 20 year period and to inform the Narrabri Local Strategic Planning Statement (LSPS). The aim of the strategy is to *provide direction for future growth in the right places, create a more diverse and prosperous economy and maintain a healthy environment and great places to live. The strategy identifies the drivers of change and opportunity in Narrabri and, consistent with the policy framework, makes recommendations that can guide amendments to planning instruments and local land use decision making*.

The strategy supports the goals of the *New England North West Regional Plan 2036* to promote development in the renewable energy sector and notes that at the time of writing that there was one approved and two proposed solar farms in Narrabri LGA. It is also noted that the Australian Energy Market Operator has identified the need to carry out immediate upgrades to interconnecting grids between Northern NSW and Queensland to facilitate increased mix of renewables in the grid. There are potential issues in attracting labour, particularly if construction

coincides with a major mining project in the LGA and the need to provide distance separation to avoid land uses conflict.

The *Narrabri Growth Management Strategy* makes the following recommendations in relation to mining and renewable energy:

- *Identify renewable energy resource precincts and infrastructure corridors with access to the electricity network;*
- *Develop a strategic and integrated planning framework to encourage the alternative and renewable energy sector to invest in Narrabri LGA;*
- *Use DPIE's Large Scale Solar Energy Guideline to guide the location of new development;*
- *Review NLEP provisions, land use tables, mapping and minimum lot sizes and best practice guidelines to:*
 - *assess RU1 and RU4 zones as appropriate zones for large scale mining, infrastructure and renewable projects; then*
 - *ensure permissibility of appropriate employment generating development and ancillary industries;*
 - *reduce risk of encroachment and impediments to the expansion and intensification of mining and renewable energy generation from incompatible development through a suite of LEP provisions to manage holding size and the number and siting of dwellings;*
 - *ensure land uses adjacent to key infrastructure and facilities such as transport routes are appropriately zoned to prevent encroachment of incompatible urban development;*
- *Review the extent of undeveloped and unserviced R5 zoned land for potential impacts on mining, renewables and ancillary employment generating activities*

The strategy seeks to provide opportunities for renewable energy to support growing industries and villages through the following actions:

- *Use DPIE guidelines for larger solar farms.*
- *Review LEP controls to provide protections and buffers on land zoned RU1 Primary Production and RU4 Primary Production Small Lots.*
- *Review RU1 and RU4 minimum lot sizes to ensure future development will not be impacted by undersized lots with dwelling potential.*

The implications of Action 5.2 of the New England North West Regional Plan 2036 for growth management are to:

- *Identify renewable energy resource precincts and infrastructure corridors with access to the electricity network*
- *Develop a strategic and integrated planning framework to encourage the alternative and renewable energy sector to invest in Narrabri LGA*
- *Review the NLEP 2012 land use tables and rural minimum lot sizes to ensure appropriate separation distances from large scale renewable projects on rural land*
- *Use DPIE's Large scale solar energy guideline to guide the location of new development*

The responsibility for each of these tasks rests with Council and DPIE.

4.5.4 NSW Renewable Energy Action Plan

The *NSW Renewable Energy Action Plan* supports the achievement of the national target of 20% renewable energy by 2020. It aims to position NSW to increase the use of energy from renewable sources at least cost to the energy customer and with maximum benefits to NSW. The plan is predicated on the following three goals:

- Attract renewable energy investment and projects
- Build community support for renewable energy
- Attract and grow expertise in renewable energy technology

These goals are supported by 24 actions which include considering a more strategic and integrated approach to assessment of renewable energy projects and promoting NSW as a leader of research and innovation in renewable energy.

The plan notes that the NSW Government is in the process of streamlining the state planning system and advocates new planning legislation founded on the principle of sustainable development that meets the needs of the current generation without compromising the ability of future generations to meet their needs. Renewable energy projects are a good example of sustainable development in action. Streamlining will focus public participation on strategic planning in order to provide greater certainty for applications and the community in development assessment.

5. ENVIRONMENTAL EFFECTS

5.1 Biodiversity

5.1.1 Assessment of impacts

A biodiversity assessment has been carried out by Red-Gum Environmental Consulting Pty Ltd to determine the potential impact on any threatened species and endangered ecological communities that are present on the development site and in the vicinity of the site. The findings of the assessment are summarized below. Reference should be made to the *Biodiversity Inspection Report* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

Methodology for the biodiversity assessment involved desktop research and a site inspection. The assessment covered details of recorded sightings of threatened species including koalas and identification of vegetation communities in the vicinity of the development site. The *Biodiversity Inspection Report* provides a test of significance in accordance with requirements of the *Biodiversity Conservation Act 2016* and a Koala Assessment Report as required by *SEPP (Koala Habitat Protection) 2020*, and also satisfies requirements of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

5.1.2 Findings

The development requires less than 1 hectare clearance of native grass and zero remnant native trees. The proposed activities are unlikely to have an adverse effect on the foraging ability or the life cycle of threatened species that may be opportunistically using the site or surrounding areas.

The small amount of native grass that will be impacted by the development will not endanger or have a significant effect on any existing native vegetation, habitats within the site, or fauna species that may be using the site.

The development will not displace any rare or threatened species, however, it is likely that a number of threatened and declining bird species and koalas may be using the area to the south and along the heavily wooded road reserve along the western boundary, hence the construction activities may prove to disturb foraging activities for a short period.

The area assessed was largely exotic species and pasture grasses, with many species commonly regarded as 'highly invasive' in more natural woodland settings – like that to the west in the road reserve. While the proposed works are unlikely to introduce noxious weeds, vermin, feral species

or genetically modified organisms into an area, the movement of vehicles, plant, equipment and people on and off the development site has the potential to introduce such impacts. Wherever possible, removal of weeds should be undertaken prior to seed developing, which for most species occurs during summer months.

The typical home ranges of koalas are from 2 hectares of connected vegetation to hundreds of hectares. Koala feed almost exclusively on a few preferred tree species which are of primary and secondary importance. The occurrence of both primary and secondary tree species varies widely on a regional, local and even a seasonal basis, meaning that koalas are unevenly distributed across their range.

In the study area, primary food tree species are River red gum (*E. camaldulensis*) and Coolabah (*E. coolabah*) with secondary food tree species including Dirty (or Baradine) gum (*E. chloroclada*), Blakely's red gum (*E. blakelyi*), *E. camaldulensis*, Poplar or Bimble box (*E. populnea*), white box (*E. albens*), and *Callitris glaucophylla*.

No viable food sources are present in the development area. Importantly, there are numerous core vegetation areas surrounding the site which represent areas of viable Koala habitat. The site is highly unlikely to be traversed or used by the species who are much more likely to stay within the connected canopy of the roadside vegetation corridor.

The report concludes that the proposed development will not have a significant effect on any threatened species and ecological communities and/or their conservation. No vegetation would need to be removed to facilitate heavy vehicle access using the existing track.

5.1.3 Mitigation measures

By way of a clearing process that minimizes the risk to threatened species that may be opportunistically using the site, it is recommended that:

- I. Construction limits and exclusion zones clearly identified prior to work;
- II. A visual inspection is conducted by environmental staff before construction commences to identify any areas of site that might be supporting native fauna;
- III. Vehicle movements around the site will be restricted to the construction footprint and away from any existing planted trees and flagging exclusion fencing to be installed.
- IV. Soil disturbance by vehicle and pedestrian access is to be kept to a minimum outside the construction footprint.
- V. Any weeds removed (particularly those bearing seeds) are to be disposed of appropriately at the nearest waste management facility.

5.2 Natural hazards

5.2.1 Flooding

The site is not mapped as being a Flood Planning Area in *Narrabri LEP 2012*. However, property information made available by the Department of Planning, Industry & Environment on the planning portal states that the site is designated a Flood Planning Area. Information provided by Narrabri Shire Council confirms that the site is flood prone and data has been supplied to assist with an analysis of flood potential and recommended mitigation measures that are summarised in section 5.3 *Water resources* of this Statement.

5.2.2 Bushfire

The site is not mapped as being a bushfire buffer on the bushfire prone land map. Infrastructure comprising electricity generating works is not a habitable building and is not listed as a *special fire protection purpose* under section 100B of the *Rural Fires Act 1997*.

However, defensible space is available within the 8 metre setback between the array and the security fence. It is also proposed that a fire emergency management plan be prepared through liaison with Council, Essential Energy and the Rural Fire Service. That plan would establish procedures to respond to a fire event and other measures such as maintenance of ground fuels, access arrangements, on site fire-fighting equipment and isolation of electrical infrastructure.

5.2.3 Land contamination

The development site is not identified as contaminated land and is not listed on a register of contaminated land. The property has been cleared and farmed for many years. There has been no known historical usage that would cause the land to be contaminated. NSW Health advise that the use of farm chemicals such as pesticides and fertilisers is not considered to contaminate soils to the extent that mediation is required. It is considered that a preliminary investigation is not required for the development of a solar farm.

5.2.4 Mitigation measures

See section 5.3 *Water resources* for recommended mitigation measures to address flooding.

Prepare a fire emergency management plan and include that plan in the environmental management plan.

There are no mitigation measures recommended in relation to land contamination.

5.3 Water resources

5.3.1 Assessment of impacts

A *Water Assessment* of potential impacts on groundwater and surface water flows and flooding has been carried out by Golder Associates Pty Ltd. The findings of the assessment are summarized below. Reference should be made to the *Water Assessment* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

5.3.2 Findings

The development site is not located within a mapped area in *Narrabri LEP 2012* that indicates groundwater sensitivity. There will be no extraction of groundwater or interference with the groundwater table and the works are not expected to contribute to any regional groundwater issues. The proposed depth of trenching to lay cables and install the supporting frames for panels is expected to be above the local groundwater level.

Potential adverse surface water-related impacts to the site relate to site accessibility and managing downstream sedimentation. As noted in section 4.3 *Local environmental plans*, the site is not mapped as a Flood Planning Area, however, the *Narrabri Flood Study* identified the site as being flood prone and recommended that the Flood Planning Map be amended to include the site within the Flood Planning Area.

There is the potential for overland flows during rainfall events from the 2nd order watercourse located at the south-east corner of the development site. The overland flow would follow site topography which would direct flows to the Namoi River to the east.

In addition, the flood study identifies potential flood hazard areas along the Newell Highway. Heavy rainfall events may cause disruption during construction activities or for access to deliver materials and equipment.

There are two potential impacts that the solar farm could have on flooding and runoff external to the facility. These are impacts on riverine flood levels due to the facility obstructing flows and impacts on flood levels due to the impervious nature of development surfaces associated with the array causing more rapid runoff.

Given that modelled flood impacts are limited to a small area within the northern extent of the lot, potential impacts from runoff obstruction would be limited. Excavated areas around the site would be backfilled and cover reinstated following completion of construction.

Solar panels do not have a significant effect on runoff volumes, peaks, or times to peak for flood events unless the runoff characteristics of the final ground cover is increased. Potential impacts of the facility obstructing the relatively shallow overland flow observed in the catchment are considered negligible.

Similarly, the panel framing structures are designed to withstand impacts to the integrity and stability of the panels from any overland flow or inundation that may occur due to flooding. The panels will be elevated above modelled maximum flood levels and the pilings will be installed to sufficient depths and may be fitted with a 300mm concrete collar depending on soil type.

The development has the potential to alter existing water quality conditions within the site. The impervious area of solar facilities is typically only marginally increased owing to associated hardstand and building areas.

However, the panels may impact the nature of vegetation/grass coverage on the site, which has the potential to increase surface runoff and peak discharge. Increased flow concentration off the panels also has the potential to erode soil at the base of solar panels.

Furthermore, as the site has been historically used for farming there is very little natural ground cover vegetation. There is the potential that site runoff will contain sediments and increase turbidity or other water quality parameters in downstream water ways. The existing farm dam should capture surface flows from the site and reduce sedimentation downstream.

5.3.3 Mitigation measures

The following mitigation measures given in Table 5 are recommended to manage downstream sedimentation.

The potential for site accessibility and the potential for inundation issues during flood events should be reviewed and procedure developed to halt construction during heavy rainfall to reduce potential impacts to the development and to increases in downstream sedimentation.

Table 5: Proposed mitigation measures to manage downstream sedimentation

Stage	Measure	Activities/approach
Design	Site drainage and water quality controls	Design Basis • Undertake hydrological assessment of the site's catchment in accordance with relevant methods outlined in Australian Rainfall and Runoff • Determine sediment management targets and drainage control standards in accordance with Managing Urban Stormwater: Soils and Construction Vol 1 (Blue Book) (DECC, 2008). • Develop a site erosion and sediment control plan in accordance with the Blue Book. • Develop site drainage design incorporating detention basins and sedimentation management structures where relevant. • Permanent site drainage should coincide with temporary arrangements where possible
Construction and/or demolition	Site drainage and water quality controls	General site works: • Project construction period to occur entirely within the dry season to prevent flooding, sedimentation and water quality impacts to waterways. • Catch drains to be located downslope of any proposed road works. • Install location appropriate sediment fences or other applicable control measures depending on whether the feature is upstream or downstream of a disturbed part of the site or will need to be trafficable. • All stormwater collection points need to have appropriate sedimentation and erosion controls. • Undertake ongoing inspections of stormwater facilities and water control measures to assess their effectiveness. • Vibration grids or wash bays at all construction exits. • Level spreaders at locations where concentrated flow is

Stage	Measure	Activities/approach
		discharged offsite to ensure sheet flow like conditions are maintained. Flat land erosion control options include erosion control blankets, gravelling, mulching, soil binder, turfing and revegetation
Construction and/or Demolition	Stormwater point source control	In the event of concrete works: - Do not undertake works if chance of heavy rain. - Store rinsate water, if applicable, separately to other water on site and dispose of offsite as appropriate. - Block on site drains in the area of the works and remove any contaminated runoff. In the event that dewatering practices are required: - Elevate pump hose intakes for withdrawing water from excavations to minimise sediment pumping and direct hose to a containment area for settling prior to discharge of water. - Limit direct discharge off site (consistent with the design requirements for sediment pond discharge). - Stormwater collected on site should be reused where possible. Controls should be inspected and maintained on a regular basis. All water released from sediment basins should be clear or disposed of off site by vehicle. - Material and waste storage areas should be designed and operated to minimise interaction with surface waters. - Vehicle washdown areas should be located away from water courses

5.4 Air quality

5.4.1 Assessment of impacts

The Department of Planning, Industry and Environment maintain air quality monitoring stations across rural NSW. The instruments used at most rural network sites are low cost indicative particulate monitors that respond to all aerosols including smoke and fog.

Total Suspended Particles are measured at this station. Total suspended particles are solid particles and liquid droplets 100 micrometres or less in diameter. They come from natural and human-made sources, such as pollen, bushfires and motor vehicle emissions. Dust emissions are also a source of air pollution and can cause poor air quality. The pollutants measured by the Department are nitrogen dioxide, sulphur dioxide and ammonia.

Particles are also measured as PM₁₀ and PM_{2.5}. PM₁₀ are particles less than 10 micrometres in diameter. Sources include crushing or grinding operations and dust stirred up by vehicles on roads. PM_{2.5} are fine particles less than 2.5 micrometres in diameter. Sources include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

Table 6 gives average hourly readings of total suspended particles, PM₁₀ particles, PM_{2.5} particles and the DPIE rating for the nearest monitoring station to the development site.

Table 6: Average hourly air quality readings

Monitoring station	Narrabri	
Period	12 March 2021, 6am-7am	
Particles	Reading	Rating
Total suspended particles	n/a	n/a
PM ₁₀	5.2	Good
PM _{2.5}	4.3	Good

Activities that disturb the earth's surface and that are carried out with the use of machinery have the potential to generate dust emissions. This may be exacerbated by wind exposure to an exposed ground surface. The previous use of the land for farming may have involved regular tilling, sowing and harvesting that may create dust and impact on air quality. Similarly, grazing would generate dust as animals trample the ground surface. The land has been modified for agriculture with the consequent loss of most native vegetation leading to exposed soil surfaces.

The construction of the solar farm will not involve extensive earthworks. Pile driving for footings for the array framework and excavation for roads and ancillary structures will be carried out.

Along with the delivery of materials using heavy vehicles, these construction works may generate dust, however, once operational the change of use of the land from agricultural to solar photovoltaic electricity generation is expected to reduce particulate emissions and lead to an improvement in local air quality. Vehicle movements would be restricted to internal access roads and the majority of the site would be revegetated with native or pasture grasses.

5.4.2 Mitigation measures

To minimize dust generation during the construction and operational phases the following mitigation measures are proposed:

During construction:

- Limit vehicle movements to areas necessary to deliver panels, ancillary structures and equipment
- Suppress dust emissions using watering and cease works during dry and windy conditions
- Ensure ground disturbance is limited to areas necessary to place footings or to be used for access
- Ensure minimal handling of excavated materials
- Ensure stockpiles of excavated material is bunded and protected from wind and vehicle movements

During operation:

- Grade and add road base to internal accessways
- Revegetate the site with suitable endemic native groundcover immediately construction works are completed
- Ensure all plant and equipment operates in accordance with specifications

5.5 Noise

5.5.1 Assessment of impacts

A *Noise Assessment* of the impacts of noise emissions has been carried out by Muller Acoustic Consulting. The findings of the assessment are summarized below. Reference should be made to the *Noise Assessment* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

The purpose of the *Noise Assessment* is to quantify potential environmental noise emissions associated with the construction and operation of the project. Where impacts are identified, recommendations are made to mitigate and manage noise. The location of noise sensitive receptors are shown in Figure 5.



Figure 5: Location of noise sensitive receptors. Source: Muller Acoustic Consulting

5.5.2 Findings

Predicted construction noise levels are expected to exceed the NMLs by up to 5dB at six receivers when works are nearest to those locations. These receivers are R02, R03, R04, R05, R06 and R06A. The exceedances would be temporary and of short duration. The exceedances would be due primarily to piling and earthworks. Operational noise levels satisfy the management levels for all assessed receivers. However, recommendations to ensure noise levels are verified have been provided in this report. Additionally, the noise assessment demonstrates that road noise

criteria will be satisfied at all receivers on the proposed transport route during the construction phase.

5.5.3 Mitigation measures

The following mitigation measures are recommended to address noise emissions during the construction phase:

- a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community,
- where possible use localised mobile screens or construction hoarding around plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (e.g. unloading and laydown areas),
- operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations,
- selection of the quietest suitable machinery available for each activity,
- avoidance of noisy plant/machinery working simultaneously where practicable,
- minimise impact noise wherever possible,
- utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm,
- provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities,
- signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site, and
- utilise project related community consultation forums to notify residences within close proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.

It is recommended that noise emissions from the solar farm be minimised when operational.

To assist in noise management, it is recommended that a one-off noise validation monitoring assessment be completed to quantify emissions from the site and to confirm that relevant criteria are satisfied.

5.6 Traffic and access

5.6.1 Assessment of impacts

A *Traffic Impact Assessment Report* of the impacts on traffic and the adequacy of access arrangements has been carried out by Price Merrett Consulting. The findings of the assessment are summarized below. Reference should be made to the *Traffic Impact Assessment Report* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

The traffic assessment includes a description of the existing road network and considers expected traffic generation during site establishment, construction and operation. Site access arrangements and intersection capacity are also considered.

5.6.2 Findings

During the three month construction period 45 heavy vehicles will access the site with an expected daily maximum of 4 trucks. Access to the site for heavy vehicles will be limited to between 10.00am and 2.00pm.

Approximately 90% of light vehicle movements transporting construction workers are expected to originate in Narrabri township. Turns into the site will be left in and left out only during the morning and afternoon peak periods, in accordance with advice provided by Transport for NSW.

The traffic assessment concludes that heavy vehicle movements would not contribute to morning or afternoon peak hour traffic volumes on the Newell Highway. Light vehicle turning movements for construction workers are assessed to be very low and therefore impacts will be minimal.

The proposed access for the development has been located at the existing western access point to the property to minimise vegetation removal and limit earthworks. This location is on a straight section of the Newell Highway and 960 metres from the junction of the Newell and Kamilaroi Highways. This existing western access point is proposed for use during construction and ongoing operation and is considered a suitable location without major geometry issues. The access would need minor pavement improvements to accommodate heavy vehicles. No vegetation would need to be removed to facilitate heavy vehicle access using the existing track.

The speed limit on the Newell Highway fronting the site is within a 110km/hr zone in both directions and reduces to 80km/hr approximately 380 metres towards the township. Lane widths on the Newell Highway near the access are approximately 3.5 metres with 1.0 metre

sealed shoulders. Safe intersection sight distances for the proposed access are required to be 285 metres and are more than 300 metres.

5.6.3 Mitigation measures

It is recommended that:

- The existing western access point be upgraded to accommodate B-Double turn safety during the construction phase
- The eastern access is to be temporarily closed during the construction period
- Undertake a dilapidation survey prior to construction works
- Appropriate signage outlined in Traffic Management Plan to prevent right turn entry from the Newell Highway into the site.
- vi. Shared transport for workers should be incorporated into the site management during construction period
- BAL widening arrangement including shoulder widening
- Gravel pavement improvements to the existing western access to accommodate construction vehicle movements
- Installation of new culvert and driveable headwalls at the western access
- Truck entering signs (W5-22) (or T2-25 as this is temporary works) to be erected 250m either side of the existing access during construction phase to notify motorist.
- No right entry sign or VMS signage to prevent right turn entry.

5.7 The community and economy

5.7.1 Population and accommodation

The population of Narrabri state suburb in 2016, as defined by the Australian Bureau of Statistics and which includes the development site, the town of Narrabri and rural land surrounding the settlement, was 7,606 persons. The total population of Narrabri local government area in 2016 was 13,084 persons. The median age of people in Narrabri state suburb in 2016 was 39 years compared to 40 for the LGA.

Unemployment at the time of the 2016 Census of Population and Housing was 5.7% of the labour force comprising persons aged 15 years and over in Narrabri state suburb. The labour force participation rate in 2016 was 47.5%. The top three occupations were professionals, technicians and trade workers, and managers. The top three industries of employment were coal mining, supermarket and grocery stores, and local government administration.

Occupied private dwellings accounted for 88.4% of dwellings in Narrabri state suburb and 11.6% or 356 dwellings were unoccupied. 87.1% of dwellings were separate houses and the remainder were medium density dwellings.

There are 31 establishments offering accommodation for visitors to Narrabri and the surrounding district listed on the NSW Government's VisitNSW website. These include holiday parks, motor inns, bed and breakfasts, serviced apartments and hotels. In addition to these establishments there are 356 unoccupied private dwellings some of which may be available as short term rentals, and unregulated accommodation places such as AirBnB and Stayz.

Table 7: Key demographic statistics. Source: ABS Census of Population and Housing 2016

Sector	Characteristic	Narrabri (state suburb)	Narrabri LGA	NSW
Population	Total persons	7,606	13,084	7,480,228
	Median age	39	40	38
Employment	Labour force participation rate	47.5%	46.0%	48.2%
	Unemployment rate	5.7%	6.0%	6.3%
Housing	Occupied private dwellings	88.4%	86.3%	90.1%
	Unoccupied private dwellings	11.6%	13.7%	9.9%
	Total private dwellings	3,071	5370	2,889,061
	Average occupancy rate	2.5	2.5	2.6
	Median monthly mortgage repayment	\$1,517	\$1,395	\$1,986
	Median weekly rent	\$220	\$200	\$380
	Proportion separate houses	87.1%	89.0%	66.4%

5.7.2 Agriculture and land capability

Narrabri is located in the New England and North West region of NSW. According to the Commonwealth Department of Agriculture the gross value of agricultural production in the region in 2018-2019 was \$1.8 billion, which was 15 per cent of the total gross value of agricultural production in New South Wales of \$11.7 billion. Agricultural land in the region occupies 79,400 square kilometres, or 80 per cent of the region. The most common land use by area is grazing modified pastures, which occupies 39,200 square kilometres or 40 per cent of the New England and North West region (<https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/nsw-new-england#regional-overview>).

The region has a diverse agricultural sector. The most important commodities in the region based on the gross value of agricultural production were cattle and calves (\$611 million), followed by cotton (\$390 million) and wool (\$115 million). These commodities together contributed 64 per cent of the total value of agricultural production in the region. ABS data indicates that in 2018-2019 there were 4,023 farms in the New England and North West region. Beef cattle farms (1,736 farms) were the most common, accounting for 43 per cent of all farms in the region, and 25 per cent of all beef cattle farms in New South Wales

(<https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/nsw-new-england#agricultural-sector>).

DPI Agriculture uses the land and soil capability mapping scheme as the preferred methodology for the classification of agricultural land. Eight classes of rural land are mapped plus flood irrigation, and mining and quarrying land. Figure 6 below shows land capability mapping for the development site and surrounding land.

The development site, including the development footprint, has a land capability of class 3 with a small intrusion of class 2 land near the eastern boundary which is proposed remain under agricultural use. Class 3 indicates that the land has moderate limitations and is capable of sustaining high-impact land uses, however, careful management is required for cropping and intensive grazing to avoid land and environmental degradation (*The land and soil capability assessment scheme – A general rural land evaluation scheme for NSW, 2nd Approximation, OEH*).

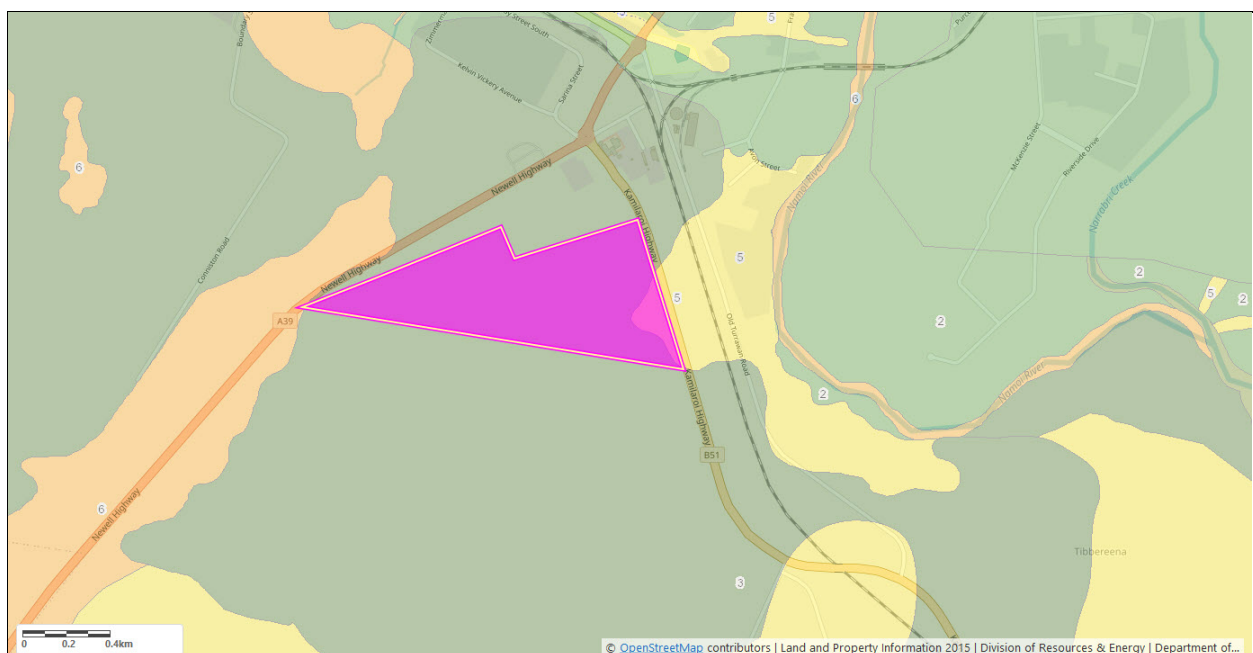


Figure 6: Land capability mapping. Source: OEH 2021

5.7.3 Potential socio-economic impacts

The benefit to the community of the solar farm will be through an understanding of sustainable development and by gaining a commitment to greater reliance on renewable energy. Similarly, the clustering of solar power generation would bring regional economic development benefits to the New England and North West region as the area gains a reputation as a suitable location for renewable energy and linked industries.

It is anticipated that there will be 50 personnel directly involved in construction on site which is expected to take approximately three months. Varying levels of expertise will be required ranging from labourers to qualified electricians and project managers. In addition, personnel would be involved in transport and delivery of materials to the site. Some of this employment is to be sourced locally. Once operational the site will be unmanned, however, two to three personnel will be necessary to carry out maintenance every quarter or as required. The skills required to be involved in the construction and ongoing maintenance of the solar farm may require some personnel to undergo further training and education, leading to an upskilling of the local workforce and enhanced employment opportunities generally.

Employment and education will bring direct economic benefits to the local economy through wages and salaries and indirect benefits through the need for accommodation and sustenance in the area for non-local employees. Restaurants, cafes, bakeries, supermarkets, pubs, newsagents would all benefit from the additional custom this will bring.

During the initial planning phase ITP (Development) Pty Ltd commissioned local professionals to carry out the land survey of the development site. This initial expenditure generates flow on effects throughout the local economy through income and employment. If necessary, sites officers employed by the Local Aboriginal Land Council will be engaged to carry out a cultural survey prior to commencement of works to identify any Indigenous items or places present on the development site.

It is considered that there is adequate accommodation available to cater to the 50 construction workers given the number of visitor accommodation establishments in the area plus short term rentals and unregulated accommodation providers. It is understood that approximately. There is likely to be negligible effects on the availability of affordable rental over the short construction period as it is not expected that landlords would evict long-term tenants in preference of short term workers. Workers coming to the area would be likely to take up tourist accommodation similar to mine workers across country NSW, however, construction may be limited to the off-peak tourist season if necessary.

The loss of agricultural land due to the development of the solar farm would be minimal – less than a quarter of the entire property and a fraction of agricultural land in the region. The loss of agricultural land would be offset by the contribution that the solar farm will make to the local economy through direct and indirect employment and expenditure over the short term and through the benefits that renewable energy power supply will bring to the region. The landowner may also choose to continue to graze livestock within and around the array, activities that do not require consent, and the additional lease income may be put to improvements elsewhere on the property.

If necessary and practical in terms of security, the land surrounding panel arrays can continue to be used for farming purposes such as the cultivation of vegetables or flowers, or potentially livestock grazing during the operation of the solar farm. The arrays of panels can be removed once the facility is decommissioned and the land can be returned to agricultural use. It is considered that the impact in terms of loss of productive agricultural land should be seen in the context of the impacts on farmland of other forms of power generation, for example, fracking for coal seam gas, and mining for coal and uranium as well as the infrastructure to support the processing of coal and gas.

In summary:

- The solar farm will generate community economic benefits through local employment opportunities during the planning and construction phases as well as limited maintenance and inspection jobs once operational. The development of a solar farm will create a new market for local contractors and expand diversity of income for the land holder
- The loss of productive agricultural land is minimal and temporary. The array of panels can be removed once the facility is decommissioned and the land can be fully returned to agricultural use
- If necessary and practical in terms of security, the land can continue to be used for farming purposes such as the cultivation of vegetables or flowers, or the grazing of sheep during the operation of the solar farm



Plate 2: Sheep grazing amongst a PV array. Source: Sydney Morning Herald 17 February 2021

5.7.6 Mitigation measures

It is recommended that labour to construct the solar farm and for ongoing maintenance be sourced from within Narrabri LGA wherever possible. Where labour needs to be brought into the area, it is considered that there would be sufficient accommodation options for employees in the LGA for the estimated 50 workers engaged during the three month construction phase.

It is recommended that advertising be placed in local media and to approach local businesses to determine whether there is the capacity and expertise available in Narrabri and surrounding districts to participate in the construction and ongoing maintenance activities.

5.8 Heritage

5.8.1 Indigenous heritage

The generic due diligence process outlined in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* was implemented to ensure that an adequate due diligence process that addresses Aboriginal cultural heritage issues has been carried out. This process follows the following five steps:

1. *Will the activity disturb the ground surface?*

Earthworks will involve trenching which is required for cabling of each PV array/module to inverters and a substation. Other earthworks would be pile-driving to support module frames, and to enable the placement of concrete slabs and gravel accessways. Most of the infrastructure would be pre-fabricated off-site, delivered and assembled on-site.

2a. *Search the AHIMS database*

In accordance with the code, an on-line search was carried out of the *Aboriginal Heritage Information Management Service (AHIMS)* that is maintained by Heritage NSW. The search is part of the due diligence process and remains valid for 12 months.

A search of Lot 102 DP 579423 was performed on 10 March 2021. The search results are:

- There are no Aboriginal sites recorded in or near the selected location, and
- There are no Aboriginal places that have been declared in or near the selected location.

It is noted that surveys for Aboriginal objects have not been carried out in all parts of NSW and Aboriginal objects may exist on a parcel of land even though they have not been recorded in AHIMS. Further, not all known Aboriginal sites are registered on the AHIMS database and not all sites consist of physical evidence or remains, e.g. dreaming and ceremonial sites.

2b. Activities in areas where landscape features indicate the presence of Aboriginal objects

The development area does not possess landscape features that indicate the presence of Aboriginal objects.

3. Can you avoid harm to the object or disturbance of the landscape features

Not applicable as the development area has been disturbed and farmed, does not possess significant landscape features and no known Aboriginal objects are listed in AHIMS.

4. Desktop assessment and visual inspection

The desktop assessment found that no known Aboriginal objects are listed in AHIMS. A site inspection was made on 12 November 2020 and there was no obvious evidence of any artefacts or items of cultural significance on the surface of the land.

5. Further investigations and impact assessment

An extensive search of AHIMS records, is not necessary given that there are no Aboriginal sites or places that have been recorded on the development site.

The property lies within the area managed by Narrabri Local Aboriginal Lands Council. The LALC has been advised of the plans to develop the solar farm by email. As not all culturally significant items or places are made public and listed on AHIMS, a request was forwarded to the LALC enquiring as to whether the organization has any knowledge of Indigenous items or places of significance on the property and whether a sites officer should conduct a site survey prior to commencement of works.

It is acknowledged that a condition of consent may be imposed to require a site survey to be carried out by an LALC sites officer either before any work commences or prior to the issue of a construction certificate.

Council may also recommend a condition of consent to comply with provisions of the *National Parks and Wildlife Act 1974* should any evidence of Aboriginal occupation be found during site works. An *Aboriginal Heritage Impact Permit* may be required to be obtained if indigenous heritage objects are found during ground disturbance.

5.8.2 Non-indigenous heritage

The development site is not listed as a heritage item in Schedule 5 Environmental heritage of *Narrabri LEP 2012*. The closest listed items to the site are I035 Railway Station Precinct located at Buri and Mooloobar Streets and I036 War Memorial, Narrabri West located at 37 Mooloobar Street.

Each of these properties is listed as being of local heritage significance. These properties are located in close proximity to each other and are more than 1.5 kilometres north of the development site at the closest point. There is no visual or physical connection between the development site and either of these items. It is considered that a heritage management document is not required.

5.8.3 Mitigation measures

Council may recommend that a condition of consent be imposed to require a site survey be carried out by an LALC sites officer either before any work commences or prior to the issue of a construction certificate.

Council may also recommend a condition of consent to comply with provisions of the *National Parks and Wildlife Act 1974* should any evidence of Aboriginal occupation be found during site works. An *Aboriginal Heritage Impact Permit* may be required to be obtained if indigenous heritage objects are found during ground disturbance.

There are no recommendations in relation to non-Indigenous heritage.

5.9 Glare and glint

5.9.1 Assessment of impacts

A *Glint and Glare Assessment* has been carried out using the Solar Glare Hazard Analysis Tool by ITP Renewables. The findings of the assessment are summarized below. Reference should be made to the *Glint and Glare Assessment* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

The assessment is based on identifying the potential sensitive receptors in close proximity to the development site having regard to the elevation of the site relative to surrounding land and

structures or vegetation that would act as visual barriers. Potential glare and glint impacts are assessed and if necessary mitigation measure are recommended to reduce potential impacts to an acceptable level.

5.9.2 Findings

As a result 11 residential premises, two commercial premises, and two arterial road routes were identified as potential visual receptors. The results of the analysis indicate that persons occupying the selected properties are unlikely to be affected as a result of the proposed solar farm. Many residences will also not have direct view of the solar farm due to visual obstruction from trees and other structures.

Existing roadside vegetation and the proposed landscape screening on all sides of the array are expected to provide a physical obstruction between the solar farm and road users of the Newell Highway and the Kamilaroi Highway. Road users along other local roads in the vicinity of the site are also not likely to be affected.

5.9.2 Mitigation measures

No mitigation measures are necessary in relation to glare and glint.

5.10 Landscape character and visual amenity

5.10.1 Assessment of impacts

Impacts on landscape character and visual amenity of the proposed solar farm have been assessed by Zenith Town Planning Pty Ltd using the RMS guideline *Environmental Impact Assessment Practice Note – Guideline for Landscape Character and Visual Impact Assessment* (EIA-N04 Version 2-0 released on 14 December 2018). The findings of the assessment are summarized below. Reference should be made to the *Landscape Character and Visual Amenity Impact Assessment* that is submitted with the development application for further information or clarification of any matter concerning the assessment and recommendations.

The assessment estimates the likely impacts on landscape character and viewpoints based on the sensitivity to physical change and the magnitude, or relative size and scale, of the works and then applies an impact ranking. The methodology included a site inspection of the location of the proposed works and the surrounding area to identify observation points and the visual catchment, land uses and characteristics of the surrounding area. The greater the distance from

the development site the less clear is the view of the solar farm. The ability to distinguish the type of land use and the actual composition of materials diminishes with distance. Planning principles established by the NSW Land and Environment Court were also considered as a check on the findings of the landscape character and visual assessment. The observation points located within the visual catchment of the site of the proposed solar farm are shown in Figure 7 below.

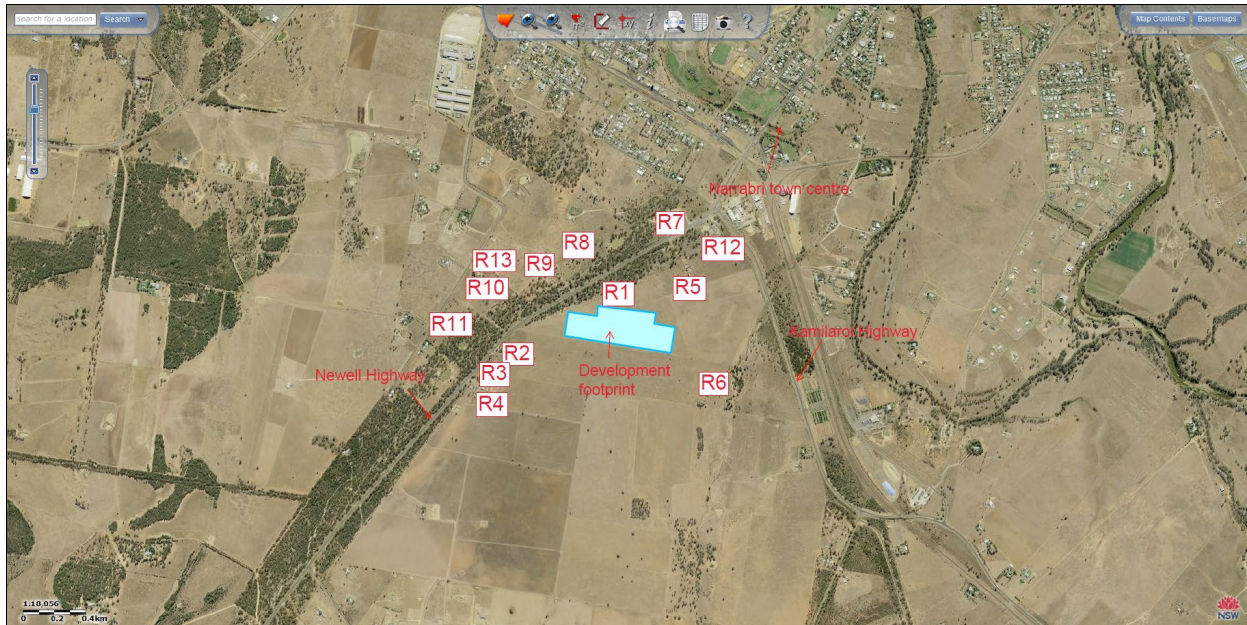


Figure 7: Observation points in the visual catchment. Source: SIX Maps

5.10.2 Findings

The rural landscape in the vicinity of the development site has been modified by the agricultural industry. It is characterised by a mix of farming, rural uses including rural industrial facilities, rural living dwellings and scattered remnant native vegetation along boundaries, road reserves and patches within private property.

The overall impact on landscape character in relation to private property is assessed to be moderate-high. The overall impact on landscape character in relation to the public domain is also assessed to be moderate-high particularly where there is an uninterrupted line of sight to the facility. The visual impact of the proposed works is assessed to range from low to high for the 11 residential observation points identified in this assessment, depending upon whether there is any roadside vegetation or within private property that interfere with a direct visual connection with the facility. It is assessed to be low for motorists using the Kamilaroi Highway due to the flat topography and presence of industrial development on approach to the township, and moderate for the Newell Highway due to gaps in roadside vegetation which allow full visibility of the site particularly when approaching from the south.

The findings of the assessment acknowledge that there will be impacts on the landscape and visual amenity as there are with any type of development. However, there is no view loss; the impact is a change to the view – a new element within the landscape. Impacts are greatest in close proximity to the solar farm as the further the distance a viewpoint is from the site the less the overall visual impact as the development occupies a lesser proportion of the total view.

The potential impacts of the proposed solar farm on views from both private property and the public domain affect only a minor proportion of the total landscape views. Impacts would be greatest during construction when there will be traffic movements into and out of the site and the temporary car parking and materials laydown areas are installed. Once operational, the proposed landscaping will provide effective screening of the fence, array and inverters over time as vegetation matures.

On balance and having regard to other matters for consideration under section 4.15 *Evaluation of the Environmental Planning and Assessment Act 1979*, the impacts are considered acceptable given that:

- the solar farm will contribute to renewable energy generation and provide a source of electricity for local domestic and commercial use whilst at the same time assisting to reduce greenhouse gas emissions and our reliance on fossil fuels,
- It will also generate employment opportunities during the construction phase and once operational will provide employment for maintenance crews,
- The placement of the array within the property downslope has been chosen to maximise distance separation from neighbouring dwellings,
- Existing vegetation along road reserves and property boundaries is to be maintained,
- The proposed landscaping surrounding all sides of the array will grow to a height that will screen the facility from observation points including public roads that are on level ground with the development site and elsewhere will soften the visual impact from land that is slightly elevated above the development site.

5.10.3 Mitigation measures

It is recommended that native plants that are endemic to the district be selected for the vegetation screen that is proposed to be planted around all sides of the array. Plants should be selected from the list of suitable species contained in the *Narrabri Shire Council Industrial Development Code*.

6. CONCLUSION

6.1 Findings

The site is considered suitable for the proposed development of the Narrabri Solar Farm. A 22kV feeder is available to connect to the Essential Energy Narrabri 66/11 zone substation to transfer power generated by the solar panels to the township and on to the grid.

The development area is relatively flat, is free of constraints and is accessible to large delivery vehicles during the construction phase and utility vehicles for ongoing maintenance.

The likely impacts of the development have been considered in this Statement and supporting documents. Considerations include impacts on biodiversity, natural hazards, visual and scenic amenity, glare and glint, traffic, noise, air quality, water resources, indigenous and non-indigenous heritage, the community and the local economy. Any impacts on these interests have been found to be acceptable and mitigation measures have been recommended where necessary.

According to the Australian Radiation Protection and Nuclear Safety Agency, which maintains continual oversight of emerging research into the potential health effects of the EMF exposure, there is no established evidence of health effects from exposure to electric and magnetic fields from powerlines, substations, transformers or other electrical sources, regardless of the proximity, causes any health effects. The location of the solar farm and the distance separation between nearby dwellings and the site mean that any potential impacts on health are mitigated.

The solar farm is designed to generate in excess of 12.71GWh of energy annually which will offset almost 8.5 thousand tonnes of CO₂ equivalent emissions (Sources: *National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Schedule 1)* and Department of the Environment and Energy) and providing enough energy to power about 2,150 NSW homes.

Electricity generated by the system will be directed to the settlement via existing electrical infrastructure to contribute to the supply of electricity for use by households and businesses in the town centre. Any surplus electricity will be sent to the grid and any deficit will be drawn from the grid. As well as the potential to utilize local contractors to construct the facility, the township will benefit through the ability to provide clean energy that is generated adjacent the settlement.

The cumulative impacts of the proposed development are minor. There are no other electricity generating works in the immediate area and the use is suited to a rural location due to the need for a large land area. The addition of a solar farm to that rural area would not detract unreasonably from local amenity or the natural environment.

The proposed development is consistent with the strategic planning framework that applies to the local government area, the site itself and to the development of electricity generating works. The solar farm is permissible with consent under provisions of *SEPP (Infrastructure) 2007* which prevails over provisions of the local environmental plan and is satisfactory to other applicable SEPPs.

The proposed rural location implements the planning priorities, goals and actions of the *New England North West Regional Plan 2036*, the *Narrabri Growth Management Strategy*, the *Narrabri Local Strategic Planning Statement 2040* and the *NSW Renewable Energy Action Plan*. These objectives seek to capitalize on solar energy resources to increase the provision of renewable energy using rural land in locations that will not cause land use conflict.

The development of the solar farm will assist the transition of our economy from reliance on fossil fuels to renewable sources. It will assist Commonwealth and NSW Governments to achieve targets and objectives relating to emissions and addressing climate change.

Given these local, regional and national benefits of renewable energy generation and based on implementation of the recommended mitigation measures to avoid, minimize or mitigate impacts to the existing natural and built environment, the development is considered to be in the public interest.

6.2 Summary of mitigation measures

Table 8 provides a summary of mitigation measures. It is recommended that an environmental management plan be prepared to cover the construction and operational phases.

Where necessary Table 8 includes a recommendation as to whether the mitigation measure should be included in the management plan.

In addition to the mitigation measures detailed below, it is recommended that a waste management plan be prepared for inclusion in an environmental management plan.

Table 8: Summary of mitigation measures

Consideration	Mitigation measures	Environmental Management Plan
Biodiversity	By way of a clearing process that minimizes the risk to threatened species that may be opportunistically using the site, it is recommended that: I. Construction limits and exclusion zones clearly identified prior to work; II. A visual inspection is conducted by environmental staff before construction commences to identify any areas of site that might be supporting native fauna; III. Vehicle movements around the site will be restricted to the construction footprint and away from any existing planted trees and flagging exclusion fencing to be installed. IV. Soil disturbance by vehicle and pedestrian access is to be kept to a minimum outside the construction footprint. V. Any weeds removed (particularly those bearing seeds) are to be disposed of appropriately at the nearest waste management facility.	Yes, with reference to ongoing site access during both construction and operational phases, and to the storage of materials within the site
Natural hazards	Prepare a fire emergency management plan and include that plan in the environmental management plan	Yes, for construction and operational phases
Water resources	Design – site drainage and water quality controls: • Undertake hydrological assessment of the sites catchment in accordance with relevant methods outlined in Australian Rainfall and Runoff. • Determine sediment management targets and drainage control standards in accordance with Managing Urban Stormwater: Soils and Construction Vol 1 (Blue Book) (DECC, 2008). • Develop a site erosion and sediment control plan in accordance with the Blue Book. • Develop site drainage design incorporating detention basins and sedimentation management structures where relevant. • Permanent site drainage should coincide with temporary arrangements where possible	Yes, for construction and operational phases. Include an erosion & sediment control plan or soil and water management plan
	Construction and/or demolition – site drainage and water quality controls: • Project construction period to occur entirely within the dry season to prevent flooding • Catch drains to be located downslope of any proposed road works. • Install location appropriate sediment fences or other applicable control measures depending on whether the feature is upstream or downstream of a disturbed part of the site or will need to be trafficable. • All stormwater collection points need to have appropriate sedimentation and erosion controls.	

	• Undertake ongoing inspections of stormwater facilities and water control measures to assess their effectiveness. • Vibration grids or wash bays at all construction exits. • Level spreaders at locations where concentrated flow is discharged offsite to ensure sheet flow like conditions are maintained. • Flat land erosion control options include erosion control blankets, gravelling, mulching, soil binder, turfing and revegetation	
	Construction and/or demolition – stormwater point source control: In the event of concrete works: • Do not undertake works if chance of heavy rain. • Store rinsate water, if applicable, separately to other water on site and dispose of offsite as appropriate. • Block on site drains in the area of the works and remove any contaminated runoff. In the event that dewatering practices are required: • Pump hose intakes for withdrawing water from excavations will be elevated to minimise sediment pumping and directed to a containment area for settling prior to discharge. • Limit direct discharge off site (consistent with the design requirements for sediment pond discharge). • Stormwater collected on site should be reused where possible. Controls should be inspected and maintained on a regular basis. All water released from sediment basins should be clear or disposed off site by vehicle. • Material and waste storage areas should be designed and operated to minimise interaction with surface waters. • Vehicle washdown areas should be located away from water courses	
Air quality	During construction: • Limit vehicle movements to areas necessary to deliver panels, ancillary structures and equipment • Suppress dust emissions using watering and cease works during dry and windy conditions • Ensure ground disturbance is limited to areas necessary to place footings or to be used for access • Ensure minimal handling of excavated materials • Ensure stockpiles of excavated material is bunded and protected from wind and vehicle movements During operation: • Grade and add road base to internal accessways	Yes, for construction and operational phases

	• Revegetate the site with suitable groundcover immediately construction works are completed • Ensure all plant and equipment operates in accordance with specifications	
Noise	The following mitigation measures are recommended to address noise emissions during the construction phase: • a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community, • where possible use localised mobile screens or construction hoarding around plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (e.g. unloading and laydown areas), • operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations, • selection of the quietest suitable machinery available for each activity, • avoidance of noisy plant/machinery working simultaneously where practicable, • minimise impact noise wherever possible, • utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm, • provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities, • signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site, and • utilise project related community consultation forums to notify residences within close proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure. It is recommended that the noise emissions from the solar farm be minimised when operational. To assist in noise management, it is recommended that a one-off noise validation monitoring assessment be completed to quantify emissions from site and to confirm emissions relevant criteria are satisfied.	Yes, for construction and operational phases
Traffic	It is recommended that: • The existing western access point be upgraded to accommodate B-Double turn safety during the construction phase • The eastern access is to be temporarily closed during the construction period	Yes, with reference to site access during the establishment and construction phases

	• Undertake a dilapidation survey prior to construction works • Appropriate signage outlined in Traffic Management Plan to prevent right turn entry from the Newell Highway into the site. • vi. Shared transport for workers should be incorporated into the site management during construction period • BAL widening arrangement including shoulder widening • Gravel pavement improvements to the existing western access to accommodate construction vehicle movements • Installation of new culvert and driveable headwalls at the western access • Truck entering signs (W5-22) (or T2-25 as this is temporary works) to be erected 250m either side of the existing access during construction phase to notify motorist. • No right entry sign or VMS signage to prevent right turn entry.	
The community & local economy	• labour to construct and maintain the solar farm be sourced from within the local government area wherever possible • advertising be placed in local media and local businesses contacted to determine whether there is the capacity and expertise available to participate in the construction and ongoing maintenance activities	n/a
Heritage	Council may recommend that a condition of consent be imposed to require a site survey be carried out by an LALC sites officer either before any work commences or prior to the issue of a construction certificate. Council may also recommend a condition of consent to comply with provisions of the <i>National Parks and Wildlife Act 1974</i> should any evidence of Aboriginal occupation be found during site works. An <i>Aboriginal Heritage Impact Permit</i> may be required to be obtained if indigenous heritage objects are found during ground disturbance. There are no recommendations in relation to non-Indigenous heritage.	n/a
Landscape character & visual amenity	It is recommended that native plants that are endemic to the district be selected for the vegetation screen that is proposed to be planted around all sides of the array. Plants should be selected from the list of suitable species contained in the <i>Narrabri Shire Council Industrial Development Code</i> .	n/a
Glare and glint	No mitigation measures are proposed.	n/a

Zenith Town Planning
P O Box 591
Moruya New South Wales 2537
Attention: Allen Grimwood
Email: zenithplan@bigpond.com

Date: 10 March 2021

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 102, DP:DP579423 with a Buffer of 0 meters, conducted by Allen Grimwood on 10 March 2021.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the [NSW Government Gazette \(http://www.nsw.gov.au/gazette\)](http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

Landscape character & visual impact assessment

Lot 102 DP 579423 No 11498 Newell Highway, Narrabri, NSW

Narrabri 3A Solar Farm



Zenith
TOWN PLANNING PTY LTD

0408 258 877 | PO Box 591 Moruya NSW 2537 Australia
zenithplan@bigpond.com | www.zenithplan.com.au

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Attachment A: Photomontages

Document Details & History

Project number	2020
Project title	Narrabri 3A Solar Farm
Document title	Landscape character & visual impact assessment
Client	ITP (Development) Pty Ltd
Author	Allen Grimwood, Director
Qualifications	Bachelor of Arts (Honours) UNSW Master of Urban & Regional Planning, USyd 
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The report has been prepared using information supplied by the client and other stakeholders. All care is taken to ensure the accuracy and veracity of this information, however, no responsibility is accepted for the interpretation of that information by end users.

1. Introduction

The purpose of this report is to assess the landscape character and visual impacts of a proposed solar farm at Narrabri, located in Narrabri local government area and to be known as the Narrabri Solar Farm.

The scope of this report is to evaluate the potential impacts on landscape character and visual amenity. To achieve this end the report addresses:

- the location and physical characteristics of the site on which the works are proposed,
- the character or the surrounding landscape and the visual catchment within which the proposed works may be of significance,
- potential impacts on the landscape, viewpoints and receivers located within the visual catchment, and
- means to avoid or mitigate potential impacts.

A site visit was carried out on 23 September 2020 and a meeting with Narrabri Shire Council staff was held on the same day.

2. Methodology

Impacts on the visual and scenic amenity of the proposed Narrabri Solar Farm have been assessed by Zenith Town Planning Pty Ltd using the RMS guideline *Environmental Impact Assessment Practice Note– Guideline for Landscape Character and Visual Impact Assessment* (EIA-N04 Version 2.1 released on 14 December 2018). Details of methodology are given below.

A site inspection of the location of the proposed works and the surrounding area has been carried out to identify the visual catchment, the context of the site of the proposed works and observation points. Land uses and characteristics of the environment such as topography, vegetation, architecture of neighbouring buildings and any heritage values of any significant sites in the vicinity of the proposed solar farm were noted and the capacity of the area to absorb physical change is assessed.

Development plans for the solar farm have been reviewed and the likely impacts on landscape character identified. This is determined by the sensitivity of the landscape to physical change and the magnitude, or relative size and scale, of the works.

The visual significance of the site to observation points and receivers within the visual catchment is described in terms of proximity to the site, landscape character, the composition of views and the

sensitivity to change that will affect scenic values. The visual impacts that will be experienced by each receiver are identified and evaluated in terms of the sensitivity of each receiver to change and the magnitude of that change in terms of the proposed works.

The impacts are calculated and ranked according to negligible, low, moderate or high impact based on the following matrix (Table 1).

Table 1: Landscape character and visual impact grading matrix. Source: RMS Guideline for Landscape Character and Visual Impact Assessment, 2018

Landscape character and visual impact grading matrix					
	Magnitude				
Sensitivity		High	Moderate	Low	Negligible
	High	High impact	High-moderate	Moderate	Negligible
	Moderate	High-moderate	Moderate	Moderate-low	Negligible
	Low	Moderate	Moderate-low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

An explanation of the rankings of impacts on landscape character and visual amenity are provided in Table 2, sourced from *Pacific Highway HW10 and Wyong Road MR335 intersection and approaches upgrade Tuggerah* by Peter Andrews & Associates Pty Ltd/Corkery Consulting Pty Ltd, September 2012.

Table 2: Explanation of rankings based on sensitivity and magnitude.

Rank	Landscape character	Visual amenity
High	The development would be the dominant feature in the landscape and would significantly affect and alter character	There is a substantial change to visual amenity or a total loss of view towards key features caused by the introduction of new elements that contrast with existing landscape character
Moderate	The development introduces a new element to the landscape and would form a significant and recognisable part of the landscape that alters character	There is partial loss or change of visual amenity towards key features caused by the introduction of new elements that may be prominent but not substantially in contrast with existing landscape character.
Low	The development constitutes a minor element of the wider view that merges with other land uses	There is a minor loss or change of visual amenity towards key features caused by the introduction of new elements that are consistent with existing landscape character
Negligible	The development is either not visible or only a small part is visible that due to distance separation does not alter character	There is very minor loss or change to visual amenity towards key features caused by the introduction of new elements that are consistent with existing landscape character approximating no change

Where magnitude and sensitivity impacts differ, the ranking would be a hybrid of the two impacts, e.g. moderate-high. Such a ranking would combine elements of both the explanation of a moderate rank and that of a high rank.

The RMS methodology has been validated by the Land and Environment Court. For example, in the case of *Houghton V Shoalhaven City Council* [2016] NSWLEC 1195 the commissioner upheld an appeal by the applicant and agreed with the findings of the visual assessment that was prepared using this methodology.

The methodology of the guidelines addresses impacts in both qualitative and quantitative terms. The qualitative assessment involves the use of descriptive and conceptual data such as descriptions of landscape characteristics and the setting of the development or viewpoint. The quantitative assessment uses numbers and values such as the distance of a viewpoint from the development and the direction of the view towards the development. The purpose of the assessment is to identify impacts and to determine whether these impacts are acceptable given the benefits of the development to the community and economy.

Although the proposed development is not classified as a state significant project reference has been made to the Large-Scale Solar Energy Guideline during the preparation of plans, drawings and reports. The document provides the following guidance for assessing visual impacts:

The impacts on landscape character and values and the visual amenity of landholders and communities.

Using the RMS methodology, which is based on the magnitude (size and scale) of the development and the sensitivity of the landscape and visual receivers to change, ensures that an objective judgement of impacts is made by the assessor. The methodology prevents the assessor from making subjective judgements. Sensitivity is a measure of how sensitive the character of the setting is to the proposed change and its capacity to absorb the change. Magnitude refers to the scale, form and character of a development proposal.

Planning principles established by the NSW Land and Environment Court were also considered as a check on the findings of the landscape character and visual assessment. These principles are derived from the case *Tenacity Consulting v Warringah* [2004] NSWLEC 140 when considering the acceptability of the impact of a proposed development on views enjoyed from private property in the vicinity of that development, and from *Rose Bay Marina Pty Ltd V Woollahra Municipal Council and Anor* [2013] NSWLEC 1046 when assessing the impact of a development on the public domain.

THE RMS methodology has been compared with that required by government guidelines that apply in other states, i.e. South Australia, Victoria and Queensland. South Australia's guideline is silent on the issue of visual assessment and the Queensland guideline suggests that visual amenity and proximity to sensitive receptors should be investigated when assessing the feasibility and impacts of a project. The Victorian guideline includes advice on minimising impacts on landscape values and on providing screening to reduce visual impacts. It also recommends that design includes visual simulations (photomontages) to illustrate the development in the context of the surrounding area and key viewpoints, and that an assessment of the impacts have regard to the scale of the project, the sensitivity of the landscape to change, visibility to private property and public places, the locations and distances from which a facility may be seen, the significance of the landscape and landscape/environmental values. This assessment applies a methodology that would comply with the Victorian guidelines.

The findings of the landscape character and visual impact assessments are summarised in the conclusion. Recommendations as to refinements of the development plans to avoid or mitigate significant landscape and visual impacts are made if necessary.

3. Proposed works

ITP (Development) Pty Ltd proposes to develop a solar farm and ancillary facilities with an AC output of 5.0MW at 11498 Newell Highway, Narrabri, NSW. The site is located approximately 4.5 kilometres to the south-west of the town centre of Narrabri and is an irregular shape with a total area of 62 hectares. The proposed development would occupy 11.32 hectares of the total site.

Components of the facility which would impact on the landscape and visual amenity are:

- 12,100 solar modules ranging in height from 1.5 metres to 2.75 metres installed in 140 rows running north to south with approximately 6.25 metres centre to centre spacing between each row,
- Two 3MW inverter stations each mounted on a 12.2 metre long skid,
- A temporary car parking and materials laydown area,
- A 1.8 metre high security fence topped with three rows of barbed wire to give a total height of 2.3 metres, and
- Perimeter landscaping on the outer side of the security fence.

The layout of the solar farm is shown on General Arrangement Plan (Drawing No NAR3A-G-2100) prepared by ITP Renewables.

4. Description of the landscape

The character of the landscape near the development site of the Narrabri Solar Farm is summarized in Table 3 below.

Table 3: Landscape character in the vicinity of the development site

Item	Description
Land use	The development site is zoned RU1 Primary Production and is located south of the township of Narrabri. The closest part of urban area of Narrabri is just over 1 kilometre from the site to the north. Land to the west of the site and separated by the Newell Highway is occupied by rural lifestyle dwellings on small acreages of around 10 hectares also zoned RU1. Larger properties used for agriculture are located to the south. Land to the east and north-east is largely industrial uses lining the Kamilaroi Highway.
Structures	The site is occupied by a dwelling house and several farm sheds. Farm machinery is scattered over the eastern section near the dwelling. The northern half of the property is separated by a low wire fence. Structures within the vicinity of the site comprise scattered farm and rural lifestyle dwellings set within vegetated properties, a service station and industrial developments to the east-north-east
Topography	The topography is generally flat with low hills in the distance to the south and east. The higher ranges of Mount Kaputar National Park provides a backdrop to the town to the north-east. A watercourse runs through the property in a south to north direction close to the eastern boundary and parallel to the Namoi River. The watercourse drains to Narrabri Lake that is within Gooriah Hill alongside open space and Narrabri Showground. The surrounding landscape is similar with gentle rolling hills typical of the south west slopes
Vegetation	Much of the rural landscape has been cleared in the past for agricultural use other than scattered eucalyptus trees and riparian vegetation along watercourses, property boundaries and road reserves. The majority of the property is covered with exotic pasture grasses. Native vegetation regrowth surrounds some of the rural lifestyle dwellings in the vicinity of the site
Infrastructure	The site is located between the Newell Highway on the western side and the Kamilaroi Highway to the east. The Newell Highway provides a major link between south-eastern Queensland and Victoria via central NSW. It carries large amounts of road freight. The Kamilaroi Highway runs east-west and extends from the New England Highway near Quirindi in the east to the Mitchell Highway at Bourke in the

Item	Description
	west. A 22kV feeder line runs through the centre of the site to connect to the Essential Energy Narrabri Zone sub-station. The Werris Creek Mungundi Railway line runs parallel to the Kamilaroi Highway and veers east before the township and joins the Narrabri West Walgett Railway line that branches to the west

Below are an aerial image of the development site and photographs of the landscape and surrounding development. All photographs were taken by Zenith Town Planning Pty Ltd at the time of the site inspection.



Figure 1: Aerial image of the development site. Source: SIX Maps, 26 April 2016



Plate 1: Looking south along the western boundary of the development site



Plate 2: The dwelling on the development site



Plate 3: Looking north-east from within the development site



Plate 4: Looking north along the Newell Highway across the development site



Plate 5: A dwelling on the adjoining property to the south



Plate 6: Farm dwelling to the south-east of to the development site



Plate 7: A rural property to the east of the development site



Plate 8: Looking north-east from within the development site



Plate 9: The proposed access to the development site

5. Assessment of impacts on landscape character

The rural landscape in the vicinity of the development site has been modified by the agricultural industry. It is characterised by a mix of farming, rural uses including rural industrial facilities, rural living dwellings and scattered remnant native vegetation along boundaries, road reserves and patches within private property.

The project occupies 11.32 hectares and the 12,100 panels have a maximum height of 2.75 metres. The development footprint within an open paddock wedged between the Newell and Kamilaroi Highways. Some existing native vegetation along the Newell Highway partially screens the site. The Kamilaroi Highway is some 600 metres to the east at the nearest point.

The size and scale, or magnitude, of the project and impact on landscape character is considered to be high for private property in the immediate vicinity of the site due to the introduction of a new type of development that is substantial in size and scale, and will change the nature of the rural landscape. It is also judged to be high for the two arterial roads from which it is visible.

The sensitivity of private property to landscape change is considered moderate given the existing modified landscape which is predominantly agricultural with intervening vegetation between the dwellings and the development footprint. All dwellings to the west of the site are setback significantly from the Newell Highway. Dwellings to the south and east of the site have a direct line of sight towards the development footprint. Vegetation would provide effective screening of the facility from dwellings to the north and west. The flat topography means that sensitivity would decrease with distance so that visibility of the solar farm to properties further away than about 1 kilometre would be negligible. The sensitivity of the two arterial roads would be moderate given the existence of commercial and industrial developments at the entry to the township.

The overall impact on landscape character in relation to private property is assessed to be moderate-high. The overall impact on landscape character in relation to the public domain is also assessed to be moderate-high particularly where there is an uninterrupted line of sight to the facility. However, when landscaping matures to the height of 2.5 metres this impact would be reduced to low for both public and private property due to vegetative screening on all sides.

6. The visual catchment

The visual impact of solar farms depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment; vegetation; and any proposed screening measures to reduce visibility of the site. Some potential observation points may not have a clear line of sight towards the solar farm because of significant existing features such as built structures and vegetation. The greater the distance from the development site the less clear is the view of the solar farm. The ability to distinguish the type of land use and the actual composition of materials diminishes with distance.

For the purposes of this analysis the visual catchment of the site of the proposed development is defined by an area within 1 kilometre of the development site from which the works may be visible as shown on the visual catchment map below (Figure 2). The separation distances from each dwelling to the nearest point of the development area are given in Table 4. The distance has been measured as a straight-line from the nearest point of a neighbouring dwelling to the centre of the solar array. Whilst it is acknowledged that the array may be visible from unoccupied parts of a property, it is considered that the view from a dwelling is more critical than from yards and paddocks. GDA94 Geographic coordinates are also provided.



Figure 2: The visual catchment. Source: SIX Maps

Observation points are shown in Figure 3. The observation points are all located within 1 kilometre of the centre of the development footprint. This is considered sufficient distance to assess visual impacts given the very flat landscape surrounding the site.

There are no dwellings or other observation points on the distant vegetated hillsides or Mount Kaputar National Park. There are 11 residential dwellings within the visual catchment plus two commercial properties. Two public roads being the Newell Highway and the Kamilaroi Highway are also within the visual catchment.

The residence on the development site that is occupied by the landowner is located 170 metres north of the facility. Commercial properties (observations points R7 and R12) are not considered sensitive receivers in terms of visual impact and consequently an impact rating is not assigned to these properties.

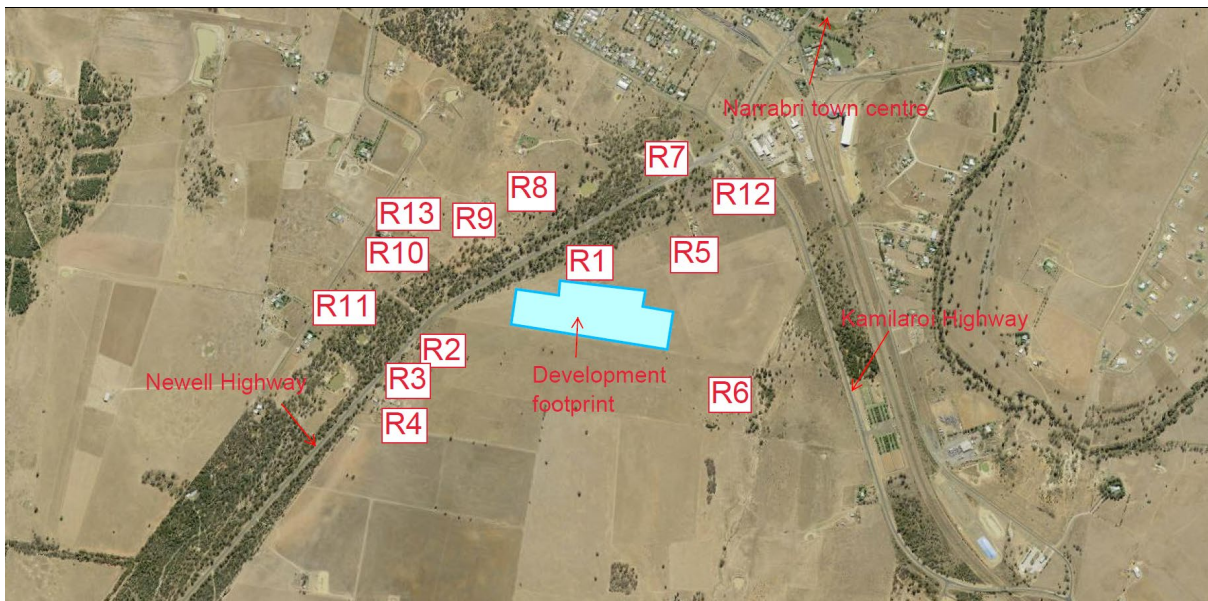


Figure 3: Observation points. Source: SIX Maps

7. Assessment of visual impacts

The magnitude of the proposed solar farm in terms of the quantum of change to views and proximity to each observation point, and the degree of sensitivity based on the quality of the view, whether the site is clearly visible or obscured by landform or vegetation, the direction and composition of the view is assessed in Table 4 below. An impact rating is then given based on magnitude and sensitivity using the landscape character and visual impact grading matrix provided in section 2 *Methodology*.

The visual impact of the proposed works is assessed to range from low to high for the residential observation points identified in this assessment. Three dwellings to the south and one to the east will have a direct line of sight to the solar farm. Vegetation and existing structures on the property is likely to screen visibility to receiver R5 to the north. Although the development footprint is cleared, extensive building line setbacks and existing vegetation along the Newell Highway road reserve, within adjoining rural properties and along property boundaries would screen the site from the receivers located to the west of the development site although it may be visible from the access driveways of these dwellings. The dwelling on the same site as the proposed solar farm would have unimpeded views towards the facility from the residence, outbuildings and yards, however, this is acceptable given that the land owner has entered into a lease agreement to construct and operate the facility.

It is assessed to be low for motorists using the Kamilaroi Highway due to the flat topography and presence of industrial development on approach to the township, and moderate for the Newell Highway

due to gaps in roadside vegetation which allow full visibility of the site particularly when approaching from the south.

However, when landscaping matures to the height of 2.5 metres impact would be reduced to low for both public and private property due to vegetative screening on all sides. The visual connection from properties with a direct line of sight would gradually improve as vegetation matures.

Table 4: Visual impacts on observation points

Observation point	Land use	Location relative to solar farm	Latitude	Longitude	Comment	Magnitude	Sensitivity	Impact rating
R1	Dwelling	170m north	-30.353179	149.75308	Dwelling on the same property as the solar farm and in same ownership	High	Low	Moderate
R2	Dwelling	623m south-west	-30.35653	149.74615	Direct line of sight to the development	High	High	High
R3	Dwelling	752m south-west	-30.357123	149.745012	Direct line of sight to the development	High	High	High
R4	Dwelling	875m south-west	-30.358363	149.744197	Slight impeded line of sight to the development due to other dwellings	High	High	High
R5	Dwelling	602m north-east	-30.351938	149.757801	Direct line of sight to the development	High	High	High
R6	Dwelling	870m south-east	-30.357993	149.760247	Direct line of sight to the development	High	High	High
R7	Commercial	755m north-east	-30.348753	149.756685	Service station located on the Newell Highway	n/a	n/a	n/a
R8	Dwelling	535m north-west	-30.350013	149.750184	Visibility impeded by intervening vegetation on private property and road reserve	Low	Low	Low
R9	Dwelling	560m north-west	-30.350605	149.748574	Visibility impeded by intervening vegetation on private property and road reserve	Low	Low	Low
R10	Dwelling	855m west	-30.351883	149.743875	Visibility impeded by intervening vegetation on private property and road reserve	Low	Low	Low
R11	Dwelling	1km west	-30.354438	149.741515	Visibility impeded by intervening vegetation on private property and road reserve	Low	Low	Low
R12	Commercial	870m north-east	-30.34942	149.759325	Depot located on the Newell Highway	n/a	n/a	n/a
R13	Dwelling	850m west	-30.350994	149.744476	Visibility impeded by intervening vegetation on private property and road reserve	Low	Low	Low
Kamilaroi Highway	Public road				Uninterrupted view across farmland from a section close to rural industrial development	Low	Low	Low
Newell Highway	Public road				Partial screening by roadside vegetation. Direct line of sight on approach from the south	Moderate	Moderate	Moderate

These impacts are considered acceptable given the nature of the proposed development and that it will contribute to renewable energy generation directed to Narrabri for use by households and businesses, use local labour where available for construction and operations, and assist to reduce greenhouse gas emissions and reliance on fossil fuels.

Photomontages that show the site prior to development and after completion of the solar farm with and without landscape screening are provided as Attachment A. The photomontages depict the appearance of the facility through stages of vegetation growth. The first image is taken from the internal fenceline near the dwelling on the development site. The second is taken from the Newell Highway on approach from the south looking across the site from a gap in roadside vegetation. The photomontages demonstrate that landscaping will provide effective screening from all directions.

Due to the complexity of the landscape and the solar farm design, photomontages can be difficult to produce and do not necessarily provide a realistic view of how the constructed solar farm will look. These are indicative only and the actual development may differ from these images.

8. Assessment against planning principles

The Land and Environment Court consistently applies a set of planning principles derived from the case *Tenacity Consulting v Warringah* [2004] NSWLEC 140 when considering the acceptability of the impact of a proposed development on views enjoyed from private property in the vicinity of that development. These planning principles are addressed below in relation to the proposed solar farm.

Impact on private property

Step 1: The views to be affected

The solar farm would be visible to dwellings located to the south and east of the development site and potentially to a dwelling located to the north. The view enjoyed from these properties is one of a cleared rural farm landscape interspersed with remnant or regrowth native vegetation along road reserves and boundaries and within private properties. Elsewhere vegetation and significant building line setbacks would obstruct direct visibility of the array.

Step 2: From what part of the property the views are obtained

Views across the rural landscape are available from the dwellings and paddocks of the properties to the south and east. The view from the property to the north would be predominantly from yards and paddocks. Vegetation obscures visibility from land to the west.

Step 3: The extent of the impact

The array will occupy approximately 11 hectares of the 62 hectare property, i.e. 18% of the total rural property. The topography is flat meaning that extensive views are available from all directions, however, intervening vegetation obscures views from the west. The extent of the impact is considered significant from the south and east, however, the proposed footprint of the array occupies less than a quarter of the whole property and is a single direction only. These properties have rural landscape views over their own land and will retain views across farmland in all other directions.

Step 4: The reasonableness of the proposal that is causing the impact

The proposed solar farm is a project that is suited to a rural location. The property is a working farm and the production of solar energy is an activity that is mandated by *SEPP (Infrastructure)* as permissible in a rural zone. The development will contribute to the viability of other farm operations, be compatible with those operations and enable the property to continue to be productive. A solar farm is considered a reasonable land use of the development site. Landscaping on all sides to screen the development is a reasonable response to the impacts on the landscape and visual amenity.

Impact on the public domain

The case *Rose Bay Marina Pty Ltd V Woollahra Municipal Council and Anor* [2013] NSWLEC 1046 established planning principles to be considered when assessing the impact of a development on the public domain. The process must account for reasonable development expectations as well as the enjoyment of members of the public of outlooks from public places.

Step 1: The nature and scope of existing views

Views from the public domain towards the development site are from two arterial roads to the east and west. The scope of views from the Newell Highway is limited by roadside vegetation although gaps in that vegetation allow uninterrupted views from the southern approach to Narrabri. Views from easterly aspects along the Kamilaroi Highway are across an open rural landscape.

Step 2: The locations from which the potentially interrupted view is enjoyed

Views from the section of the Newell Highway to the south of the site are across the development footprint. Views towards the facility from the Kamilaroi Highway are close to the town entry and industrial development.

Step 3: The extent of the obstruction at each relevant location

The photomontages indicate the extent of view obstruction from the affected roads. There are no significant landscape features that would obscure views of the solar farm from the southern approach to town along the Newell Highway although the generally flat landscape would moderate impacts. The relative distance from the Kamilaroi Highway would lessen the extent of impacts.

Step 4: The intensity of public use of those locations where that enjoyment will be obscured

Both highways are arterial roads and used extensively for freight movements as well as passenger vehicles.

Step 5: Whether or not there is any document that identifies the importance of the view

There is no strategic plan of Narrabri Shire Council or the NSW Government that identifies the importance of the view. It is not mapped as a scenic landscape or as visually sensitive land in *Narrabri LEP 2012*.

In summary, assessment against the planning principles established by the NSW Land and Environment Court finds that the potential impacts of the proposed solar farm on views from both private property and the public domain are acceptable and, although significant, affect only a minor proportion of the total landscape views. It is important to note that all development has a visual impact, irrespective of the size or scale of that development. Impacts would be greatest during construction when there will be traffic movements into and out of the site and the temporary car parking and materials laydown areas are installed. Once operational, the proposed landscaping will provide effective screening of the fence, array and inverters over time as vegetation matures.

The planning principles are not predicated on a position that a landowner or occupant has a proprietary right to retain all or part of the views enjoyed from their land. The Court has acknowledged that even entire view loss is reasonable in certain circumstances (Lindsay Taylor Lawyers, November 2015).

9. Conclusion and recommendations

The rural landscape in the vicinity of the development site has been modified by the agricultural industry. It is characterised by a mix of farming, rural uses including rural industrial facilities, rural living dwellings and scattered remnant native vegetation along boundaries, road reserves and patches within private property.

The overall impact on landscape character in relation to private property is assessed to be moderate-high. The overall impact on landscape character in relation to the public domain is also assessed to be moderate-high particularly where there is an uninterrupted line of sight to the facility. The visual impact of the proposed works is assessed to range from low to high for the residential observation points identified in this assessment, depending upon whether there is any roadside vegetation or within private property that interfere with a direct visual connection with the facility. It is assessed to be low for motorists using the Kamilaroi Highway due to the flat topography and presence of industrial development on approach to the township, and moderate for the Newell Highway due to gaps in roadside vegetation which allow full visibility of the site particularly when approaching from the south. The findings of the assessment acknowledge that there will be impacts on the landscape and visual amenity as there are with any type of development. However, there is no view loss; the impact is a change to the view – a new element within the landscape. Impacts are greatest in close proximity to the solar farm as the further the distance a viewpoint is from the site the less the overall visual impact as the development occupies a lesser proportion of the total view.

The potential impacts of the proposed solar farm on views from both private property and the public domain affect only a minor proportion of the total landscape views. Impacts would be greatest during construction when there will be traffic movements into and out of the site and the temporary car parking and materials laydown areas are installed. Once operational, the proposed landscaping will provide effective screening of the fence, array and inverters over time as vegetation matures.

To mitigate impacts on the landscape and visual amenity, it is recommended that native plants that are endemic to the Narrabri district be selected for the vegetation screen that is proposed to be planted around all sides of the array. Narrabri Shire Council should be consulted to determine appropriate plant species.

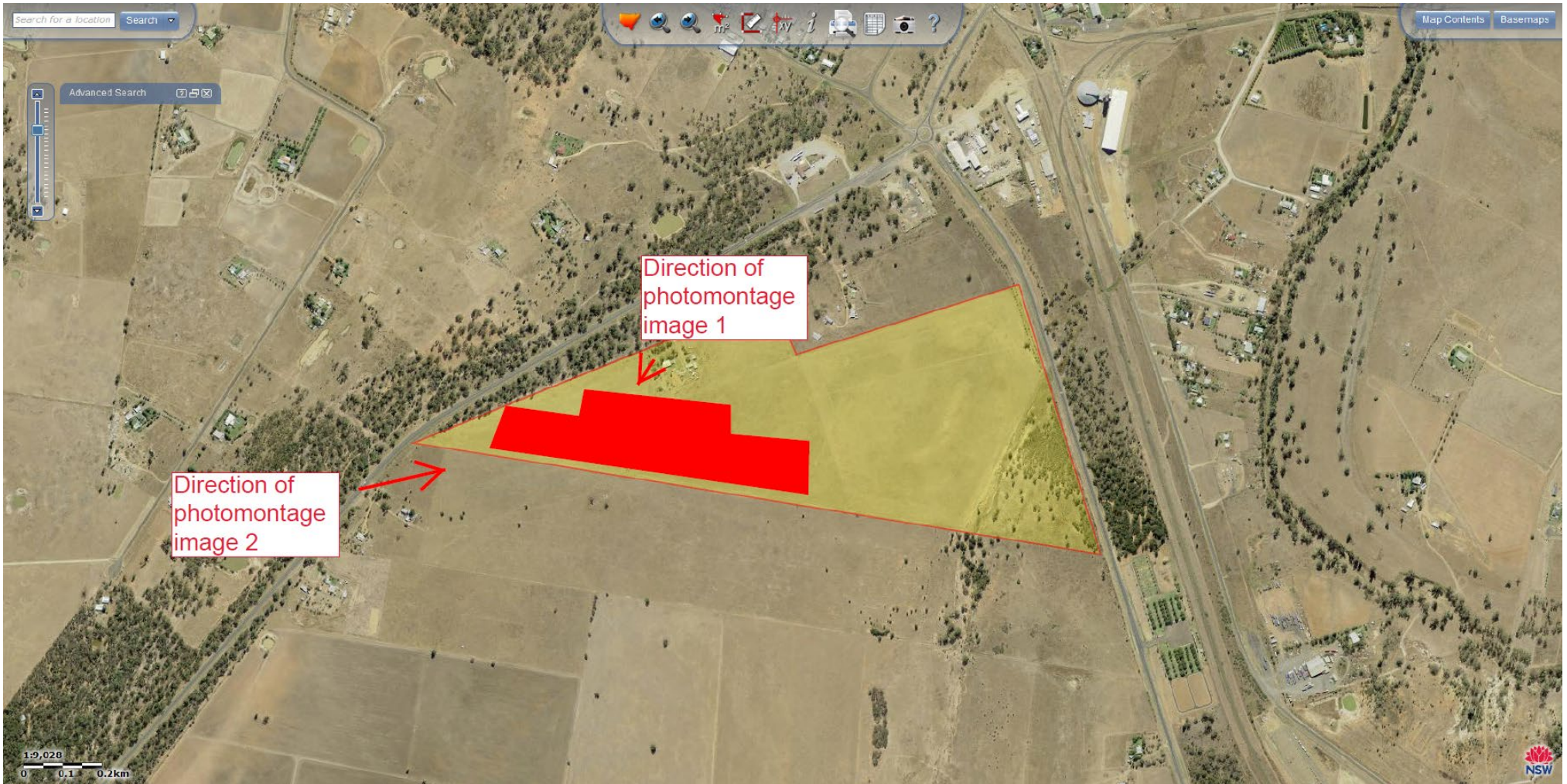
On balance and having regard to other matters for consideration under section 4.15 *Evaluation* of the *Environmental Planning and Assessment Act 1979*, the impacts are considered acceptable given that:

- the solar farm will contribute to renewable energy generation and provide a source of electricity for local domestic and commercial use whilst at the same time assisting to reduce greenhouse gas emissions and our reliance on fossil fuels,
- It will also generate employment opportunities during the construction phase and once operational will provide employment for maintenance crews,
- The placement of the array within the property downslope has been chosen to maximise distance separation from neighbouring dwellings,
- Existing vegetation along road reserves and property boundaries is to be maintained,

- The proposed landscaping surrounding all sides of the array will grow to a height that will screen the facility from observation points including public roads that are on level ground with the development site and elsewhere will soften the visual impact from land that is slightly elevated above the development site.
-

Attachment A

Photomontages



Relative location of photomontage images

Narrabri Solar Farm



Image 1a: Looking south from internal fenceline before development of solar farm



Image 1b: Looking south from internal fenceline after development and before landscaping



Image 1c: Looking south from internal fenceline after development and landscape planting



Image 1d: Looking south from internal fenceline after development with semi-mature landscaping



Image 1e: Looking south from internal fenceline after development with mature landscaping



Image 2a: Approaching north on the Newell Highway before development of solar farm



Image 2b: Approaching north on the Newell Highway after development without landscaping



Image 2c: Approaching north on the Newell Highway after development and landscape planting



Image 2d: Approaching north on the Newell Highway after development with semi-mature landscaping



Image 2e: Approaching north on the Newell Highway after development with mature landscaping



Glint and Glare Assessment

Narrabri 3A Solar Farm

March 2021

ENGINEERING | STRATEGY | ANALYTICS | CONSTRUCTION

DOCUMENT CONTROL

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ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au

Project No. Narrabri 3A – Glint and Glare Assessment March 2021

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ABBREVIATIONS

AC	Alternating current
CASA	Civil Aviation Safety Authority
DC	Direct current
FAA	Federal Aviation Administration (United States)
Ha	Hectare
ITP	ITP Renewables
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions used to indicate PV system capacity
NSW	New South Wales
OP	Observation point
PV	Photovoltaic
SGHAT	Solar Glare Hazard Analysis Tool

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1 INTRODUCTION

1.1 Overview

ITP Development is proposing to develop a solar farm as described in Table 1. It will be located approximately 3.5 km southwest of the town of Narrabri, NSW (see Figure 1).

Table 1. Site Information

Parameter	Description
Solar farm name	Narrabri 3A Solar Farm
Site reference	Narrabri 3A
Lot/DP(s)	102/579423
Street address	11498 Newell Hwy, Narrabri, NSW 2390
Council	Narrabri Shire Council
AC capacity	5 MW
DC capacity	6.4 MW
Project area	Approx. 11.32 ha
Current land use	Grazing, recently destocked

This report provides a desktop glint and glare assessment to support the Development Application for the project. It provides:

- Identification of potential receptors of glint and glare from the proposed solar farm; and
- Assessment of the glint and glare hazard using the Solar Glare Hazard Analysis Tool (SGHAT) GlareGauge analysis

1.2 Glint and Glare

Glint is defined as a momentary flash of bright light, while glare is a continuous source of excessive brightness relative to ambient lighting (Federal Aviation Administration [FAA], 2018). The GlareGauge analysis used to assess the glint and glare hazard (see Section 3) was run with a simulation interval of one minute, as sunlight reflection from PV modules typically lasts for at least one minute. Glint, which lasts for less than one minute, is unlikely to occur from the sun based on how slowly the sun and modules move, so has not been considered further in this assessment.

Solar photovoltaic (PV) modules are designed to absorb as much light as possible to maximise efficiency (generally around 98% of the light received). To limit reflection, the modules are constructed from dark, light-absorbing material and the glass is treated with an anti-reflective coating. As a result, the glare generated from PV modules is lower than from many other surfaces, including cropping/grassland and concrete (an albedo of 20% is typically assumed for PV modules, compared to 25-30% for grass and up to 25% for concrete; Ramírez & Muñoz, 2012).

However, the glass modules still have the potential to generate glare. This needs to be assessed to ensure that visual receptors—such as road users, nearby buildings, air traffic control towers and aircraft pilots—are not impacted by the development of solar farms.

2 PROJECT DESCRIPTION

ITP Development is proposing to construct a solar farm with a DC capacity of 6.4 MW_p and AC output of 5 MW, on an approximately 11.32 ha site that is currently used for grazing and has recently been destocked.

There are to be approximately 12,100 solar modules installed on around 140 mounting structures running north to south. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day. The hub height of each tracker will be around 1.5 m, with the peak of the modules reaching a height of approximately 2.75 m when the array is fully tilted to 60 degrees from horizontal. The general arrangement of the solar farm is shown on drawing NAR3A-G-210, and the array tracker details on drawing NAR3A -E-341.

The solar farm will also comprise two 3 MW inverter stations. These inverters are to be located within the array and are both mounted on a 12.19 m skid. Each of these inverter stations incorporate the high voltage switchgear and transformers. The arrangement of the inverter station skid is shown in drawing NAR3A -E-430.

The mounting system is constructed on piles that are driven into the ground. During construction, there is expected to be 50 personnel on site working from 7am – 4pm, Monday to Friday. The construction is expected to take approximately 3 months. Once operational, the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 – 3 people.

Solar panels and related infrastructure will be decommissioned and removed upon cessation of operations. This is likely to occur within two years of the end of the project. The site will be returned to the pre-development land use.



Figure 1 - Proposed 62 ha solar farm site and surrounding farm area (note the project will comprise 11.24 ha within this area)

3 ANALYSIS

3.1 Overview

In a fixed-tilt PV array, the angle of incidence at which direct sunlight hits the PV modules varies as the sun moves across the sky. It will be smallest around noon when the sun is overhead and largest in the early morning and late afternoon when the sun is near the horizon. If the PV array is mounted on a single-axis tracking system as proposed in this project, the variation in the angle of incidence will be much smaller since the modules rotate to follow the sun. The main variation will be seasonal, i.e. because the sun is higher in the sky during summer and lower during winter. A PV array that is mounted on a tracking system therefore has less potential to cause glare.

The SGHAT was developed by Sandia National Laboratories to evaluate glare resulting from solar farms at different viewpoints, based on the location, orientation and specifications of the PV modules. This tool is required by the United States FAA for glare hazard analysis near airports and is also recognised by the Australian Government Civil Aviation Safety Authority (CASA).

The GlareGauge analysis uses SGHAT to provide an indication of the type of glare that can be expected at each potential receptor. Glare is indicated by three colours according to severity:

- Green glare: Low potential for temporary after-image;
- Yellow glare: Potential for temporary after-image; and
- Red glare: Retinal burn, not expected for PV.

The parameters used in the SGHAT model for the project are detailed in Table 2. GlareGauge default settings were adopted for the analysis time interval, direct normal irradiance, observer eye characteristics and slope error. The heights of the observation points were assumed to be 1.5m for a road user (i.e. sitting in a car) and 1.65m for a person (i.e. standing).

Table 2. SGHAT specification inputs

Parameters	Input
Time zone	UTC+10:00
Module tracking	Single axis
Module surface material	Smooth glass with ARC (anti-reflective coating)
Tracking axis tilt	0°
Tracking axis orientation	0°
Module offset angle (angle between module and tracking axis)	0°
Maximum tracking angle	60°
Resting angle	30°
Height of modules above ground	1.78m (height from the ground to the PV panel centroid)

3.2 Potential Receptors

For this project, visual receptors within 2 km of the site were considered including residences and road users. There is no formal guidance on the maximum distance at which glint and glare should be assessed; however, the significance of a reflection decreases with distance. This is due to the proportion of the observer's field of vision taken up by the reflective area decreasing as distance increases. In addition, as the separation distance increases, terrain and shielding by vegetation and other structures are more likely to obstruct the view of the reflective area. A 2-km radius from the site was considered appropriate based on it being highly unlikely for glint and glare impacts at distances greater than this. This is a conservative distance based on existing studies and assessment experience.

As shown in Figure 2, 4 commercial points and 18 residential observation points were identified as potential visual receptors of the site. The potential for glare was also assessed along 19 different road routes.

While there was a greater number of residential/commercial properties considered, some were discounted based on large stands of trees and other structures acting as visual barriers.

The Narrabri Airport is located approximately 8 km north-east of the site so was not considered a potential visual receptor.



Figure 2. Map showing potential visual receptors within 2km of the site

3.3 Assumptions

The visual impact of solar farm development depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site. Some potential viewpoints were discounted because of significant existing features (such as trees or buildings), however, minor screening—such as roadside vegetation—was not assessed in detail. The GlareGauge analysis results are therefore considered conservative as the model assumes there is no screening. It is noted that the site is mostly cleared with only a few trees within the property.

Atmospheric conditions such as cloud cover, will also influence light reflection and the resulting impact on visual receptors. The same is true of varying tilt angles of the modules. Varying atmospheric conditions have not been accounted for in the GlareGauge analysis, nor have the complexities of backtracking (due to the software's limitations). The GlareGauge analysis assumes clear sky conditions, with a peak direct normal irradiance (DNI) of 1,000 W/m² which varies throughout the day.

3.4 Results

The results of the GlareGauge analysis (attached in Appendix A) at each of the observation points are summarised in Table 3. None of the residences, commercial properties or road users are expected to experience any glare from the solar farm. Many residences will also not have direct view of the solar farm due to visual obstructions from trees and other structures. The distances in the table below are provided as indication of the location of the receptor relative to the solar array, but are not direct inputs to the GlareGauge analysis, which utilises the PV array centroid for its calculations.

Table 3. Glare potential at observation points

	Type of Observation Point	Location relative to solar farm	Green glare (minutes)	Yellow glare (minutes)	Glare potential
OP1	Residential	0.14 km north-east	0	0	No glare
OP2	Residential	0.18 km north-east	0	0	No glare
OP3	Residential	0.49 km north-east	0	0	No glare
OP4	Residential	0.59 km north-east	0	0	No glare
OP5	Residential	0.63 km north-east	0	0	No glare
OP6	Residential	0.64 km south-west	0	0	No glare
OP7	Residential	0.97 km south-west	0	0	No glare
OP8	Residential	1.73 km south-west	0	0	No glare
OP9	Residential	1.54 km south-east	0	0	No glare
OP10	Residential	1.55 km south-east	0	0	No glare
OP11	Residential	1.53 km south-east	0	0	No glare
OP12	Commercial	1.83 km south-east	0	0	No glare
OP13	Residential	1.41 km east	0	0	No glare

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OP14	Residential	1.38 km east	0	0	No glare
OP15	Commercial	1.04 km north-east	0	0	No glare
OP16	Commercial	1.19 km north-east	0	0	No glare
OP17	Commercial	0.72 km north-east	0	0	No glare
OP18	Residential	1.55 km north-east	0	0	No glare
OP19	Residential	1.51 km north-east	0	0	No glare
OP20	Residential	1.48 km north-east	0	0	No glare
OP21	Residential	1.39 km north	0	0	No glare
OP22	Residential	1.40 km north-east	0	0	No glare
Avon Street	Road Route	North-east	0	0	No glare
Boheena Street	Road Route	North	0	0	No glare
Boundary Street	Road Route	West	0	0	No glare
Burigal Street	Road Route	North	0	0	No glare
Burt Street	Road Route	North	0	0	No glare
Fraser Street	Road Route	North-east	0	0	No glare
Goobar Street	Road Route	North	0	0	No glare
Gould Street	Road Route	North	0	0	No glare
Kamilaroi Highway	Road Route	West	0	0	No glare
Kelvin Vickery Avenue	Road Route	North	0	0	No glare
Mooloolbar Street	Road Route	North	0	0	No glare
Newell Highway	Road Route	North-west	0	0	No glare

Old Turrawan Road	Road Route	North-east	0	0	No glare
Railway Street North	Road Route	North-west	0	0	No glare
Railway Street South	Road Route	North	0	0	No glare
Sarnia Street	Road Route	North	0	0	No glare
Unnamed Road	Road Route	West	0	0	No glare
Wukawa Street	Road Route	North	0	0	No glare
Zimmerman Street	Road Route	North	0	0	No glare

4 SUMMARY

The results of the GlareGauge analysis indicated that the selected observation points are unlikely to receive glare due to the proposed solar farm.

Existing roadside vegetation and structures are expected to provide a physical obstruction between the solar farm and road users on the major road to the west of the site (Newell Highway), further minimising the visual impact of the project. Road users approaching the solar farm along the other roads surrounding the site are also not expected to experience any glare.

REFERENCES

- Federal Aviation Administration (FAA) (2018). Solar Guide: Technical Guidance for Evaluating Selected Solar Technologies on Airports. Retrieved from the FAA website: <https://www.faa.gov/airports/environmental/>
- Ramírez, A. Z., & Muñoz, C. B (2012). Albedo effect and energy efficiency of cities. Sustainable Development – Energy, Engineering and Technologies – Manufacturing and Environment. Retrieved from <https://www.intechopen.com/books/sustainable-development-energy-engineering-and-technologies-manufacturing-and-environment/albedo-effect-and-energy-efficiency-of-cities>

APPENDIX A. FORGESOLAR GLARE ANALYSIS

FORGESOLAR GLARE ANALYSIS

Project: **NAR3A**

Site configuration: **NAR3A**

Analysis conducted by ITP Engineering (engineering@itpau.com.au) at 03:34 on 23 Sep, 2020.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

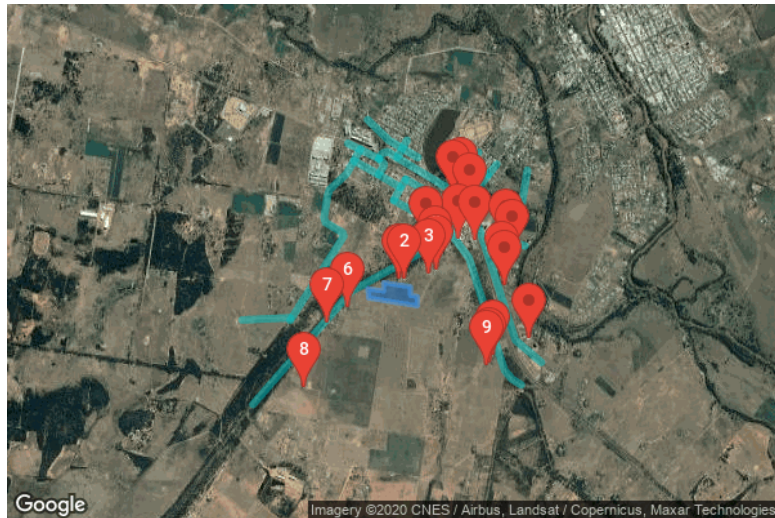
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m²
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 43262.7843



PV Array(s)

Name: PV array NAR3A - KMZ
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 30.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.354030	149.754500	216.78	1.78	218.56
2	-30.355010	149.754500	216.86	1.78	218.64
3	-30.355130	149.755400	216.00	1.78	217.78
4	-30.356210	149.755400	216.43	1.78	218.21
5	-30.355310	149.748900	216.39	1.78	218.17
6	-30.354240	149.748800	216.99	1.78	218.77
7	-30.354520	149.750900	215.53	1.78	217.31
8	-30.353540	149.750900	215.95	1.78	217.73

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-30.353173	149.753079	218.72	1.65
OP 2	2	-30.353247	149.753722	218.21	1.65
OP 3	3	-30.352532	149.757019	215.94	1.65
OP 4	4	-30.352074	149.757974	216.06	1.65
OP 5	5	-30.351148	149.757765	216.42	1.65
OP 6	6	-30.356492	149.746138	217.96	1.65
OP 7	7	-30.358253	149.743475	220.29	1.65
OP 8	8	-30.365571	149.740265	221.00	1.65
OP 9	9	-30.363083	149.764647	218.09	1.65
OP 10	10	-30.362759	149.765108	219.23	1.65
OP 11	11	-30.361944	149.765527	219.31	1.65
OP 12	12	-30.360056	149.770269	219.24	1.65
OP 13	13	-30.353969	149.767152	216.05	1.65
OP 14	14	-30.352941	149.766685	215.92	1.65
OP 15	15	-30.348599	149.760967	215.73	1.65
OP 16	16	-30.348729	149.763166	215.26	1.65
OP 17	17	-30.348821	149.756643	216.73	1.65
OP 18	18	-30.350312	149.768036	214.95	1.65
OP 19	19	-30.349155	149.767178	214.00	1.65
OP 20	20	-30.343240	149.761269	213.06	1.65
OP 21	21	-30.343531	149.760282	214.52	1.65
OP 22	22	-30.345022	149.762411	214.00	1.65

Route Receptor(s)

Name: Avon Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.348099	149.767619	212.25	1.50	213.75
2	-30.348913	149.768080	213.34	1.50	214.84
3	-30.349330	149.769765	215.58	1.50	217.08

Name: Boheena Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.339753	149.762667	214.09	1.50	215.59
2	-30.341179	149.764791	214.79	1.50	216.29

Name: Boundary Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.338211	149.747813	217.78	1.50	219.28
2	-30.341035	149.745973	216.62	1.50	218.12
3	-30.342880	149.743677	219.06	1.50	220.56
4	-30.343674	149.743409	219.47	1.50	220.97
5	-30.346072	149.742961	218.67	1.50	220.17
6	-30.346632	149.743135	219.00	1.50	220.50
7	-30.347803	149.745438	215.28	1.50	216.78
8	-30.348233	149.745580	215.77	1.50	217.27
9	-30.357885	149.738434	218.73	1.50	220.23

Name: Burigal Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.339144	149.752741	213.85	1.50	215.35
2	-30.337200	149.754007	215.75	1.50	217.25

Name: Burt St

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.339340	149.750317	215.19	1.50	216.69
2	-30.339877	149.750918	214.69	1.50	216.19
3	-30.340211	149.750896	214.83	1.50	216.33
4	-30.341100	149.750253	213.54	1.50	215.04

Name: Fraser Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.348099	149.767587	212.25	1.50	213.75
2	-30.345136	149.769239	214.22	1.50	215.72
3	-30.340654	149.770076	214.23	1.50	215.73

Name: Goobar Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.339181	149.755487	215.37	1.50	216.87
2	-30.337218	149.751604	214.00	1.50	215.50
3	-30.334848	149.748771	214.30	1.50	215.80

Name: Gould St

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.339525	149.746948	216.80	1.50	218.30
2	-30.342600	149.753107	214.75	1.50	216.25

Name: Kamilaroi Highway
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.348165	149.760094	217.41	1.50	218.91
2	-30.350728	149.762307	214.28	1.50	215.78
3	-30.363564	149.767006	221.05	1.50	222.55
4	-30.364619	149.768014	226.10	1.50	227.60
5	-30.365285	149.769259	227.12	1.50	228.62

Name: Kelvin Vickery Avenue
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.347933	149.759758	216.55	1.50	218.05
2	-30.346988	149.758235	216.00	1.50	217.50
3	-30.344100	149.752227	213.79	1.50	215.29

Name: Moolooloob Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.344266	149.762441	214.34	1.50	215.84
2	-30.338507	149.751390	214.27	1.50	215.77
3	-30.338711	149.750703	214.00	1.50	215.50
4	-30.339285	149.750296	215.17	1.50	216.67

Name: Newell Highway

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.367516	149.733479	224.17	1.50	225.67
2	-30.354518	149.746632	219.68	1.50	221.18
3	-30.348222	149.759765	217.17	1.50	218.67
4	-30.344889	149.761524	214.93	1.50	216.43
5	-30.339945	149.765987	213.86	1.50	215.36

Name: Old Turrawan Road

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.362708	149.771946	222.80	1.50	224.30
2	-30.360153	149.768492	218.06	1.50	219.56
3	-30.344377	149.762548	214.41	1.50	215.91

Name: Railway Street North

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.339340	149.750317	215.19	1.50	216.69
2	-30.337562	149.746154	216.36	1.50	217.86

Name: Railway Street South

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.341674	149.753879	214.15	1.50	215.65
2	-30.344581	149.759651	215.20	1.50	216.70

Name: Sarnia Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.344637	149.759673	215.09	1.50	216.59
2	-30.345062	149.759673	214.74	1.50	216.24
3	-30.346933	149.758321	216.00	1.50	217.50

Name: Unnamed Road

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.357634	149.738497	218.01	1.50	219.51
2	-30.357578	149.738347	217.86	1.50	219.36
3	-30.357838	149.732017	220.76	1.50	222.26

Name: Wukawa Street

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.342124	149.760521	212.55	1.50	214.05
2	-30.338587	149.763568	213.01	1.50	214.51

Name: Zimmerman Street
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.344062	149.752291	213.99	1.50	215.49
2	-30.341711	149.753793	214.08	1.50	215.58

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array NAR3A - KMZ	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
Avon Street	0	0
Boheena Street	0	0
Boundary Street	0	0
Burigal Street	0	0
Burt St	0	0
Fraser Street	0	0
Goobar Street	0	0
Gould St	0	0
Kamilaroi Highway	0	0
Kelvin Vickery Avenue	0	0
Mooloobar Street	0	0
Newell Highway	0	0
Old Turrawan Road	0	0
Railway Street North	0	0
Railway Street South	0	0
Sarnia Street	0	0
Unnamed Road	0	0
Wukawa Street	0	0
Zimmerman Street	0	0

Results for: PV array NAR3A - KMZ

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
Avon Street	0	0
Boheena Street	0	0
Boundary Street	0	0
Burigal Street	0	0
Burt St	0	0
Fraser Street	0	0
Goobar Street	0	0
Gould St	0	0
Kamilaroi Highway	0	0
Kelvin Vickery Avenue	0	0
Mooloobar Street	0	0
Newell Highway	0	0
Old Turrawan Road	0	0
Railway Street North	0	0
Railway Street South	0	0
Sarnia Street	0	0
Unnamed Road	0	0
Wukawa Street	0	0
Zimmerman Street	0	0

Point Receptor: OP 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare

0 minutes of green glare

Route: Avon Street

0 minutes of yellow glare

0 minutes of green glare

Route: Boheena Street

0 minutes of yellow glare

0 minutes of green glare

Route: Boundary Street

0 minutes of yellow glare

0 minutes of green glare

Route: Burigal Street

0 minutes of yellow glare

0 minutes of green glare

Route: Burt St

0 minutes of yellow glare

0 minutes of green glare

Route: Fraser Street

0 minutes of yellow glare

0 minutes of green glare

Route: Goobar Street

0 minutes of yellow glare

0 minutes of green glare

Route: Gould St

0 minutes of yellow glare

0 minutes of green glare

Route: Kamilaroi Highway

0 minutes of yellow glare

0 minutes of green glare

Route: Kelvin Vickery Avenue

0 minutes of yellow glare

0 minutes of green glare

Route: Mooloolbar Street

0 minutes of yellow glare

0 minutes of green glare

Route: Newell Highway

0 minutes of yellow glare

0 minutes of green glare

Route: Old Turrawan Road

0 minutes of yellow glare

0 minutes of green glare

Route: Railway Street North

0 minutes of yellow glare

0 minutes of green glare

Route: Railway Street South

0 minutes of yellow glare

0 minutes of green glare

Route: Sarnia Street

0 minutes of yellow glare

0 minutes of green glare

Route: Unnamed Road

0 minutes of yellow glare

0 minutes of green glare

Route: Wukawa Street

0 minutes of yellow glare

0 minutes of green glare

Route: Zimmerman Street

0 minutes of yellow glare

0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.

Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.



ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au



REPORT

Narrabri 3A Solar Farm

Water Assessment

Submitted to:

Mishka Talent

ITP Development Pty Ltd
Level 1, 19 Moore Street, Turner ACT
PO Box 6127, O'Connor, ACT, 2602

Submitted by:

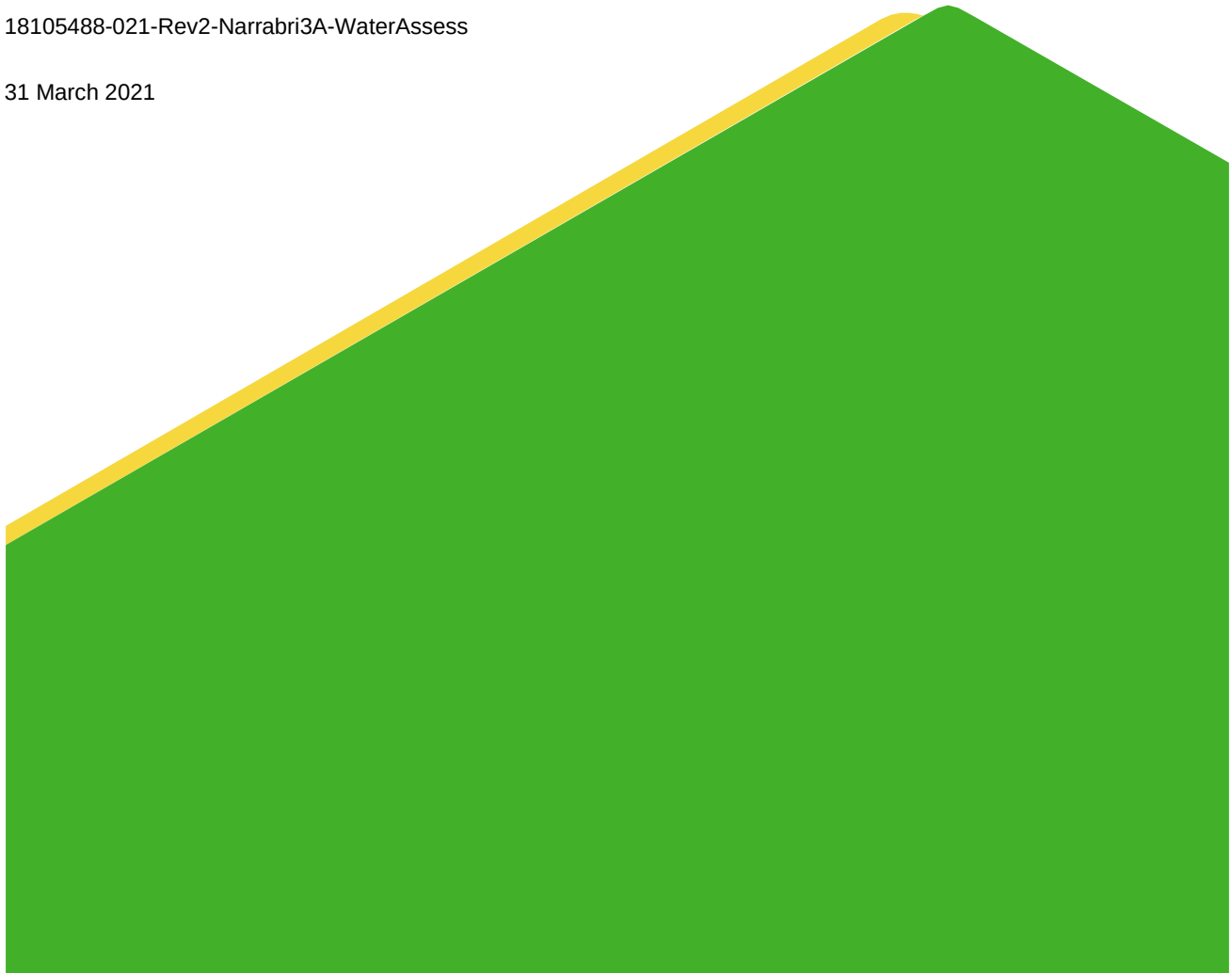
Golder Associates Pty Ltd

147 Coronation Drive, Milton, Queensland 4064, Australia

+61 7 3721 5400

18105488-021-Rev2-Narrabri3A-WaterAssess

31 March 2021



Distribution List

ITP Development Pty Ltd

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APPENDICES

APPENDIX A

Important Information Relating to this Report

APPENDIX B

Proposed Layout

APPENDIX C

Mudgee LEP Maps

APPENDIX D

Provisional Hydraulic Hazard Mapping

APPENDIX E

Narrabri Flood Study 2016 - Predicted Flood Extents

1.0 INTRODUCTION

The proposed Narrabri 3A Solar Farm is located at 11498 Newell Hwy, 4.5 km south-west of the town of Narrabri in NSW, within the Narrabri Shire Council local government area (LGA). The Project site is within Lot 102 / DP 579423. ITP Development Pty Ltd (ITP Development) propose to construct a 5 MW solar facility within the site that has recently been used for grazing and recently destocked.

This report, which provides a desktop water assessment to support the Development Application for the project, includes a:

- Desktop review of local hydrology and catchment and water quality data.
- Desktop review of surface and groundwater quality data.
- Desktop review of the flood risk potential against the published references, Local Environmental Plan and Land-use Plan.
- Desktop impact assessment against New South Wales (NSW) policies and referenced industry standards for solar arrays.
- Desktop management assessment with mitigation measures recommend for construction and operation.

1.1 Limitations of assessment

The assessment is based on publicly available information and data and does not include a site inspection, sampling, or any additional hydrological and/or hydraulic modelling.

1.2 Important information relating to this report

Your attention is drawn to the document titled - "Important Information Relating to this Report", which is included in Appendix A of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

2.0 PROJECT DESCRIPTION

The proposed Narrabri 3A Solar Farm is located at 11498 Newell Hwy, approximately 4.5 km south-west of the town of Narrabri in NSW (Figure 2).

Narrabri is located on the western side of the Great Dividing Range within the Namoi Valley, approximately 521 km north-west of Sydney in the North West slopes and plains of NSW. The Project area is within the Narrabri Shire Council area.

The town of Narrabri is located within the floodplain and on the banks of the Namoi River, a major perennial river which forms part of the Barwon catchment of the Murray-Darling Basin and is significant in the region.

The Namoi River divides into two branches, the Namoi River and Narrabri Creek, the approximately 2.5 km upstream of Narrabri's town centre before re-joining approximately 10 km downstream of Narrabri. All flow is carried by Narrabri Creek under normal flow conditions, as a large sand and gravel bar in the Namoi River at its offtake from Narrabri Creek prevents flow entering into the Namoi River until low-level flooding from Narrabri Creek starts to occur (Ribbons, Bewsher & Booby, 1995).

The topography of Narrabri is relatively flat being located within a floodplain, with slight hills rising in the north-east of the town which form part of the Nandewar Range further east. The area south-east of Narrabri is characterised by river valleys with broad floodplains bounded by low hills. West of Narrabri there is low topographic relief, with the land forming an extensive alluvial plain (Australian Government, 2018).

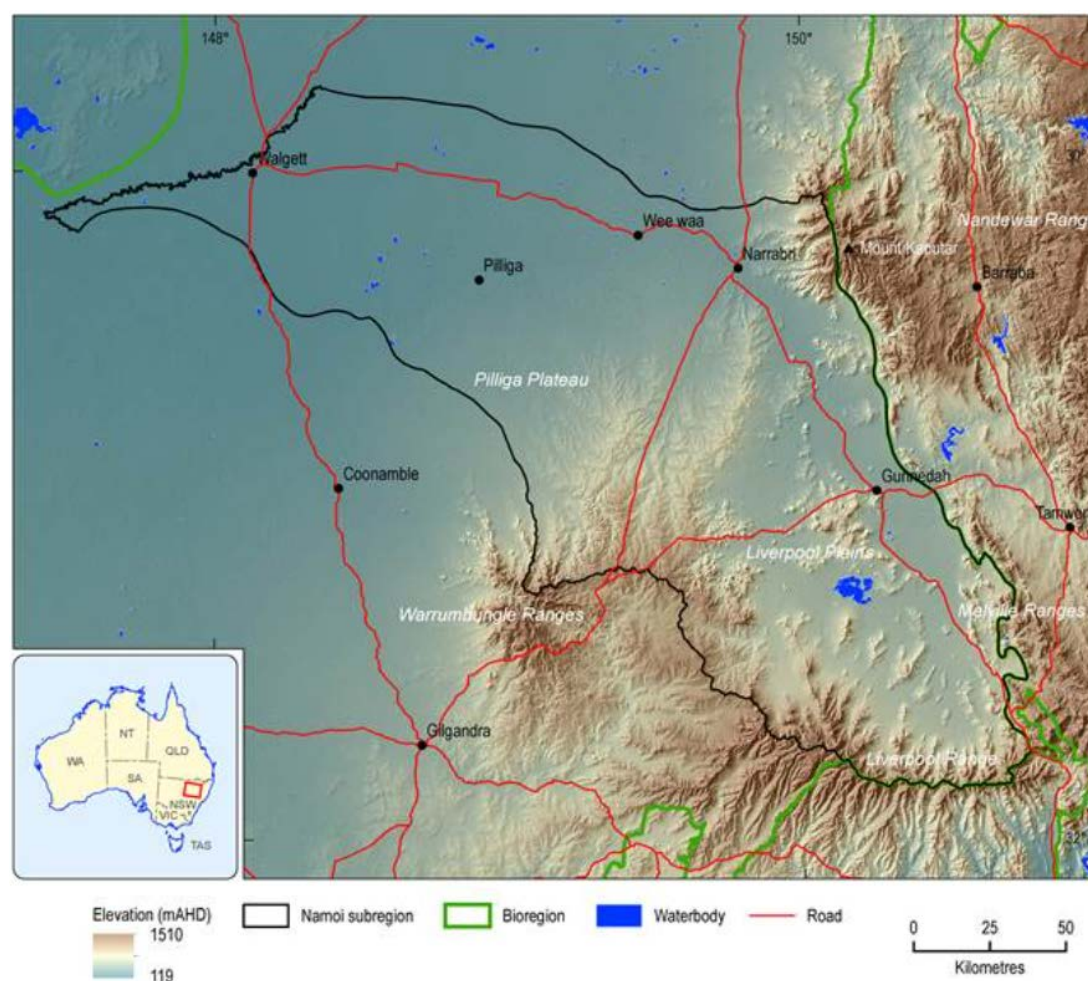


Figure 1: Digital elevation model of Namoi sub-catchment (Australian Government, 2018)

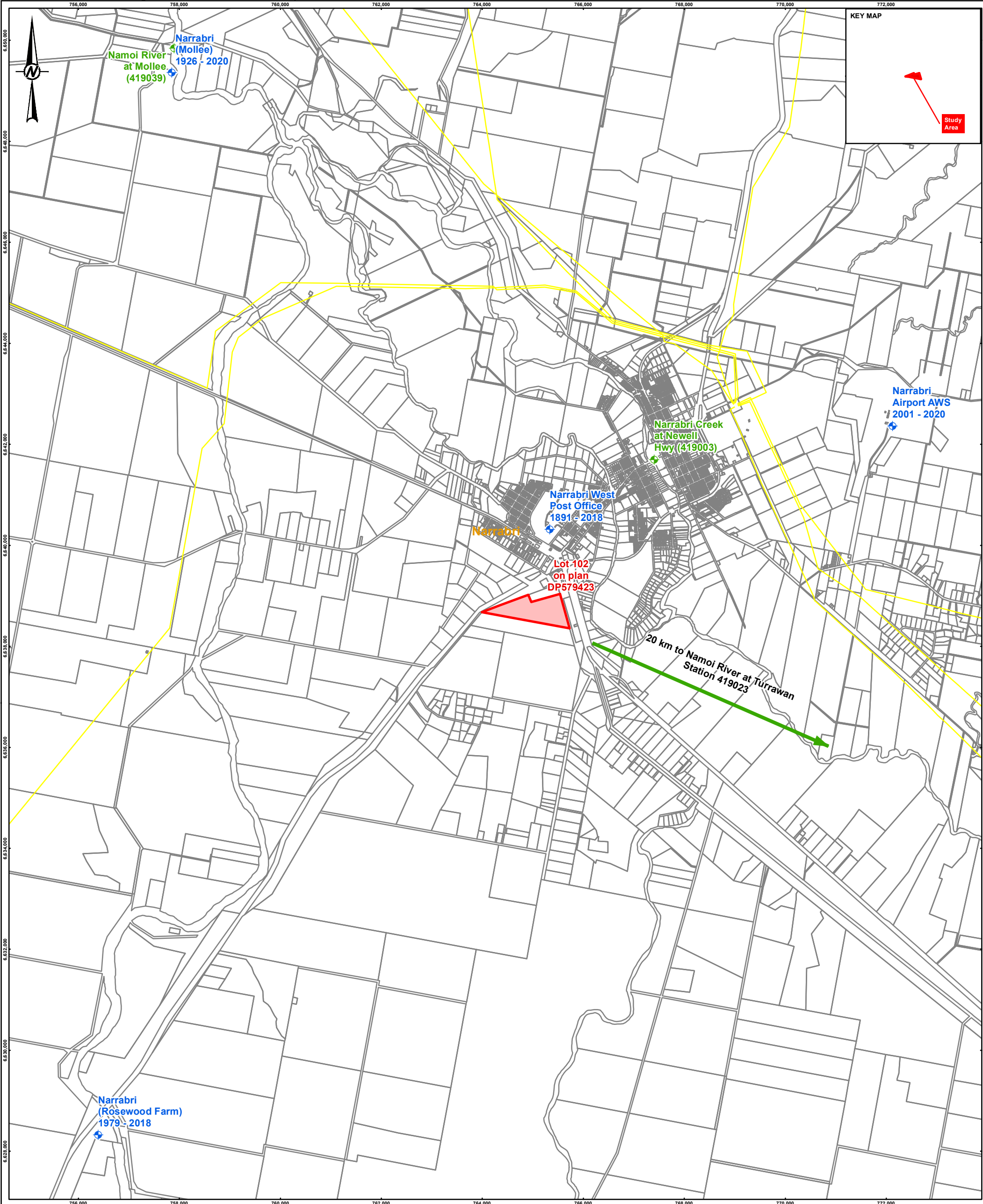
The proposed facility is located 1.2 km west of the Namoi River. The Project area is relatively flat, with the land gently sloping towards the south and west by 2 and 3 metres, respectively, ranging between 219 mAHD in the west and 215 m AHD in the south. A 2nd order drainage line flows through Lot 102 / DP579423 directly east of the Project area outside of the proposed Project footprint to Narrabri Lake located 1.5 km to the north. The land is mostly cleared of native vegetation and has historically been used for grazing, though was recently destocked (Figure 3).

ITP Development propose to construct a solar farm on the parcel of land (Lot 102 / DP 579423). The land has recently been used for grazing. The system will have a DC array capacity of 6.4 MW_{DC} and an AC output of 5 MW_{AC}. Details are contained on the layout provided by ITP Development and attached in Appendix B.

Approximately 12,100 solar modules will be installed in 140 rows (each row being ~103 m long and ~2 m wide) running north-south across the site. Each row of PV modules will rotate to track the sun across the sky from east to west each day. There is approximately 6.25 m spacing between each row. The hub height of each tracker is 1.53 m with the peak of the modules reaching a height of approximately 2.75 m when the array is fully tilted to 60 degrees from horizontal.

The solar farm will also contain two 3 MW inverter stations, located within the arrays and mounted on a 12.19 m skid. The inverter stations will incorporate High/Medium voltage switchgear and transformers.

The mounting system will be constructed on piles that are driven into the ground. Trenching requirements for low voltage cabling is around 600 mm and, for high voltage, is around 1,200 mm. During construction, which is expected to take approximately 3 months, there is expected to be around 50 personnel on site working from 7 am – 4 pm Monday to Friday. Once operational the site will be unmanned with maintenance expected to be carried out quarterly by a crew of 2 – 3 people.



LEGEND

- BOM Stations
- Streamflow Locations
- Electricity Transmission Line
- Cadastre
- Lot 102 DP579423
- Denotes distance to streamflow station from site

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

CLIENT
ITP DEVELOPMENT PTY LTD

0 1 2 3
Kilometers
1:70,000 @A3

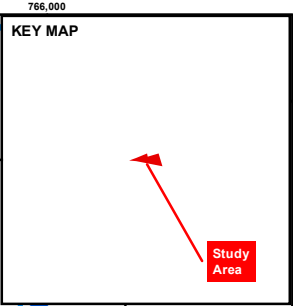
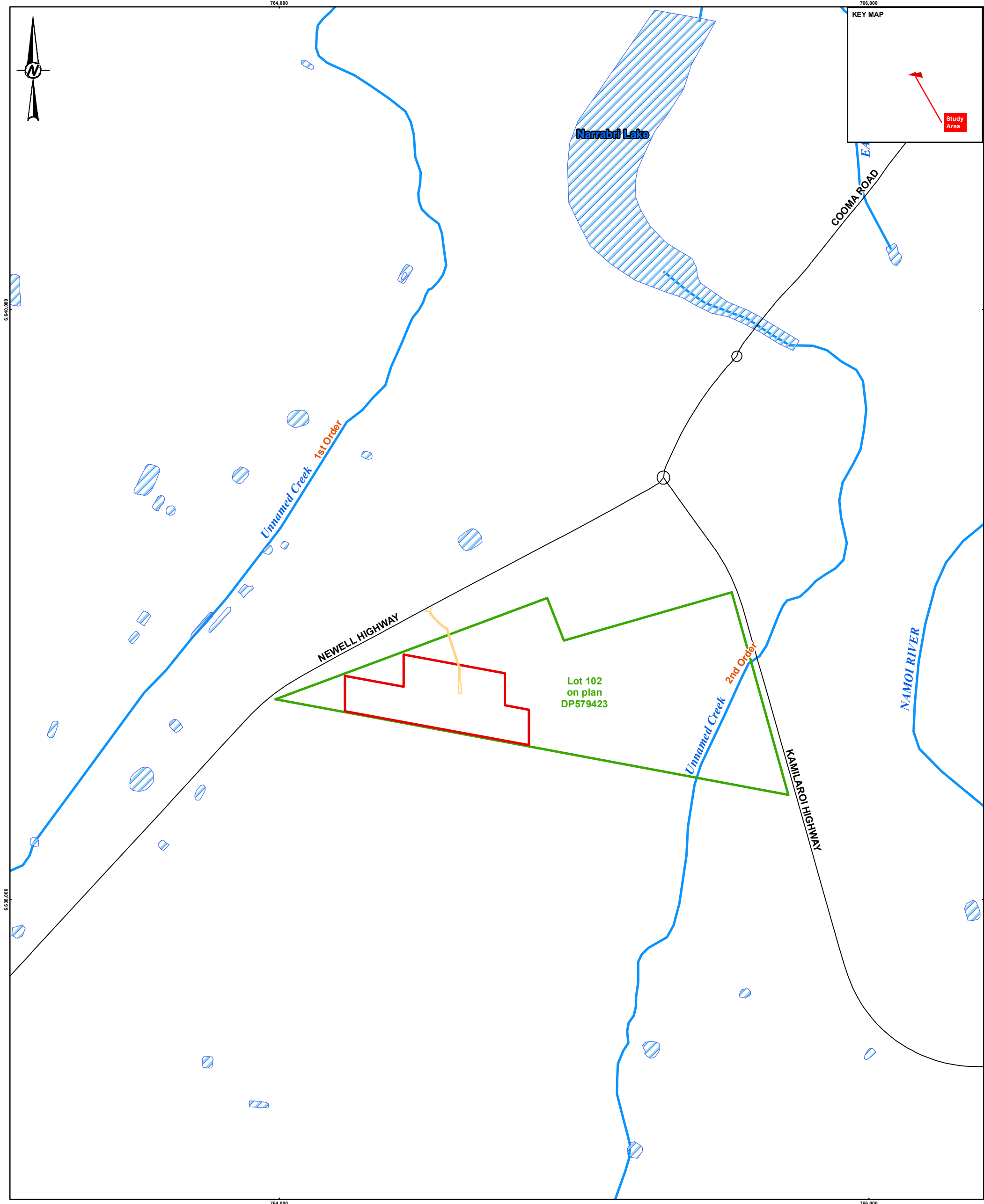
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Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

REFERENCE(S)
Electricity Transmission Lines, Cadastre: © State of NSW (Spatial Services - Department of Finance, Services and Innovation) 2018
Rainfall Stations: WaterNSW 2018

PROJECT
NARRABRI 3A SOLAR FARM

CONSULTANT	DD/MM/YYYY	01/10/2020
	DESIGNED	HPB
	PREPARED	HPB
	REVIEWED	SB
	APPROVED	SB

TITLE PROJECT LOCATION			
PROJECT NO. 18105488	CONTROL 021	REV. A	FIGURE 2



LEGEND

- 10 m surface elevation contours

Roads

electricitytransmissionline

Hydroline

Hydroareas (i.e. dams, lakes, etc.)

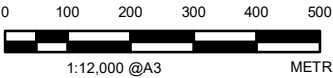
Cadastre
- Vehicle Access Path

Solar Farm Extent

Lot 102 DP579423

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

CLIENT
ITP DEVELOPMENT PTY LTD



NOTE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

REFERENCE(S)
Electricity Transmission Lines, Cadastre: © State of NSW (Spatial Services - Department of Finance, Services and Innovation) 2018
Rainfall Stations: WaterNSW 2018

PROJECT
NARRABRI 3A SOLAR FARM

CONSULTANT	DD/MM/YYYY	01/10/2020
	DESIGNED	SD
	PREPARED	SD
	REVIEWED	JR
	APPROVED	JR

TITLE PROJECT AREA			
PROJECT NO.	CONTROL	REV.	FIGURE
18105488	021	1	3



Figure 4: Project area elevation

3.0 LEGISLATIVE CONTEXT

NSW has a comprehensive legislative and policy framework for the management of floodplain risk and flood prone areas of the state with clear areas of responsibility as outlined below in Figure 5.

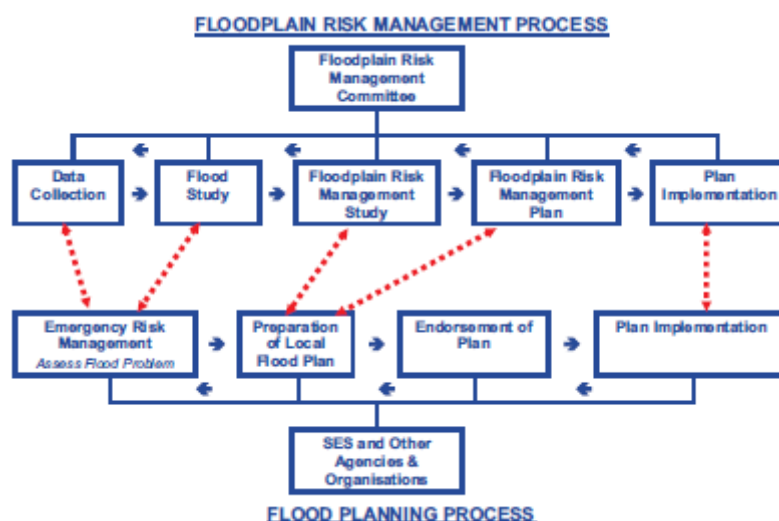


Figure 5: Floodplain risk management and planning process

3.1 Local Government Act 1993

This Act provides a legal framework for the NSW system of local government. The Floodplain Management Manual was gazetted in 2005 as the manual relating to the development of flood-liable land for the purposes of section 733. This section exempts councils from liability in relation to flood prone land provided they have undertaken assessments substantially in accordance with the latest manual.

The Floodplain Development Manual (NSW Government, 2005) is the approved Section 733 manual for flood prone land. The manual supports the NSW Government's Flood Prone Land Policy in providing for the development of sustainable strategies for the management of floodplains specifically in relation to human occupation. It provides a framework for councils to implement the policy and a process for managing floodplain risk.

3.2 Environmental Planning and Assessment Act 1979

This is an Act to institute an environmental planning system and assessment arrangements for NSW. In 2017 there were major amendments passed with a view to improving the planning system through simpler processes, improved strategic planning and community participation in order to enable more balanced and transparent decision making. Clause 3.43 makes provision for the preparation of development control plans by relevant authorities (outlined further in Section 3.4.1).

3.3 Water Management Act 2000

The Act provides for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations. Water management principles intended to guide decision making under the Act in relation to floodplain management require the existing and future risk to human life and property arising from occupation of the floodplain to be minimised.

3.3.1 Surface water sharing plan

The *Water Management Act 2000* applies to areas of NSW that have a water sharing plan. The Project area is located within the Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012 area. The water sources for the area are listed as being the Upper Namoi and Maules Creek Water Sources.

Water sharing plans relate to the protection of surface water resources. The Namoi and Peel Unregulated Rivers Water Sources 2012 covers 31 unregulated surface water sources. As this plan relates to licencing and use of water resources under the *Water Management Act 2000*, it is not relevant for the Project (as no water extraction is proposed).

3.3.2 Groundwater sharing plan

The relevant groundwater sharing plan for the Project area is the Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources 2020 under the *Water Management Act 2000*. The site is within the Southern Recharge Groundwater Source area.

As this plan relates to licencing and use of water resources under the *Water Management Act 2000*, it is not relevant for the Project (as no water extraction is proposed).

3.3.3 Controlled activity approvals

Controlled activity approvals are a requirement of the *Water Management Act 2000* for activities that are defined as a controlled activity under the *Water Management Act 2000* (such as, earth works), and are carried out on waterfront land, which is the bed of any river, lake or estuary, and the land within 40 m of the riverbanks, lake shore or estuary mean high water mark.

A 2nd order drainage line flows through Lot 102 / DP579423 directly east of the Project area outside of the proposed Project footprint. This drainage line flows to Narrabri Lake located 1.5 km to the north. As shown in Figure 3, the proposed project footprint is approximately 500 m away from this drainage line. Given the setback to this watercourse is greater than 40 m, from the high water mark of the watercourse, a controlled activity approval is not required.

3.4 Narrabri Local Environmental Plan 2012

The Narrabri Local Environmental Plan 2012 (hereby referred to as the Plan) makes local environmental planning provisions for land in Narrabri in accordance with the relevant standard environmental planning instrument. The regional area covered by the Plan includes towns of Narrabri, Boggabri, Wee Waa and Bellata. It is noted that the Plan pre-dates the Narrabri Flood Study (Section 4.1).

The Plan details prohibited and permitted types of development within the local area. Some types of development are also regulated by particular state environmental planning policies.

The Plan (Part 6.2) provides specific management requirements for flood planning which applies to land at or below the flood planning level (1 in 100 ARI plus 0.5 m freeboard). It requires that development consent cannot be granted unless the proposed development is compatible with the flood hazard of the land, will not cause significantly adverse impacts to other developments, the environment and the community and incorporates measures to manage risk to life.

According to the flood planning map accompanying the Plan, the site is not considered to be within a mapped flood planning area (see Figure 6 with the Project area marked in red and Appendix C for the full Flood Planning Map - Sheet FLD_004B from the Local Environmental Plan). The closest flood planning area is located approximately 600 m to the north of the Project area, which is indicated by blue shading to the south of Narrabri Lake.

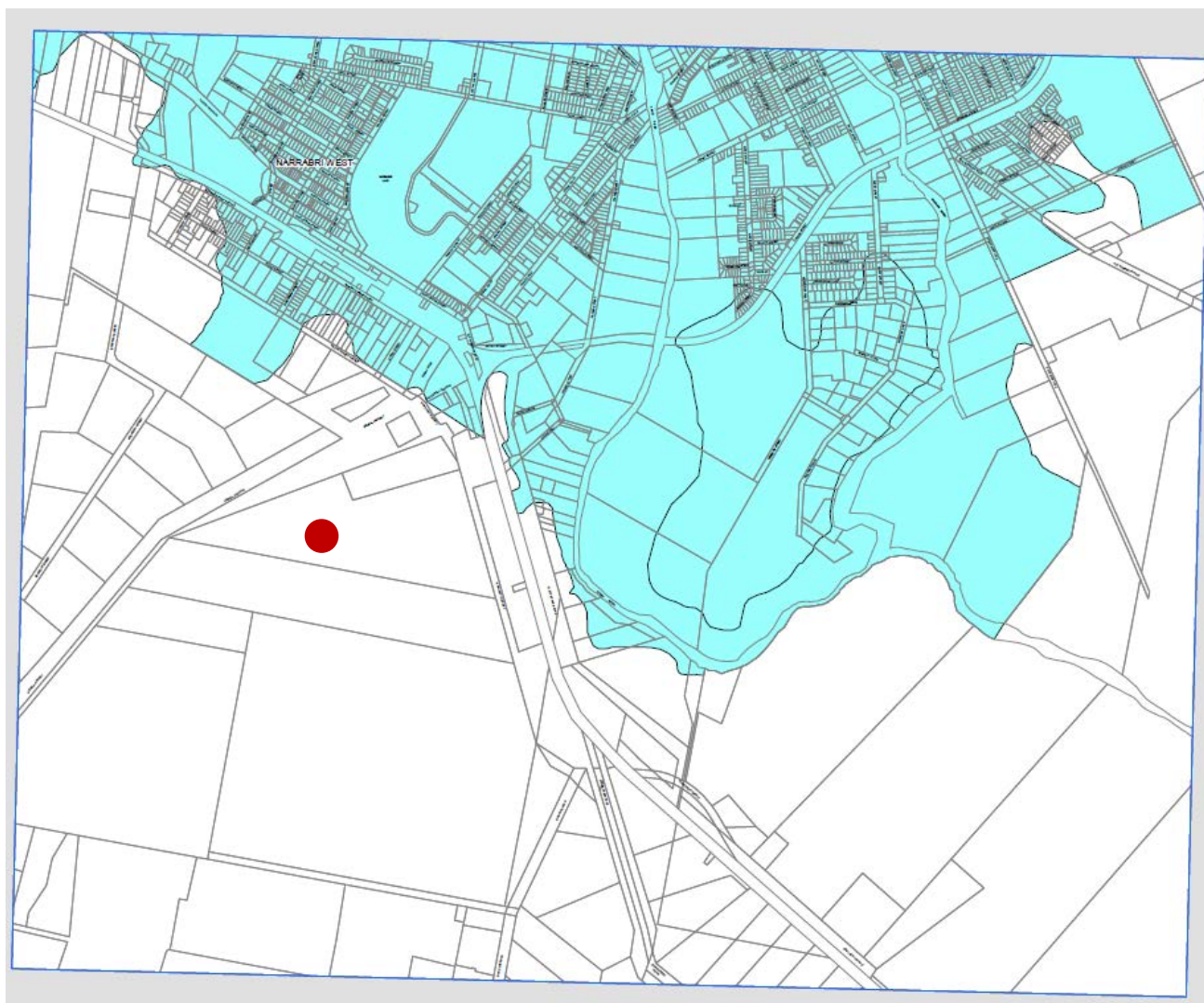


Figure 6: Flood planning area

The Plan provides additional provisions for earthworks to ensure that earthworks for which development consent is required will not have a detrimental impact on environmental functions and processes, neighbouring uses, cultural or heritage items or features of the surrounding land.

Additionally, provisions for essential services require that the consent authority is satisfied that services such as the supply of water, electricity, stormwater drainage or on-site conservation, are available or that adequate arrangements have been made to make them available when required.

3.4.1 Narrabri Development Control Plan 2000

The Narrabri Development Control Plan 2000 (DCP) provides guidance for developments and supports the statutory planning controls of the Local Environmental Plan. The guidance provides proponents assistance with criteria to address in development applications, however this relates mostly to housing developments.

The DCP does not contain schedules relating to flood or stormwater management in relation to new developments.

3.4.2 Narrabri Shire Community Strategic Plan 2027

The Narrabri Shire Community Strategic Plan is planned and executed under four key themes with a defined strategic direction:

- Theme 1: Our Society, Strategic Direction 1: Safe, Inclusive and Connected Community
- Theme 2: Our Environment, Strategic Direction 2: Environmentally Sustainable and Productive Shire
- Theme 3: Our Economic, Strategic Direction 3: Progressive and Diverse Economy
- Theme 4: Our Civic Leadership, Strategic Direction 4: Collaborative and Proactive Leadership.

The themes do not contain specific flood or water management aspects. However, within the 'Our Environment' theme, one strategy includes the conservation and management of natural water resources for environmental and agricultural sustainability to meet an objective of reducing and managing natural resource consumption (keeping water supplies resourced and waterways clean).

3.4.3 Narrabri Shire 2040 Local Strategic Planning Statement

The purpose of the Local Strategic Planning Statement (LSPS) is to outline the Narrabri Local Government Area's (LGA) economic, social and environmental land use needs over the next 20 years

The LSPS gives effect to the New England North West Regional Plan 2036 (NENWRP), implementing the directions and actions at a local level. It is also informed by other state-wide and regional policies including Future Transport Plan 2056 and the State Infrastructure Strategy. The LSPS outlines how these plans will result in changes at the local level, such as new or improved transport connections.

The LSPS works with Council's Community Strategic Plan, which has a similar but broader purpose on how Council will work to meet on the community's needs. The LSPS has been derived from the community strategic visioning process that was conducted as part of the Community Strategic Plan.

The LSPS identifies the following actions that council will undertake to ensure that developments are not located in areas identified as high flooding risk:

- Complete Flood Studies for Wee Waa, Narrabri, Boggabri
- Complete Flood Risk Management Plans for Wee Waa, Narrabri, Boggabri
- Amend the LEP zones to restrict development in high flood-risk constrained areas.

3.5 State Environmental Planning Policy (Infrastructure) 2007

Division 4 of the State Environmental Planning Policy (Infrastructure) 2007 relates to 'Electricity generating works or solar energy systems'. The policy relates to the approval process for solar energy systems, and there are specific details required for flood liable land which means land that is susceptible to flooding by a probable maximum flood event. The policy states consultation with the relevant council is required if the proposal will alter flood patterns other than to a minor extent and their response must be taken into consideration.

The Project area is not in an area mapped as being within the flood planning area under the Local Environmental Plan.

3.6 Protection of the Environment Operations (POEO) Act 1997

The POEO Act aims to protect and restore and enhance the quality of the environment in NSW, while still having regard to ecologically sustainable development.

With relevance to the site, the Act aims to reduce risks to human health and to prevent degradation of the environment by promoting pollution prevention and the reduction in the use of materials and the re-use, recovery or recycling of materials. The Act contains the requirements for the management of water discharges and also the offences that relate to pollution. Section 148 requires that any pollution incidents or those that threaten material harm to the environment must be notified to the relevant authority (e.g., NSW Environment Protection Authority).

3.7 Soil Conservation Act 1938

This Act makes provision for the conservation of soil resources and for the mitigation of erosion. The act allows the Minister for Primary Industries¹ to issue soil conservation notices, declare areas to be sites of erosion hazard, proclaim works in catchment areas and outlines specific regulations regarding the Rural Assistance Act 1989.

Of general relevance to this Project is the promotion of sustainable use and prevention of loss of soil resources from a site.

¹ Except Parts 2A, 3 and 4, and sections 15 and 30A in so far as they relate to Parts 2A, 3 and 4, jointly with the Minister for the Environment

4.0 CATCHMENT AND FLOOD HISTORY

The Project site is located in the Narrabri Shire Council LGA, 4.5 km south-west of the town of Narrabri. The proposed facility is located 1.2 km west of the Namoi River (Figure 3). The township of Narrabri is located on the Namoi River floodplain and is drained by a number of smaller tributaries including Mulgate Creek, Horsearm Creek and Long Gully. Narrabri has experienced above floor flooding from each of these sources on a regular basis in the past (WRM Water and Environment, 2016).

The proposed facility is located 1.2 km west of the Namoi River. The Project area is relatively flat, with the land gently sloping towards the south and west by 2 and 3 metres, respectively, ranging between 219 mAHD in the west and 215 mAHD in the south (Figure 4).

A 2nd order drainage line flows through Lot 102 / DP579423 directly east of the Project area outside of the proposed Project footprint. This drainage line subsequently flows to Narrabri Lake located 1.5 km to the north. The land is mostly cleared of native vegetation and has historically been used for grazing, though was recently destocked (Figure 3).

4.1 Narrabri Flood Study 2016

The Narrabri Flood Study: Namoi River, Mulgate Creek and Long Gully (WRM Water and Environment, 2016) aimed to:

- Determine the flood behaviour including design flood levels over the full range of flooding up to and including the Probable Maximum Flood (PMF) from both the Namoi River and the local tributaries;
- Provide a model that can establish the effects on flood behaviour of future development;
- Assess the sensitivity of flood behaviour to potential climate change effects such as increases in rainfall intensities; and
- Assess the provisional hydraulic categories and undertake mapping of provisional hazard, preliminary emergency response planning classifications, and preliminary flood planning extent areas.

This study was commissioned by Narrabri Shire Council, with funding assistance administered by the NSW Office of Environment and Heritage (OEH), to define the flood behaviour at Narrabri.

The study identified three catchments for the flood study, that were further divided into 69 sub-catchments. The Project site is located within the Long Gully catchment, with the subject land parcel straddling both the Narrabri and Long Gully catchments.

The study assessed the Annual Exceedance Probability and the Probable Maximum Flood (PMF) extent for Long Gully catchment (at the Narrabri Walgett Railway). The PMF is described as the limiting value of floods that could reasonably be expected to occur. The PMF discharge estimate for Long Gully was calculated to be 480 m³/s.

The report notes that the 1955 flood was the highest on record, marginally higher than the 1910 flood. The hydraulic model was calibrated to the recorded water level data for three Namoi River flood events including the 1955, 1971 and 1998 floods. However, the two largest flooding events that occurred within the last 20 years were in December 2004 and February 2012.

Figure 7 shows the predicted February 2012 flood extents for Mulgate Creek and Long Gully catchments as derived by the model. The recorded Narrabri Creek at Narrabri (GS419003) gauge flows were used to represent the Namoi River/Narrabri Creek flow that occurred during the event. The peak Namoi River flow during the event was approximately 1,500 m³/s, which had an AEP of between 10% and 20%.

Some minor flooding at the east of the subject lot associated with the 2nd order drainage line that connects to the Narrabri lake has been predicted by this flood study. The majority of the Project footprint does not fall within this predicted flood level, however the western extent of the Project site may be impacted by flooding during a similar event, as shown in Figure 7 with the Project area marked in red.

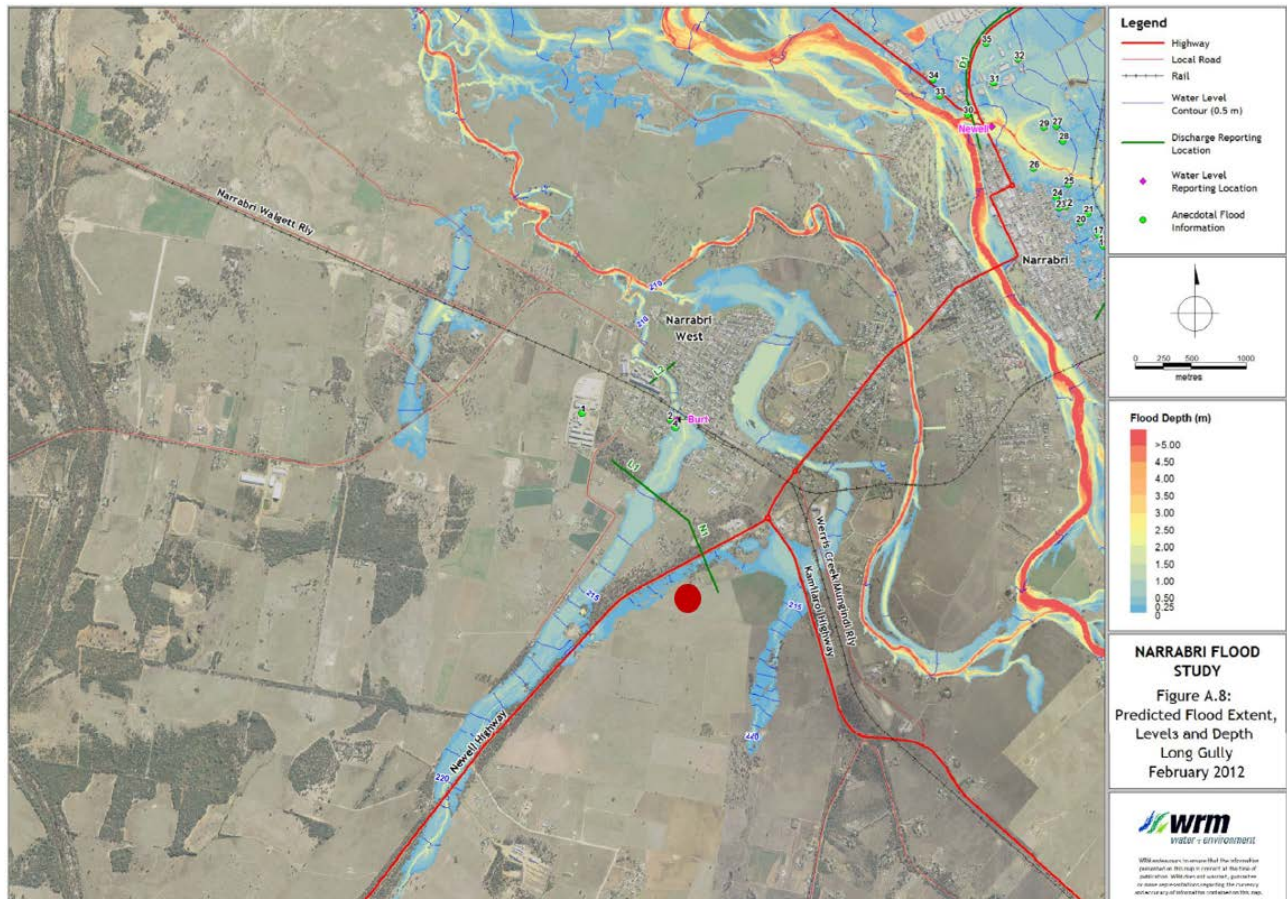


Figure 7: Long Gully catchment – predicted flood extent

Design event mapping shows that the 2004 event had an AEP of between 5% and 2% in Mulgate Creek and Long Gully, and the 2012 event had an AEP of between 5% and 2% in Mulgate Creek and about a 5% AEP in Long Gully. Note that these flow distributions assume that the levees and bunds do not fail during flooding. The flow distributions and flood levels could potentially change if the levees and bunds fail. A description of flooding for the various events in the Mulgate Creek and Long Gully catchments are given below.

4.2 Narrabri Floodplain Risk Management Study and Plan 2019

The Narrabri Floodplain Management Study and Plan (FMSP) (WRM Water and Environment, 2019) was developed to update the flood modelling conducted for the 2016 Narrabri Flood Study to bring the modelling up to date. Accordingly, the results presented in the Floodplain Management Study and Plan supersede the 2016 Flood Study.

The flood modelling results show that regional flooding poses the greatest threat to the developed areas of Narrabri. Significant areas of Narrabri are liable to flooding to varying levels of risk. Any development within flood prone areas would therefore be considered to be in a flood hazard zone as they are prone to damage if mitigation measures are not implemented. Provisional hydraulic hazard mapping has been prepared by combining the hazards from both local and regional flooding (WRM Water and Environment, 2019). Appendix D shows the provisional hydraulic hazard categories in the study area from a combination of local and regional

catchment flooding. Provisional hydraulic hazards have been defined using the depth and velocity of the floodwaters calculated using the flood model as prescribed by the NSW Floodplain Development Manual (NSW Government, 2005). These predicted hazard maps indicate the site is within the Low Hazard category for 1%, 2%, 5%, 10%, 20% AEP and Extreme Events.

The FMSP recommends future updates to the Local Environmental Plans and Development Control Plans to consider the modelled flood planning levels.

5.0 AVAILABLE DATA

Climatic data and water quantity and quality monitoring information is available in the region as outlined in the following sections.

5.1 Rainfall

The Bureau of Meteorology (BOM) has four stations in and within proximity to Narrabri (Figure 2), being Narrabri West Post Office (station 053030) located 2 km north of the site, Narrabri Airport AWS (station 054038) located 8.5 km north-east of the site, Narrabri (Mollee) (station 053026) located 13 km north-west of the site and Narrabri (Rosewood Farm) (station 0531030) located 13 km south-west of the site. Table 1 outlines the average annual, maximum annual, maximum daily and maximum monthly rainfall. Average monthly values for the two rainfall stations are in Table 2.

Table 1: Rainfall

Station Number	Station Name	Period of Record	Rainfall (mm)			
			Average Annual	Highest Annual	Maximum Daily	Highest Monthly
053030	Narrabri West Post Office	1891 - 2018	658.5	1012.1	159	307.0
054038	Narrabri Airport AWS	2001 - 2020	540.5	891.4	125.2	247.4
053026	Narrabri (Mollee)	1926 - 2020	595.9	1002.6	178	293.4
053103	Narrabri (Rosewood Farm)	1979 - 2018	678.0	992.8	195.5	406.9

Table 2: Average Monthly Rainfall

Station Number	Rainfall (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
053030	82.9	61.1	60.0	38.1	46.7	49.0	45.2	39.9	40.8	51.4	60.3	75.7
054038	69.1	58.3	60.5	28.2	23.9	48.4	28.2	29.4	31.0	36.6	70.9	64.6
053026	84.0	66.6	48.9	33.8	42.9	40.8	39.4	33.3	35.7	49.4	60.9	63.4
053103	83.9	64.1	41.5	25.1	47.8	50.0	47.6	30.5	44.6	47.6	76.3	87.2

Flood producing weather systems across the region include inland troughs, cold fronts, and thunderstorms. Consequently, each rainfall event is a function of the prevailing meteorological conditions. Therefore, the rainfall data provides useful information about expected seasonal rainfall in the area.

5.2 Streamflow

There are three government surface water monitoring sites located within 20 km of the site. Streamflow records (Table 3) for these sites are available for various locations in the region from the WaterNSW portal.

Table 3: Stream Gauging Stations

Station Number	Station Name	Available/Relevant Data	Distance from project area
419003	Narrabri Creek at Newell Hwy	Level, discharge, EC, water temp	1.5 km north
419039	Namoi River at Mollee	Level, discharge, EC, water temp, turbidity	13 km north-west
419023	Namoi River at Turrawan	Level, discharge	13 km south-east

Generally, data from the available stream gauges do not provide specific information on local site flooding but are more useful in the context of assessing major regional flooding events which may impact on site access. Information is publicly available from WaterNSW Real-time data portal and could be incorporated into site management plans.

5.3 Groundwater

The Project area falls within the Namoi catchment area where groundwater sources include:

- Alluvium of the Upper and Lower Namoi River, Great Artesian Basin, Peel Valley and Barwon region
- Fractured rock aquifers of the New England Fold Belt, Warrambungle Basalt, Liverpool Ranges Basalt and Peel Valley
- Porous rock aquifers associated with the Gunnedah Basin, Great Artesian Basin and Oxley Basin.

The lower part of the catchment to the west of Narrabri is underlain by the aquifers of the Great Artesian Basin. This is one of the largest artesian basins in the world covering 1.7 million km² or 22 per cent of Australia (Crabb, 1997) and containing an estimated 8,700 million ML of artesian water (Thoms et al. 2004).

Shallow aquifers that are highly connected to the river system are common in the Peel and Upper Namoi and as a result levels are highly dependent on surface water flows. As expected in these areas the quality of the water is high and suitable for most purposes. Water quality deteriorates towards the western end of the catchment where groundwater quality is brackish to saline, and is sometimes too salty for stock (Figure 8). The aquifers of the Great Artesian Basin have high levels of sodium which make them unsuitable for irrigation use. However, the water from these aquifers is generally suitable for domestic and town water supply (NSW Office of Water, 2011).

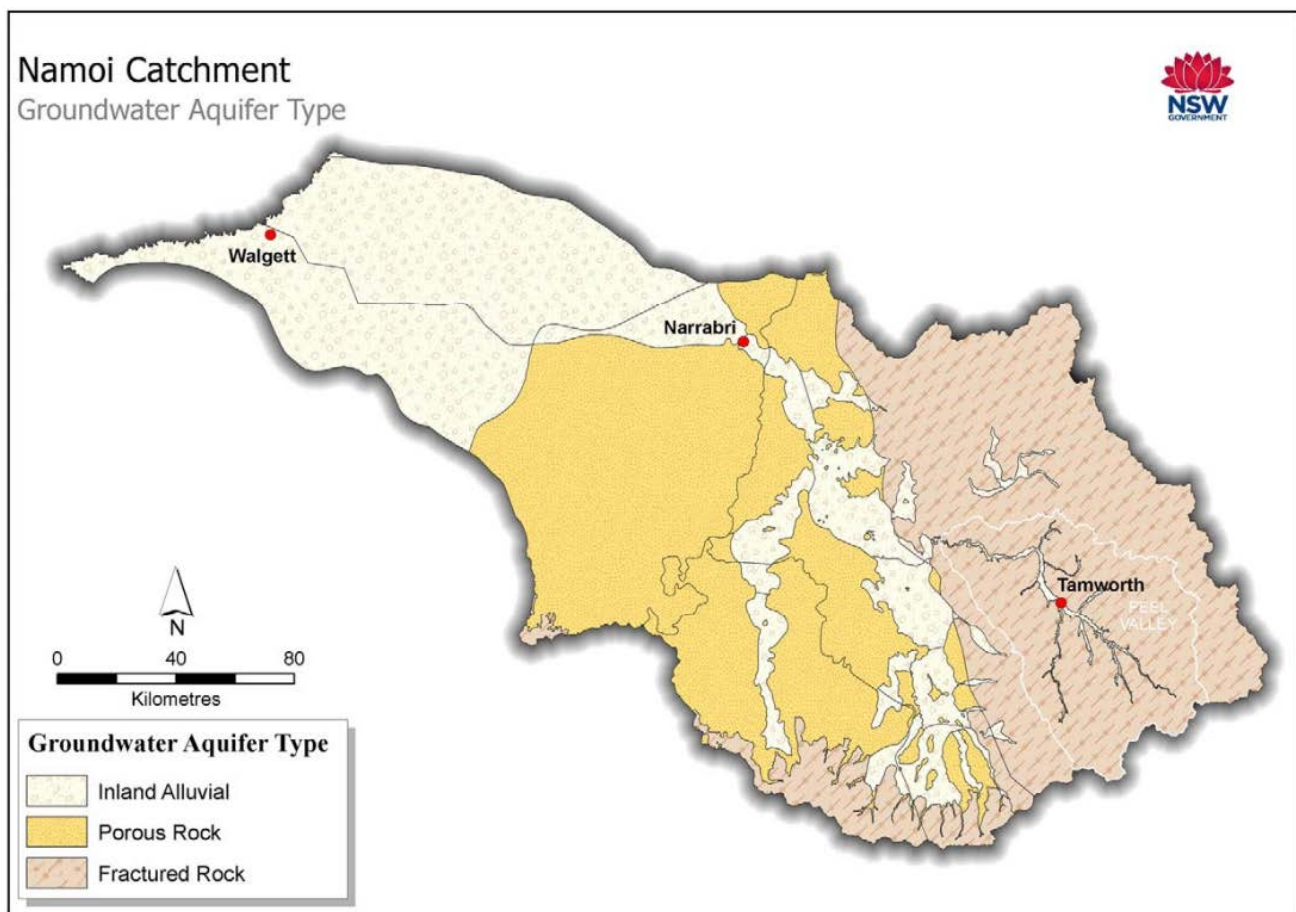


Figure 8: Namoi Catchment Groundwater Aquifer Type (NSW Office of Water, 2011)

The NSW Great Artesian Basin (GAB) Groundwater sources comprise all water contained in the sandstone aquifers of the GAB. The aquifers are comprised of predominantly sandstones, confined by aquitards of both fluvial and marine siltstones, mudstones and shale. These are described as the geological formations of the Cretaceous and Jurassic age, 65 to 210 million years old, belonging to the GAB, and the intake beds of the GAB. The GAB has been divided into five groundwater sources, for management purposes. Two of these (the Eastern and Southern Recharge Groundwater Sources) are in the non-artesian part of Basin. The remaining three (Surat, Warrego and Central Groundwater Sources) are in the artesian part of the Basin, where water in bores flows naturally to the surface (Department of Water and Energy, 2009).

The Southern Recharge Groundwater Source is bounded by outcrops of Gunnedah - Oxley Basins to the east, the Surat Groundwater Source to the west and Lower Macquarie groundwater sources to the south. The Southern Recharge Groundwater Source overlies the Lachlan Fold Belt in the west and the Gunnedah Basin in the east. It in turn underlies the Warrumbungle Basalt Groundwater Source and parts of Lower Namoi, Upper Namoi, Upper Macquarie and Castlereagh alluvial groundwater sources.

The Southern Recharge Groundwater Source increases in thickness northward and westward, being up to 300 m thick in its north-west portion. Recharge to the Southern Recharge Groundwater Source occurs directly through exposed outcrops of Pilliga Sandstone and via overlying strata. The recharge takes place as diffuse rainfall recharge as well as leakage from overlying alluvium and rivers. The groundwater flows from the east to a westerly direction in this groundwater source (Department of Planning, Industry and Environment, 2020).

The groundwater is used for stock, domestic, industrial, irrigation and town-water supply purposes. The low sodium content and low salinity of this groundwater make it suitable for irrigation. Moderate scale groundwater irrigation occurs near Narramine, Collie, Gilgandra and Narrabri with the bores yielding up to 50 L/s (Department of Planning, Industry and Environment, 2020).

WaterNSW monitors groundwater level, pressure and quality through its network of groundwater observation bores across NSW. Monitoring bores are designed to monitor a specific aquifer for water level and water quality. The nearest bore screened within the Southern Recharge Groundwater Source is GW030123, located approximately 500 m north of the Project site. Long-term data from this bore (Figure 9) indicates a relatively stable water level which is impacted by seasonal fluctuations.

The nearest real time Groundwater Monitoring Site on the Water NSW database (WaterNSW, 2019) is located approximately 5 km north of the Project site at Narrabri Speedway (Site no. GW030121.1.3). The levels recorded on 1 October 2020 indicated that the bore level below MP was 9.505 m and the ground water level 202.135 m AHD (Figure 10).

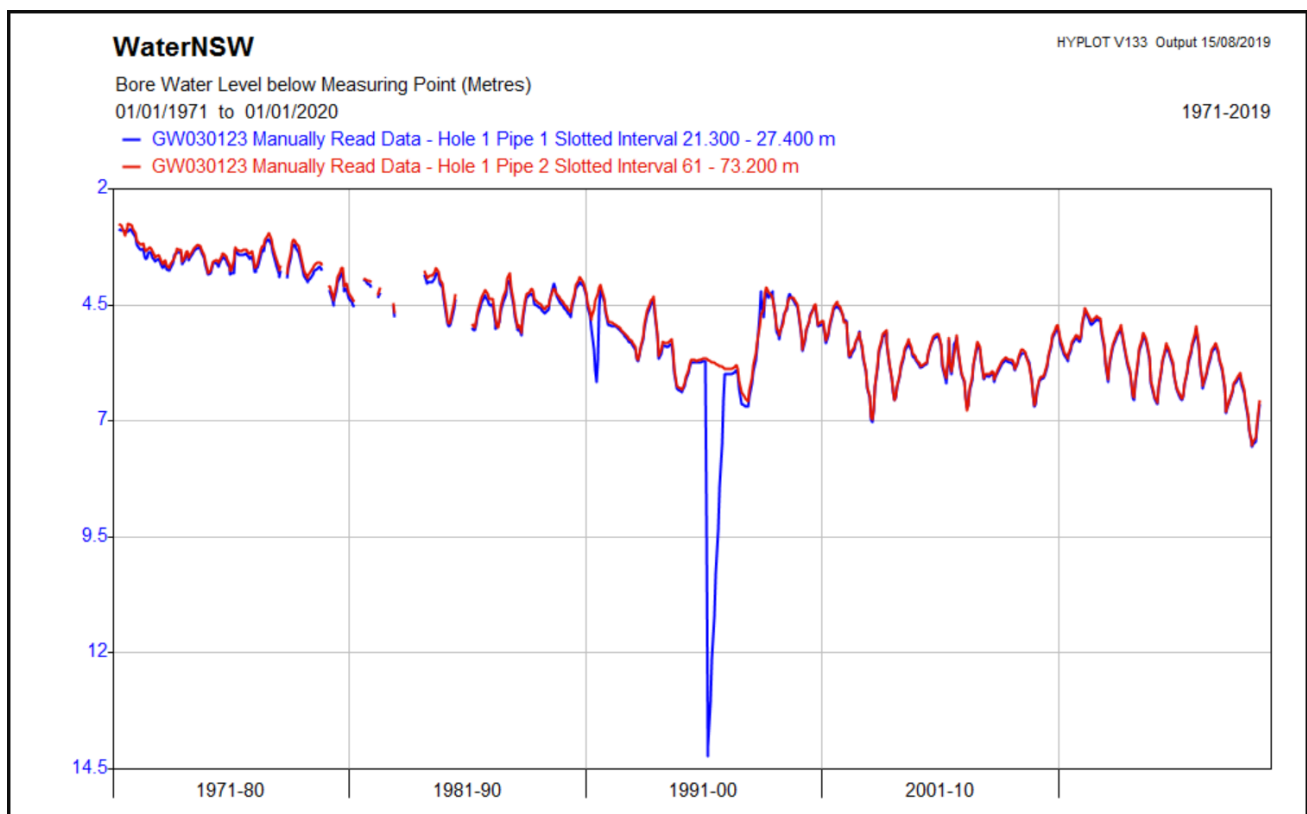


Figure 9: Southern Recharge Groundwater Source bore levels in GW030123

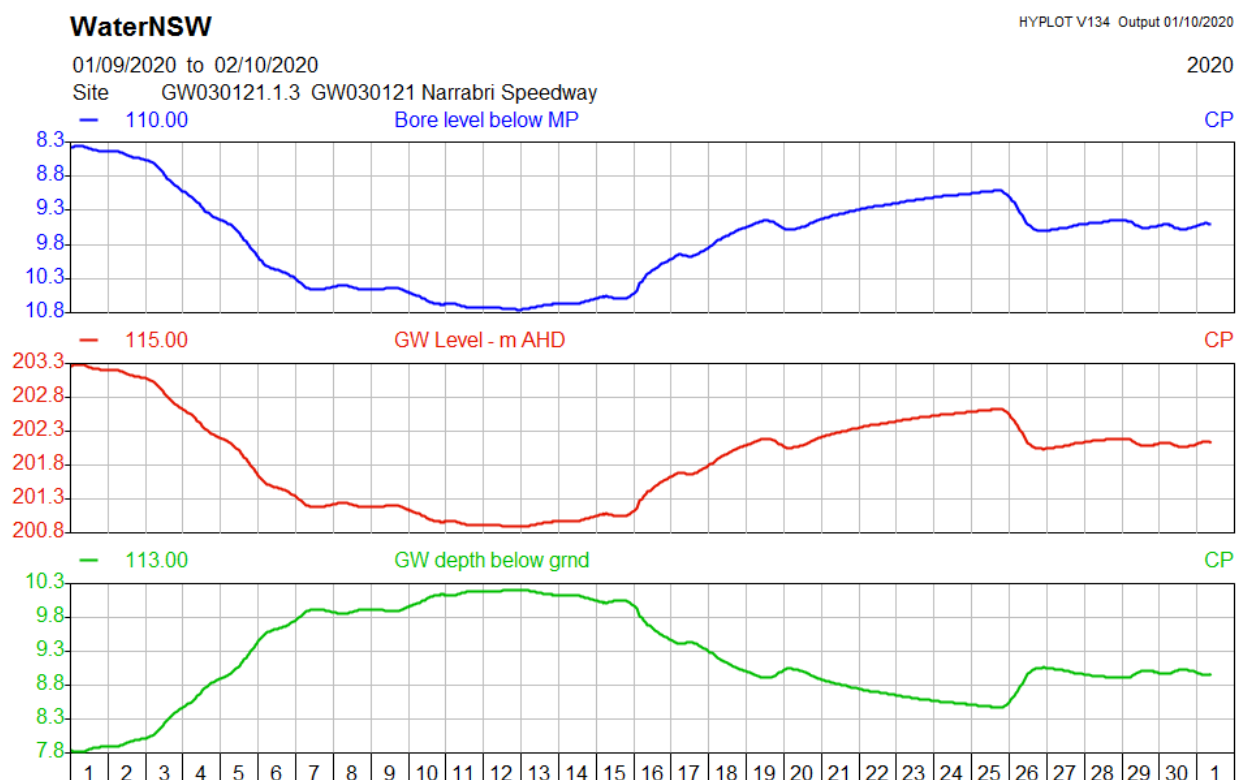


Figure 10: Narrabri Speedway GW030121.1.3 groundwater levels (levels recorded on 1 October 2020)

6.0 POTENTIAL IMPACTS

The site is not located within any mapped areas that may be sensitive to flooding or groundwater impacts as prescribed by the LEP.

Accordingly, proposed on-site activity is not expected to materially contribute to any regional groundwater issues, particularly those associated with nearby irrigation districts. Proposed trenching would be to a maximum 1,200 mm deep and piling would extend to a maximum depth of 1.5 m, which is expected to be above the local groundwater level.

Generally, there are two potential impacts a solar farm could have on flooding and runoff external to the Project Area:

- 1) Impacts on riverine flood levels due to the Project Area obstructing flow.
- 2) Impacts on flood levels due the impervious nature of development surfaces associated with the Project causing more rapid runoff.

Based on the current available information, potential adverse surface water-related impacts at the site include:

- Site accessibility and inundation
- Managing downstream sedimentation.

As there will be no extraction of groundwater or interference with the groundwater table during Project activities, potential for impacts to groundwater have not been considered further.

6.1 Flooding

Flood planning maps referenced by the LEP indicate that site is not within an area likely to flood. However, heavy rainfall during storm events (or flash flooding) may cause disruption during construction activities or for material suppliers.

The Narrabri Flood Study 2016 (WRM Water and Environment) modelled predicted flood extents, depths and flood contours for the 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP and the PMF, in the context of both regional scale flood events and localised flood events. Appendix E shows the modelled extents of flood impacts under each of these scenarios.

Regional flooding has no impacts under each of the above AEP scenarios, however, flood impacts under the extreme event scenario at the northern extent of the lot (although beyond the proposed development site) up to 2 m are predicted.

Local flooding may have impacts in the northern extent of the lot of up to 0.5 m under the 20% and 10% AEP, up to 1 m under the 5%, 2% and 1% AEP, and up to 2 m of flood impacts in an extreme event. With the exception of the extreme event, none of these scenarios will significantly impact the area of the proposed Project development footprint.

Within the model, the flood storage was defined by the 1% AEP flood extent outside the floodway areas, while the flood fringe was defined by the residual area between the 1% AEP extent and the extreme event extent. The proposed Project area is therefore within the flood fringe, however, the results of the modelling showed that these non-floodplain areas were not inundated during flooding events (i.e., the hill slope areas on the fringe of the hydraulic model (WRM Water and Environment, 2016)). Additionally, development in the flood fringe areas is not expected to have any significant effect on the pattern of flood flows.

As a 2nd order drainage line exists within the land parcel, to the east of the Project footprint, there is potential for localised overland flow during rainfall.

Additionally, the flood study identifies potential flood hazard areas along the apron of the Newell Highway and associated with the drainage line.

Given any modelled flood impacts are limited to a small area within the most northern extent of the lot, though generally not intersecting the Project footprint, potential impacts from runoff obstruction (blockage) due to the solar farm would be limited. Solar panel pile depths will be in the range of 1.5 m bgl, with any excavated areas around the site backfilled and cover reinstated following installation.

A study conducted by Cook and McCuen (2013) concluded that solar panels themselves do not have a significant effect on catchment runoff volumes, peaks, or times to peak for flood events, unless the runoff characteristics of the final ground cover under the panels is increased. Potential impacts of the solar farm obstructing the relatively shallow overland flow observed in the catchment are therefore considered likely to be negligible.

Similarly, the solar panel structure will be sufficiently designed and constructed to withstand impacts to the stability and integrity of the panels from any inundation or overland flow that may occur due to flooding. The solar panels will be elevated above modelled maximum flood levels, and the pilings will be installed to sufficient depths and may also be fitted with a 300 mm concrete collar if required, depending on soil type.

6.2 Water quality and erosion

The Project has the potential to alter existing water quality conditions within the site. The impervious area of solar facilities is typically only marginally increased owing to associated hardstand and building areas. However, the panels may impact the nature of vegetation/grass coverage on the site, which has the potential to increase surface runoff and peak discharge. Increased flow concentration off the panels also has the potential to erode soil at the base of solar panels (Cook & McCuen, 2013).

Furthermore, as the site has been historically used for grazing there is very little natural ground cover vegetation.

The Project site occurs on soils that are characterised as grey sodosols. Sodosols are texture-contrast soils with impermeable subsoils due to the concentration of sodium. These soils are slowly permeable and poorly drained, run on is moderate and runoff is low. Generally, Sodosols have a low-nutrient status and are very vulnerable to erosion and dryland salinity when vegetation is removed (Office of Environment and Heritage, 2017).

There is the potential that site runoff will contain sediments and increase turbidity or impact water quality parameters in downstream water ways. The existing farm dam should capture surface flow from the site and reduce sedimentation downstream.

7.0 PROPOSED MITIGATION MEASURES

7.1 Site accessibility and inundation

The site accessibility and potential for inundation issues may be managed in the project's risk management register(s) owing to the regional nature of the events and the potential to impact whole of site works. There should be procedures in place to halt construction during heavy rainfall to reduce impacts to the project construction and also to increase sedimentation downstream.

7.2 Downstream sedimentation

Impacts associated with erosion and sedimentation resulting from construction activities can be minimised by undertaking works in accordance with provisions of the NSW government's best practice sediment and erosion control series Managing Urban Stormwater: Soils and Construction (DECC, 2008).

Proposed mitigation measures associated with managing downstream actionable nuisance (sedimentation) are outlined in Table 4.

Table 4: Proposed Mitigation Measures

Stage	Measure	Activities/Approach
Design	Site drainage and water quality controls	Design Basis ■ Undertake hydrological assessment of the catchment in which the site sits in accordance with relevant methods outlined in Australian Rainfall and Runoff. ■ Determine sediment management targets and drainage control standards in accordance with Managing Urban Stormwater: Soils and Construction Vol 1 (Blue Book) (DECC, 2008). ■ Develop a site erosion and sediment control plan in accordance with the Blue Book. ■ Develop site drainage design incorporating detention basins and sedimentation management structures where relevant. ■ Permanent site drainage should coincide with temporary arrangements where possible.
Construction and/or Demolition	Site drainage and water quality controls	General site works: ■ Project construction period to occur entirely within the dry season to prevent flooding, sedimentation and water quality impacts to waterways. ■ Catch drains to be located downslope of any proposed road works. ■ Install location appropriate sediment fences or other applicable control measures depending on whether the feature is upstream or downstream of a disturbed part of the site or will need to be trafficable. ■ All stormwater collection points need to have appropriate sedimentation and erosion controls.

Stage	Measure	Activities/Approach
		■ Undertake ongoing inspections of stormwater facilities and water control measures to assess their effectiveness. ■ Vibration grids or wash bays at all construction exits. ■ Level spreaders at locations where concentrated flow is discharged offsite to ensure sheet flow like conditions are maintained. ■ Flat land erosion control options include erosion control blankets, gravelling, mulching, soil binder, turfing and revegetation.
Construction and/or Demolition	Stormwater point source control	In the event of concrete works: ■ Do not undertake works if chance of heavy rain. ■ Store rinsate² water, if applicable, separately to other water on site and dispose of offsite as appropriate. ■ Block on site drains in the area of the works and remove any contaminated runoff. In the event that dewatering practices are required: ■ Pump hose intakes for withdrawing water from excavations will be elevated to minimise sediment pumping and directed to a containment area for settling prior to discharge. ■ Limit direct discharge off site (consistent with the design requirements for sediment pond discharge). ■ Stormwater collected on site should be reused where possible. Controls should be inspected and maintained on a regular basis. All water released from sediment basins should be clear or disposed off site by vehicle. ■ Material and waste storage areas should be designed and operated to minimise interaction with surface waters. ■ Vehicle washdown areas should be located away from water courses.

² A dilute solution of chemical resulting from washing the container and equipment with water, as defined by NSW EPA accessed 20 December 2018
<https://www.epa.nsw.gov.au/licensing-and-regulation/licensing/environment-protection-licences/authorised-officers/glossary#r>

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Signature Page

Golder Associates Pty Ltd



Sarah Duarte
Senior Environmental Scientist



James Comley
Principal Environmental Scientist

SD/JC/sd

A.B.N. 64 006 107 857

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<https://golderassociates.sharepoint.com/sites/29921g/deliverables/r-021-narrabri3a-water/18105488-021-rev2-narrabri3a-waterassess.docx>

APPENDIX A

Important Information Relating to this Report

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

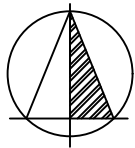
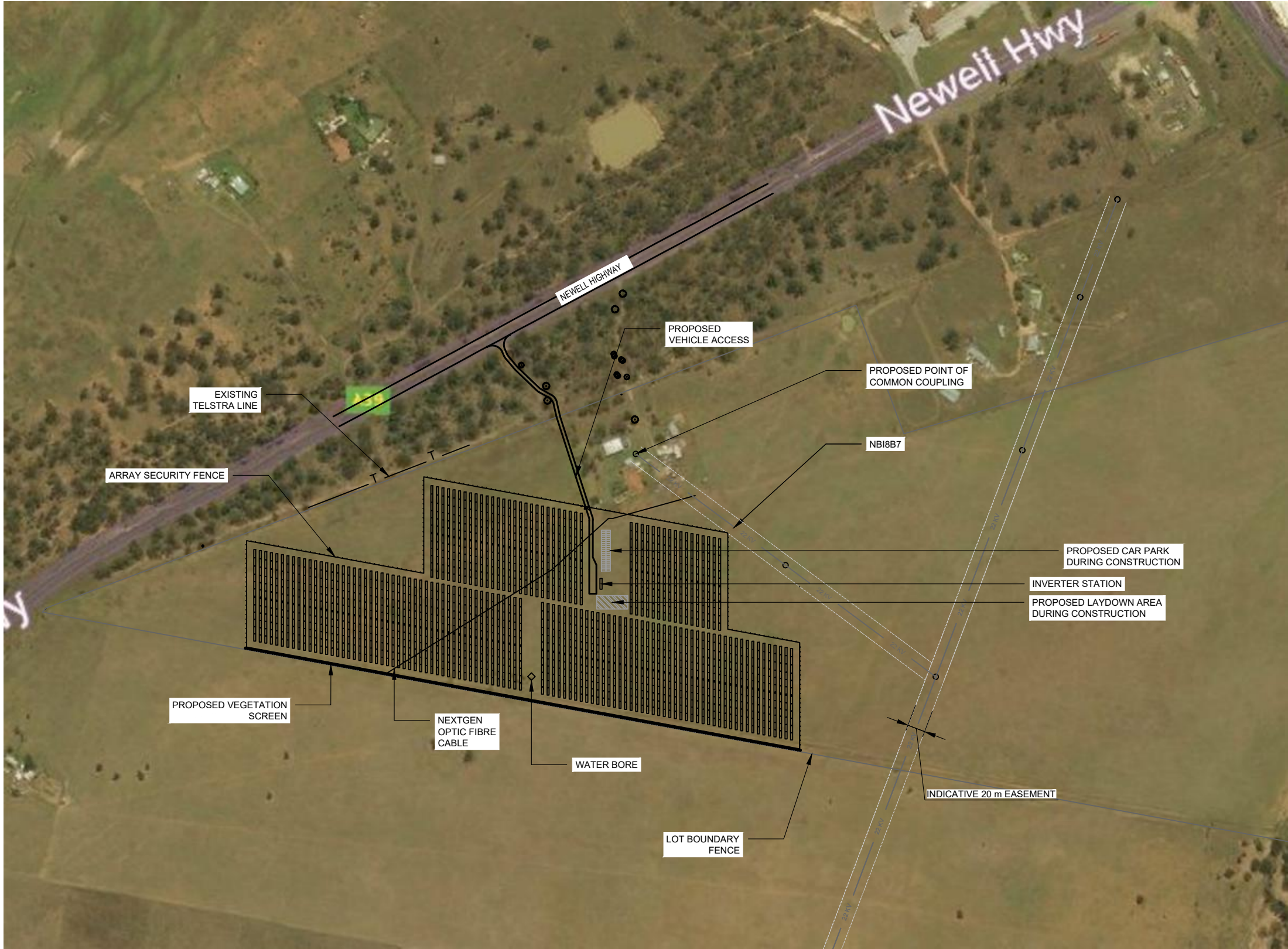
Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification

APPENDIX B

Proposed Layout



SITE INFORMATION

LOT / DP	102/579423
ADDRESS	11498 NEWELL HIGHWAY, NARRABRI, NSW 2390
LGA	NARRABRI SHIRE COUNCIL
LAT / LONG	-30.355485 / 149.760305
ELEVATION	212 m
LOT AREA	61.64 ha
FENCED AREA	11.24 ha
DNSP	ESSENTIAL ENERGY

PROJECT INFORMATION

AC CAPACITY	5.0 MW
INVERTERS	2 x 3.0 MW AC
TRACKER SPACING (N-S)	5.5 m
ARRAY PITCH	6.25 m
CONNECTION VOLTAGE	22 kV
CONNECTION FEEDER	ESSENTIAL ENERGY NB18B5
CONNECTION SUBSTATION	ESSENTIAL ENERGY NARRABRI
SECURITY FENCE SETBACK	ALIGNED WITH PROPERTY BOUNDARY
ARRAY SETBACK	MIN. 8 m FROM SECURITY FENCE
VEHICLE ACCESS WIDTH	4 m

1 GENERAL ARRANGEMENT PLAN
SCALE: 1:5000

PRELIMINARY DESIGN

NO.		STAGE	DATE	NOTES	PARTNERS	 P: +61 2 6257 3511 info@itp.com.au www.itpau.com.au PO BOX 6217 O'CONNOR, ACT 2602 AUSTRALIA	DRAWN	ISC	DRAWING GENERAL ARRANGEMENT PLAN ----							
							CHECKED	PM								
							APPROVED	SD								
1		ISSUED FOR INVESTOR APPROVAL	19/3/20							DO NOT SCALE. ALL MEASUREMENTS IN MM UNLESS OTHERWISE STATED.		PROJECT	NARRABRI 3A 5MW SOLAR FARM		SCALE	AS NOTED
2		ADDED 2M SETBACK FROM THE OPTIC FIBRE CABLE	22/7/20							CLIENT ADDRESS	ITP DEVELOPMENT 11498 NEWELL HIGHWAY NARRABRI, NSW 2390	THIS DOCUMENT MAY ONLY BE USED BY CLIENTS OF ITP OR THOSE WHO HAVE RECEIVED EXPRESS PERMISSION FROM ITP. THE USE OF THIS DRAWING SHALL NOT EXTEND BEYOND THE PURPOSE FOR WHICH IT WAS ORIGINALLY PREPARED.		SHEET SIZE	A3	
3		UPDATED MODULES AND REMOVED SETBACK FROM OF CABLE	7/8/20											ORIG. DATE	10/3/20	
4		----	----											REV. DATE	21/8/20	
5		----	----	DRAWING NO.	A5000 NAR3A-G-210	REV NO.								3		
6		----	----													

APPENDIX C

Narrabri LEP Maps



**Narrabri Local
Environmental
Plan 2012**

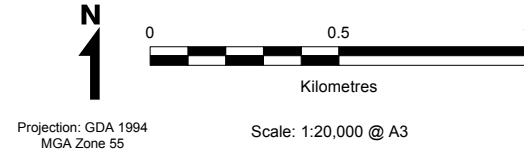
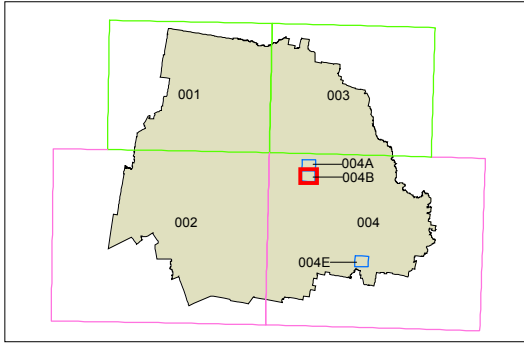
**Flood Planning Map -
Sheet FLD_004B**

Flood Planning Land

 Flood Planning Area

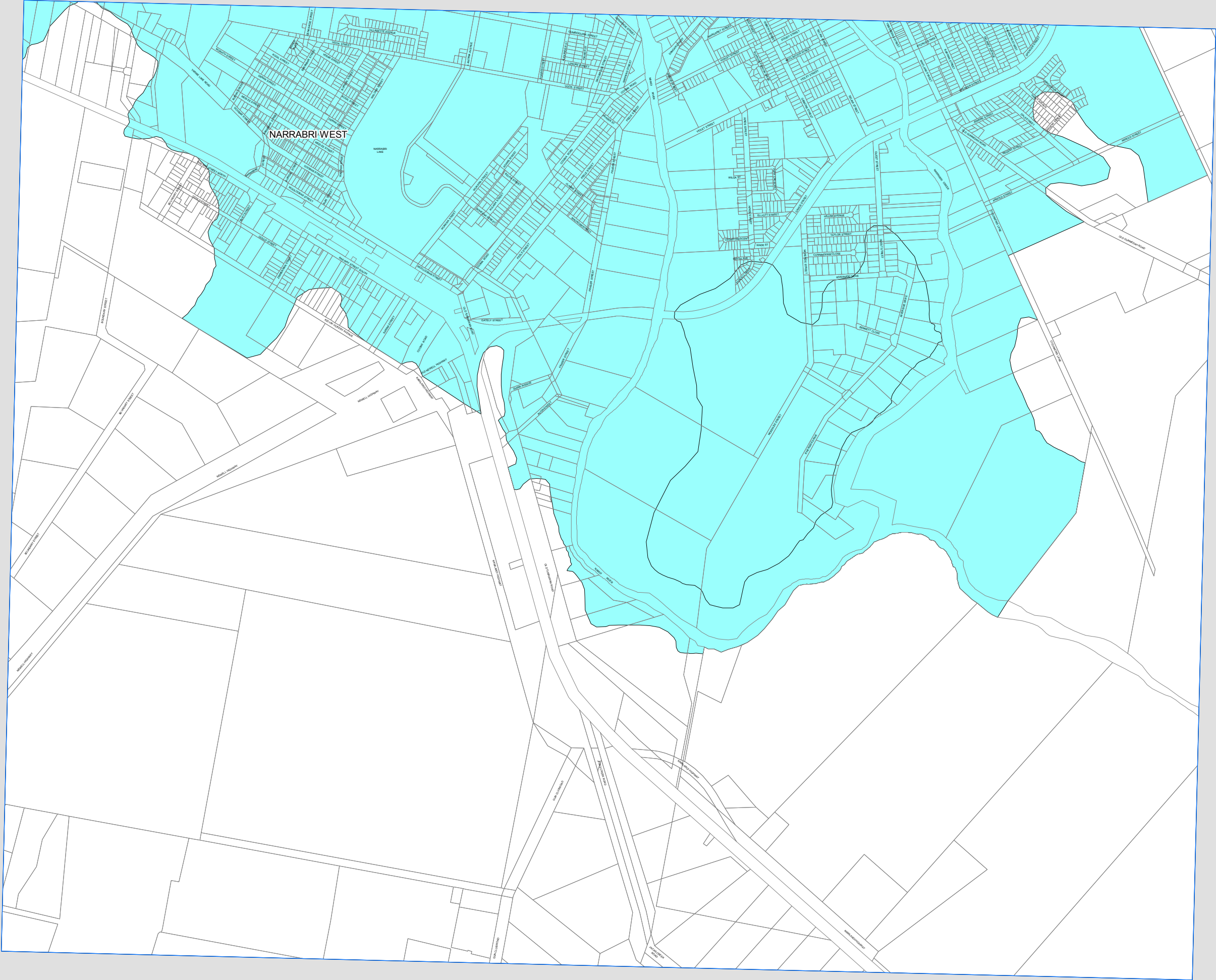
Cadastre

 Cadastre 18/03/2011 © Land & Property Information (LPI)



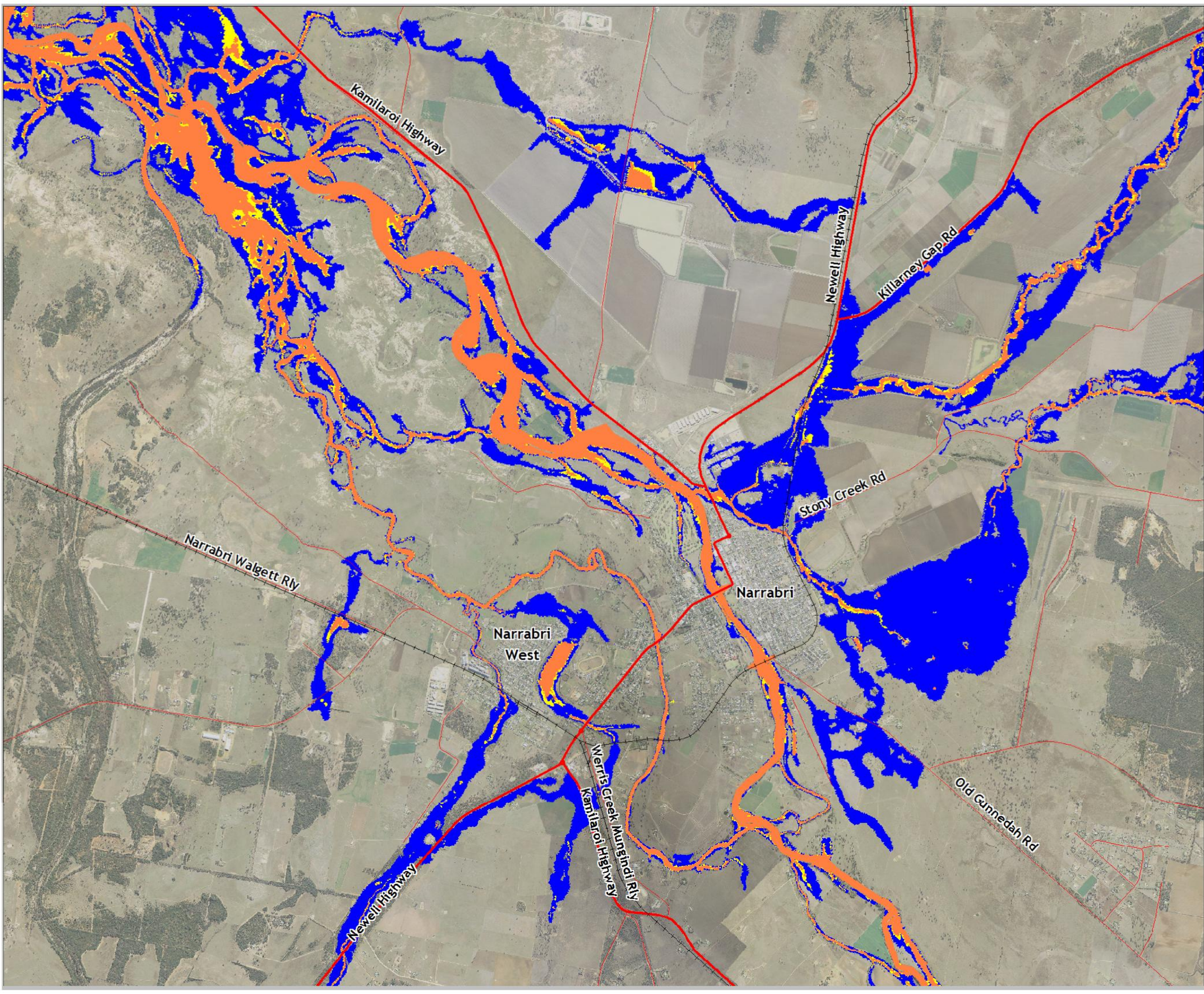
Projection: GDA 1994
MGA Zone 55

Scale: 1:20,000 @ A3



APPENDIX D

Provisional Hydraulic Hazard Mapping



Legend

- Highway
- Local Road
- Rail

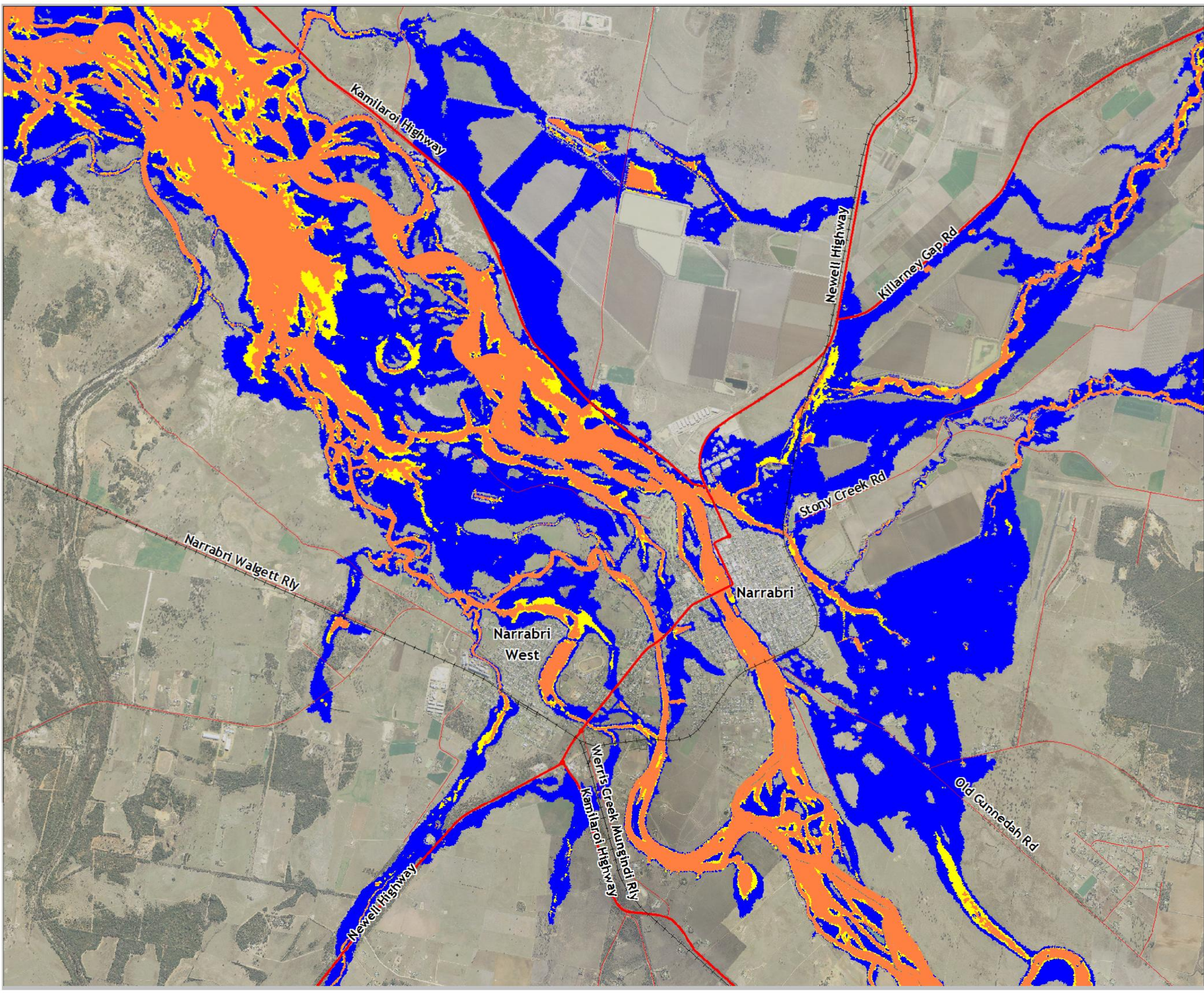
Hydraulic Hazard Category

- High Hazard
- Intermediate Hazard
- Low Hazard

NARRABRI FLOOD STUDY

Figure C.1:
Preliminary Hydraulic
Hazards
20% AEP Event

WRM endeavours to ensure that the information presented on this map is correct at the time of publication. WRM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained on this map.



Legend

- Highway
- Local Road
- Rail

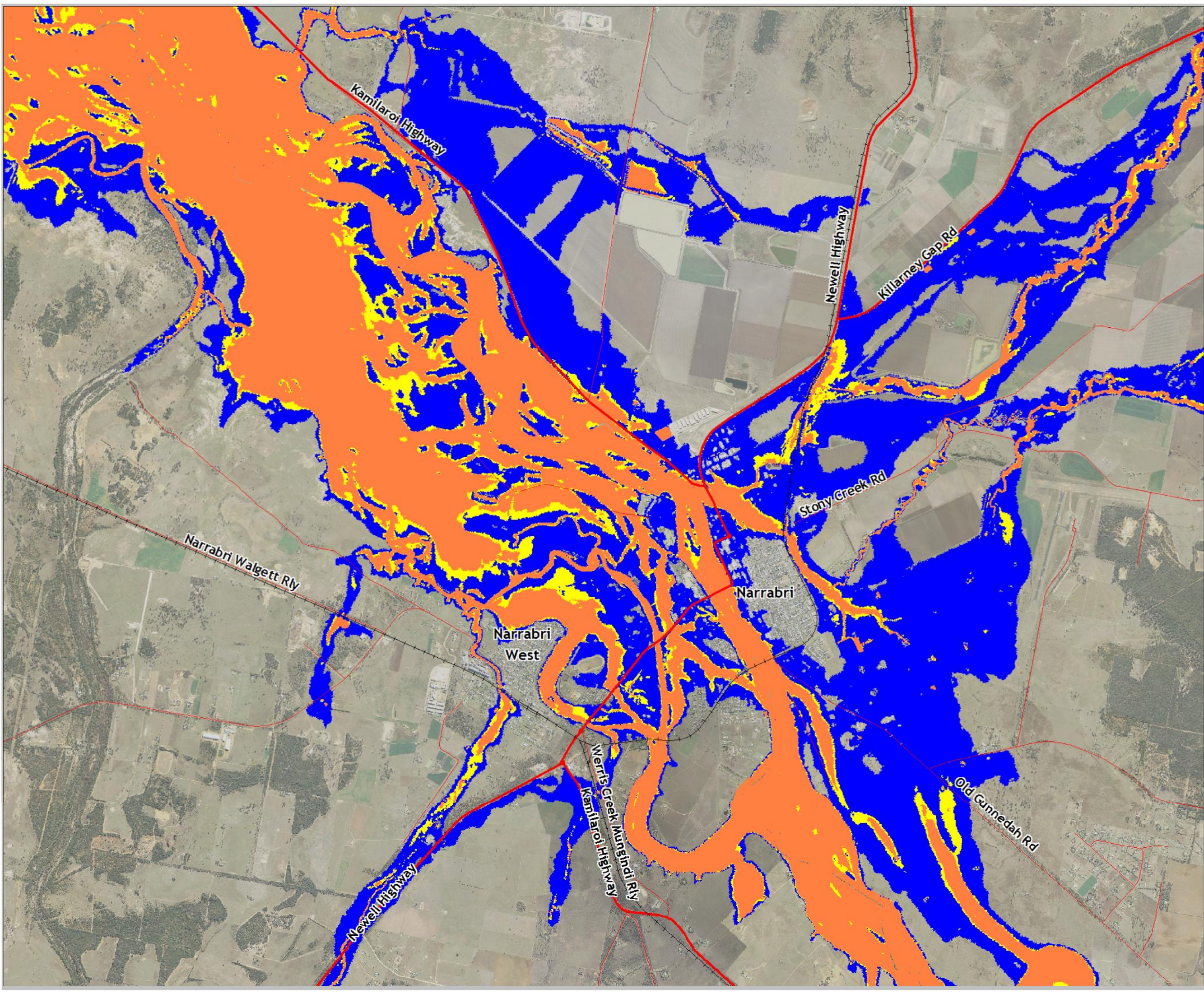
Hydraulic Hazard Category

- High Hazard
- Intermediate Hazard
- Low Hazard

NARRABRI FLOOD STUDY

Figure C.2:
Preliminary Hydraulic
Hazards
10% AEP Event

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Legend

- Highway
- Local Road
- Rail

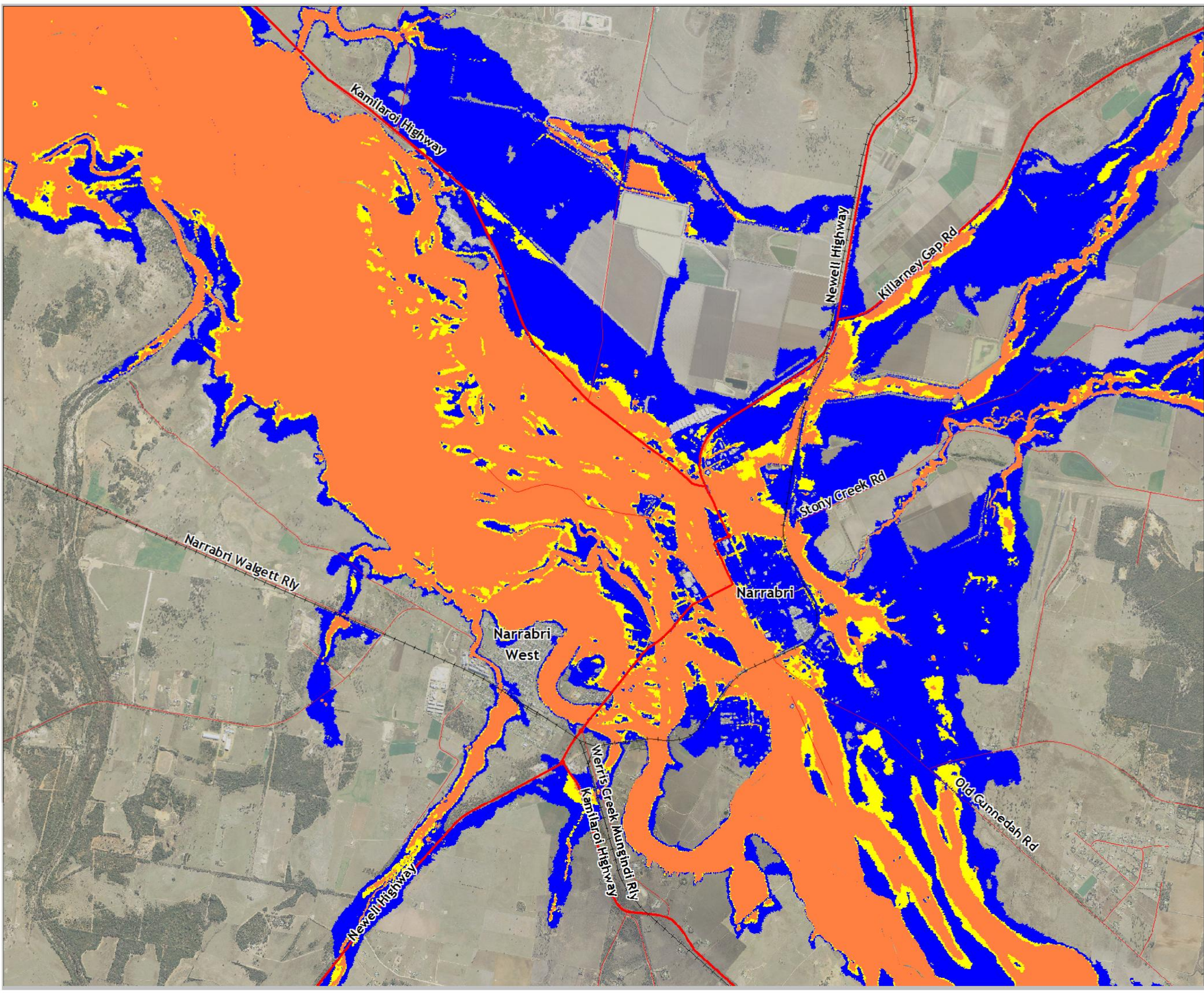
Hydraulic Hazard Category

- High Hazard
- Intermediate Hazard
- Low Hazard

NARRABRI FLOOD STUDY

Figure C.3:
Preliminary Hydraulic
Hazards
5% AEP Event

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Legend

- Highway
- Local Road
- Rail

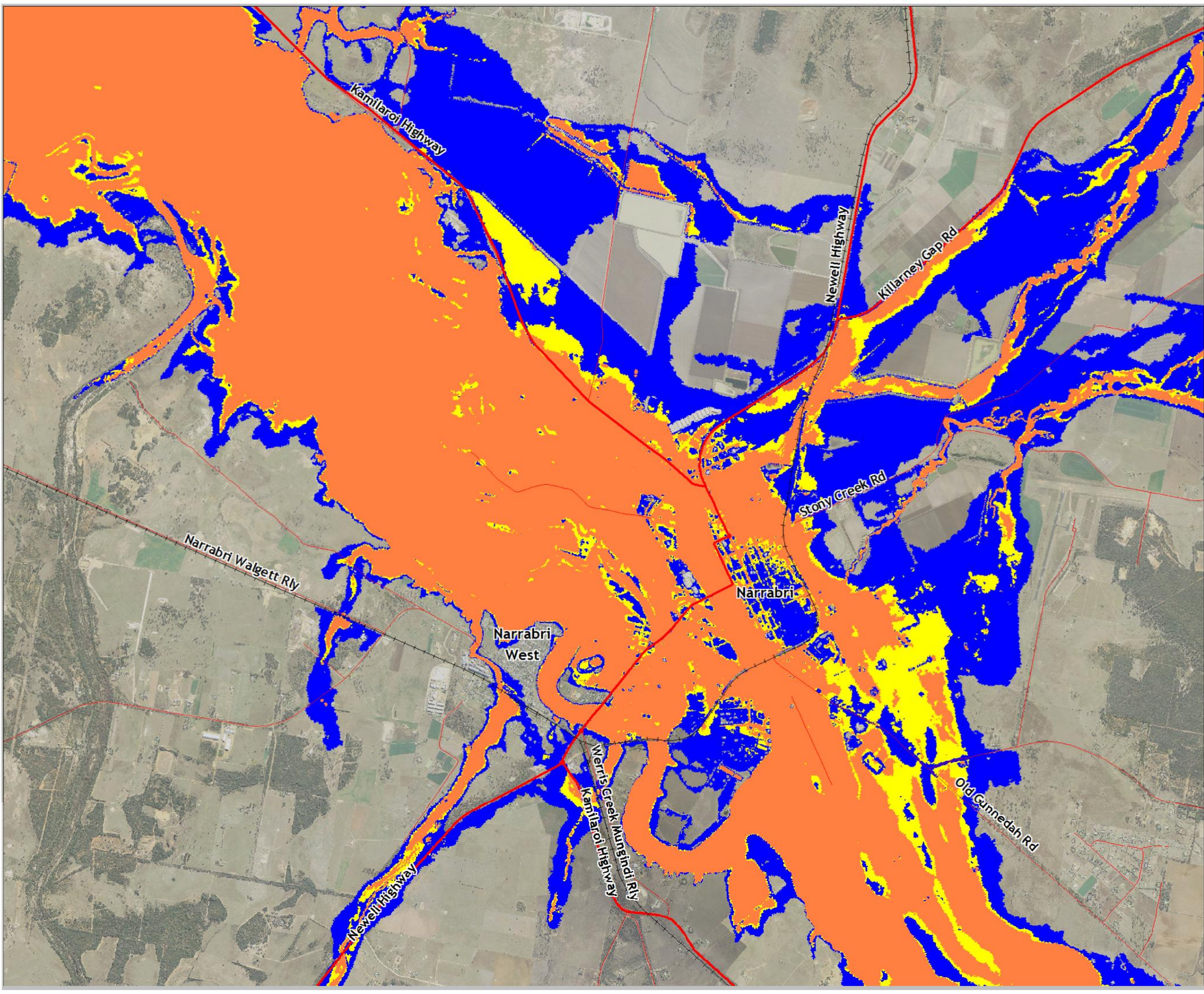
Hydraulic Hazard Category

- High Hazard
- Intermediate Hazard
- Low Hazard

NARRABRI FLOOD STUDY

Figure C.4:
Preliminary Hydraulic
Hazards
2% AEP Event

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Legend

- Highway
- Local Road
- Rail

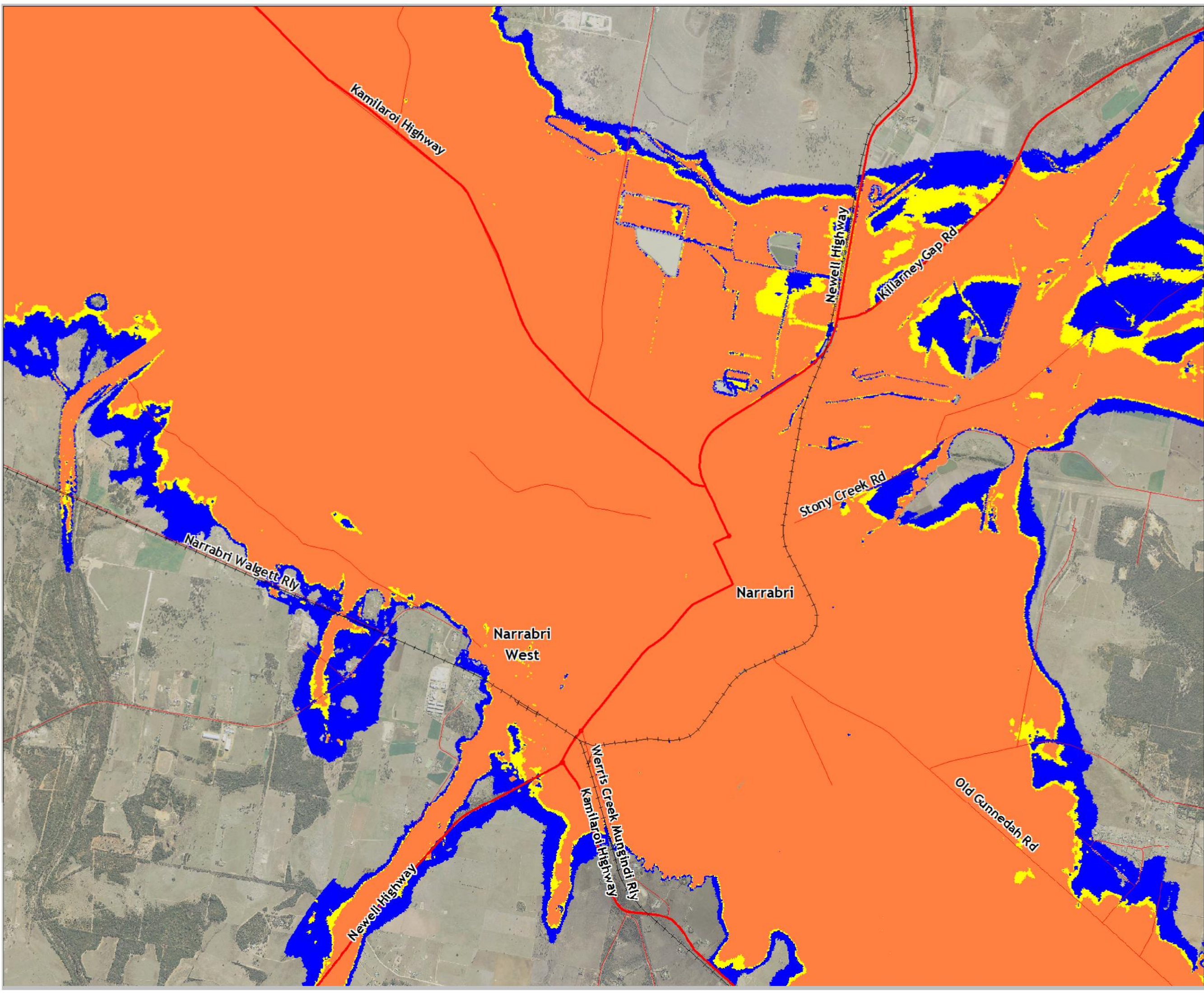
Hydraulic Hazard Category

- High Hazard
- Intermediate Hazard
- Low Hazard

NARRABRI FLOOD STUDY

Figure C.5:
Preliminary Hydraulic
Hazards
1% AEP Event

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Legend

- Highway
- Local Road
- Rail

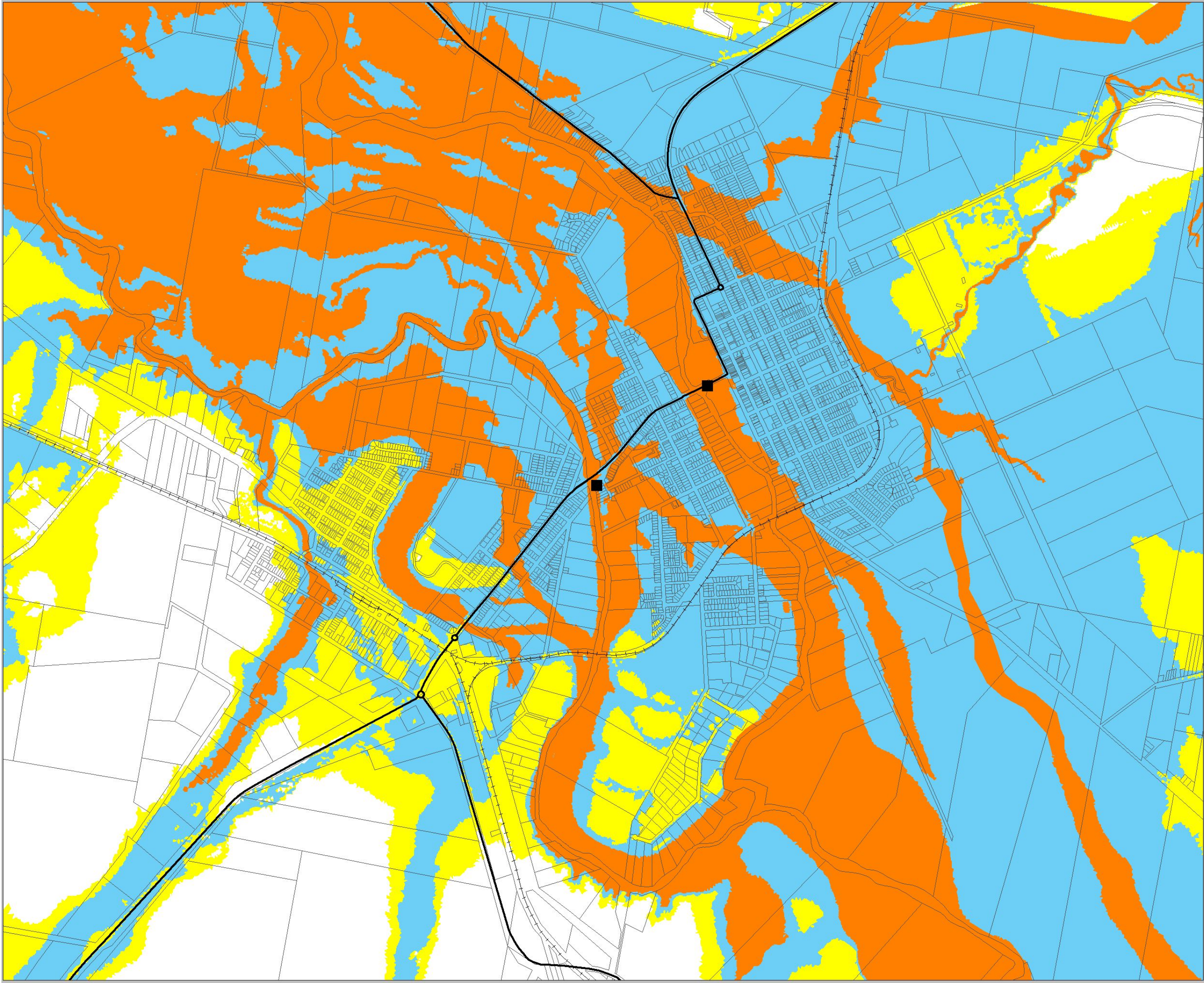
Hydraulic Hazard Category

- High Hazard
- Intermediate Hazard
- Low Hazard

NARRABRI FLOOD STUDY

Figure C.6:
Preliminary Hydraulic
Hazards
Extreme Event

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Legend

- Cadastre
- Rail
- Highway
- Streamgauge

0 250 500 1000
metres

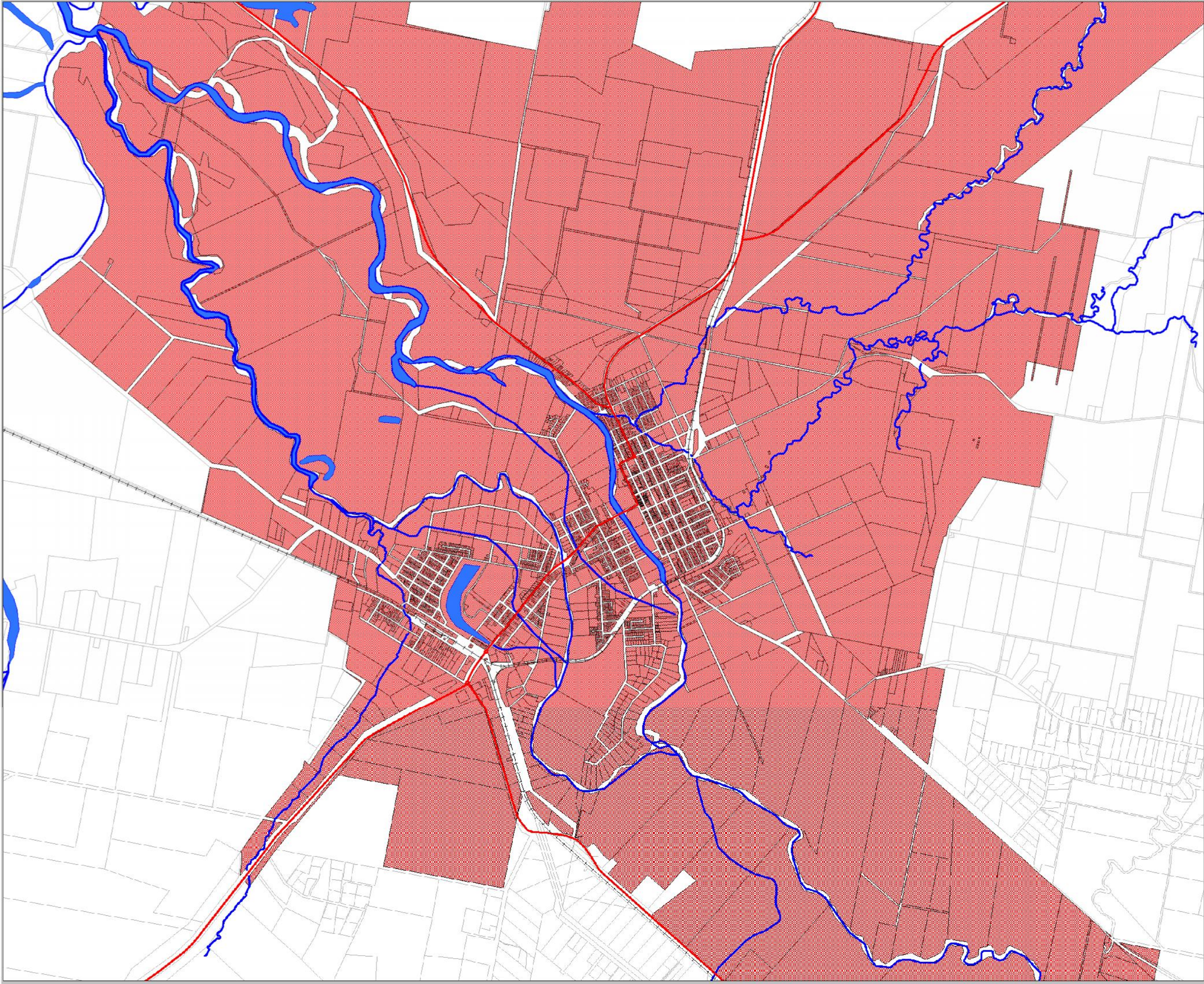
Hydraulic Categorisation

- Floodway
- Flood storage
- Flood fringe

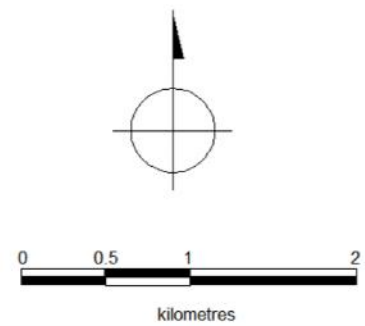
NARRABRI FLOOD STUDY

Figure C.7:
Provisional Hydraulic Categorisation

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- Legend**
- Highway
 - Rail
 - Cadastral
 - Flood Planning Area



NARRABRI FLOOD STUDY

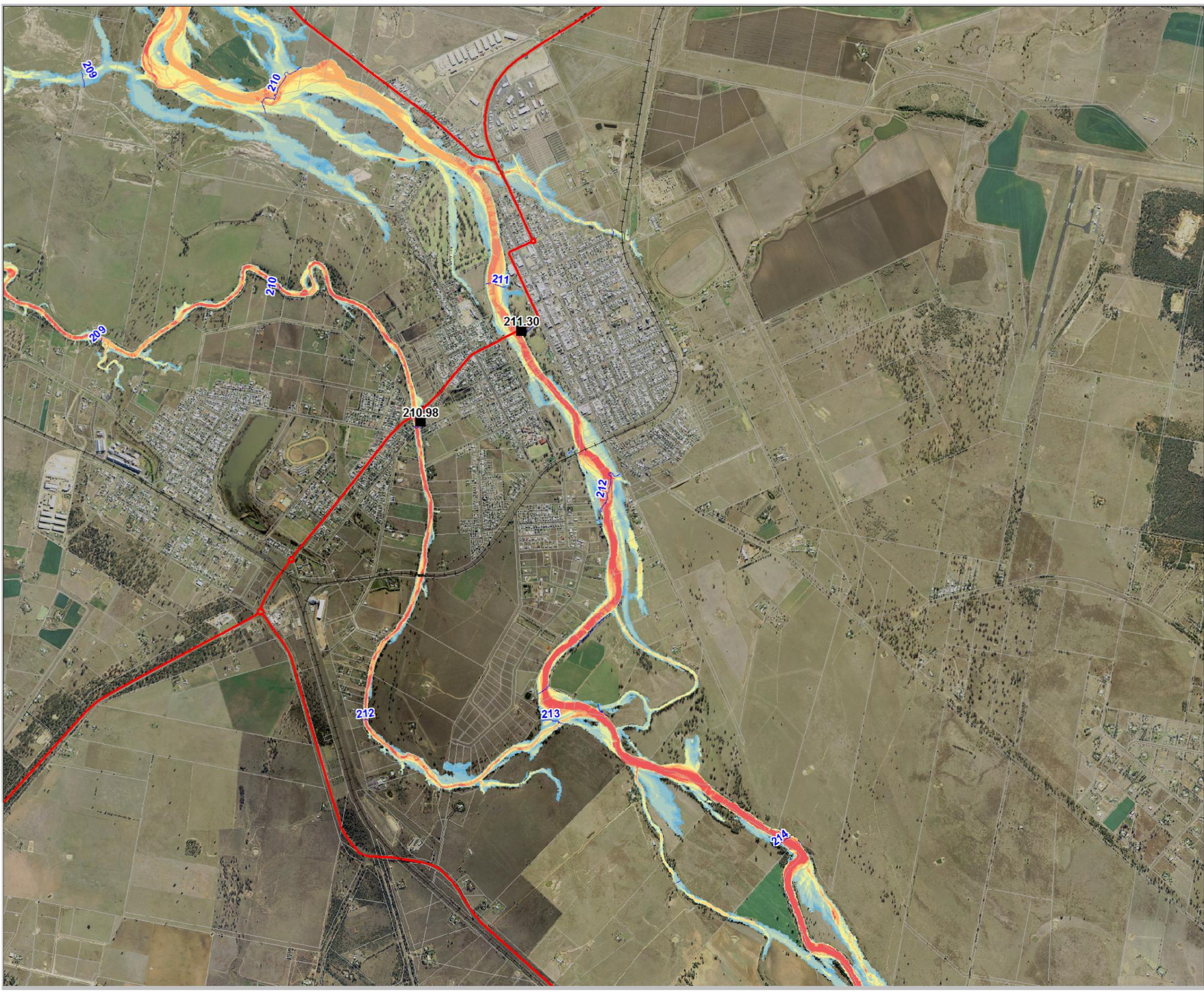
**Figure C.8:
Flood Planning Area**



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APPENDIX E

**Narrabri Flood Study 2016 -
Predicted Flood Extents**



Legend

- Cadastre
- Rail
- Highway
- Streamgauge
- Water Level Contour (1.0 m)

0 250 500 1000
metres

Flood Depth (m)

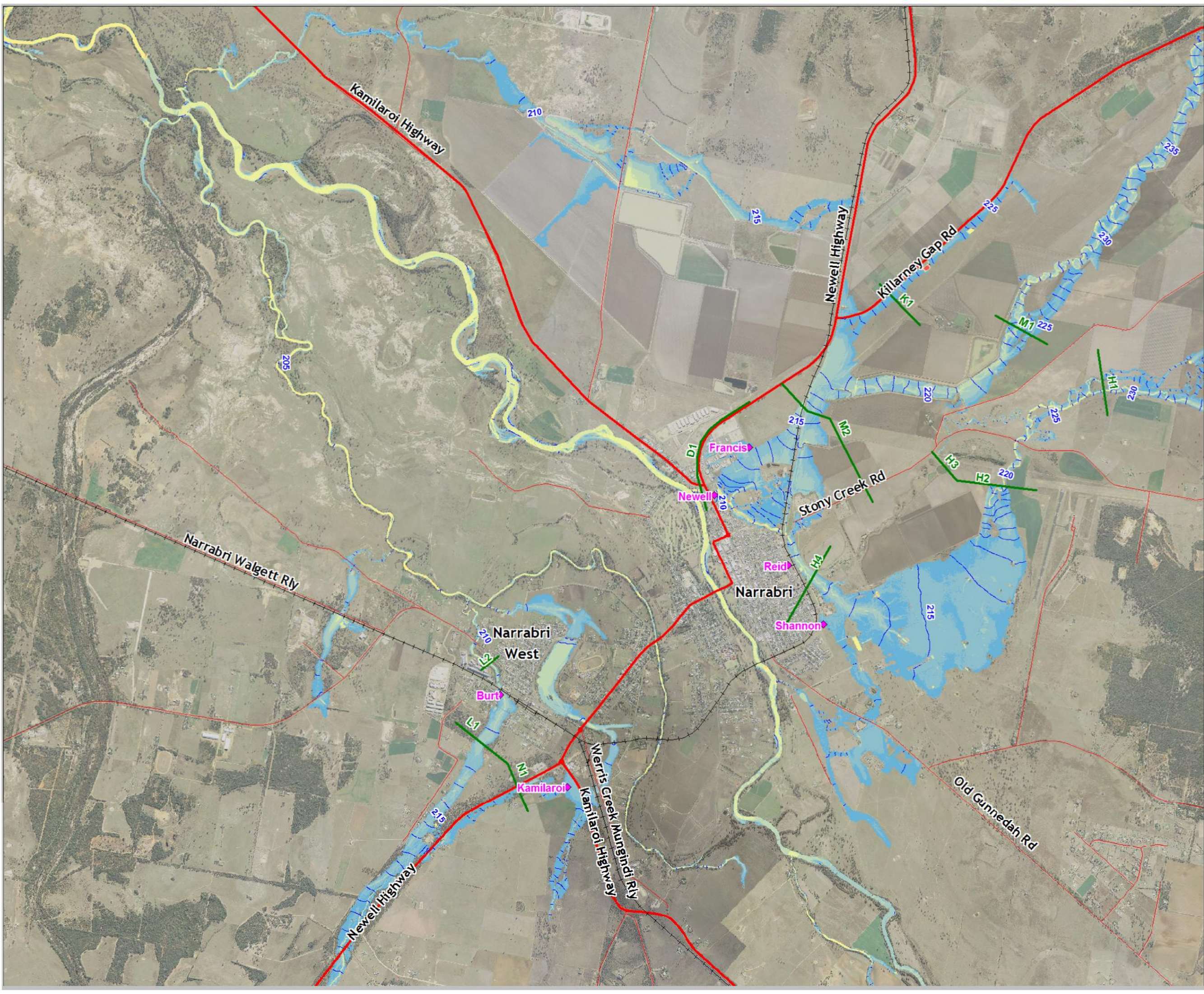
>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.1:
Predicted Flood Extent,
Level and Depth
Regional 20% AEP Event

WRM
water + environment

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Legend

- Highway
- Local Road
- Rail
- Water Level Contour (0.5 m)
- Discharge Reporting Location
- Water Level Reporting Location

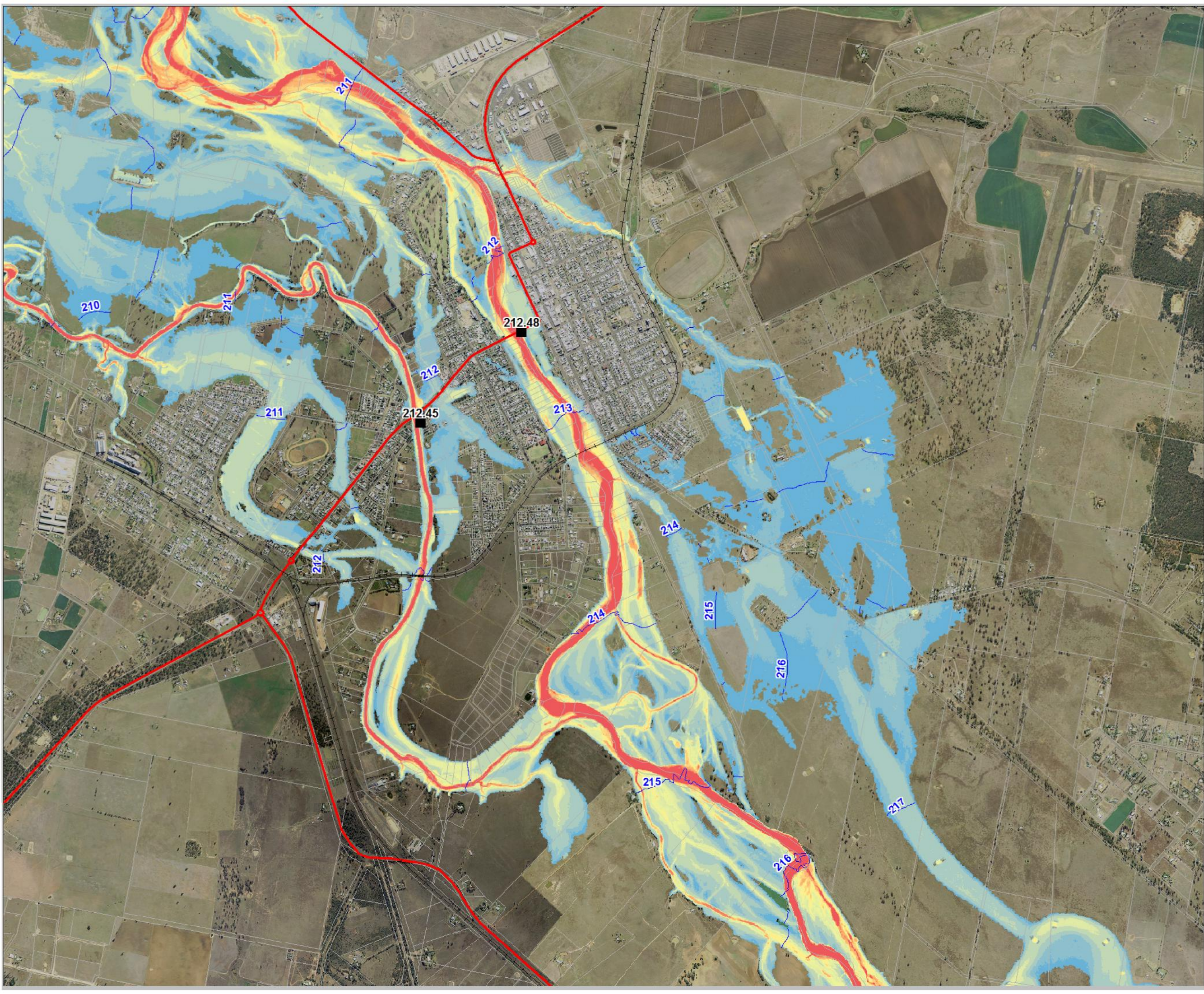
Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.2:
Predicted Flood Extent,
Levels and Depth
Local 20% AEP Event

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Legend

- Cadastral
- Rail
- Highway
- Streamgauge
- Water Level Contour (1.0 m)

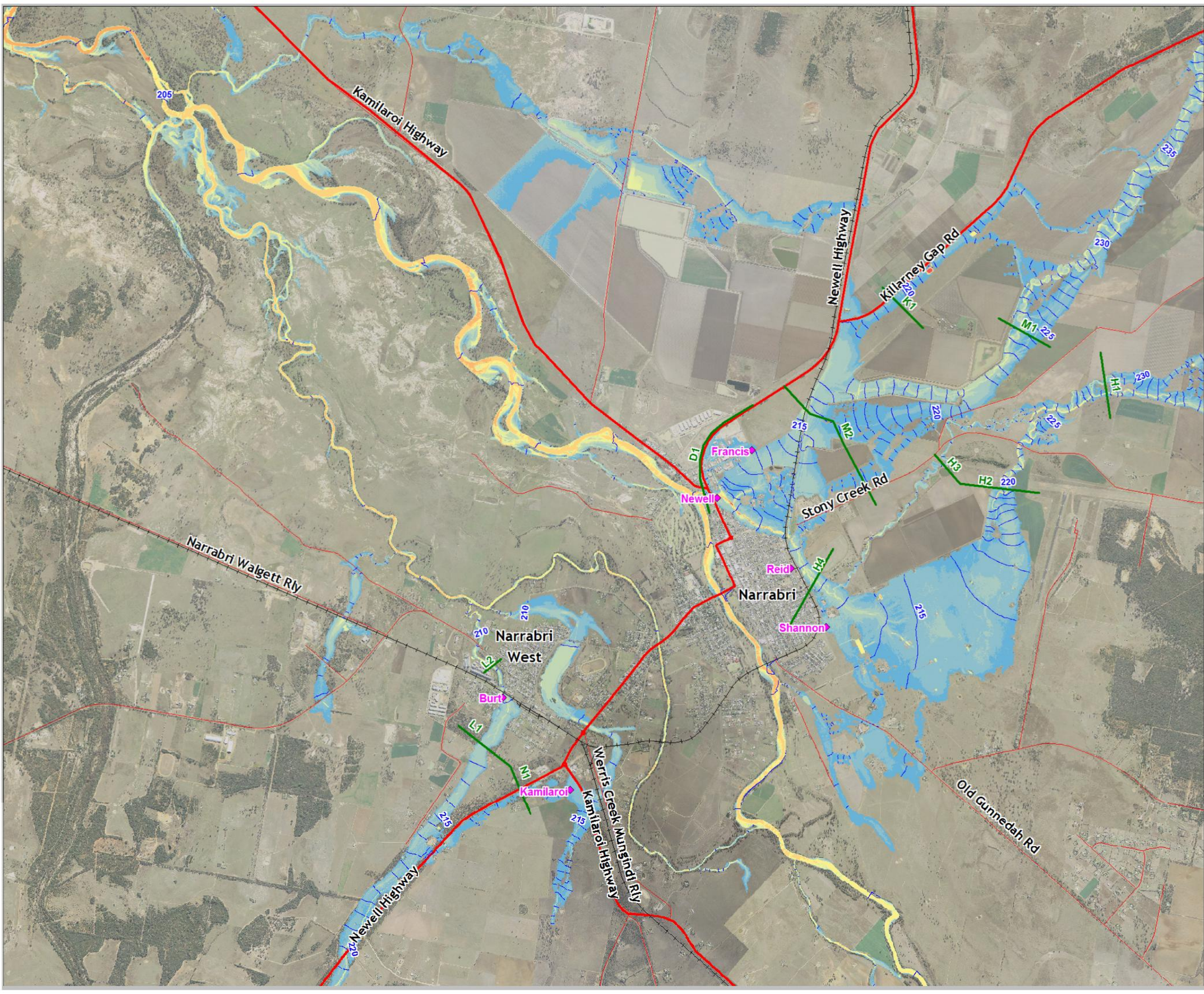
Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.3:
Predicted Flood Extent,
Level and Depth
Regional 10% AEP Event

WRM endeavours to ensure that the information presented on this map is correct at the time of publication. WRM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained on this map.



Legend

- Highway
- Local Road
- Rail
- Water Level Contour (0.5 m)
- Discharge Reporting Location
- Water Level Reporting Location

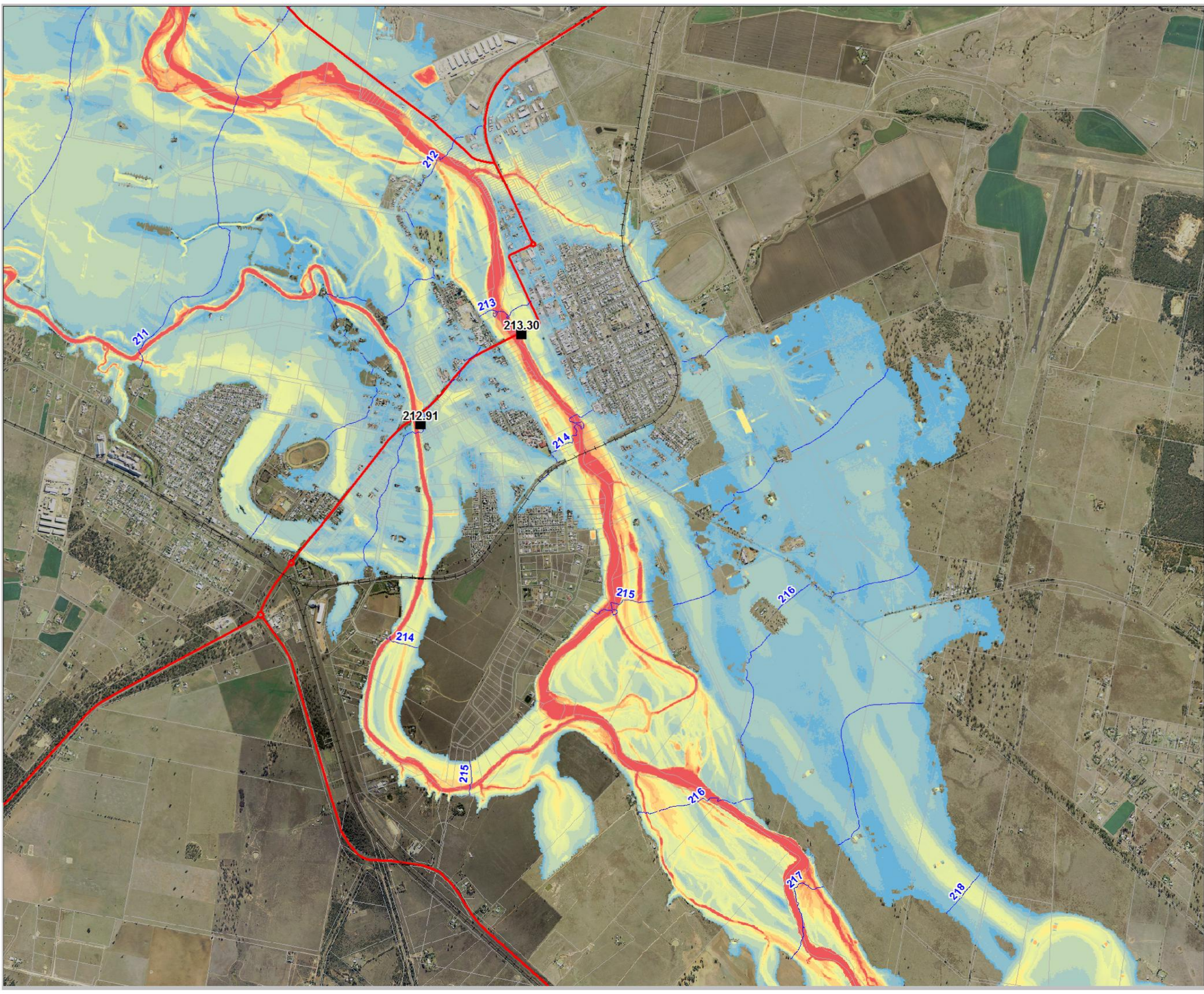
North arrow and scale bar (0 to 2 kilometres).

Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.4:
Predicted Flood Extent,
Levels and Depth
Local 10% AEP Event



Legend

- Cadastre
- Rail
- Highway
- Streamgauge
- Water Level Contour (1.0 m)

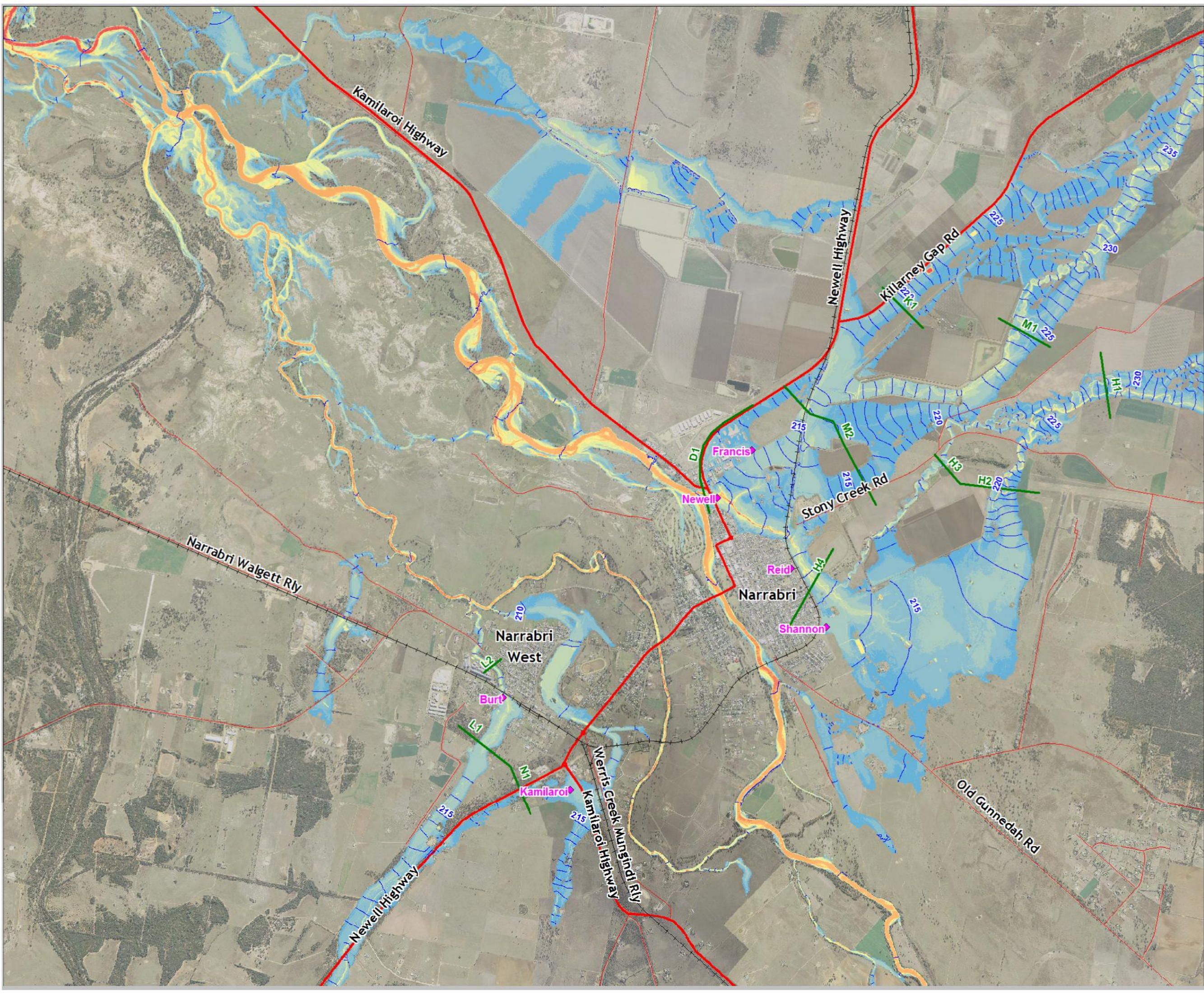
Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

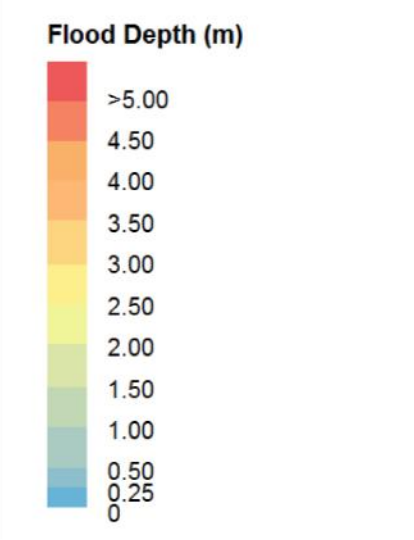
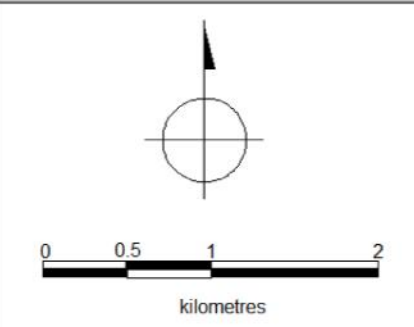
NARRABRI FLOOD STUDY

Figure B.5:
Predicted Flood Extent,
Level and Depth
Regional 5% AEP Event

WRM endeavours to ensure that the information presented on this map is correct at the time of publication. WRM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained on this map.

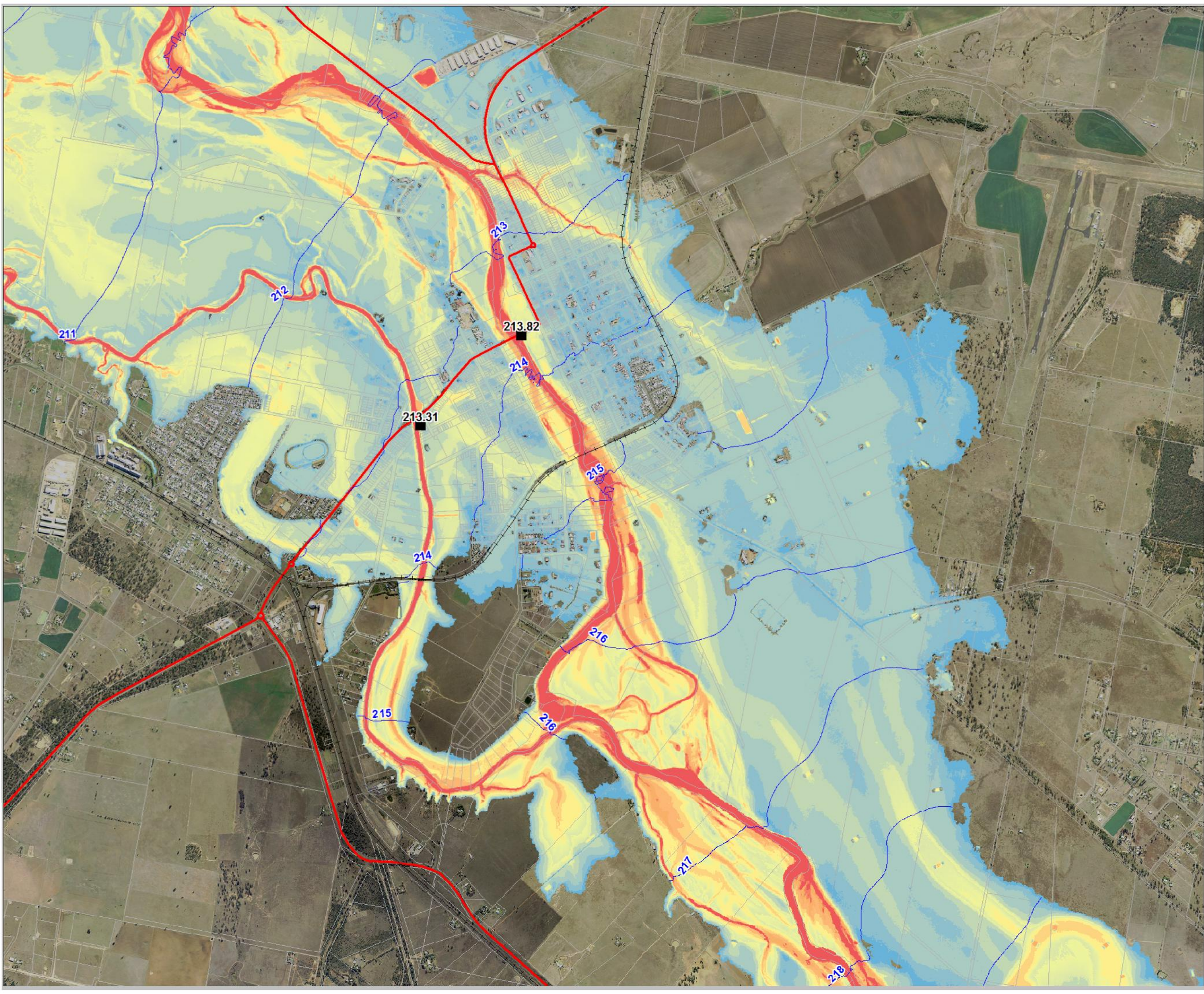


- Legend**
- Highway
 - Local Road
 - Rail
 - Water Level Contour (0.5 m)
 - Discharge Reporting Location
 - Water Level Reporting Location



NARRABRI FLOOD STUDY

Figure B.6:
Predicted Flood Extent,
Levels and Depth
Local 5% AEP Event



Legend

- Cadastre
- Rail
- Highway
- Streamgauge
- Water Level Contour (1.0 m)

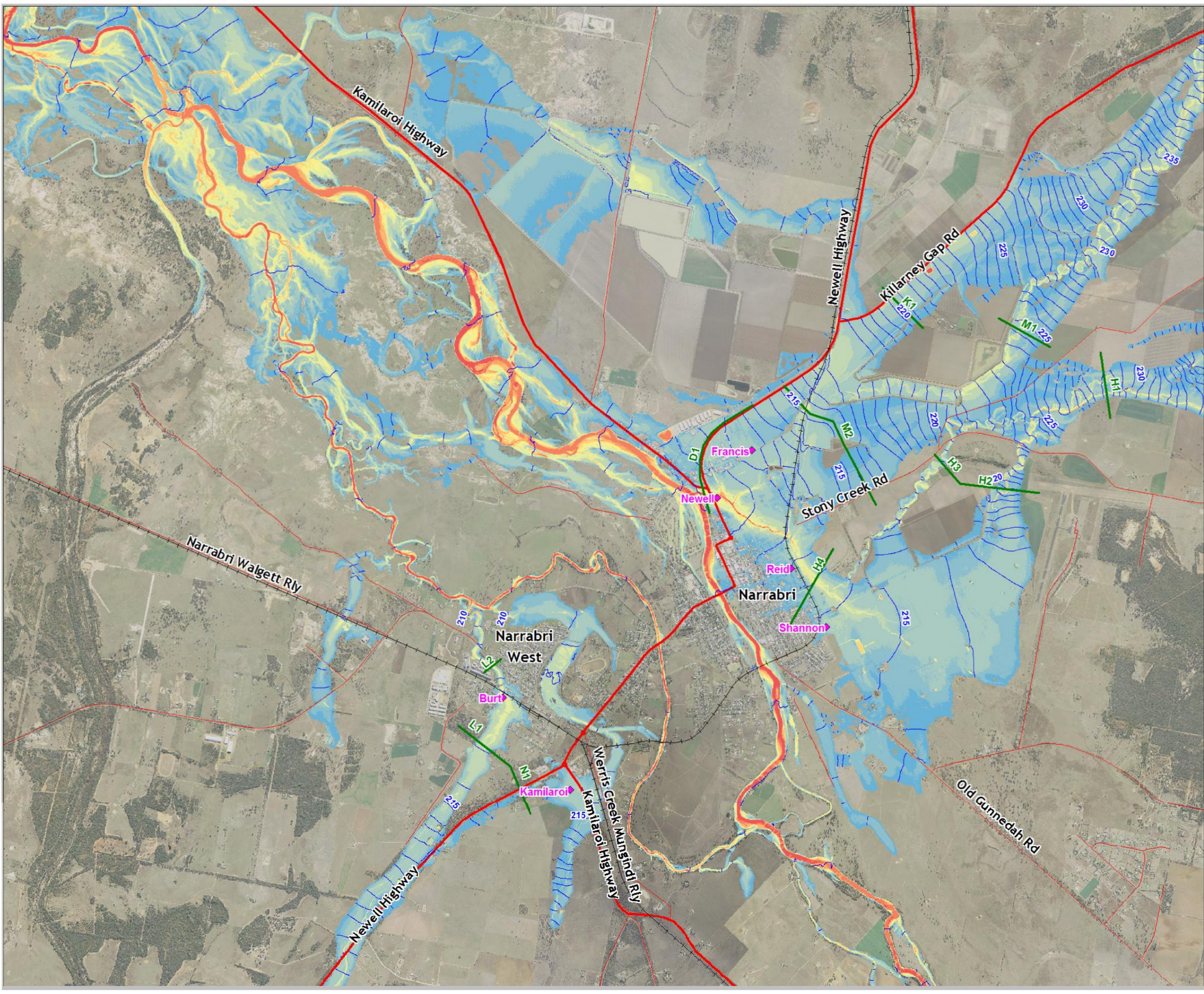
Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.7:
Predicted Flood Extent,
Level and Depth
Regional 2% AEP Event

WRM endeavours to ensure that the information presented on this map is correct at the time of publication. WRM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained on this map.



Legend

- Highway
- Local Road
- Rail
- Water Level Contour (0.5 m)
- Discharge Reporting Location
- Water Level Reporting Location

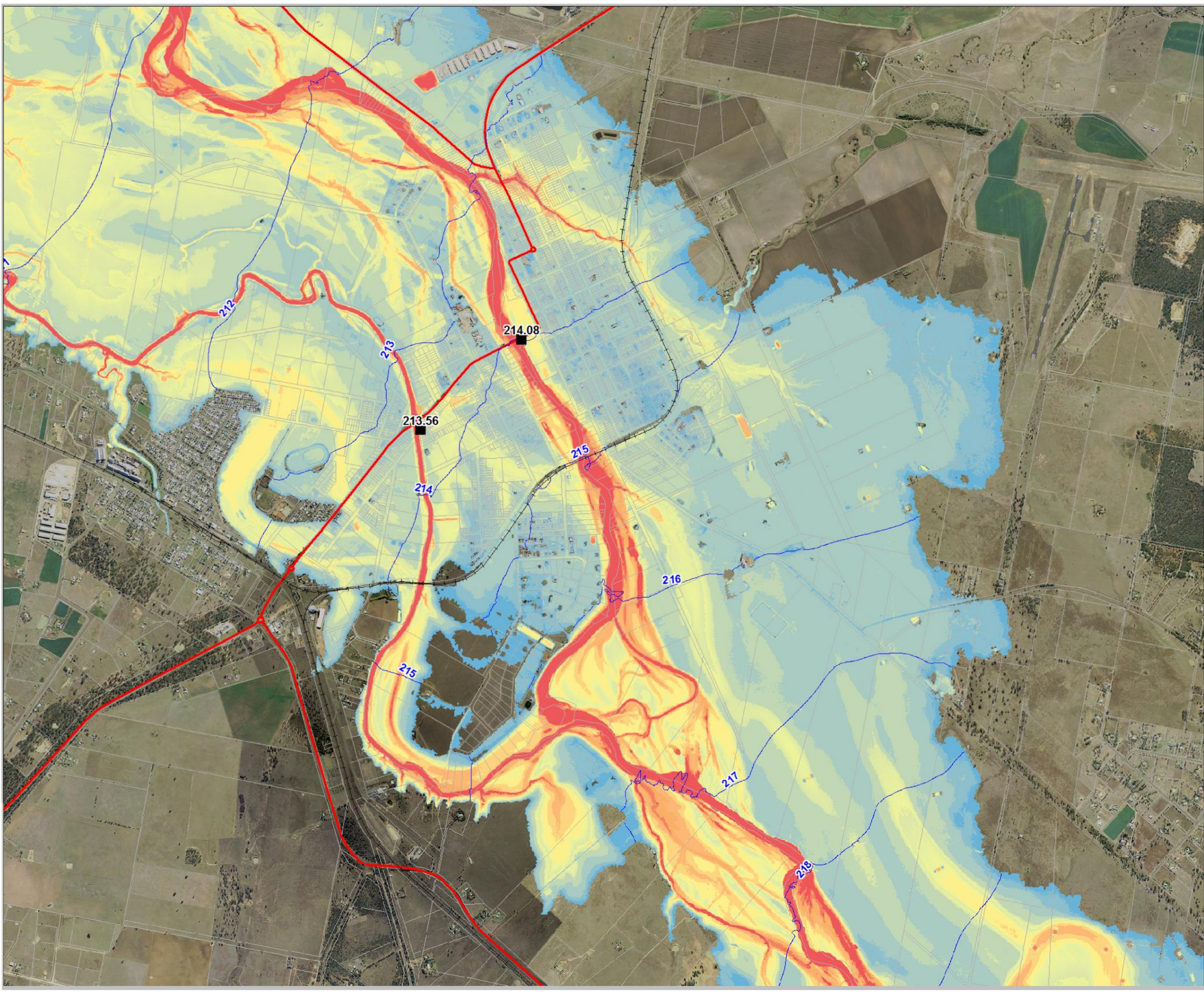
0 0.5 1 2
kilometres

Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.8:
Predicted Flood Extent,
Levels and Depth
Local 2% AEP Event



Legend

- Cadastre
- Rail
- Highway
- Streamgauge
- Water Level Contour (1.0 m)

North arrow pointing up.

Scale bar: 0, 250, 500, 1000 metres

Flood Depth (m)

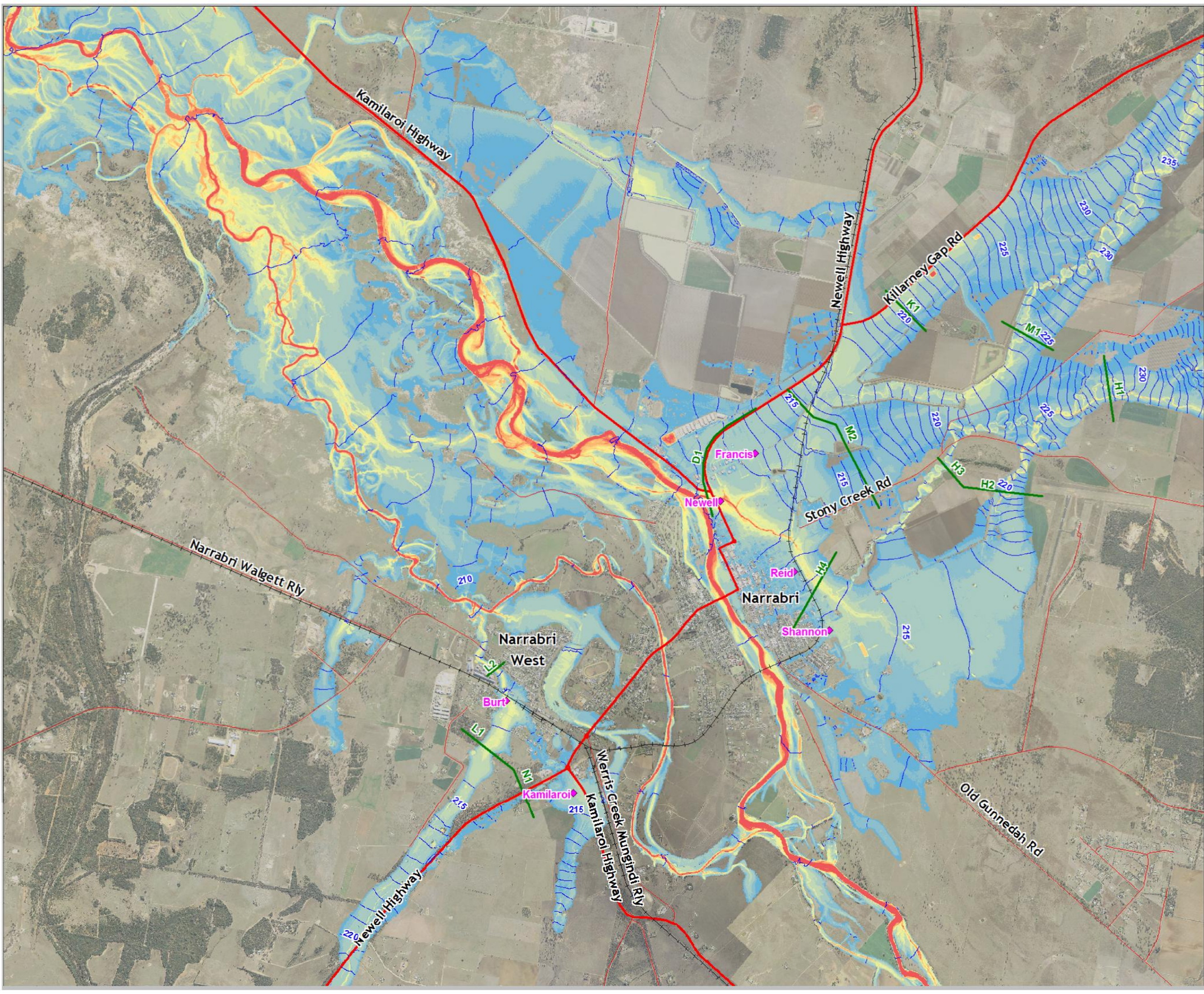
>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.9:
Predicted Flood Extent,
Level and Depth
Regional 1% AEP Event


WRM
water + environment

WRM endeavours to ensure that the information presented on this map is correct at the time of publication. WRM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained on this map.



Legend

- Highway
- Local Road
- Rail
- Water Level Contour (0.5 m)
- Discharge Reporting Location
- Water Level Reporting Location

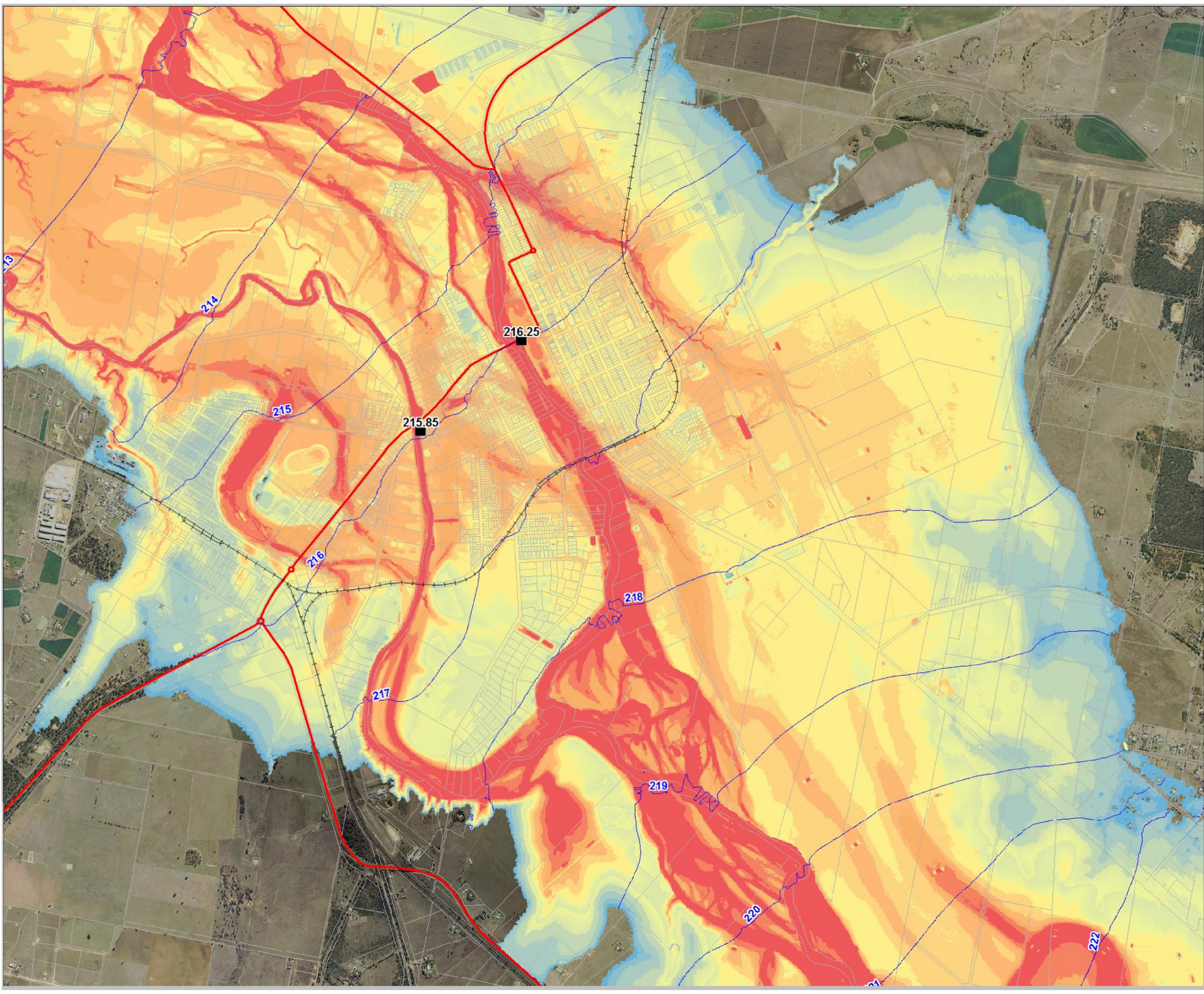
Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

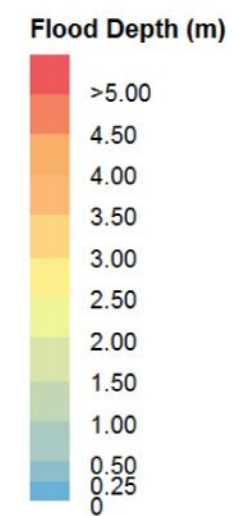
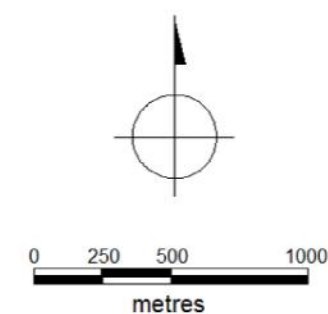
NARRABRI FLOOD STUDY

Figure B.10:
Predicted Flood Extent,
Levels and Depth
Local 1% AEP Event

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- Legend**
- Cadastre
 - Rail
 - Highway
 - Streamgauge
 - Water Level Contour (1.0 m)

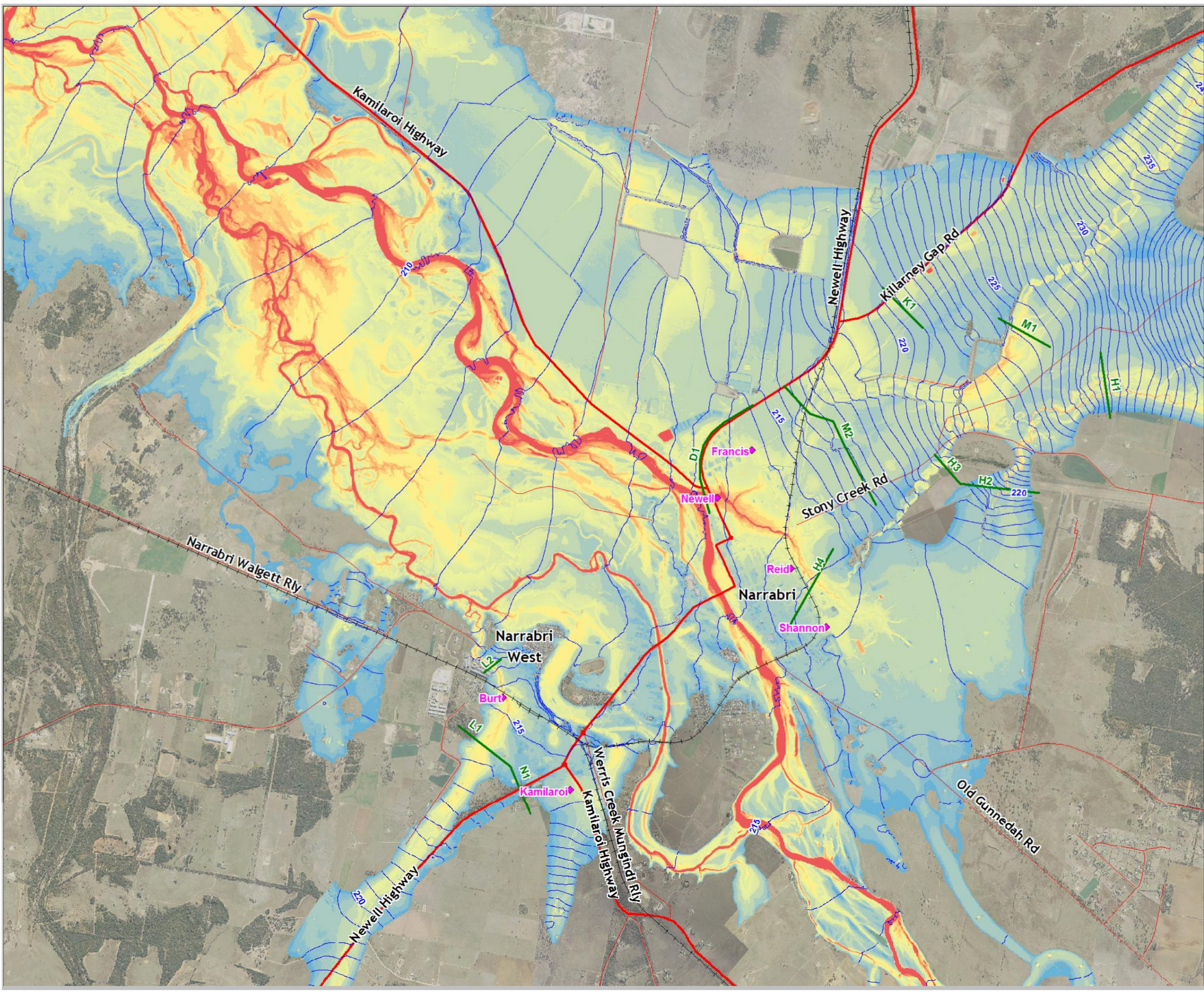


NARRABRI FLOOD STUDY

Figure B.11:
Predicted Flood Extent,
Level and Depth
Regional Extreme Flood



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Legend

- Highway
- Local Road
- Rail
- Water Level Contour (0.5 m)
- Discharge Reporting Location
- Water Level Reporting Location

North arrow and scale bar (0 to 2 kilometres).

Flood Depth (m)

>5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.25
0

NARRABRI FLOOD STUDY

Figure B.12:
Predicted Flood Extent,
Levels and Depth
Local PMF Event



golder.com

Mr Zaed Aznam
ITP Development
Project Manager – Planning
PO Box 6127
O'Connor, ACT 2602



RED-GUM
Environmental Consulting



By email on 12/03/2021 to zaznam@itpau.com.au

***Re: Biodiversity inspection report –Narrabri 3A 5MW Solar Farm, 11498 Newell
Highway Narrabri, NSW***

Dear Zaed,

Thank-you for the opportunity to assist with the project. Please be advised that in this engagement, I am assuming the role of your Ecological Consultant and Biodiversity Assessment Method (BAM) Accredited Assessor. I confirm that I am listed on the Biodiversity Assessment Method (BAM) Accredited Person database.

Desk-top review

Database searches concluded that the likely Plant Community Type (PCT) adjacent to the area is either PCT 397 (Poplar Box - White Cypress Pine shrub grass tall woodland), PCT 398 (Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest) or PCT 35 (Brigalow - Belah open forest / woodland on alluvial often gilgaied clay). Aerial photography confirmed that as at 22/2/2021 the entire site is likely cleared of native shrubs and trees, but native grasses may persist under a likely grazing regime (i.e. nil cropping evident on 100% of the development area).

EPBC Protected Matters Online Search Tool

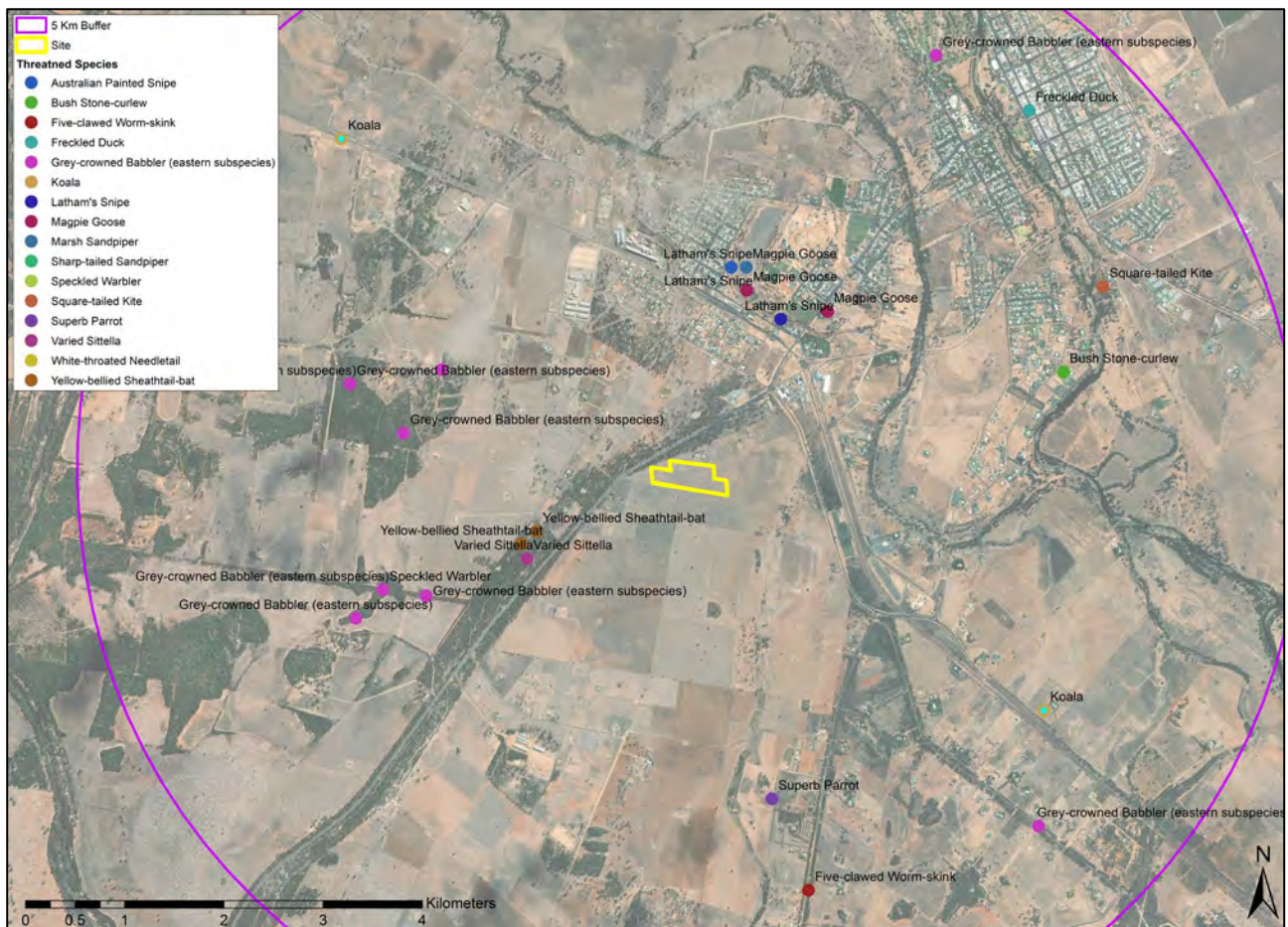
Consultation with the EPBC Protected Matters Online Search Tool searched a 5km radius of the site area for threatened **Flora** and **Vegetation Communities** returning 4 threatened species and 6 threatened communities. Of which there were 3 Vulnerable, 2 Critically Endangered and 5 Endangered species whose habitat may occur within that specified geographic range. **Table 1** considers their likelihood of occurring in the proposed site. Consultation with the same online database for threatened **Fauna** in the same geographic range returned 15 Vulnerable, 18 Migratory, 4 Endangered and 4 Critically Endangered species. **Table 2** considers their likelihood of occurring in the proposed site.

NSW BioNet (The Atlas of NSW Wildlife)

Consultation with NSW BioNet (The Atlas of NSW Wildlife) for listed **Flora** considered threatened in NSW, returned 3 Vulnerable and 1 Endangered species recorded within 10km by 10km radius of the site (**Map 1**). These species were not recorded on site during the inspection period and are considered unlikely to be present due to a lack of suitable habitat and structure. Consultation with the same online database for threatened **Fauna** in the same geographic range returned 16 species records, 9 Vulnerable, 3 Endangered, 2 CAMBA, JAMBA, ROKAMBA, 1 JAMBA, ROKAMBA and 1 CAMBA, JAMBA, ROKAMBA. **Table 3** considers their likelihood of occurring in the proposed site.

Biodiversity Values Map and Threshold Tool

The Biodiversity Offsets Scheme Threshold (BOSET) is a test used to determine when is necessary to engage an accredited assessor to apply the Biodiversity Assessment Method (the BAM) to assess the impacts of a proposal. A search conducted on 26/2/21 revealed that the project site does not intersect any areas mapped as possessing 'Biodiversity Values' (**Attachment 4**).



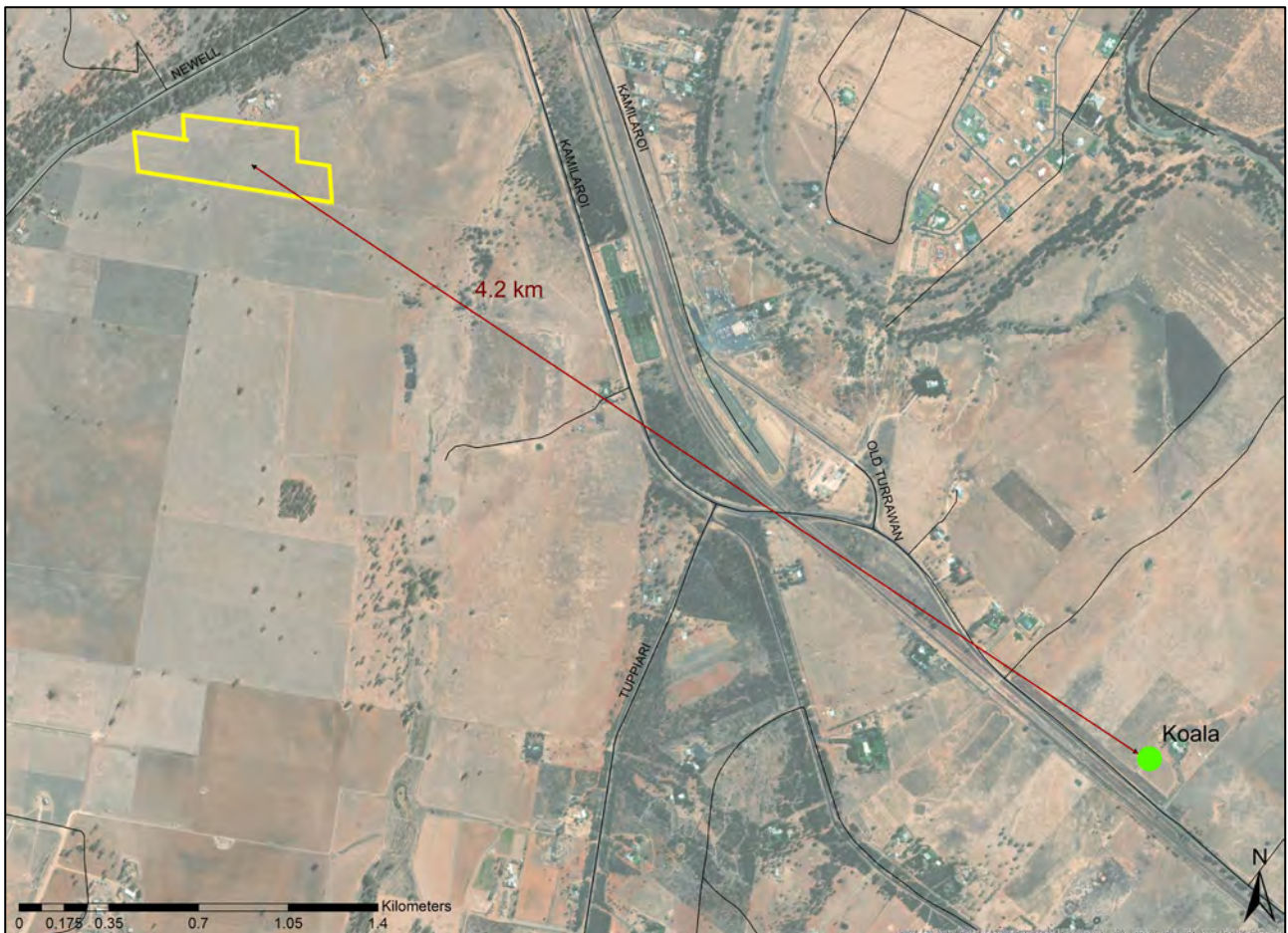
Map 1: Recorded threatened species, NSW BioNET. Data download, 21/2/21

Koala Assessment

In 2018, the then Office of Environment & Heritage (now DPIE) produced ‘A review of koala tree use across New South Wales’ which assessed evidence of koala tree use, for whatever purpose, across New South Wales. The study was intended as a platform to inform the predictive modelling of koala tree species and to contribute to a koala habitat suitability information base and importantly, the data collected for the seven (7) Koala Management Areas (KMAs) (after Phillips 2000 & DECC 2008) ‘allows for a bottom-up consideration of a fundamental driver of koala habitat selection – local tree use patterns and tree associations’ (OEH, 2018).

The assessment site at Narrabri is in the Western Slopes and Plains KMA in which the study identified 19 tree species regularly used by Koalas, including 13 eucalypts (24% of 54 with >9 BioNet VIS records) and six (6) non-eucalypts. All eucalypts used were from *Symphyomyrtus* sub-genus (Trees or mallees; bark smooth, exfoliating in small or large flakes or ribbons, or persistent, shortly fibrous-flaky, fibrous, or shortly fibrous and heavily impregnated with kino).

Pre-inspection database searches revealed two (2) sightings of Koala (*Phascolarctos cinereus*) within a 5km buffer of the site, with the closest being 4.2 km to the south east along the Kamilaroi Highway adjacent to a heavily vegetated roadside corridor (**Map 2**). It is likely that the record coordinate was of the location the recorded ‘spotted’ the Koala and not the actual location of the individual itself. It is entirely feasible that Koala could be using the roadside corridor on the western boundary of the site, however none have been recorded in that zone previously.



Map 2: Nearest Recorded Koala sighting, NSW BioNET. Data download, 21/2/21

Site inspection

Site inspection on 24/2/2021 was conducted mid-morning, conditions were clear and 18°C. The designated 'clear zone' was thoroughly inspected in accordance with *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011)*. I confirm that the proposed area for development will not see the loss of >1 ha of native grass or any dead or alive remnant trees. The following observations were made at the time of inspection:

1. If any threatened native fauna (birds) are present in the surrounding connected native vegetation (in particular Grey-crowned Babbler & Superb Parrot) they were not recorded during survey on the loss site on 24/2/2021 and the nesting period for these species is closed (both typically breed between June and December) meaning that the possibility of harming a fledgling is unlikely.
2. The site is a highly modified grazing paddock with some native grasses present and an obvious history of pastoralism and or cultivation;
3. No threatened species, scats or other evidence of the use of this zone or the development site were recorded during the survey effort.
4. No Koalas, scats or other evidence of use of this zone or the development site were recorded during the survey effort.
5. The remnant vegetation on the roadside on the western boundary is of High Conservation Value (HCV) and impacts to this zone by the proposed access have been minimized by use of an existing gravel track to the property boundary off the highway. This zone is potential Koala habitat.

Summary of Findings

Red-Gum contends that the project requires <1 ha clearance of native grass and zero remnant native trees. The proposed activities are unlikely to have an adverse effect on the foraging ability or the life cycle of threatened species that may be opportunistically using the site or surrounding areas.

The small amount of native grass that will be impacted by the development will not endanger or have a significant effect on any existing native vegetation, habitats within the site, or fauna species that may be using the site.

This project will not displace any rare or threatened species, however it is likely that a number of threatened and declining bird species and Koala may be using the area to the south and along the heavily wooded road reserve on the western boundary, hence the construction activities may prove to disturb foraging activities for a short period.

The area assessed was largely exotic species and pasture grasses, with many species commonly regarded as 'highly invasive' in more natural woodland settings – like that to the west in the road reserve. While the proposed works are unlikely to introduce noxious weeds, vermin, feral species or genetically modified organisms into an area, the movement of vehicles, plant, equipment and people on and off the subject site/s has the potential to introduce such impacts. Wherever possible, removal of weeds should be undertaken prior to seed developing, which for most species occurs during the warmer months (i.e. summer).

The typical home ranges of Koalas are from 2ha of connected vegetation to hundreds of hectares. Koala feed almost exclusively on a few preferred tree species which are of primary and secondary importance. The occurrence of both primary and secondary tree species varies widely on a regional, local and even a seasonal basis, meaning that koalas are unevenly distributed across their range. In the study area, primary food tree species are River red gum (*E. camaldulensis*) and Coolabah (*E. coolabah*) with secondary food tree species including Dirty (or Baradine) gum (*E. chloroclada*), Blakely's red gum (*E. blakelyi*), *E. camaldulensis*, Poplar or Bimble box (*E. populnea*), white box (*E. albens*), and *Callitris glaucophylla*.

No viable food sources are present in the development area. Importantly, there are numerous core vegetation areas surrounding the site which represent areas of viable Koala habitat. The site is highly unlikely to be traversed or used by the species who are much more likely to stay within the connected canopy of the roadside vegetation corridor.

I am of the opinion that the activities as proposed will not have a significant effect on any threatened species and ecological communities and/or their conservation as noted within this assessment.

Recommendations

By way of a clearing process that minimizes the risk to threatened species that may be opportunistically using the site, I recommend:

- I. Construction limits and exclusion zones clearly identified prior to work;
- II. A visual inspection is conducted by environmental staff before construction commences to identify any areas of site that might be supporting native fauna;
- III. Vehicle movements around the site will be restricted to the construction footprint and away from any existing planted trees and flagging exclusion fencing to be installed.
- IV. Soil disturbance by vehicle and pedestrian access is to be kept to a minimum outside the construction footprint.

- V. Any weeds removed (particularly those bearing seeds) are to be disposed of appropriately at the nearest waste management facility.

Regards



Mr Damian Wall

Managing Director

BAppSc, MEnvMgt, GradCert CHM, MAACAI

12/3/21

Attachment 1: Database Search Results v Likelihood Tables

¹ Five categories for the 'likelihood of occurrence' of species has been used. The categories are based on recorded sightings listed in credible databases, the presence or absence of suitable habitat, other features of the site, results of the field survey and professional judgement. The 5 categories are:

'Yes'	The species/community was or has been observed on the site.
'Likely'	A medium to High probability that a species uses the site
'Potential'	A suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as 'likely' or 'unlikely' to occur.
'Unlikely'	A Very Low to Low probability that a species uses the site.
'No'	Habitat on the site and in the vicinity is unsuitable for the species.

Table 1: EPBC Protected Matters Database results – Flora (5km x 5km)

Species	Preferred Habitat	EPBC Act Status	Likelihood ¹
White Box-Yellow Box Blakely's Red-Gum Grassy Woodland and Derived Native Grassland		Critically Endangered	No
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia		Endangered	No
Poplar Box Grassy Woodland on Alluvial Plains		Endangered	No
Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and Southern Queensland.		Critically Endangered	No
Weeping Myall Woodlands		Endangered	No
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions.		Endangered	No
<i>Cadellia pentastylis</i> - Ooline	Strong correlation between the presence of Ooline and low- to medium-nutrient soils of sandy clay or clayey consistencies	Vulnerable	No
<i>Dichanthium setosum</i> - Bluegrass	Disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	Vulnerable	No
<i>Androcalva procumbens</i>	Grows in sandy sites, often along roadsides.	Vulnerable	No
<i>Tylophora linearis</i>	Grows in dry scrub and open forest.	Endangered	No

Table 2: EPBC Protected Matters Database results – Fauna (5km x 5km)

Species	Preferred Habitat	EPBC Act Status	Likelihood ¹
Birds			
<i>Anthochaera hrygia</i> – Regent Honeyeater	Dry open forest and woodlands on inland slopes and valleys particularly Box Woodlands.	Critically Endangered	Unlikely
<i>Hirundapus caudacutus</i> - White-throated Needletail	Feed, drink and rest on the wing in large groups. May rest at night in forested country.	Vulnerable	No
<i>Falco hypoleucos</i> Grey Falcon	Usually restricted to shrubland, grassland and wooded watercourses of arid regions	Vulnerable	No
<i>Rostratula australis</i> - Australian Painted Snipe	Margins of densely vegetated swamps and wetlands	Endangered	No
<i>Botaurus poiciloptilus</i> – Australasian Bittern	Found in wetlands with tall, dense vegetation, favours permanent freshwater habitats.	Endangered	No
<i>Calidris ferruginea</i> – Curlew Sandpiper	Occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons	Critically Endangered	No
<i>Polytelis swainsonii</i> – Superb Parrot	Mainly inhabits forests and woodlands dominated by eucalypts.	Vulnerable	Unlikely
<i>Leipoa ocellata</i> – Malleefowl	Predominantly inhabit mallee communities, with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey.	Vulnerable	No
<i>Grantiella picta</i> – Painted Honeyeater	Inhabits Boree/ Weeping Myall (<i>Acacia pendula</i>), Brigalow and Box-Gum Woodlands	Vulnerable	No
Fish			
<i>Maccullochella peelii peelii</i> – Murray Cod	Slow flowing turbid rivers and billabongs.	Vulnerable	No
Mammals			
<i>Dasyurus maculatus</i> – Spot-tailed Quoll	Mature wet forest habitat in areas with rainfall 600 mm/year	Endangered	No
<i>Nyctophilus corbeni</i> – Corben's Long-eared Bat	Mallee, bullock Allocasuarina and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine.	Vulnerable	No
<i>Pteropus poliocephalus</i> – Grey-headed Flying-fox	Requires foraging resources and roosting sites.	Vulnerable	No
<i>Phascolarctos cinereus</i> – Koala	Temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by Eucalyptus species	Vulnerable	Unlikely
<i>Pseudomys pilligaensis</i> - Pilliga Mouse	Restricted to low-nutrient deep sand soils which are recognised as supporting a distinctive vegetation type referred to as the Pilliga Scrub.	Vulnerable	No
<i>Chalinolobus dwyeri</i> – Large -eared Pied Bat	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin.	Vulnerable	No
Reptiles			
<i>Aprasia parapulchella</i> – Pink-tailed Worm-lizard	Small rocks (15–60 cm basal area) shallowly embedded in the soil.	Vulnerable	No
<i>Anomalopus mackayi</i> – Five-clawed Worm-skink.	Lower slopes of slight rises in grassy White Box woodland on moist black soils, and River Red Gum-Coolibah-Bimble Box woodland on deep cracking loose clay soils.	Vulnerable	No
Migratory Marine Birds			
<i>Apus pacificus</i> – Fork-tailed Swift	Spend most their life airborne. Build their nests on cliffs.	Migratory	No
Migratory Terrestrial Birds			
<i>Hirundapus caudacutus</i> – White-throated Needletail	Feed, drink and rest on the wing in large groups. May rest at night in forested country.	Vulnerable	No

Species	Preferred Habitat	EPBC Act Status	Likelihood ¹
<i>Motacilla flava</i> – Yellow Wagtail	Found in short grass, bare ground, swamp margins, sewage ponds and town lawns.	Migratory	No
<i>Myiagra cyanoleuca</i> – Satin Flycatcher	Tall wet eucalypt forests of SE Australia.	Migratory	No
<i>Rhipidura rufifrons</i> – Rufous Fantail	Rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground.	Migratory	No
Migratory Wetland Birds			
<i>Calidris ferruginea</i> – Curlew Sandpiper	Occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons	Critically Endangered	No
<i>Gallinago hardwickii</i> – Latham's Snipe	Freshwater swamps and marshes as well as salt marshes and mud flats	Migratory	No
<i>Actitis hypoleucos</i> – Common Sandpiper	Found in coastal or inland wetlands, both saline or fresh.	Migratory	No
<i>Calidris acuminata</i> - Sharp-tailed Sandpiper	Prefers the grassy edges of shallow inland freshwater wetlands.	Migratory	No
<i>Calidris melanotos</i> – Pectoral Sandpiper	Prefers the grassy edges of shallow inland freshwater wetlands.	Migratory	No
Listed Marine Birds			
<i>Apus pacificus</i> – Fork-tailed Swift	Spend most their life airborne. Build their nests on cliffs.	Migratory	No
<i>Ardea ibis</i> – Cattle Egret	Shallow water and open dry grassy habitats	Migratory	No
<i>Ardea alba</i> – Great Egret	Wetland habitats, inland and coastal, freshwater and saline, permanent and ephemeral water.	Migratory	No
<i>Rostratula benghalensis (sensu lato)</i> – Painted Snipe	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands	Endangered	No
<i>Hirundapus caudacutus</i> – White-throated Needletail	Feed, drink and rest on the wing in large groups. May rest at night in forested country.	Vulnerable	No
<i>Motacilla flava</i> – Yellow Wagtail	Found in short grass, bare ground, swamp margins, sewage ponds and town lawns.	Migratory	No
<i>Myiagra cyanoleuca</i> – Satin Flycatcher	Tall wet eucalypt forests of SE Australia.	Migratory	No
<i>Calidris ferruginea</i> - Curlew Sandpiper	Occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons	Critically Endangered	No
<i>Gallinago hardwickii</i> - Latham's Snipe	Freshwater swamps and marshes as well as salt marshes and mud flats	Migratory	No
<i>Haliaeetus leucogaster</i> - White-bellied Sea-Eagle	Surface waters along coasts, islands, inlets also along larger inland rivers and lakes.	Migratory	No
<i>Merops ornatus</i> - Rainbow Bee-eater	Occurs in open woodlands, shrublands, grasslands and forests including riparian areas.	Migratory	Unlikely
<i>Actitis hypoleucos</i> - Common Sandpiper	Found in coastal or inland wetlands, both saline or fresh.	Migratory	No
<i>Calidris acuminata</i> - Sharp-tailed Sandpiper	Grassy edges of shallow inland freshwater wetlands.	Migratory	No
<i>Calidris melanotos</i> – Pectoral Sandpiper	Prefers shallow fresh to saline wetlands.	Migratory	No
<i>Chrysococcyx osculans</i> - Black-eared Cuckoo	Found in drier country where species such as mulga and mallee form open woodlands	Migratory	Unlikely
<i>Rhipidura rufifrons</i> - Rufous Fantail	Rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground.	Migratory	No

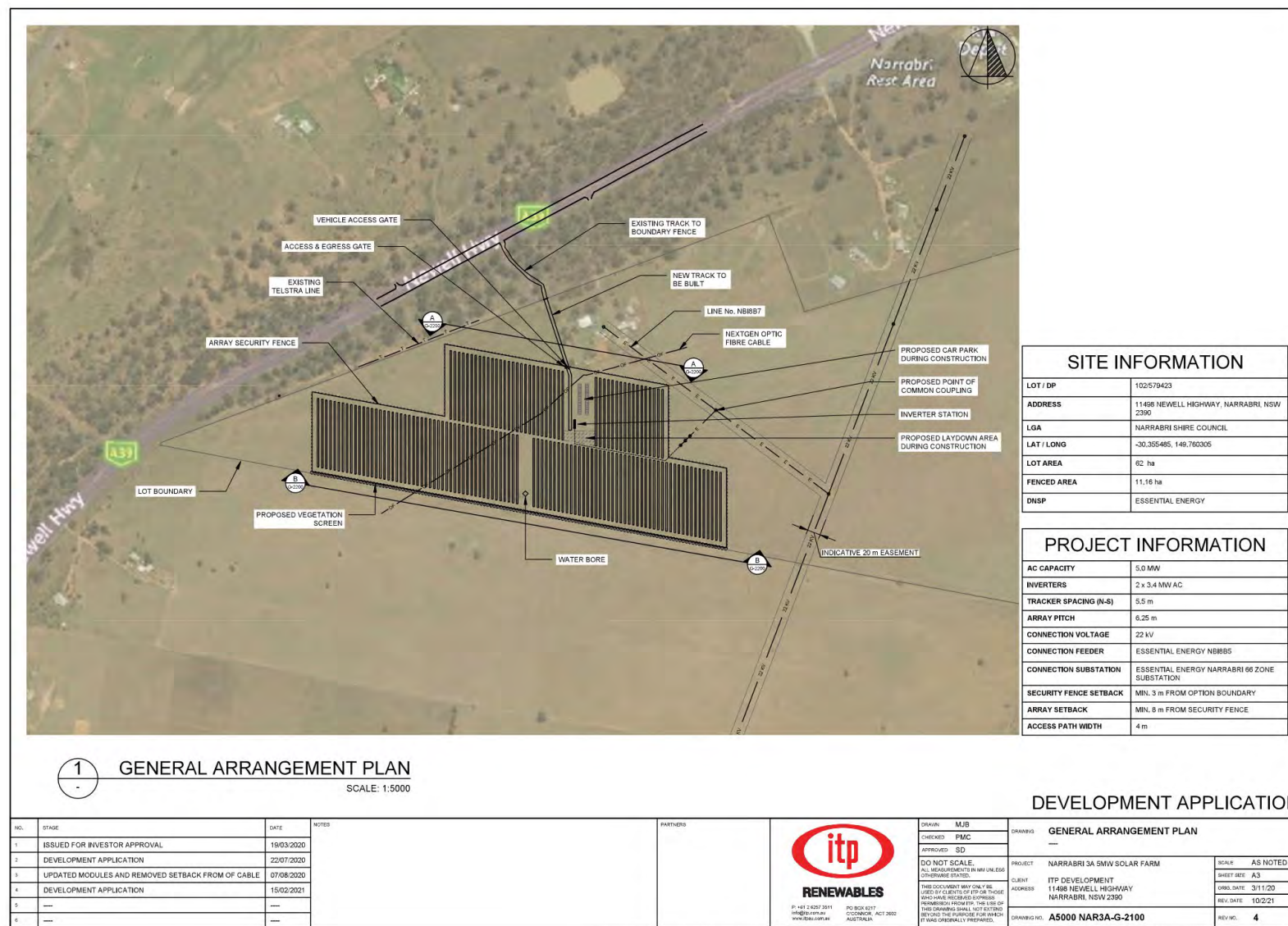
Table 3: BioNet Atlas of NSW Wildlife – Fauna (10km x 10km)

Species	Preferred Habitat	BC Act Status	Likelihood ¹
Aves			
Suburb parrot <i>Polytelis swainsonii</i>	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. Nest in the hollows of large trees.	Vulnerable	Unlikely
<i>Chthonicola sagittata</i> - Speckled warbler	Found in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies.	Vulnerable	No
<i>Anseranas semipalmata</i> - Maggie Goose	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges.	Vulnerable	No
<i>Stictonetta naevosa</i> - Freckled Duck	Prefers permanent fresh water swamps and creeks with heavy growth of cumbungi (bullrushes), lignum or tea-tree.	Vulnerable	No
<i>Hirundapus caudacutus</i> - White-throated Needletail	Feed, drink and rest on the wing in large groups. May rest at night in forested country.	CAMBA, JAMBA, V, K	No
<i>Lophoictinia isura</i> - Square-tailed Kite	Dry woodlands and open forests. Shows a particular preference for timbered watercourses.	Vulnerable	No
<i>Burhinus grallarius</i> - Bush Stone-curlew	Largely confined to grassy woodlands and farmland.	Endangered	No
<i>Rostratula australis</i> - Australian Painted Snipe	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Endangered	No
<i>Calidris acuminata</i> – Sharp-tailed Sandpiper	Prefers the grassy edges of shallow inland freshwater wetlands.	CAMBA, JAMBA, ROKAMBA	No
<i>Gallinago hardwickii</i> - Latham's Snipe	freshwater wetlands on or near the coast, generally among dense cover.	JAMBA, ROKAMBA	No
<i>Tringa stagnatilis</i> - Marsh Sandpiper	Fresh or brackish (slightly salty) wetlands such as rivers, water meadows, sewage farms, drains, lagoons and swamps.	CAMBA, JAMBA, ROKAMBA	No
<i>Pomatostomus temporalis</i> <i>temporalis</i> - Grey-crowned Babbler (eastern subspecies)	Open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains.	Vulnerable	Unlikely
<i>Daphoenositta chrysoptera</i> - Varied Sittella	Found in eucalypt woodlands and forests, prefer rough-barked trees like stringybarks and ironbark's or mature trees with hollows or dead branches.	Vulnerable	No
Mammalia			
<i>Phascolarctos cinereus</i> - Koala	Temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by Eucalyptus species	Vulnerable	Unlikely
<i>Pteropus poliocephalus</i> - Grey-headed Flying-fox	Requires foraging resources and roosting sites	Vulnerable	No
<i>Saccolaimus flaviventris</i> - Yellow-bellied Sheath-tail- bat	Roosts in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	Vulnerable	No
Reptilia			
<i>Anomalopus mackayi</i> - Five- clawed Worm-skink	Lower slopes of slight rises in grassy White Box woodland on moist black soils, and River Red Gum-Coolibah-Bimble Box woodland on deep cracking loose clay soils.	Endangered	No

Table 3: BioNet Atlas of NSW Wildlife – Flora (10km x 10km)

Species	Preferred Habitat	BC Act Status	Likelihood ¹
<i>Lepidium aschersonii</i> – Spiny Peppercress	Found on ridges of gilgai clays dominated by Brigalow, Belah, Buloke and Grey Box	Vulnerable	No
<i>Lepidium monolocoides</i> - Winged Peppercress	Seasonally moist to waterlogged sites, on heavy fertile soils, with a mean annual rainfall of around 300-500 mm.	Endangered	No
<i>Swainsona murrayana</i> - Slender Darling Pea	Bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species.	Vulnerable	No
<i>Dichanthium setosum</i> - Bluegrass	Found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	Vulnerable	No

Attachment 2: Proposed Design and Impacts. Source: ITP Development, 2021



Attachment 3: Photos from the Site Inspection – 24/2/21



Photo 1: Existing track off the Newell Highway to the entry of site. D. Wall 2021



Photo 2: Patch of remnant large trees west of the development site. D. Wall 2021



Photo 3: Exotic (Cooch) dominated pasture, entry of site, east orientation. D. Wall 2021



Photo 4: Mid site, Prickly Pear to be managed. Priority weed species. D. Wall 2021

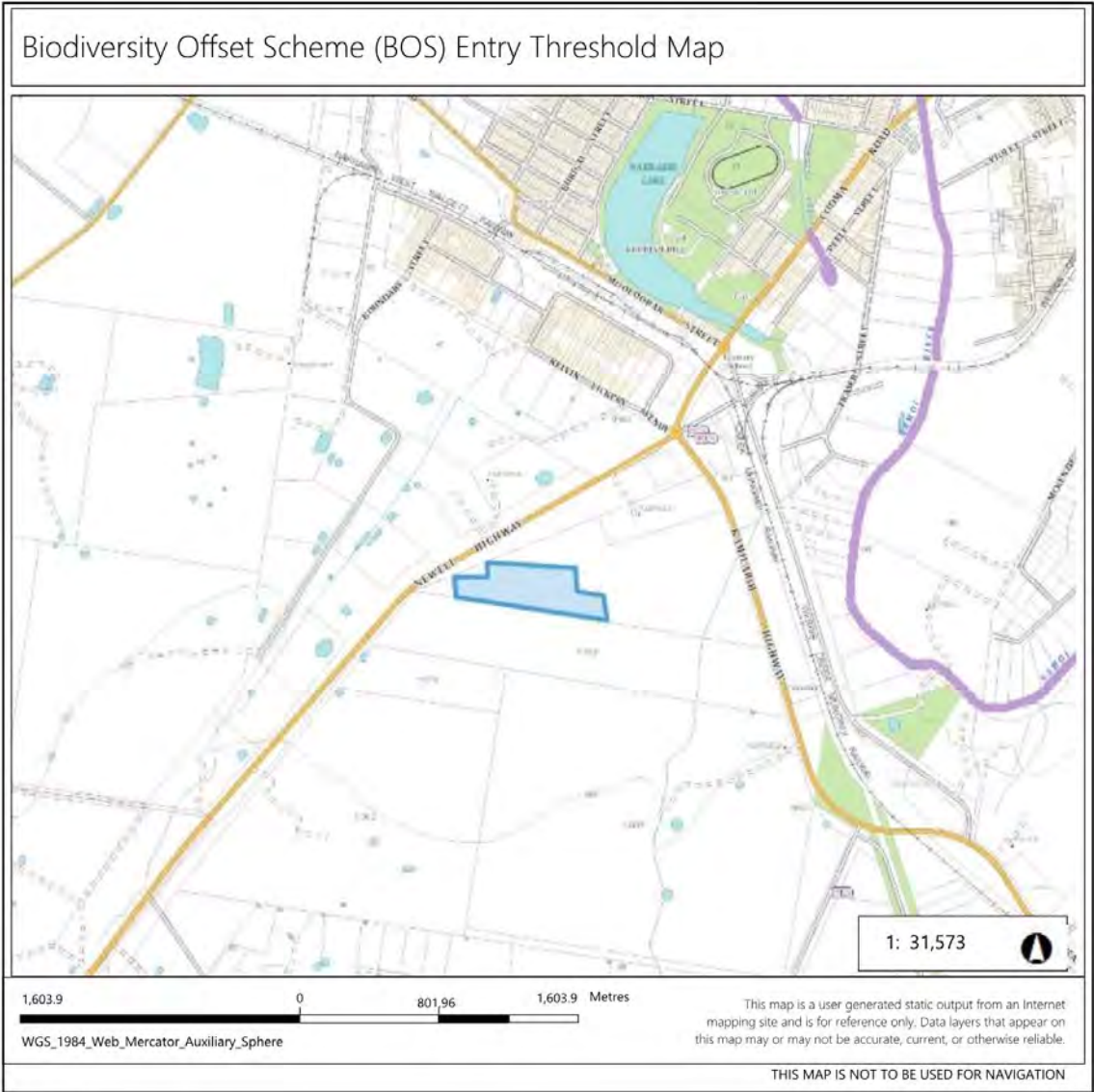


Photo 5: Boxthorn at bore site to be managed as priority weed. D. Wall 2021



Photo 6: Mixed native grass values and annual exotic grass (Lovegrass and cooch). Photo: D.Wall 2021

Attachment 4: BOSET Report Results



Legend

- Biodiversity Values that have been mapped for more than 90 days
- Biodiversity Values added within last 90 days

Notes

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NSW Environment & Heritage

Noise Assessment

Narrabri 3A Solar Farm
Narrabri, NSW.



Document Information

NOISE ASSESSMENT

Narrabri 3A Solar Farm, Narrabri NSW.

Prepared for: ITP Development Pty Ltd
Southern Cross House
Level 1, 19 Moore Street
Turner ACT 2612

Prepared by: Muller Acoustic Consulting Pty Ltd
PO Box 262, Newcastle NSW 2300
ABN: 36 602 225 132
P: +61 2 4920 1833
www.mulleracoustic.com

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APPENDIX A – GLOSSARY OF TERMS		

1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by ITP Development Pty Ltd (ITP) to complete a Noise Assessment (NA) for the proposed Narrabri 3A Solar Farm at 11498 Newell Highway Narrabri, NSW (the 'project'). This report presents the methodology and findings of the NA for the construction and operation of the project.

1.1 Purpose and Objectives

A NA is required as part of the Statement of Environmental Effects (SEE) to be submitted to the Narrabri Shire Council (NSC) as part of the Development Application (DA). The purpose of the NA is to quantify potential environmental noise emissions associated with the construction and operation of the project. Where impacts are identified, the assessment includes recommendations for potential noise mitigation and management measures.

1.2 Scope of the Assessment

The NA includes the following key tasks:

- review construction and operating activities to identify key noise generating plant, equipment, machinery or activities proposed to be undertaken as part of the project;
- identify the closest and/or potentially most affected receivers situated within the area of influence to the project;
- establish existing noise levels to determine project-specific construction Noise Management Levels (NMLs), and operational noise criteria;
- undertake 3D noise modelling to predict levels that may occur as a result of the construction and operation of the project at the closest and/or potentially most affected receivers;
- provide a comparison of predicted noise levels against relevant construction and operational criteria;
- assess the potential noise impacts associated with construction and operational aspects of the project; and
- provide feasible and reasonable noise mitigation and management measures, and monitoring options, where NMLs or operational criteria may be exceeded.

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Project Description

2.1 Background

ITP propose to construct and operate a 5 Megawatt (MW AC) solar farm using photovoltaic (PV) technology on the Newell Highway, approximately 3.5km south west of the township of Narrabri, NSW.

2.2 Description of Proposed Construction Works

The project includes installation of groups of north facing PV modules (approximately 2m x 1m) on mounting structures up to approximately 1.5m in height. An estimated 12,100 PV panels will be installed using a single axis tracking system, tilted +/- 60° along the north-south axis. The PV mounting structure would comprise steel posts driven up to approximately 1.5m to 3.5m below ground using a small pile driver. Additional support structures would be attached to the piles, which would then support the PV panels.

Earthworks will primarily involve trenching which is required for cabling of each PV array/module to the inverters. Other minor earthworks would be completed for the preparation of the site and in most cases a concrete slab would be required to support the ancillary infrastructure. Most of the infrastructure would be pre-fabricated off-site, delivered and assembled on-site.

It is anticipated that the solar farm would be constructed in stages, with two to three stages in construction at any one time over a three month period during standard construction hours.

During construction and operational phases, all vehicles would access the project directly from the Newell Highway.

During construction, traffic generated by the project would include employee and delivery vehicles. During the peak construction period, the daily traffic volume is expected to be up to four heavy vehicles (semi-trailers or b-doubles) per hour and 25 light commercial vehicles or equivalent mini buses for worker transport during the morning and afternoon peaks.

2.3 Description of Proposed Operation

PV infrastructure on site will comprise of groups of PV panels installed in rows running north to south. Each row of PV modules will rotate to track the sun across the sky from east to west each day. There is approximately 6.25m spacing between each row. The hub height of each tracker is 1.5m with the peak of the modules reaching a height of 2.75m when the array is fully tilted.

Electrical cabling would be attached beneath the modules and would connect the individual PV modules to each other. Inverters will be located centrally to groups of PV panels and connected to each other by underground cables. The PV modules will be on a single axis tracker system which will follow the sun and move in an east to west direction.

The project will be contained solely within the site as shown in **Figure 1**.

The project would operate 24 hours a day, 7 days a week, with no permanent staff on site. During operation, the PV panels would generate electricity which would be fed into the power grid. Key noise emissions from the operation of the project are associated with the inverter and transformer(s). It is noted that emissions from these sources are anticipated to be acoustically insignificant compared to ambient background noise levels at assessed receivers.

When required, maintenance activities will occur during standard working hours (except for emergencies) and are expected to include:

- panel cleaning;
- repairs or replacement of infrastructure, as required; and
- land management including mowing to control vegetation as required.

Typical noise sources associated with maintenance activities would include light vehicle movements on site and maintenance of equipment.

2.4 Potentially Sensitive Receivers

Using aerial photography, geospatial information and other project design information, MAC has identified the following potentially sensitive receivers that may be affected by noise from operation or construction activities and project related road traffic. **Table 1** presents a summary of receiver identification address and coordinates. These are reproduced visually in **Figure 1**.

Table 1 Noise Sensitive Receivers				
ID	Description/Address	Receiver Type	Coordinates (MGA 55)	
			Easting	Northing
C1	Roadhouse	Commercial	764997	6639346
R01 ¹	11498 Newell Highway	Residential	764630	6638855
R02	11540 Newell Highway	Residential	765110	6639019
R03	11467 Newell Highway	Residential	764365	6639212
R04	11 Kelvin Vickery Avenue	Residential	764376	6639404
R05	11465 Newell Highway	Residential	764214	6639149
R06	11402 Newell Highway	Residential	763963	6638513
R06A	11402 Newell Highway	Residential	763854	6638449
R07	11376 Newell Highway	Residential	763778	6638315
R08	217 Boundary Street	Residential	763528	6638749
R09	223 Boundary Street	Residential	763498	6638709
R10	235 Boundary Street	Residential	763422	6638598
R11	265 Boundary Street	Residential	763199	6638301
R12	177 Boundary Street	Residential	763760	6639018
R13	167 Boundary Street	Residential	763817	6639125
R14	153 Boundary Street	Residential	763868	6639251
R15	129 Boundary Street	Residential	764015	6639526
R16	23 Kelvin Vickery Avenue	Residential	764802	6639651
R17	23 Kelvin Vickery Avenue	Residential	765064	6639606
R18	Old Turrawan Road	Residential	765973	6638739
R19	18937 Kamilaroi Highway	Residential	765801	6637856
R20	33 Piper Lane	Residential	763726	6636862

Note 1: Project related receiver



FIGURE 1

Project Layout

MAC180781-14

Narrabri 3A Solar Farm

KEY

- Receivers
- Access Route
- Project Boundary



3 Noise Policy and Guidelines

This Noise Assessment has been conducted in accordance with the following key policy and guidelines:

- NSW Department of Environment and Climate Change, NSW Interim Construction Noise Guideline (ICNG), 2009;
- NSW Environment Protection Authority's (EPA's), Noise Policy for Industry (NPI), 2017;
- NSW Department of Environment, Climate Change and Water (DECCW), NSW Road Noise Policy (RNP), 2011; and
- US Federal Highways Administration/Environmental Protection Agency-Report 550/9-74-004 March (US FHWA).

The assessment has also considered and applied the following additional policy, guidelines and standards where relevant:

- Australian Standard AS 2436-2010 (R2016) (AS 2436) – Guide to Noise and Vibration Control on Construction, Demolition and Maintenance sites;
- Australian Standard AS 1055:2018 – Description and Measurement of Environmental Noise;
- Australian Standard AS /NZS IEC 61672.1-2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring; and
- Australian Standard AS IEC 60942-2004 (AS 60942) – Electroacoustics – Sound Calibrators.

3.1 Interim Construction Noise Guideline

The assessment and management of noise from construction work is completed with reference to the Interim Construction Noise Guideline (ICNG). The ICNG is specifically aimed at managing noise from construction work regulated by the EPA and is used to assist in setting statutory conditions in licences or other regulatory instruments. The types of construction regulated by the EPA under the POEO Act (1997), include construction, maintenance and renewal activities carried out by a public authority, such as road upgrades as described in Schedule 1 of the POEO Act.

The ICNG sets out procedures to identify and address the impact of construction noise on residences and other sensitive land uses. This section provides a summary of noise objectives that are applicable to the assessment.

The ICNG provides two methodologies for the assessment of construction noise emissions:

- Quantitative, which is suited to major construction projects with typical durations of more than three weeks; or
- Qualitative, which is suited to short term infrastructure maintenance (for projects with a typical duration of less than three weeks).

The methodology for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the nearest relevant receivers. The qualitative assessment methodology is a more simplified approach that relies more on noise management strategies. This study has adopted a quantitative assessment approach.

The quantitative approach includes identification of potentially affected receivers, description of activities involved in the project, derivation of the construction noise management levels, quantification of potential noise impact at receivers and, provides management and mitigation recommendations. **Table 2** summarises the ICNG recommended standard hours for construction.

Table 2 Recommended Hours for Construction																											
Hour Commencing	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11			
	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM			
Monday	OOH Period 2							Standard Hours												OOH Period 1							
Tuesday																											
Wednesday																											
Thursday																											
Friday																											
Saturday												OOH Period 1										OOH Period 2					
Sunday																											
Public Holiday																											

The recommended hours do not apply in the event of direction from police, or other relevant authorities, for safety reasons or where required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm. Work conducted outside of standard hours are considered out of hours work (OOH). OOH periods are divided into two categories representing evening and night periods and cover the hours listed below:

Period 1 (evening/low risk period): Monday to Friday – 6pm to 10pm, Saturdays – 7am to 8am and 1pm to 6pm, Sundays – 8am to 6pm.

Period 2 (night/medium to high risk period): Monday to Friday – 10pm to 7am, Saturdays/Sundays – 6pm to 7am (8am on Sunday mornings).

There are no out of hours work proposed for this project.

3.1.1 Construction Noise Management Levels

Section 4 of the ICNG details the quantitative assessment method involving predicting noise levels and comparing them with the Noise Management Level (NML) and are important indicators of the potential level of construction noise impact. **Table 3** provides the ICNG recommended LAeq(15min) NMLs and how they are to be applied.

Table 3 Noise Management Levels		
Time of Day	Management Level LAeq(15min) ¹	How to Apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays.	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences; and if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours.	Noise affected RBL + 5dB	A strong justification would typically be required for work outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community.

Note 1: The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the construction noise management levels for noise assessment purposes and is the median of the ABL's.

3.1.2 Construction Sleep Disturbance

Section 4.3 of the ICNG (DECC, 2009) states that a sleep disturbance assessment is required where construction activities are planned to occur for more than two consecutive nights. Given that construction activities are anticipated to occur during standard construction hours, sleep disturbance has not been considered in this assessment.

3.2 Noise Policy for Industry

The EPA released the Noise Policy for Industry (NPI) in October 2017 which provides a process for establishing noise criteria for consents and licenses enabling the EPA to regulate noise emissions from scheduled premises under the Protection of the Environment Operations Act 1997.

The objectives of the NPI are to:

- provide noise criteria that is used to assess the change in both short term and long-term noise levels;
- provide a clear and consistent framework for assessing environmental noise impacts from industrial premises and industrial development proposals;
- promote the use of best-practice noise mitigation measures that are feasible and reasonable where potential impacts have been identified; and
- support a process to guide the determination of achievable noise limits for planning approvals and/or licences, considering the matters that must be considered under the relevant legislation (such as the economic and social benefits and impacts of industrial development).

The policy sets out a process for industrial noise management involving the following key steps:

1. Determine the Project Noise Trigger Levels (PNTLs) (ie criteria) for a development. These are the levels (criteria), above which noise management measures are required to be considered. They are derived by considering two factors: shorter-term intrusiveness due to changes in the noise environment; and maintaining the noise amenity of an area.
2. Predict or measure the noise levels produced by the development with regard to the presence of annoying noise characteristics and meteorological effects such as temperature inversions and wind.
3. Compare the predicted or measured noise level with the PNTL, assessing impacts and the need for noise mitigation and management measures.

4. Consider residual noise impacts - that is, where noise levels exceed the PNTLs after the application of feasible and reasonable noise mitigation measures. This may involve balancing economic, social and environmental costs and benefits from the proposed development against the noise impacts, including consultation with the affected community where impacts are expected to be significant.
5. Set statutory compliance levels that reflect the best achievable and agreed noise limits for the development.
6. Monitor and report environmental noise levels from the development.

3.2.1 Project Noise Trigger Levels (PNTL)

The policy sets out the procedure to determine the PNTLs relevant to an industrial development. The PNTL is the lower (ie, the more stringent) of the **Project Intrusiveness Noise Level** (PINL) and **Project Amenity Noise Level** (PANL) determined in accordance with Section 2.3 and Section 2.4 of the NPI.

3.2.2 Rating Background Level (RBL)

The Rating Background Level (RBL) is a determined parameter from noise monitoring and is used for assessment purposes. As per the NPI, the RBL is an overall single figure background level representing each assessment period (day, evening and night) over the noise monitoring period.

The RBLs relevant to the project are contained in **Section 4**.

3.2.3 Project Intrusiveness Noise Level (PINL)

The PINL ($LA_{eq}(15min)$) is the RBL + 5dB and seeks to limit the degree of change a new noise source introduces to an existing environment.

3.2.4 Project Amenity Noise Level (PANL)

The PANL is relevant to a specific land use or locality. To limit continuing increases in intrusiveness levels, the ambient noise level within an area from all combined industrial sources should remain below the recommended amenity noise levels specified in Table 2.2 (of the NPI). The NPI defines two categories of amenity noise levels:

- **Amenity Noise Levels (ANL)** – are determined considering all current and future industrial noise within a receiver area; and
- **Project Amenity Noise Level (PANL)** – is the recommended level for a receiver area, specifically focusing on the project being assessed.

Additionally, Section 2.4 of the NPI states: “*to ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows*”:

PANL for new industrial developments = recommended **ANL** minus 5dBA.

The following exceptions apply when deriving the PANL:

- areas with high traffic noise levels;
- proposed developments in major industrial clusters;
- existing industrial noise and cumulative industrial noise effects; and
- greenfield sites.

The NPI states with respect to high traffic noise areas:

The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the LAeq, period(traffic) minus 15 dB(A).

Where relevant this assessment has considered influences of traffic with respect to amenity noise levels (ie areas where existing traffic noise levels are 10dB greater than the recommended amenity noise level).

The recommended amenity noise levels as per Table 2.2 of the NPI are reproduced in **Table 4**.

Table 4 Amenity Criteria

Receiver Type	Noise Amenity Area	Time of day	Recommended amenity noise level dB LAeq(period)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks.	See column 4	See column 4	5dB above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School Classroom	All	Noisiest 1-hour period when in use	35 (internal) 45 (external)
Hospital ward			
- internal	All	Noisiest 1-hour	35
- external	All	Noisiest 1-hour	50
Place of worship			
- internal	All	When in use	40
Passive Recreation	All	When in use	50
Active Recreation	All	When in use	55
Commercial premises	All	When in use	65
Industrial	All	When in use	70

Notes: The recommended amenity noise levels refer only to noise from industrial noise sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as rural residential; suburban residential; urban residential; industrial interface; commercial; industrial – see Table 2.3 and Section 2.7 of the NPI.

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

3.2.5 Maximum Noise Assessment Trigger Level

The potential for sleep disturbance from maximum noise level events from a project during the night-time period needs to be considered. The NPI considers sleep disturbance to be both awakenings and disturbance to sleep stages.

Where night-time noise levels from a development/premises at a residential location exceed the following criteria, a detailed maximum noise level event assessment should be undertaken:

- LAeq(15min) 40dB or the prevailing RBL plus 5dBA, whichever is the greater, and/or
- LAmax 52dB or the prevailing RBL plus 15dBA, whichever is the greater.

A detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Other factors that may be important in assessing the impacts on sleep disturbance include:

- how often the events would occur;
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the development;
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods); and
- current understanding of effects of maximum noise level events at night.

3.3 Road Noise Policy

The road traffic noise criteria are provided in the Department of Environment, Climate Change and Water NSW (DECCW), Road Noise Policy (RNP), 2011. The policy sets out noise criteria applicable to different road classifications for the purpose of quantifying traffic noise impacts. Road noise criteria relevant to this assessment are presented in detail in **Section 4.3**.

4 Assessment Criteria

Background noise monitoring has not been conducted for this project and hence, the minimum applicable RBLs of 35dBA for the daytime period and 30dBA for the evening and night time periods have been adopted in accordance with NPI methodology.

4.1 Construction Noise Management Levels

Noise Management Levels (NMLs) for construction activities at all residential receivers are 45dB LAeq(15min) (RBL +10dB). Construction activities are planned for standard hours, however the relevant NML standard construction hours and out of hours periods are summarised in **Table 5**.

Table 5 Construction Noise Management Levels			
Location	Assessment Period ¹	RBL, dBA	NML dB LAeq(15min)
All Residential Receivers	Day (Standard Hours)	35	45 (RBL+10dBA)
	Evening (OOH Period 1)	30	35 (RBL+5dBA)
	Night (OOH Period 2)	30	35 (RBL+5dBA)
Commercial	All Periods	N/A	65dB LAeq(period)

Note 1: See table 2 for Recommended Standard Hours for Construction.

4.2 Operational Noise Criteria

4.2.1 Project Intrusiveness Noise Levels

The PINLs for the project are presented in **Table 6** and have been determined based on the RBLs +5dBA.

Table 6 Project Intrusiveness Noise Levels			
Receiver	Period ¹	Adopted RBL dB LA90	PINL dB LAeq(15min)
All Residential Receivers	Day	35	40
	Evening	30	35
	Night	30	35

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2.2 Project Amenity Noise Levels

The PANLs for receivers potentially affected by the project are presented in **Table 7**.

Table 7 Project Amenity Noise Levels					
Receiver Type	Noise Amenity Area	Assessment Period ¹	Recommended ANL dB LAeq(period) ²	PANL dB LAeq(period) ³	PANL dB LAeq(15min) ⁴
Residential	Rural	Day	50	50	53
		Evening	45	45	48
		Night	40	40	43

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Recommended amenity noise levels as per Table 2.2 of the NPI.

Note 3: Project Amenity Noise Level equals the amenity noise level as there is no other industry in the area.

Note 4: Includes a +3dB adjustment to the amenity period level to convert to a fifteen-minute assessment period as per Section 2.2 of the NPI.

4.2.3 Project Noise Trigger Levels

The PNTLs are the lower of either the PINLs or the PANLs. **Table 8** presents the derivation of the PNTLs in accordance with the methodologies outlined in the NPI. For this assessment the night time PNTL of 35dB LAeq(15min) is the limiting criteria for residential receivers.

Table 8 Project Noise Trigger Levels				
Catchment	Assessment Period ¹	PINL dB LAeq(15min)	PANL dB LAeq(15min)	PNTL dB LAeq(15min)
Residential Receivers (Rural)	Day	40	53	40
	Evening	35	48	35
	Night	35	43	35
Commercial	When in use	N/A	65	68

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2.4 Maximum Noise Assessment Trigger Levels

The maximum noise trigger levels shown in **Table 9** are based on night time RBLs and trigger levels as per Section 2.5 of the NPI. The trigger levels will be applied to transient noise events that have the potential to cause sleep disturbance.

Table 9 Maximum Noise Assessment Trigger Levels			
Residential Receivers			
LAeq(15min)		LAmax	
40dB LAeq(15min) or RBL + 5dB		52dB LAmax or RBL + 15dB	
Trigger	40	Trigger	52
RBL +5dB	35	RBL +15dB	45
Highest	40	Highest	52

Note: Monday to Saturday; Night 10pm to 7am. On Sundays and Public Holidays; Night 10pm to 8pm.

Note: As per Section 2.5 of the NPI, the highest of the two criteria are adopted as the trigger level.

4.3 Road Traffic Noise Criteria

The road traffic noise criteria are provided in the RNP. For this assessment, there are receivers along the Newell Highway. The relevant road traffic noise criteria are provided in the RNP and are presented in **Table 10** for residential receivers.

Table 10 Road Traffic Noise Assessment Criteria for Residential Land Uses				
Road category	Road Name	Type of Project/Development	Assessment Criteria - dBA	
			Day (7am to 10pm)	Night (10pm to 7am)
Arterial Roads	Newell Highway	Existing residences affected by additional traffic on existing arterial roads generated by land use developments	60dBA LAeq(15hr) external	55dBA LAeq(9hr) external
		Existing residences affected by additional traffic on existing local roads generated by land use developments	55dB LAeq(1hr) external	50dB LAeq(1hr) external

Note: For road noise assessments, the day period is from 7am to 10pm (ie there is no evening assessment period as there is with operational noise). Night is from 10pm to 7am.

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2dB, which is generally accepted as the threshold of perceptibility to a change in noise level.

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5 Modelling Methodology

A computer model was developed to quantify project noise emissions to neighbouring receivers for typical construction activities and operations. DGMR (iNoise, Version 2020.0) noise modelling software was used to quantify noise emissions from typical construction activities and operations. iNoise is a new intuitive and quality assured software for industrial noise calculations in the environment. 3D noise modelling is considered industry best practice for assessing noise emissions from projects.

The model incorporated a three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. Additionally, the model uses relevant noise source data, ground type, attenuation from barrier or buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation'. The ISO 9613 standard from 1996 is the most used noise prediction method worldwide. Many countries refer to ISO 9613 in their noise legislation. However, the ISO 9613 standard does not contain guidelines for quality assured software implementation, which leads to differences between applications in calculated results. In 2015 this changed with the release of ISO/TR 17534-3. This quality standard gives clear recommendations for interpreting the ISO 9613 method. iNoise fully supports these recommendations. The models and results for the 19 test cases are included in the software.

5.1 Construction Assessment Methodology

Construction activities are proposed to be progressive (trenching, piling and assembly) and will occur at several locations simultaneously. Noise emissions were modelled for the following four scenarios:

- earthworks for internal road and compound construction including the stripping of topsoil and unsuitable soil and the placement and compaction of road base;
- earthworks involving trenching for cabling;
- piling of panel supports; and
- assembly of the panels.

It is envisaged that all construction scenarios have the potential to occur simultaneously at up to three locations across the site. Noise emission data and assumptions used in this assessment are summarised in **Table 11**. All significant noise generating construction activities will be limited to standard construction hours. Where low intensity construction activities are required to be undertaken outside standard construction hours, such as cabling, minor assembly, use of hand tools etc, they will be managed such that they are not audible at any residential receivers.

Table 11 Construction Equipment Sound Power Levels, Lw dBA re 10⁻¹² W				
Noise Source/Item	Utilisation %	Quantity	Lw/Item	Total Lw
Trenching & Earthworks				
Backhoe	80	1	104	103
Light vehicle	25	2	76	73
Total – Trenching & Earthworks				103
Piling				
Piling Rig (hydraulic)	80	1	113	112
Tele-handler	75	1	106	105
Light vehicle	25	2	76	73
Total – Piling				113
Assembly				
Mobile Crane/HIAB	75	1	104	103
Tele-handler	75	1	106	105
Light vehicle	25	2	76	73
Hand tools/Power tools	50	1	102	99
Welder	50	1	105	102
Total – Assembly				109
Transport (on site)				
Heavy vehicle	40	1	104	101
Tele-handler	50	1	106	103
Total – Transport				105

5.2 Operational Assessment Methodology

5.2.1 Operational Noise Modelling Scenarios

For this assessment, noise predictions were modelled for a typical worst-case operational scenario over a 15-minute assessment period based on the assumptions and sound power levels in **Table 12**. Plant noise emission data used in modelling for this assessment were obtained from manufacturers data or the MAC database. Where relevant, modifying factors in accordance with Section 3.3 and Fact Sheet D of the NPI have been applied to calculations.

Table 12 Operational Equipment Sound Power Levels, Lw dBA re 10⁻¹² W

Noise Source/Item	Activity	Quantity	Lw/Item	Total Lw
PV Panel Tracking Motor ^{1,2}	All tracking motors in operation	140	78	81
	1 minute per 15-minute period			
3MW Inverter	Constant	2	94 ²	97
5MVA Transformer	Constant	1	87 ²	87

Note 1: Tracking motor is situated underneath the PV panel, -5dB attenuation applied to account for shielding provided by the panel.

Note 2: Modifying factor penalty of +5dB added for low frequency and +5dB added for tonality.

5.2.2 Meteorological Analysis

Noise emissions from industry can be significantly influenced by prevailing weather conditions. Light stable winds (<3m/s) and temperature inversions have the potential to increase noise at a receiver.

Fact Sheet D of the NPI provides two options when considering meteorological effects:

- adopt the noise enhancing conditions for all assessment periods without an assessment of how often the conditions occur – a conservative approach that considers a source to receiver winds for all receivers and F class temperature inversions with wind speeds up to 2m/s at night; or
- determine the significance of noise enhancing conditions. This requires assessing the significance of temperature inversions (F and G Class stability categories) for the night time period and the significance of light winds up to 3m/s for all assessment periods during stability categories other than E, F or G.

Given that a detailed analysis of the significance of noise enhancing conditions has not been undertaken the meteorological conditions adopted in the noise modelling assessment are summarised in **Table 13**.

Table 13 Modelled Site Specific Meteorological Parameters

Assessment Condition ¹	Temperature	Wind Speed / Direction	Relative Humidity	Stability Class
Day - Calm	20°C	3m/s all directions	50%	D
Evening - Calm	10°C	3m/s all directions	50%	D
Night - Calm	10°C	2m/s all directions	50%	F

Note 1: Day 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening 6pm to 10pm; Night - the remaining periods.

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6 Results

6.1 Construction Noise Results

Noise levels were predicted at each assessed receiver at a height of 1.5m above ground level for typical construction activities. **Table 14** summarises the maximum predicted noise level from each of the construction scenarios (trenching, piling and assembly) at each receiver.

Table 14 Predicted Construction Noise Levels					
Receiver ID	Description/Address	Predicted Noise Level Range dB LAeq(15min) ¹	Highest Predicted Noise Level dB LAeq(15min)	NML Standard Hours dB LAeq(15min)	Compliance Achieved
C1	Roadhouse	25-45	45	65	Yes
R01 ²	11498 Newell Highway	41-61	61	45	N/A
R02	11540 Newell Highway	28-48	48	45	No
R03	11467 Newell Highway	29-49	49	45	No
R04	11 Kelvin Vickery Avenue	25-46	46	45	No
R05	11465 Newell Highway	28-49	49	45	No
R06	11402 Newell Highway	29-50	50	45	No
R06A	11402 Newell Highway	26-47	47	45	No
R07	11376 Newell Highway	24-45	45	45	Yes
R08	217 Boundary Street	22-43	43	45	Yes
R09	223 Boundary Street	21-42	42	45	Yes
R10	235 Boundary Street	20-41	41	45	Yes
R11	265 Boundary Street	17-38	38	45	Yes
R12	177 Boundary Street	24-45	45	45	Yes
R13	167 Boundary Street	24-45	45	45	Yes
R14	153 Boundary Street	23-44	44	45	Yes
R15	129 Boundary Street	22-42	42	45	Yes
R16	23 Kelvin Vickery Avenue	22-42	42	45	Yes
R17	23 Kelvin Vickery Avenue	21-41	41	45	Yes
R18	Old Turrawan Road	18-37	37	45	Yes
R19	18937 Kamilaroi Highway	17-36	36	45	Yes
R20	33 Piper Lane	12-32	32	45	Yes

Note 1: Noise levels from construction activities vary due to their location across the project site.

Note 2: Project related receiver.

Noise levels at six receivers (R02 - R06A) are expected to exceed the NMLs by up to 5dB when works are nearest to those locations. The exceedance would be temporary, and of short duration and is primarily due to piling and earthworks activities when at their closest point to receivers. An exceedance of 5dB, and of short duration during the daytime period, in the context of construction noise would be considered a negligible impact.

6.2 Operational Noise Results

Noise levels were predicted at each assessed receiver at a height of 1.5m above ground level during worst case noise enhancing meteorological conditions. **Table 15** summarises the predicted operational noise levels which are demonstrated to comply with the PNTLs at all residential receivers.

Table 15 Predicted Operational Noise Levels				
Receiver ID	Description/Address	Predicted Noise Level dB LAeq(15min)	Limiting Night PNTL dB LAeq(15min)	Compliance Achieved
C1	Roadhouse	<30	68	Yes
R01 ¹	11498 Newell Highway	34	35	N/A
R02	11540 Newell Highway	<30	35	Yes
R03	11467 Newell Highway	<30	35	Yes
R04	11 Kelvin Vickery Avenue	<30	35	Yes
R05	11465 Newell Highway	<30	35	Yes
R06	11402 Newell Highway	<30	35	Yes
R06A	11402 Newell Highway	<30	35	Yes
R07	11376 Newell Highway	<30	35	Yes
R08	217 Boundary Street	<30	35	Yes
R09	223 Boundary Street	<30	35	Yes
R10	235 Boundary Street	<30	35	Yes
R11	265 Boundary Street	<30	35	Yes
R12	177 Boundary Street	<30	35	Yes
R13	167 Boundary Street	<30	35	Yes
R14	153 Boundary Street	<30	35	Yes
R15	129 Boundary Street	<30	35	Yes
R16	23 Kelvin Vickery Avenue	<30	35	Yes
R17	23 Kelvin Vickery Avenue	<30	35	Yes
R18	Old Turrawan Road	<30	35	Yes
R19	18937 Kamilaroi Highway	<30	35	Yes
R20	33 Piper Lane	<30	35	Yes

Note 1: Project related receiver.

6.3 Maximum Noise Level Assessment - Operations

A detailed maximum noise level assessment is not required as predicted noise levels for night time operations do not exceed the maximum noise level screening criterion of 40dB LAeq(15min) and there are no operational noise sources that could be considered to cause maximum noise events.

6.4 Road Traffic Noise Assessment

Access to the site will be directly from the Newell Highway and would be the major transport route for all vehicles to access the project site. During construction, traffic generated by the project includes employee/subcontractor and delivery vehicles. The traffic volume over a typical day for standard construction hours is expected to be up to four heavy vehicles (semi-trailers or B-doubles) per hour and 25 light commercial vehicles or equivalent mini buses for worker transport during the morning and afternoon peak hour periods.

Predicted noise levels from project related construction traffic at 12m from the road to represent the potential for receivers situated along the Newell Highway, between the project site and the township, has been completed using the United States (US) Environment Protection Agency's road traffic calculation method and results are presented in **Table 16**. The US FHWA road traffic calculation method (based on equations in Appendix A-13) was used to predict the LAeq noise levels from construction vehicles travelling past receivers along public roads. This method is an internationally accepted theoretical traffic noise prediction model and is ideal for calculating road traffic noise where relatively small traffic flows are encountered.

Table 16 Predicted Construction Road Traffic Noise Levels

Road Name	Offset Distance to Receiver	Predicted Noise Level	RTN Criteria	Compliance Achieved
Newell Highway	12m	48dB LAeq(15hr)	60dBA LAeq(15hr)	Yes
Any Local Road	12m	53dB LAeq(15hr)	55dBA LAeq(1hr)	Yes

Results demonstrate that project construction traffic noise levels would comply with the relevant RNP criteria.

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7 Recommendations

7.1 Construction Noise Recommendations

It is noted that construction noise emissions are expected to exceed the relevant NMLs at the six nearest receivers to the project. Recommendations for consideration during construction activities to reduce emissions to the surrounding community for this project may include:

- a construction noise management protocol to minimise noise emissions, manage out of hours (minor) works to be inaudible, and to respond to potential concerns from the community;
- where possible use localised mobile screens or construction hoarding around plant to act as barriers between construction works and receivers, particularly where equipment is near the site boundary and/or a residential receiver including areas in constant or regular use (eg unloading and laydown areas);
- operating plant in a conservative manner (no over-revving), shutdown when not in use, and be parked/started at farthest point from relevant assessment locations;
- selection of the quietest suitable machinery available for each activity;
- avoidance of noisy plant/machinery working simultaneously where practicable;
- minimise impact noise wherever possible;
- utilise a broadband reverse alarm in lieu of the traditional high frequency type reverse alarm;
- provide toolbox meetings, training and education to drivers and contractors visiting the site during construction so they are aware of the location of noise sensitive receivers and to be cognisant of any noise generating activities;
- signage is to be placed at the front entrance advising truck drivers of their requirement to minimise noise both on and off-site; and
- utilise project related community consultation forums to notify residences within close proximity of the site with project progress, proposed/upcoming potentially noise generating works, its duration and nature and complaint procedure.

7.2 Operational Noise Recommendations

Operational noise predictions identify that relevant noise criteria would be satisfied at all receivers. Notwithstanding, it is recommended that the proponent actively minimise potential noise emissions from the project. To assist in noise management for the project it is recommended that a one-off noise validation monitoring assessment be completed to quantify emissions from site and to confirm emissions meet relevant criteria.

8 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has been engaged by ITP Development Pty Ltd (ITP) to complete a Noise Assessment (NA) for the proposed Narrabri 3A Solar Farm near Narrabri, NSW. The assessment has quantified potential noise emissions associated with the construction and operation of the project.

The results of the NA demonstrate that construction noise levels have potential to exceed relevant construction NMLs at six receivers in proximity to the project. Recommendations have been provided to minimise the potential noise impacts from construction, albeit of a temporary nature during the daytime over a three month construction period.

Operational noise levels satisfy the NPI PNTLs for assessed receivers. However, recommendations to ensure noise levels are verified have been provided in this report.

Additionally, the NA demonstrates that the road noise criteria as specified in the RNP will be satisfied at receivers on the proposed transport route.

Based on the NA results, there are no noise related issues which would prevent the approval of the project. The results of the assessment shows compliance with the relevant operational and road noise criteria. Accordingly, no additional ameliorative measures will be required.

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Appendix A – Glossary of Terms

A number of technical terms have been used in this report and are explained in Table A1.

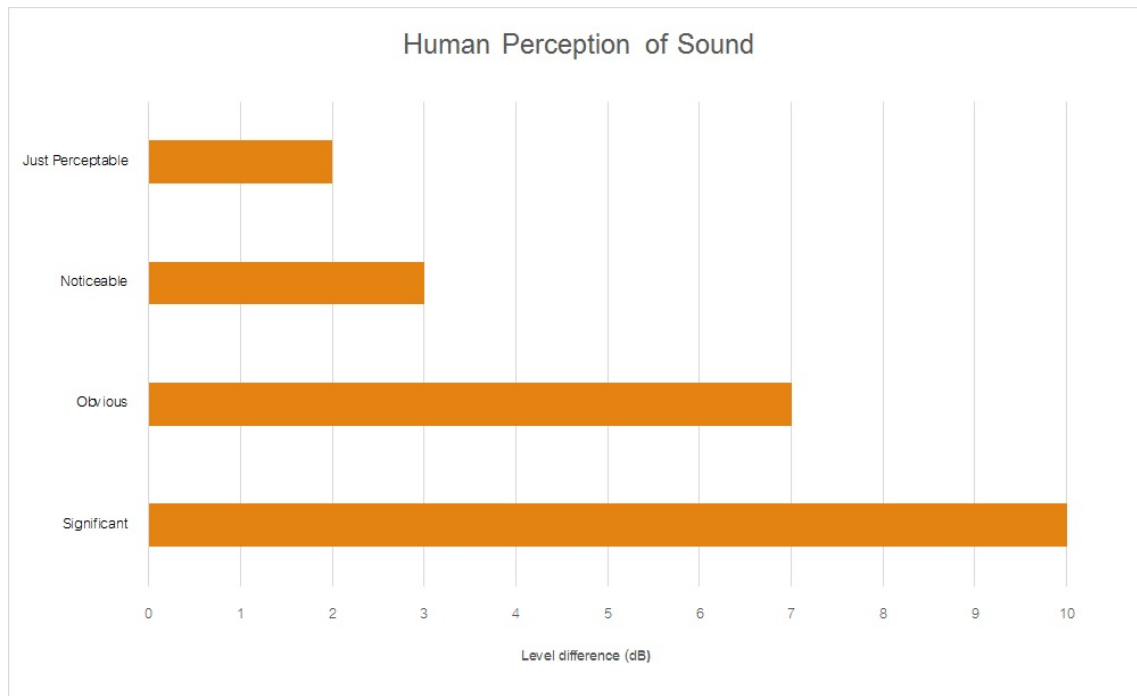
Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Ambient Noise	The noise associated with a given environment. Typically, a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmx	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by : $= 10 \cdot \log_{10} (W/W_0)$ Where: W is the sound power in watts and W₀ is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



Muller Acoustic Consulting Pty Ltd
PO Box 262, Newcastle NSW 2300
ABN: 36 602 225 132
P: +61 2 4920 1833
www.mulleracoustic.com





pricemerrett

C O N S U L T I N G

Narrabri Solar Farm

Traffic Impact Assessment Report

F8619

9478 Murray Valley Hwy
PO Box 313
KERANG VICTORIA 3579
Ph: (03) 5452 2490
Fax: 03) 5452 2566
E-mail: pmc@pricemerrett.com.au
www.pricemerrett.com.au

ABN: 62 903 527 353
ACN: 139 256 938



SURVEYING
ENGINEERING
IRRIGATION
PROJECT
MANAGEMENT

Version	Description	Written by	Approved by	Date issued
1	Draft	SG	MC	30/10/20
2	Final	SG	MC	15/01/21
3	Final	SG	MC	06/08/21
4	Amendment following TfNSW consultation	SG	MC	27/09/21

Project Details

Project Name	Narrabri Solar Farm
Client	ITP renewables
Report Authors	Mark Carter
PMC Project Reference	F8619

Author: Price Merrett Consulting Pty. Ltd.

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1 Introduction

This report entails a Traffic Impact Assessment Report (TIAR) for the development of the 5.0 MW Narrabri Solar Farm on the Newell Highway (A39).

The TIAR will review, traffic volumes, traffic growth and accident statistics to evaluate the adequacy of the proposed works for safe operation of the intersection into the future. A new site access has been proposed on the south of the Newell Highway 3.5km south west of Narrabri.

The traffic and transport implications of the proposed development are documented in this report.

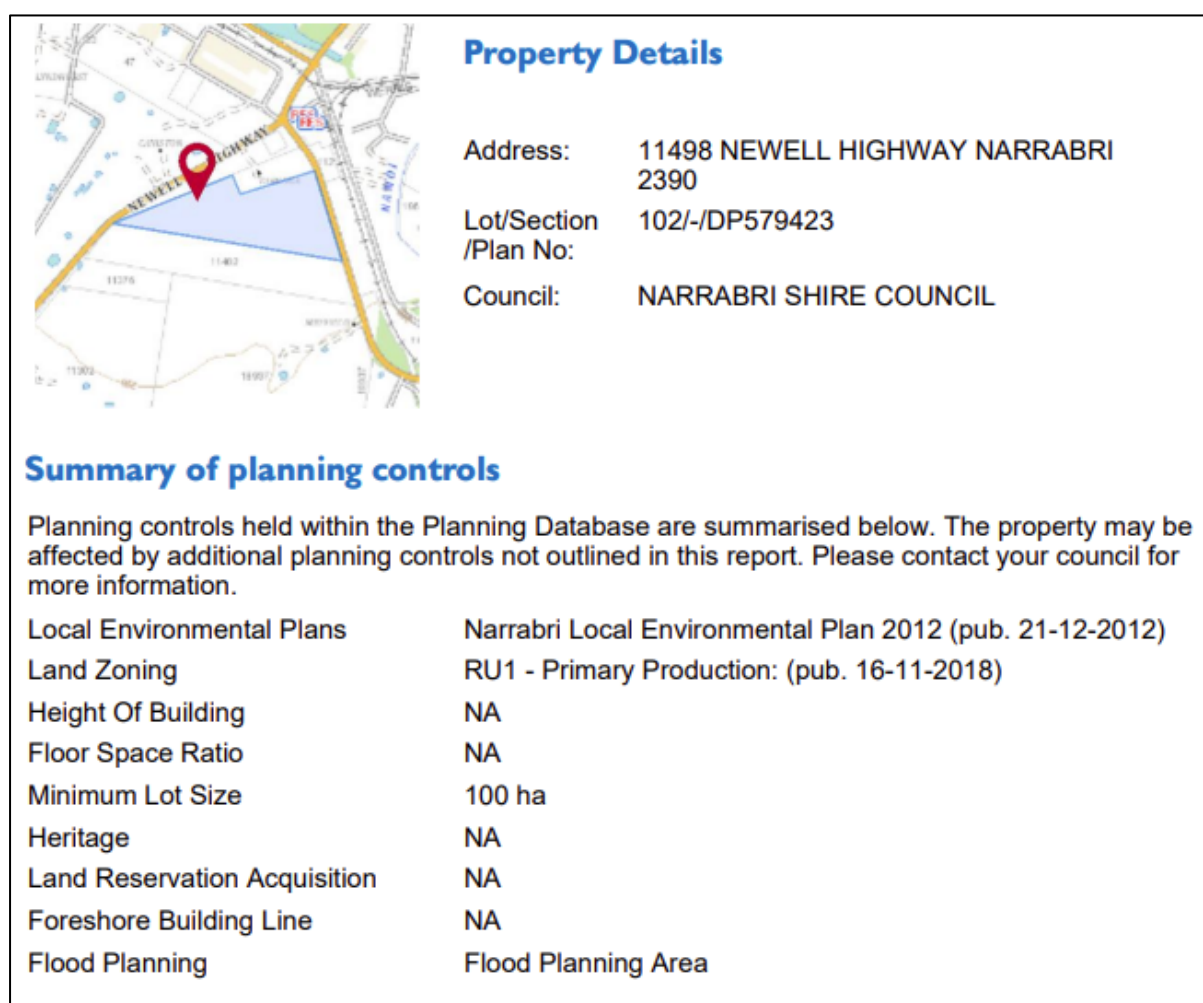


Figure 1 – Property details

1.1 Project Description

The solar array project involves construction of around 12,100 solar modules, an inverter station, perimeter fencing and access and parking arrangements.

The site is proposed on previously cleared farmland.

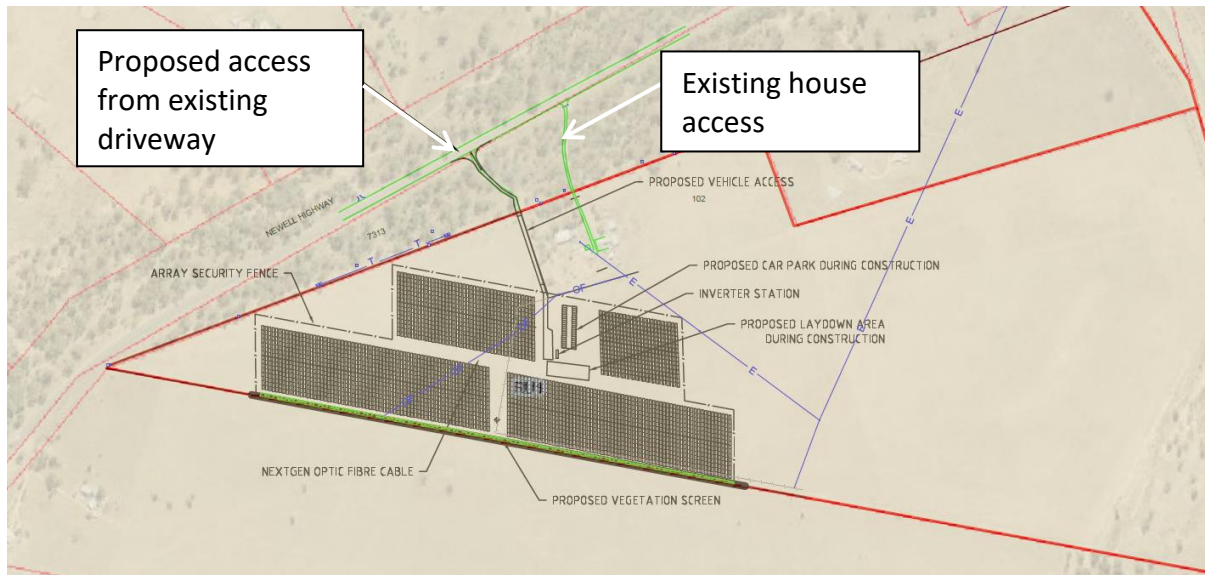


Figure 2 – Proposed Solar development and access point

2 Existing Conditions

2.1 Location

The subject site is within the 'Primary Production' land zone. The site is located on Lot 102 DP579423, 11498 Newell Highway Narrabri, NSW 2390"). The development falls within the Narrabri Shire Council area.

Geographical position is described as Lat/Long: -30.355485/149.760305. Z55 764,500 E 6,638,960 N.

The proposed solar site is currently used for primary production and has been a cereal cropping paddock.

To access the site from the Newell Highway, the current driveway crosses a crown land reserve shown in Figure 4 below.

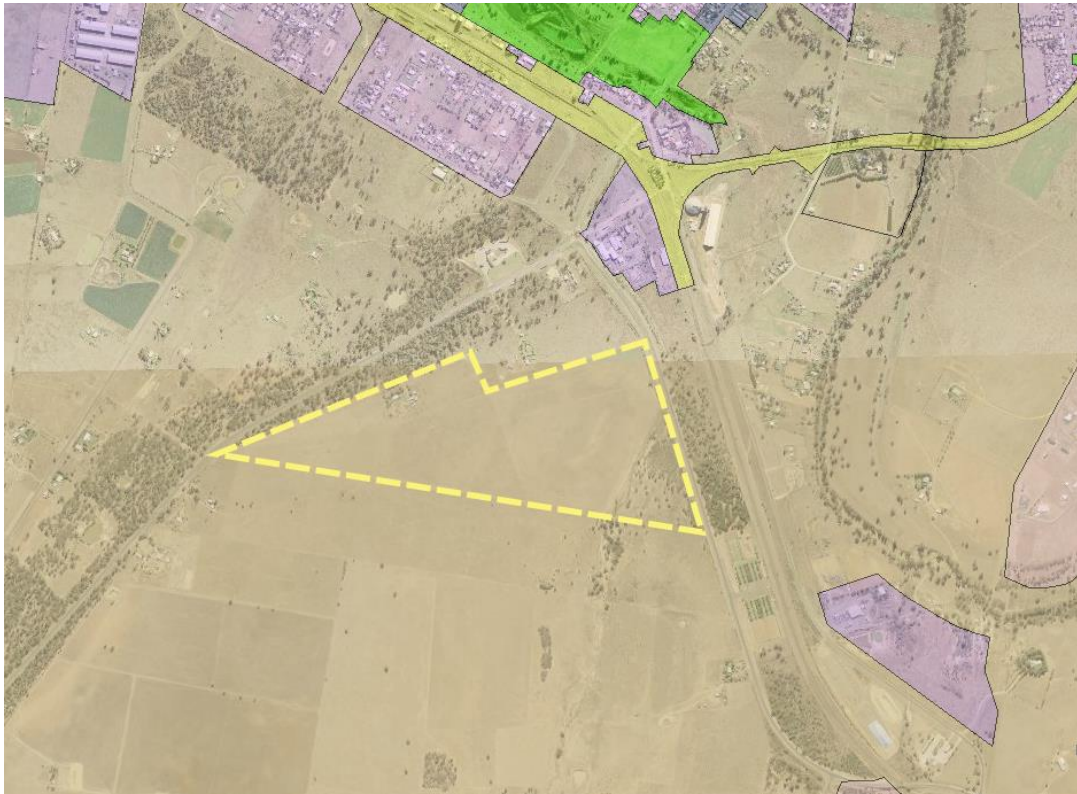


Figure 3 – Site Location (Image from NSW Planning Portal)

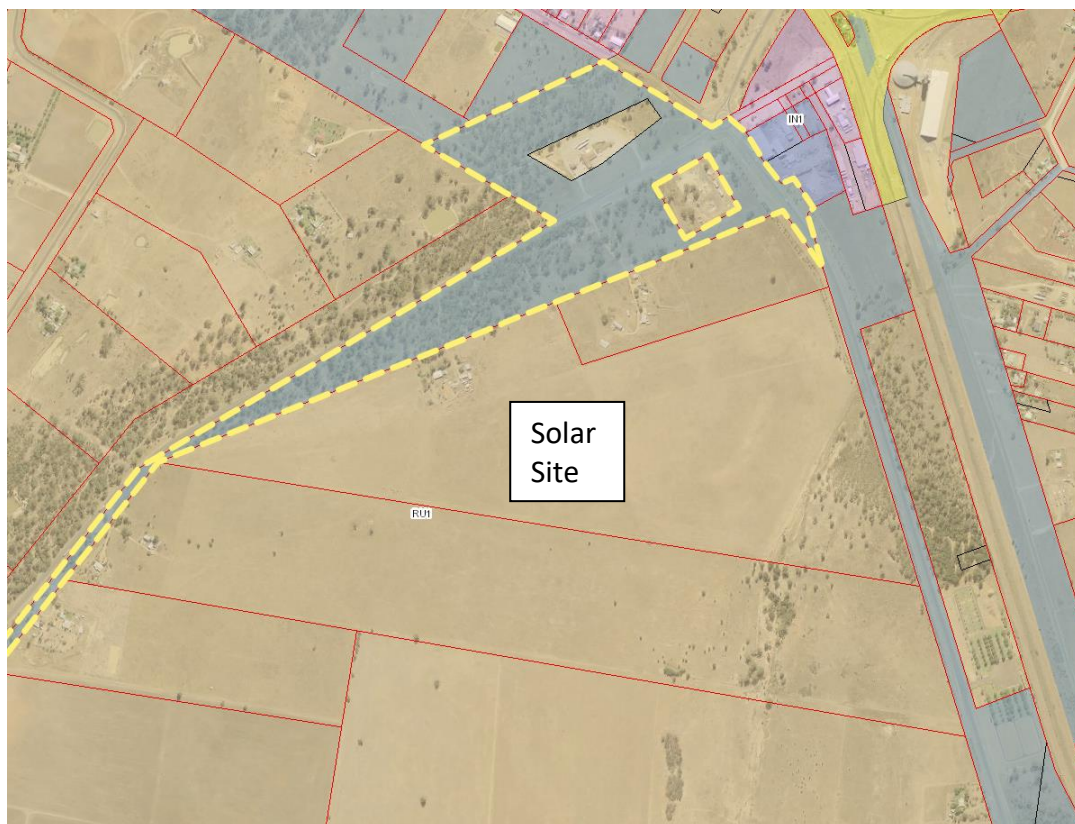


Figure 4 – Access to Solar Site crosses Lot 7313 DP1147165

2.2 Existing Access Arrangement

The existing site is accessed from Newell Highway through Lot 7313 DP1147165 as shown in Figure 4 + 5. The existing western access crosses this lot for approximately 100m, and the eastern driveway to the residence crosses it for about 125m.

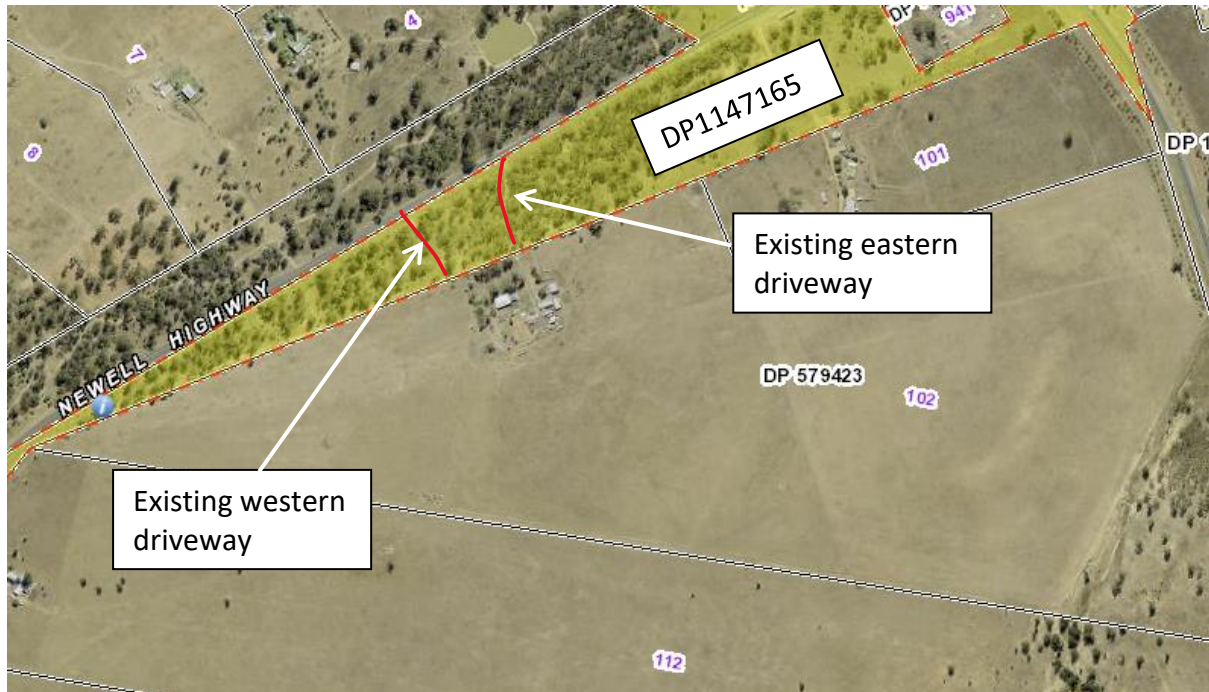


Figure 5 – Existing driveways from Newell Highway

The eastern access is used to access the dwelling located midway along the northern lot boundary approximately 900m west on the Newell Highway from the intersection with the Kamilaroi Highway. The western driveway is located approximately 151m from the eastern driveway and is used to access the farmland surrounding the residence. The western access will be closed for the duration of construction to prevent confusion. Dwelling access will be created along existing western driveway to service the residence.

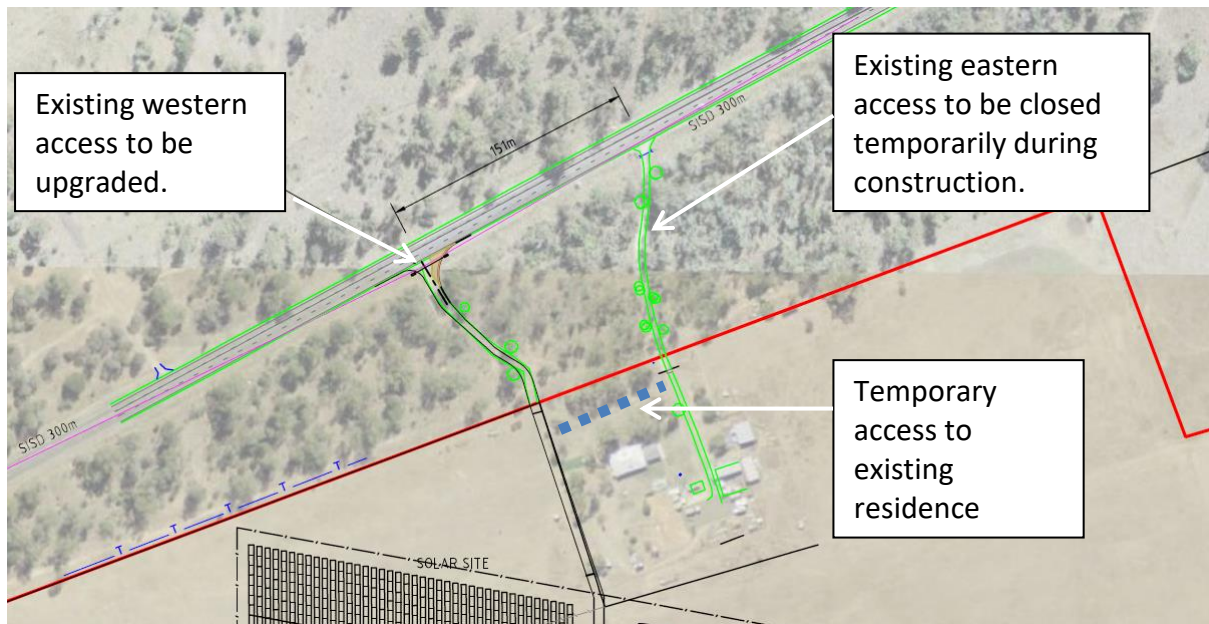


Figure 6 – Proposed solar farm access

Safe intersection site distances should be provided for access points. The existing access is within the 110 km/hr zone and therefore would have SISD of 285m for a reaction time of 2.0 sec.

The sight distance available exceeds the minimum requirements.



Looking west sight distances extend to the bend located over 500m away.

Figure 7 – Looking west from existing western access along Newell Highway



Looking east sight distances extend well over required SISD.

Figure 8 – Looking east from existing western access along Newell Highway

2.3 Transport Route and Surrounding Road Network

Equipment for the construction of the Solar farm is likely to be transported from Sydney via the Newell Highway. Figure 9 below details the B Double approved road network.

A roundabout located approximately 900m to the east of the access will enable vehicles travelling from the west to pass the site and preform a left turn entry into the site.

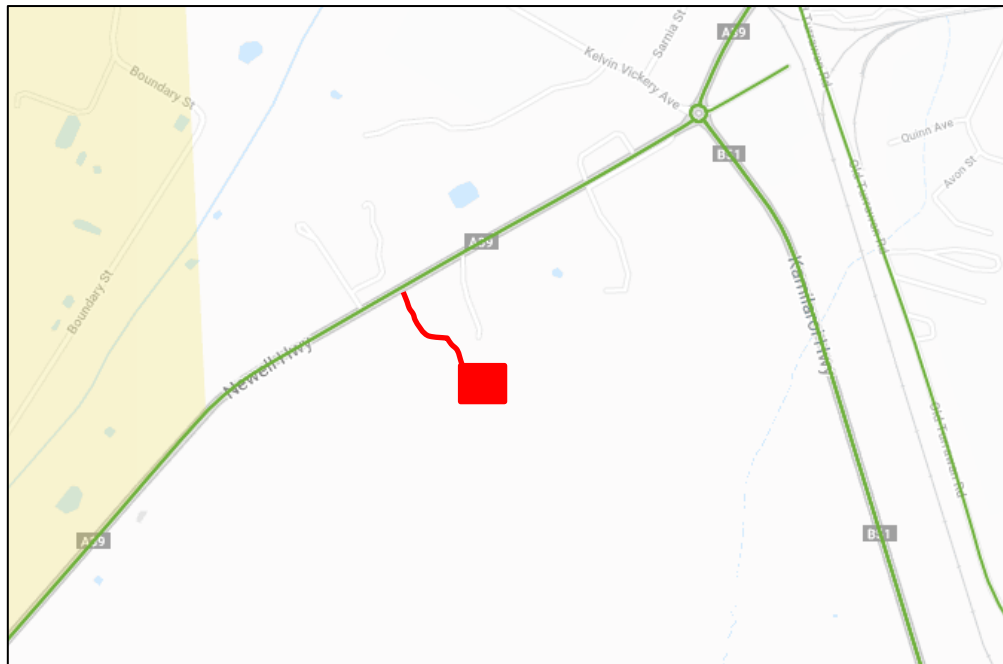


Figure 9 – B Double approved Roads – RMS interactive map.

2.4 Newell Highway

The Newell Highway (A39) is a 1058-kilometre national highway located in the western Riverina and western region of New South Wales, Australia. The highway services rural communities of the Murrumbidgee Irrigation area and is the most direct link from Victoria to south-eastern Queensland, bypassing the more urbanised and congested coastal areas of the state. The highway is generally a single carriageway, two-lane road, although there are many overtaking lanes under construction.

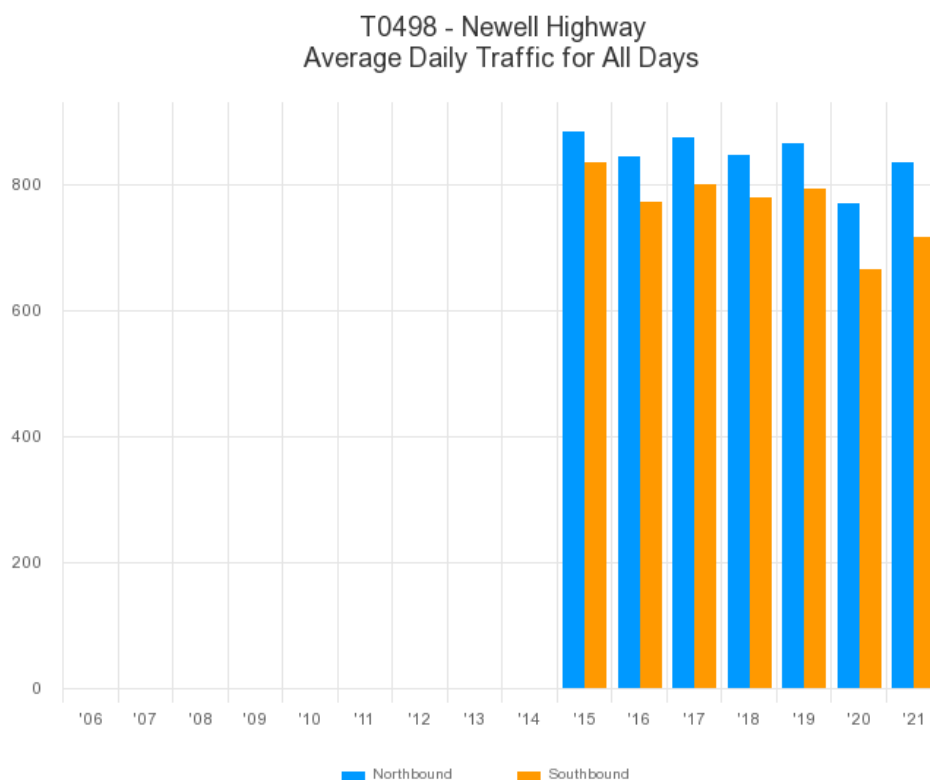
The speed limit on the Newell Highway fronting the site is within a 110km/hr zone in both directions and reduces to 80km/hr approximately 380m to the east of the access.

Lane widths on the Newell Highway near the access are approximately 3.5m with 1.0m sealed shoulders.

Traffic count data on the Newell Highway based on 2021 counts 800m north of Oxley Highway reported on the NSW Traffic Volume Viewer are:

- Two way, average daily volume: 1558
- Heavy vehicle percentages: 45 %

There is slightly more northbound average daily traffic at 839 (386 heavy) with southbound at 719 (319 heavy).



Exported on Thu Sep 23 2021 at 7:7:4. © Roads and Maritime Services 2015.

Figure 10 – Daily traffic - Station T0498 – RMS interactive map

Traffic count data from 2015 to 2021 is relatively consistent with slight decrease in numbers.

Newell Highway (T0498) Data

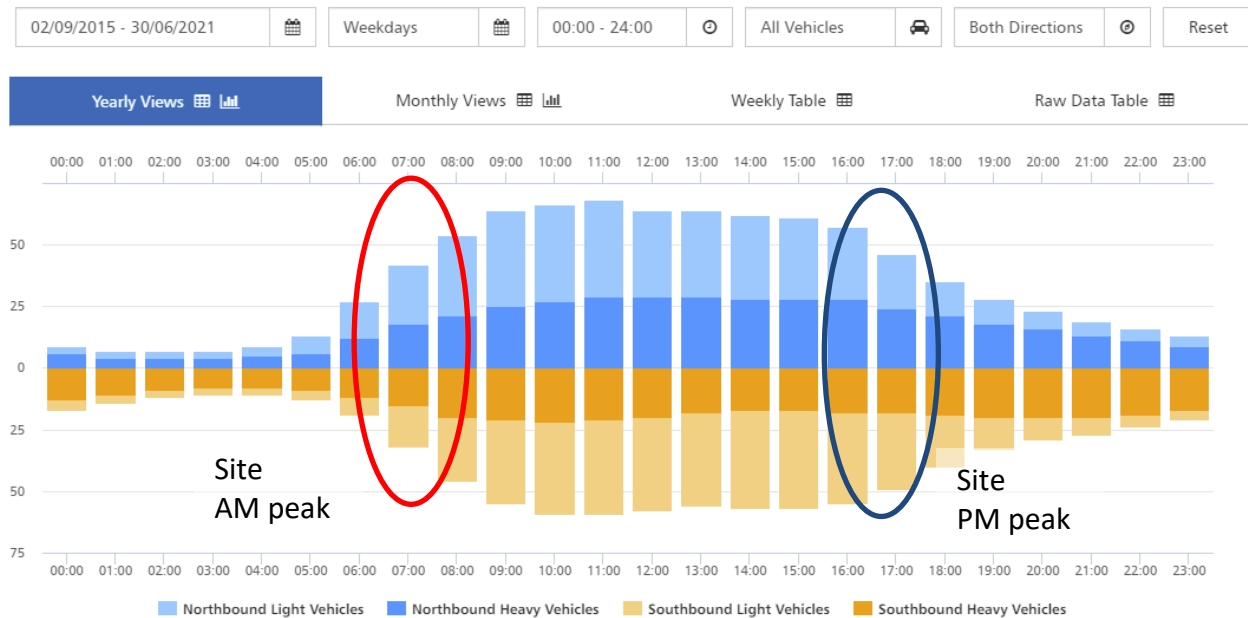


Figure 11 – Hourly traffic - Station T0498 – RMS interactive map

Data from T0498 indicates hourly traffic peak is around 10 to 11am. The peak construction traffic will be workers entering the site between 7am and 8am then exiting the site between 4 pm and 5pm.

The Newell Highway Corridor Strategy (2015) sets out a plan to manage transport along the corridor. The Strategy sets out the Newell Highway into planning sections with the proposed solar development in section 16 – Coonabarabran to Narrabri. The Strategy uses 2011 traffic data sourced from Cardno report and indicates that the AADT along the Newell Highway fronting the solar development as 1821 with 808 heavy vehicles at 44%.

The Newell Highway Corridor Strategy has a higher counts to the more recent figures from 2015 to 2021. This appears to be consistent with the gradual decline in traffic numbers seen from 2015 to 2021.

As the construction is likely to occur within the next few years, the current traffic count figures would be appropriate.

3 Proposal

The solar farm is to have an AC capacity of 5 MW and will cover an area of approximately 11.24 Ha of the site.

During construction phase there will be a large number of heavy vehicles (approx. 45 x 19m) accessing the site delivering panel components.

It is likely to take up to 12 weeks to complete delivery of equipment. Installation of the components will be occurring during delivery therefore completion of the site should occur within approximately 14 weeks. Upon completion of construction, the traffic generation at the site will be very low and only comprise the infrequent service vehicles.

During the construction phase the work site will involve the following:

Week 1 – 2

Establishment phase

Earthworks and general site establishment and fencing to construct new access and site compound development. This will comprise graders, rollers and water carts.

The existing access would be improved during the initial stage.

Likely traffic generation during this period is:

- 6 to 8 light vehicle trips per day (earthworks contractor's staff 3-4. Two way trips).
- 10-15 Truck and trailer loads of gravel over approximately 2-3 days

Week 3-10

Construction Phase

Main construction of piers, installation of panels and underground infrastructure.

Site operation includes:

- 50 construction workers
- Operating hours 7am to 4pm Monday to Friday

Expected traffic generation during the construction phase will be:

- 33 Semi Trailers (19m articulated) including
 - 6 for site establishment (buildings etc)

- 2 for delivery of inverters
 - 12 for delivery of mounting systems
 - 7 for delivery of balance of system
 - 6 for demobilisation
- 12 x B Double (26m articulated) for PV Module delivery

Week 10-12

Commissioning

Specialist electrical contractors will commission the site through light or heavy rigid vehicles 12m.

- 10 construction workers
- Operating hours 7am to 4pm Monday to Friday

4 Traffic Engineering Assessment

4.1 Traffic Impacts

During the 12-week construction period up to 33 semi-articulated trucks and 12 B-Doubles will access the site with an expected daily maximum likelihood of 4 trucks. The trucks will access the site throughout the day generally between 10am and 2 pm and would therefore not contribute to morning or afternoon peak hour.

The anticipated 50 construction workers are likely to generate peak number of vehicles entering the site in the morning between 6:30 to 8:00am and leaving at the afternoon peak around 4:00 to 5:00pm.

To decrease the numbers of light vehicles, the development will propose a shuttle bus service and car-pooling which will reduce the number of vehicles to fewer than 20. It is expected that a large number of workers will be staying at one of the three local caravan parks which are relatively close to one another. This will make shared transport more convenient.

Movements are expected to be 90% between Narrabri township and the site, therefore predominately left turn in to the site during the morning peak and right turn out of the site in the afternoon.

Peak traffic volumes Figure 11 above suggest southbound and northbound volumes would be less than 50 per hour during main worker arrival time. PM peaks are slightly higher at 60 to 50 vph.

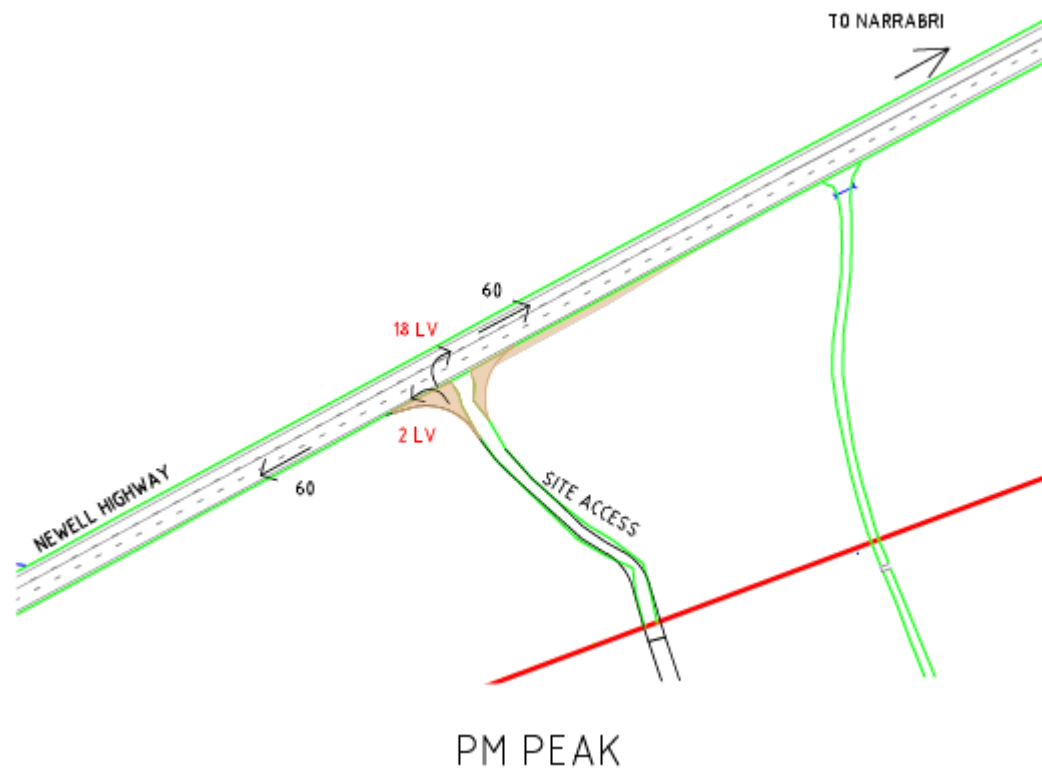
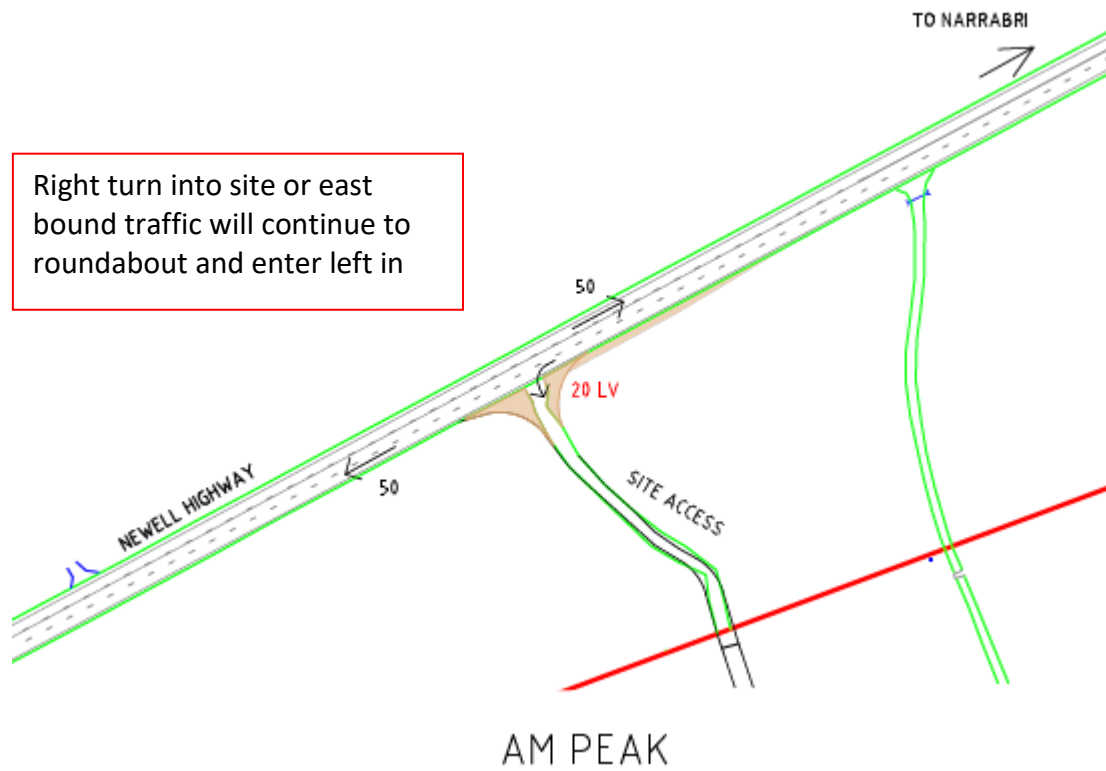


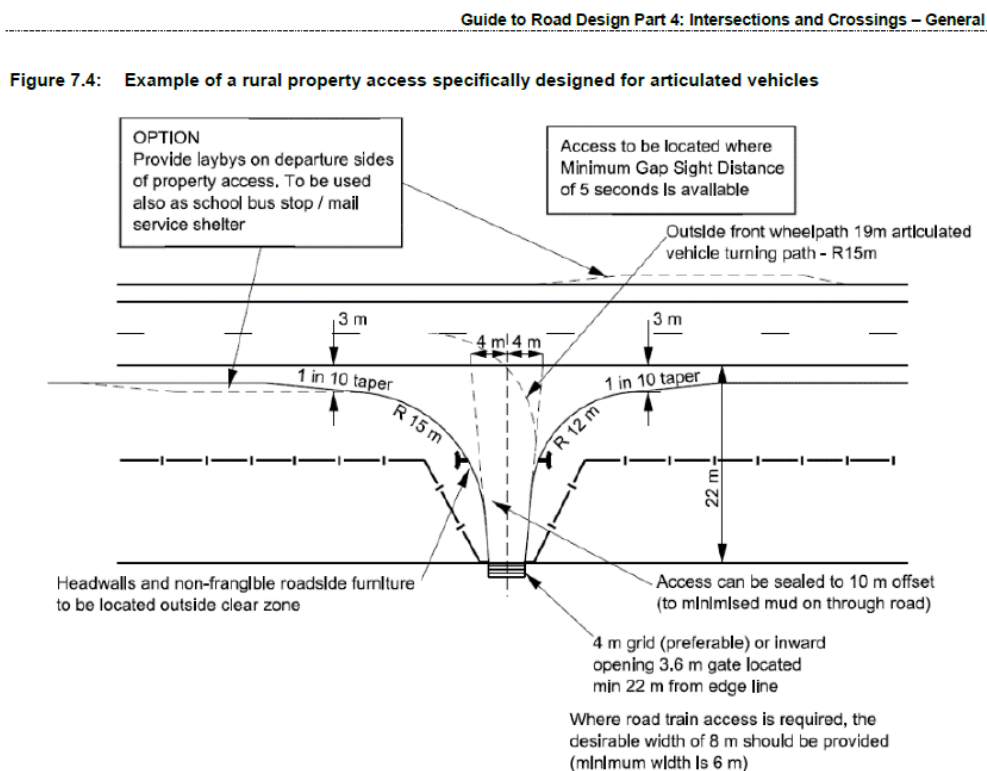
Figure 12 – AM and PM Peak vehicle movements per hour

4.1 Proposed Site Access

The proposed access for the development has been located on an existing access point to the property to minimise vegetation removal and limit earthworks. This location is on a straight section of the Newell Highway and 960m from the roundabout of the Newell and Kamilaroi Highways.

It is anticipated that trucks will only be allowed to enter the site from the north and therefore left turn in only. This will improve safety at the access point. The minor widening of the existing access will enable a B-Double to enter the site without crossing into the overtaking lane. Left turn out of the site will be possible to maintain turn within the left lane with widening on the west side of the access.

The access arrangement is consistent with the warrants of an access arrangement shown in Figure 7.4 of Austroads Guide to Road Design Part 4 – Intersections and Crossing – General.



Note: Minimum requirement for a single carriageway with design AADT < 2000 or minimum requirement for dual carriageway left-in-left-out access for single unit truck. Where AADT > 1000 and access is required for a semi-trailer then use the layout.

Source: Department of Main Roads (2006)¹⁰.

Figure 13 – Austroads example of rural access for articulated vehicles with AADT < 2000

Left turn entry to the site will be able to utilise the existing left lane whilst west bound traffic can continue via the passing lane.

To improve safety, it would be recommended that a BAL turn treatment be applied in accordance with Figure 8.2 of AGRD Part 4A.

Figure 8.2: Rural basic left-turn treatment (BAL)

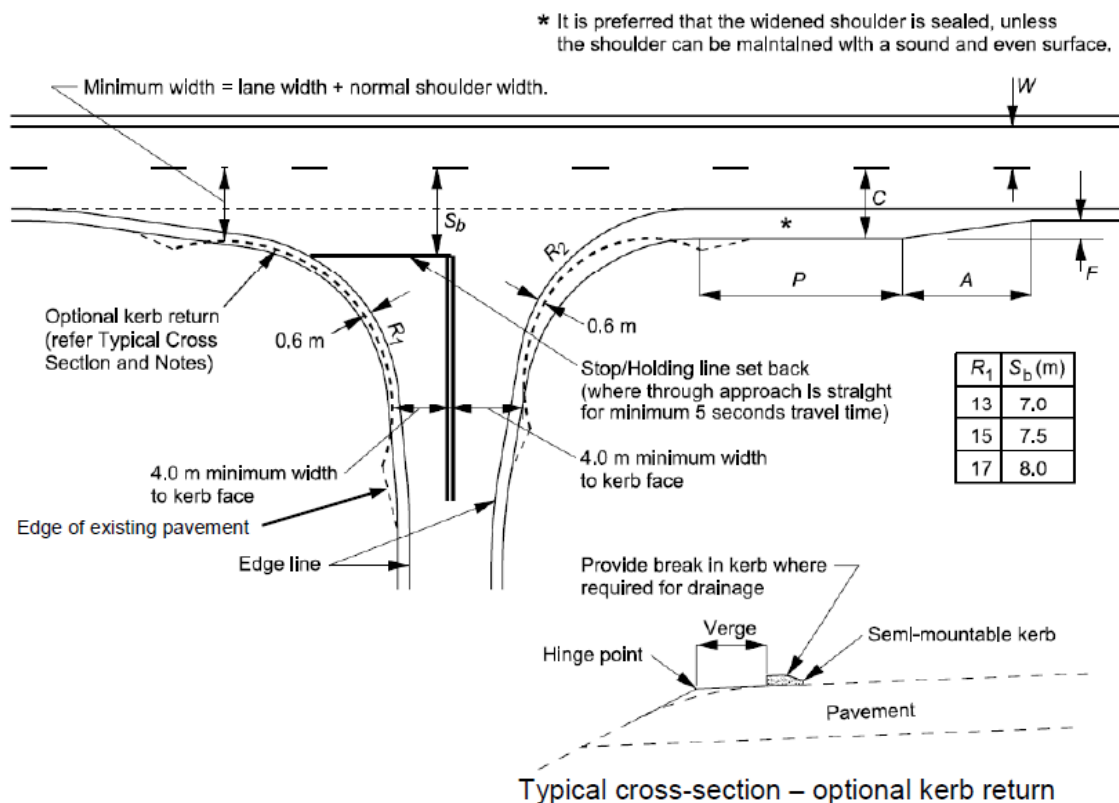


Figure 14 – Austroads Figure 8.2 of AGRD Part 4A

5 Conclusion

The relevant documents, plans and traffic counts have been perused for access requirements to the proposed solar farm development off the Newell Highway.

General indication of the access is shown in Appendix 7. Detailed design will be required prior to construction.

The main findings and proposed upgrades are outlined below:

Recommendations

- i. The existing access point to Lot 102 DP 579423 (western one) should be upgrade to accommodate a B-Double turn safety during the construction phase.
- ii. Eastern access to exiting residence is to be temporarily closed during the construction period.
- iii. Existing western access point proposed for use during short term construction and ongoing operation is considered a suitable location and there are no major geometry issues.
- iv. Dilapidation survey to be undertaken prior to construction works.
- v. Appropriate signage outlined in Traffic Management Plan to prevent right turn entry from the Newell Highway into the site.
- vi. Shared transport for workers should be incorporated into the site management during construction period.

Findings

- vii. Sight lines for the proposed access are adequate.

Proposed Works

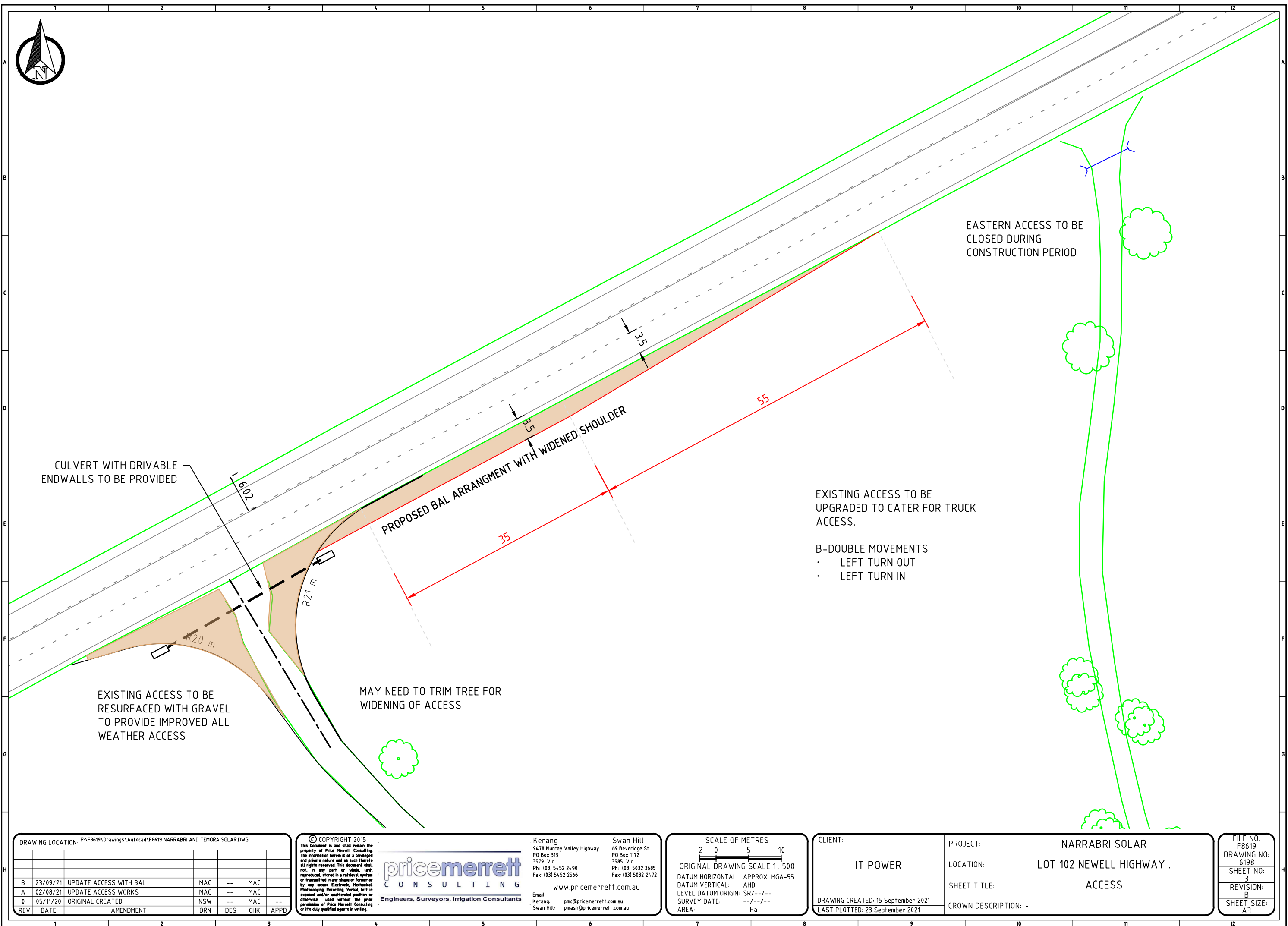
- viii. BAL widening arrangement including shoulder widening.
- ix. Gravel pavement improvements to the existing western access to accommodate construction stages.
- x. Installation of new culvert and drivable headwalls at western access.
- xi. Truck entering signs (W5-22) (or T2-25 as this is temporary works) to be erected 250m either side of the existing access during construction phase to notify motorist.
- xii. No right entry sign or VMS signage to prevent right turn entry.

6 References

- Austroads Guide to Road Design Part4A: Unsignalised and Signalised Intersections (2017)
- Austroads Guide to Road Design: Part 3 (2016)
- Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis (2017)
- RTA traffic NSW Guide to Traffic Generating Developments (2002)
- Newell Highway Corridor Strategy (2015)

7 Appendix A

7.1 Drawings



DRAWING LOCATION: P:\F8619\Drawings\Autocad\F8619 NARRABRI AND TEMORA SOLAR.DWG						
REV	DATE	AMENDMENT	DRN	DES	CHK	APPD
B	23/09/21	UPDATE ACCESS WITH BAL	MAC	--	MAC	
A	02/08/21	UPDATE ACCESS WORKS	MAC	--	MAC	
0	05/11/20	ORIGINAL CREATED	NSW	--	MAC	--

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pricemerrett
CONSULTING
Engineers, Surveyors, Irrigation Consultants

Kerang
94/78 Murray Valley Highway
PO Box 313
3579 Vic
Ph: (03) 5452 2490
Fax: (03) 5452 2566

Swan Hill
69 Beveridge St
PO Box 1172
3585 Vic
Ph: (03) 5032 3685
Fax: (03) 5032 2472

www.pricemerrett.com.au
Email: pmc@pricemerrett.com.au
Kerang: pmash@pricemerrett.com.au
Swan Hill: pmash@pricemerrett.com.au

SCALE OF METRES
2 0 5 10

ORIGINAL DRAWING SCALE 1: 500
DATUM HORIZONTAL: APPROX. MGA-55
DATUM VERTICAL: AHD
LEVEL DATUM ORIGIN: SR/--/--
SURVEY DATE: --/--/--
AREA: --Ha

CLIENT:
IT POWER

DRAWING CREATED: 15 September 2021
LAST PLOTTED: 23 September 2021

PROJECT:
NARRABRI SOLAR

LOCATION:
LOT 102 NEWELL HIGHWAY .

SHEET TITLE:
ACCESS

CROWN DESCRIPTION: -

FILE NO: F8619
DRAWING NO: 6198
SHEET NO: 3
REVISION: B
SHEET SIZE: A3



Waste Assessment

Narrabri 3A Solar Farm



DOCUMENT CONTROL

Report Title		Waste Assessment – Narrabri 3A Solar Farm			
Rev	Date	Status	Author/s	Reviewed By	Approved
1	11/09/2020	Final	I Berwick	C Wilson	Approved

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ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au



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ITP Renewables (ITP) is a global leader in renewable energy engineering, strategy, construction, and energy sector analytics. Our technical and policy expertise spans the breadth of renewable energy, energy storage, energy efficiency and smart integration technologies. Our range of services cover the entire spectrum of the energy sector value chain, from technology assessment and market forecasting right through to project operations, maintenance and quality assurance.

We were established in 2003 and operate out of offices in Canberra (Head Office), Sydney, North Coast NSW, Adelaide and Auckland, New Zealand. We are part of the international ITP Energised Group, one of the world's largest, most experienced and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

Our regular clients include governments, energy utilities, financial institutions, international development donor agencies, project developers and investors, the R&D community, and private firms.

ABBREVIATIONS

AC	Alternating current
EPA	Environmental Protection Agency
Ha	hectare
ITP	ITP Renewables
LCA	Life cycle analysis
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions used to indicate PV system capacity
NSW	New South Wales
POEO	Protection of the Environment Operations (Act)
PV	Photovoltaic
WMP	Waste management plan

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1 INTRODUCTION

The proposed Narrabri 3A Solar Farm (referred to as the Project) is located at 11498 Newell Highway to the southwest of the town of Narrabri, within the Narrabri Shire Council area, NSW (Figure 1). ITP Development (ITP) is proposing to construct a 6.4 MW DC solar facility within the 62 ha site.

Table 1. Site Information

Parameter	Description
Solar farm name	Narrabri 3A Solar Farm
Site reference	Narrabri 3A
Lot/DP(s)	Lot 102 DP579423
Street address	11498 Newell Highway, Narrabri, NSW 2390
Council	Narrabri Shire Council
AC capacity	5 MW
DC capacity	6.4 MW
Site area	Approx. 62 ha
Project area	Approx. 11.32 ha
Current land use	Grazing, recently destocked

This report provides a waste assessment to support the Development Application for the project. It provides a:

- Desktop review of resource use, waste generation type and quantity expected and Life Cycle Analysis (LCA) during construction and operation.
- Desktop review of waste generation against the Protection of the Environment Operations (POEO) Act 1997, POEO (Waste) Regulation 2014 and Waste Avoidance and Resource Recovery Act 2001.
- Desktop review of waste disposal options (local approved waste disposal facility), during construction and operation.
- Desktop impact assessment against NSW policies and referenced industry standards for solar photovoltaic systems.
- Desktop management assessment with mitigation measure recommendations for construction and operation.



Figure 1 - Proposed 62 ha solar farm site and surrounding farm area (note the project will comprise 11.32 ha within this area)

2 PROJECT DESCRIPTION

ITP is proposing to construct a solar farm with a DC capacity of 6.4 MWp and AC output of 5 MW on an approximately 11.32 ha site that is currently used for grazing.

There are to be approximately 12,100 solar modules installed in 140 rows (each row being approximately 103 m long and 2 m wide) running east to west. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day. There is approximately 6.25 m spacing between each row. The maximum hub height of each module is 2.75 m.

The solar farm will also consist of an inverter station. The inverter station incorporates the high/medium voltage switchgear and transformers and two 3 MW inverters. The inverter station is ground mounted and incorporated on a 12.19 m skid.

The mounting system is constructed on piles that are driven into the ground. During construction there is expected to be 50 personnel on site working from 7 am – 4 pm Monday to Friday. The construction is expected to take approximately 3 months. Once operational the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 – 3 people.

Solar panels and related infrastructure will be decommissioned and removed upon cessation of operations. This is likely to occur within two years of the end of the project. The site will be returned to the pre- development land use of agriculture.

3 LEGISLATIVE CONTEXT

Waste management is an integral part of the construction, operation and decommissioning phases of a project. There are several acts and guidelines that relate to the assessment of waste and ongoing management during project operation.

3.1 Protection of the Environment Operations (POEO) Act 1997

The POEO Act aims to protect and restore and enhance the quality of the environment in NSW, while still having regard to ecologically sustainable development.

With relevance to waste management, the Act aims to reduce risks to human health and to prevent degradation of the environment by promoting pollution prevention and the reduction in the use of materials and the re-use, recovery or recycling of materials. The Act contains the requirements for the management of waste and also the offences that relate to pollution. Section 148 requires that any pollution incidents or those that threaten material harm to the environment must be notified to the relevant authority (e.g. NSW Environment Protection Authority).

Section 143 of the POEO Act requires waste to be transported to a place that can lawfully accept it. It is an offence under Section 115 to negligently dispose of waste that may cause harm to the environment, unlawfully transport and deposit waste (e.g., if waste is transported to a place that cannot be used as a waste facility for the waste).

The waste classification definitions are also provided in the Act, and more information is provided in the EPA Waste Classification Guidelines (EPA, 2014) (Section 3.4).

Wastes that may be generated as part of construction and demolition activities, including 'building and demolition waste' as defined in the Act and includes unsegregated material that results from the demolition, erection, construction, refurbishment or alteration of buildings. Materials such as bricks, concrete, paper, plastics, glass and metal, and timber are included in this category.

3.2 Protection of the Environment Operations (Waste) Regulation 2014

The POEO Waste Regulation aims to protect human health and the environment and provides the framework for the waste industry in NSW, including the details of the licencing, reforms and the waste levy system.

The POEO Waste Regulation prescribes the wastes (hazardous waste, restricted solid waste etc) which are automatically deemed to be land pollution and the person is guilty of an offence if the waste is illegally dumped.

3.3 Waste Avoidance and Resource Recovery Act 2001

The Waste Avoidance and Resource Recovery Act 2001 aims to encourage the efficient use of resources and to reduce environmental harm. Waste management for the project must be

conducted in accordance with the Act. The projects' waste management program needs to consider the hierarchy outlined in the Act:

- i. Avoidance of unnecessary resource consumption;
- ii. Resource recovery (including reuse, reprocessing, recycling and energy recovery); and
- iii. Disposal.

ITP has an obligation to minimise material harm to the environment as a result of the construction, operation and decommissioning of the project. Details of the project waste management and minimisation can be found in Section 6.

3.4 EPA Waste Classification Guidelines

The EPA Waste Classification Guidelines (EPA, 2014) comprise four parts:

1. Part 1: Classifying waste;
2. Part 2: Immobilisation of waste;
3. Part 3: Waste containing radioactive material; and
4. Part 4: Acid sulfate soils.

Part 1 of the guidelines provide details on each of the classes of waste that are defined in clause 49 of Schedule 1 of the (POEO Act):

- Special waste;
- Liquid waste;
- Hazardous waste;
- Restricted solid waste;
- General solid waste (putrescible); and
- General solid waste (non-putrescible).

Classification of the projects' waste is discussed in more detail in Section 4.

3.5 Narrabri Local Environmental Plan 2012

The Narrabri Local Environmental Plan 2012 aims to make local environmental planning provisions for land in Narrabri in accordance with the relevant standard environmental planning instrument. The Plan does not provide specific management requirements for waste as it relates mostly to urban planning and conflicting land use management. The Plan provides additional provisions for earthworks to ensure that earthworks for which development consent is required will not have a detrimental impact on environmental functions and processes, neighbouring uses, cultural or heritage items or features of the surrounding land.

The Plan provides the prohibited and permitted types of development within the local area. Some types of development are also regulated by specific state environmental planning policies.

3.6 State Environmental Planning Policy (Infrastructure) 2007

Division 4 of the State Environmental Planning Policy (Infrastructure) 2007 relates to 'Electricity generating works or solar energy systems'. The policy relates to the approval process for solar energy systems, and there are no specific details required for waste management. The policy generally states that for infrastructure projects waste materials must be sorted and must be disposed of at a waste or resource management facility.

4 PROJECT WASTE

Waste will mostly be generated during the construction phase of the project, and at the decommissioning phase (after 35 years of operation). The wastes are likely to include construction materials waste (e.g., wood pallets, cardboard), green waste and domestic waste. There will be no putrescible waste as a result of the project. The waste types generated from the project are likely to be classified as general solid waste (non- putrescible) class under the POEO Act.

The operating phase will not generate waste streams unless there is maintenance, repairs or replacement of equipment required.

Table 1 provides the details of the waste generation types and quantities expected during construction, operation and decommissioning. It also provides the options for disposal and management. Section 6 provides further details on the disposal and management options for the waste material. These quantities are estimates based on other solar projects and the actual waste from the project may vary depending on the packaging options from the PV supplier.

Table 2 - Waste Materials and Disposal and Management Options

Activity	Waste Material	Disposal and Management
Construction	Packaging waste such as cardboard, wood pallets, plastic wrap, scrap metal, general waste including approximately 810 wooden pallets and cardboard packing boxes.	Laydown area to contain a skip bin to allow segregation of solid wastes into the following categories, for appropriate recycling/disposal as indicated: - Steel and scrap metal (recycled) - Timber/cardboard (recycled) - General wastes and plastic (landfill).
	Concrete waste (minimal quantities)	
	- Electric cable waste and cable reels - Plastic pipe offcuts/scrap	
	Empty drums and containers (minimal quantities)	Collected and disposed at offsite waste facilities.
	- Minimal used lubricating oil and filters - Unused or spent chemicals	Fluids recycled where possible. Where not possible, disposed of at offsite waste facilities.
Operation	Minimal volumes of domestic wastes such as office consumables, paper, plastics, glass.	Taken offsite to appropriate recycling/disposal.

	Waste as a result of maintenance or replacement of equipment.	
Decommissioning	• PV panels (12,100 panels) and supporting poles and mounts • Glass for panels (250 tonnes) • Silicon for wafers (40 tonnes) • Inverters / transformers / batteries • PV boxes, skids, scrap metal (410 tonnes) • Electrical cables	Taken offsite to appropriate recycling/disposal for PV panels.
	• Fencing • Storage containers (two 20-foot containers)	Removed from site and reused.

5 WASTE DISPOSAL FACILITIES

The closest waste management facility to the project site is on Yarrie Lake Road in Narrabri, approximately 10 minutes' drive (6.4 km) from the project site (see Figure 1). It is open 8 am to 5 pm 7 days a week. The Narrabri Community Recycling Centre is also located at the waste management facility. The Recycling Centre offers recycling for paper and cardboard as well as paint, batteries, motor oil and fluorescent lights. Scrap metal can be recycled at French's Scrap Metal, located on Goobar Street in Narrabri.

6 WASTE MANAGEMENT AND MINIMISATION

Waste management and minimisation for the project should be in accordance with the POEO Act.

The waste management hierarchy is an internationally and nationally accepted guide for waste management practices with the objective of achieving optimal waste management outcomes. This hierarchy promotes waste avoidance and reduction and encourages resource recovery and efficiency and specifies the preferred order of practices, ranked from most to least preferred. This hierarchy is shown in Figure 2 and described below:

- AVOID or REDUCE unnecessary resource consumption and waste generation.
- RE-USE waste resources without further manufacturing.
- RECYCLE waste resources to make the same or different products.
- RECOVER waste resources, including the recovery of energy.
- TREAT waste before disposal, including reducing the hazardous nature of waste.
- DISPOSE of waste only if no viable alternative.

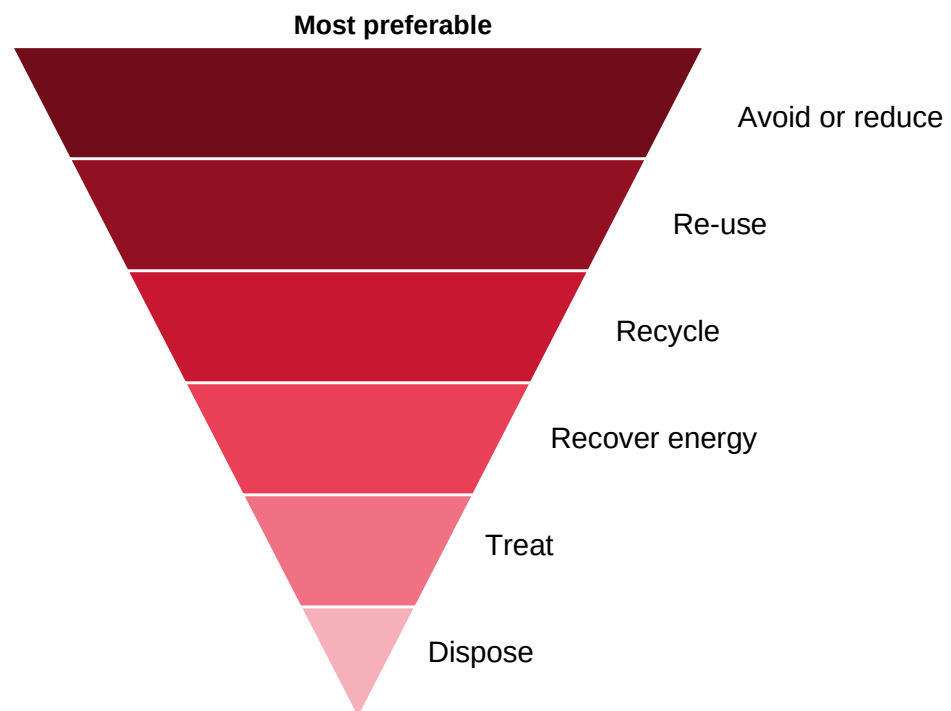


Figure 2 - Waste Management Hierarchy

6.1 Reduce

The project should aim to reduce waste where possible when purchasing goods for construction and during the operation phases. Inductions and staff education should include waste management and recycling procedures, particularly for the construction phase.

6.2 Resource Recovery (Reuse, Recycle, Recover)

If vegetation clearance is required during construction activities, the cleared vegetation should be re-used for mulch and soil erosion control where possible.

At the end of the 35 year life of the solar products the site will be decommissioned. Decommissioning should consider recycling where possible. Recycling of solar PV modules is becoming more common in Australia (Energy Matters, 2012 and Renew Economy, 2016).

There are companies who specialise in providing a drop off location or collection of modules. The decommissioned PV panels are then reclaimed and recycled into other products (Reclaim PV Recycling, 2018). The general steps in the recycling process done by specialist companies are:

- Remove aluminium frames, junction boxes and cables;
- Remove glue, recover glass, aluminium, solar cells and contacts;
- Separate out glass (crushed into small pieces) and other products for re-use in other new products; and
- Remove other materials for use in new models or other products.

6.3 Dispose

If no viable alternative exists for the waste product it will require disposal to a suitable waste facility. The waste should be separated during construction into different bins or skips for different waste streams (separate reusable and recyclable from non-reusable and non-recyclable waste).

The waste should be classified on site according to the EPA Waste Classification Guidelines and then stored and handled on site in accordance with its classification. All waste should be removed as soon as practicable and then sent to an appropriately licenced facility for disposal.

Waste should be classified and logged in a register and then tracked to ensure it reaches its destination offsite. The tracking process should include classification, a description of the waste, volume of the waste, date the waste is transported from site and the destination. An example of a waste tracking register is in Table 3.

If transported by a third party, the details of the company transporting the waste should also be recorded. The EPA have an online waste tracking system for hazardous waste. This should be used if disposal of hazardous waste is required (EPA, 2018).

Table 3 - Waste Register Example

Date	Description of Waste	Classification	Volume	Tracking	Transport Details	Destination
1 Dec 2018	Cardboard	General solid waste (non-putrescible)	1 tonne		Example transport company	Recycled at waste disposal location

6.4 Waste Management Plan

Prior to operation of the project, a Waste Management Plan (WMP) should be developed. This will build on what is proposed in this report and provide detailed procedures regarding management, minimisation, recycling, record keeping and tracking and disposal of waste.

The WMP should contain:

- Strategies to reduce waste during all project phases;
- Recycling, re-use and recovery strategies and opportunities;
- Classification of all waste streams;
- Tracking register and details;
- Recycling management onsite;
- Responsibilities for recycling, re-use and disposal; and
- Reporting and notification procedures if a waste incident occurs where there is a threat to the material harm of the environment.

7 LIFE CYCLE ANALYSIS

A Life Cycle Analysis (LCA), also called a Life Cycle Assessment, is an approach that considers all aspects of a project's resource use. It is an environmental accounting and management approach that considers all the aspects of resource use and environmental releases associated with a system from cradle to grave. The LCA assessment considers raw materials, material processing, manufacturing, operational/use phase, decommissioning and provides an estimate of energy and emissions based on the total life of the project (Wu et al, 2017).

Construction materials and energy used for solar panels includes purification of silicon, production of PV frames and cabling. The construction of each of these uses energy and creates waste products. Energy consumption and use of resources is greatest in the production of the PV panels and silicon (Alsema et al, 2006). The Department of Industry, Resources and Energy NSW (2016) states that during plant operation, PV modules emit no pollution, produce no greenhouse gases and use no finite fossil-fuel resources.

Müller, et al (2005) reviewed the environmental impacts of recycling processes for crystalline silicon modules. The findings indicated that energy consumption during the recycling process of PV panels can be substantial. However, overall the recycling solar components is worthwhile. This is mostly due to the potential reuse of recovered component in future projects.

For solar projects the LCA considers the total energy input and annual energy output of the project. This is termed the 'Energy Payback Time'. The energy payback time varies depending on the project's design and geographic location. For solar projects the general timeframe for energy payback is achieved in less than four years for projects with a 25-30 year operating period (Bhandari et al, 2015, Department of Industry, Resources and Energy NSW, 2016). Alsema et al (2006) found that PV panels had an energy payback of 1.5 – 2 years in southern Europe and 2.7 – 3.5 years for middle Europe. Due to the greater solar resource in Australia the energy payback for this project is expected to be at the lower end of these ranges.

The Fraunhofer Institute for Solar Energy Systems (2015) considered the ratio of energy produced by a solar PV compared to the energy used to create the module. It was determined that the PV panels would provide more than 10 x the amount of energy used to make the system.

8 SUMMARY

The project will generate the most waste during the construction and decommissioning phases. To comply with the NSW legislation and policies, the waste should be recycled or re-used where possible and only disposed of if no alternative is available.

Cardboard, scrap metal and wood from the construction phase can be recycled. Plastics and general waste will require disposal at the local waste facilities. Decommissioning of the project is likely to occur in 35 years' time. Technology for recycling of PV panels is likely to be more advanced and readily available. Options for recycling of PV panels should be reviewed as the project progresses.

9 REFERENCES

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ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au



Decommissioning Assessment

Narrabri 3A Solar Farm

DOCUMENT CONTROL

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1	11/03/2021	Draft	A Nicholls		

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ITP Development Pty Ltd
ABN 38 633 420 309

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au



ABOUT ITP DEVELOPMENT

ITP Development Pty Ltd (ITPD) is a developer of town-scale solar farms in regional Australia designed to match current and future electricity demand. We undertake solar farm landholder engagement, system design, planning approvals, financing, electrical connection approvals and commissioning. ITPD maintains relationships with multiple stakeholders to ensure projects are successfully delivered in accordance with their expectations.

We are part of the international ITP Energised Group, one of the world's largest, most experienced and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

ABBREVIATIONS

ha	hectare
ITPD	ITP Development
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions used to indicate PV system capacity
NSW	New South Wales
PV	Photovoltaic

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1 INTRODUCTION

The proposed Narrabri 3A Solar Farm (referred to as the Project) is located at 11498 Newell Highway to the southwest of the town of Narrabri, within the Narrabri Shire Council area, NSW (Figure 1). ITP Development (ITPD) is proposing to construct a 6.4 MW DC solar facility within the 62 ha site.

Table 1 - Site information

Parameter	Description
Solar farm name	Narrabri 3A Solar Farm
Site reference	Narrabri 3A
Lot/DP(s)	Lot 102 DP579423
Street address	11498 Newell Highway, Narrabri, NSW 2390
Council	Narrabri Shire Council
AC capacity	5 MW
DC capacity	6.4 MW
Site area	Approx. 62 ha
Project area	Approx. 11.32 ha
Current land use	Grazing, recently destocked



Figure 1 - Proposed 62 ha solar farm site and surrounding farm area (note the project will comprise 11.32 ha within this area)
Decommissioning Assessment of the Narrabri 3A Solar Farm March 2021

2 PROJECT DESCRIPTION

ITPD is proposing to construct a solar farm with a DC capacity of 6.4 MWp and AC output of 5 MW on an approximately 11.32 ha site that is currently used for grazing.

There are to be approximately 12,100 solar modules installed in 140 rows (each row being approximately 103 m long and 2 m wide) running east to west. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day. There is approximately 6.25 m spacing between each row. The maximum hub height of each module is 2.75 m.

The solar farm will also consist of an inverter station. The inverter station incorporates the high/medium voltage switchgear and transformers and two 3 MW inverters. The inverter station is ground mounted and incorporated on a 12.19 m skid.

The mounting system is constructed on piles that are driven into the ground. During construction there is expected to be 50 personnel on site working from 7 am – 4 pm Monday to Friday. The construction is expected to take approximately 3 months. Once operational the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 – 3 people.

Solar panels and related infrastructure will be decommissioned and removed upon cessation of operations. This is likely to occur within two years of the end of the project. The site will be returned to the pre- development land use of agriculture.

3 DECOMMISSIONING

The Narrabri 3A solar farm is intended to be operational for 35 years, at which point the solar farm will be decommissioned and the site returned to the original state.

3.1 Decommissioning Plan

The decommissioning process for the Narrabri 3A solar farm will involve:

- Notification of stakeholders of proposed de-energisation
- De-energisation of the solar farm and disconnection of assets
- Removal of PV modules and associated infrastructure
- Removal of electrical wiring
- Rehabilitation of land

Relevant equipment will be brought to site to facilitate decommissioning, including amenities for site crew for the duration of the works. This equipment may include mobile cranes, excavators, skid steers, loaders, rollers/compactors, pile drivers, telehandlers, skip bins, water carts, temporary shipping containers for storage, site office and site ablution blocks.

3.1.1 Notification of stakeholders of proposed de-energisation

ITPD will contact Essential Energy, the state-owned enterprise responsible for operating the distribution network 12 months prior to the commencement of decommissioning.

Narrabri Shire Council will be notified and any necessary permits or approvals required for decommissioning will be sought from the Council or issuing authority. Any measures stipulated in these approvals will be implemented prior to works commencing on site.

ITPD does not foresee any issues arising from stakeholder notification of decommissioning.

3.1.2 De-energisation of the solar farm and disconnection of assets

Essential Energy crew or subcontractors will be brought to site to disconnect the service mains from the point of connection and ensure full isolation of the site from the grid.

All aspects of the solar system will be turned off for safety prior to commencement of work on the site in accordance with the shut down procedure stipulated in the system operation manuals. All generation assets will be disconnected and isolated.

The inverter, transformer will be removed from the site via a crane onto a semi-trailer or e-waste dismantling, recycling, scrapping and safe disposal at the waste disposal facility identified in Section 5 of the associated waste assessment. If possible, the transformer can be reconditioned and refurbished for additional service life at another site.

The concrete foundations of the inverter, transformer will be excavated and the concrete recycled.

3.1.3 Removal of PV modules and associated infrastructure

At the end of their life, the PV modules will be removed from site and recycled appropriately. Reclaim PV are in the late stages of opening an end-of-life panel and battery recycling facility located in South Australia. A number of additional PV recycling plants are expected to be operational around Australia by the time of decommissioning. The PV module tracker structure will be disassembled. The steel piles will be excavated from the ground and recycled at a scrap metal facility.

Other site infrastructure, including the security fence surrounding the solar farm and other concrete on site will be removed and re-used or taken to a waste facility to be recycled where possible.

3.1.4 Removal of electrical wiring

Underground cabling and earthing networks will be excavated and recycled. Other cable materials, including cable covers, will be put into skip bins and taken to landfill. Any trenches excavated during this process will be refilled and levelled.

3.1.5 Rehabilitation of land

Any disruptions to the site created during the decommissioning process will be filled and/or levelled as required, such as the locations where piles were removed.

Gravel surfaces and accessways that were established as part of the development will be removed and the ground remediated unless a request is made by the landholder for it to remain for future use.

The site will be revegetated for cropping or grazing, as per the original use of the site in consultation with the landholder. It is intended that established landscaping, including trees planted during the construction, will remain on-site. If the removal of trees is requested by the landholder, a permit may be required.

4 SUMMARY

The project will predominantly generate waste during the construction and decommissioning phases, rather than during operation. To comply with the NSW legislation and policies, waste will be recycled or re-used where possible and only disposed of if no alternative is available.

Cardboard, scrap metal and wood from the construction phase can be recycled. Plastics and general waste will require disposal at the local waste facilities. Technology for recycling of PV panels is advancing rapidly worldwide and while recycling options currently exist, they are likely to be more advanced and readily available at the time of decommissioning. Options for recycling of PV panels should be reviewed as the project progresses.



ITP Development Pty Ltd
ABN 38 633 420 309

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au