Lyall & Associates

TECHNICAL PAPER 15 - FLOODING

CENTRAL-WEST ORANA RENEWABLE ENERGY ZONE TRANSMISSION

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NOTE ON FLOOD FREQUENCY TERMINOLOGY

The frequency of flood events is generally referred to in terms of their Annual Exceedance Probability (AEP) or Average Recurrence Interval (ARI). For example, for a flood magnitude having five per cent AEP, there is a five per cent probability (or 1 in 20 chance) that there would be floods of greater magnitude each year. As another example, for a flood having a 20 year ARI, there would be floods of equal or greater magnitude once in twenty years on average. The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) per cent	Average Recurrence Interval (ARI) years
0.2	500
0.5	200
1	100
5	20
10	10
20	5
50	2
1 EY(1)	1
2 EY(1)	0.5

1. Floods more frequent than 50% AEP are expressed in terms of the number of exceedances per year (EY).

In this technical paper the frequency of flood events generated by runoff from the catchments within the study area (i.e. catchment flooding) is referred to in terms of their AEP, for example a 1% AEP flood.

The frequencies of peak water levels derived from ocean flooding are also referred to in terms of their AEP; for example, a 1% AEP peak ocean water level.

The technical paper also refers to the Probable Maximum Flood (PMF). This flood occurs as a result of the Probable Maximum Precipitation (PMP) on the catchments within the study area. The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a catchment hydrologic model that simulates the conversion of rainfall to runoff. The PMF is defined as the upper limiting value of floods that could reasonably be expected to occur and defines the extent of flood prone land (i.e. the floodplain).

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Meaning
Access roads	Permanent access roads to switching stations and energy hubs.
Access tracks	Temporary and permanent access tracks to transmission lines.
AEP	Annual exceedance probability. The chance of a rainfall or a flood event exceeding a nominated level in any one year, usually expressed as a percentage. For example, if a peak flood level has an AEP of five per cent, it means that there is a five per cent chance (that is one-in-20 chance) of being exceeded in any one year. The frequency of floods is generally referred to in terms of their AEP or ARI. In this technical paper the frequency of floods generated by runoff from the study catchments is referred to in terms of their AEP, for example a 1% AEP flood.
Afflux	Increase/decrease in water level resulting from a change in conditions. The change may relate to the watercourse, floodplain, flow rate, tailwater level, etc.
AHD	Australian height datum. A common national surface level datum approximately corresponding to mean sea level.
ARI	Average recurrence interval. An indicator used to describe the frequency of a rainfall or a flood event, expressed as an average interval in years between events of a given magnitude. For example, over a long period of say 200 years, a flood equivalent to or greater than a 20 year ARI event would occur 10 times. A 20 year ARI flood has a one-in-5 chance of occurrence in any one year. See also AEP.
ARR 1987	Australian Rainfall and Runoff (Institute of Engineers Australia (IEAust) 1987).
ARR 2019	Australian Rainfall and Runoff (Geosciences Australia (GA) 2019).
BoM	Bureau of Meteorology.
Box culvert	A culvert of rectangular cross section.
Brake and winch sites	A brake and winch site is a temporarily cleared area where plant and equipment is located for the purposes of spooling and winching a conductor into place on erected towers along a transmission line corridor. Dependent upon the angle of line deviation, the location of the brake and winch site at that angle may or may not be within the nominated transmission line easement. The brake and winch site is only required for the construction phase of the project. It does not need to be maintained for ongoing operation and / or maintenance of the transmission line.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Central-West Orana REZ	A geographic area of approximately 20,000 square kilometres centred by Dubbo and Dunedoo and extending west to Narromine and east beyond Mudgee and to Wellington in the south and Gilgandra in the north, that will combine renewable energy generation, storage and HV transmission infrastructure to deliver energy to electricity consumers.
Climate change	A change in the state of the climate that can be identified (for example by statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period of time, typically decades or longer (IPCC 2007).

Term	Meaning
Climate projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which in turn is based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised (IPCC 2007).
CEMP	Construction Environmental Management Plan.
Construction area	Refers to the area that would be directly impacted by the construction of the project, including all project infrastructure elements (including the transmission lines and towers, energy hubs, switching stations, access roads to switching stations and energy hubs, access tracks to easements, communications infrastructure, workforce accommodation camps, construction compounds, brake and winch sites and laydown and staging areas.
Construction compound	The key construction compounds that would support construction at energy hubs and along the transmission line. It does not refer to work areas along the transmission line.
Cumulative impact	The combined impacts of the project on a matter with other relevant future projects.
DCP	Development control plan.
DECC	Department of Environment and Climate Change (now DPE EES).
DECCW	Department of Environment, Climate Change and Water (now DPE EES).
Detailed design	The detailed design of the project, including construction methodology. This term represents the next phase of project development and will further develop the design and construction methodology of the project considering: • the performance outcomes as recommended in the EIS • mitigation measures as recommended in the EIS • any conditions of approval.
DIPNR	Department of Infrastructure, Planning and Natural Resources (now DPE EES).
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving (e.g. metres per second [m/s]).
DPIE	Department of Planning and Environment.
DPE EES	Department of Planning and Environment – Environment Energy and Science.
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
DRAINS	A computer simulation program which converts rainfall patterns to stormwater runoff and generates discharge hydrographs. These hydrographs can then be routed through networks of piped drainage systems, culverts, storages and open channels using the DRAINS software to calculate hydraulic grade lines and analyse the magnitude of overflows. Alternatively, discharge hydrographs generated by DRAINS can be used as inflows to alternative hydraulic models (such as the TUFLOW two-dimensional hydraulic modelling software) to calculate water surface levels and flooding patterns.
Earthworks	All operations involving the loosening, excavating, placing, shaping and compacting of soil or rock.
Emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.

Term	Meaning
EIS	Environmental Impact Statement.
Embankment	An earthen structure where the road (or other infrastructure) is located above the natural surface.
Energy hub	An energy hub is a substation where energy exported from renewable energy generators or storage is aggregated, transformed to 500 kV (where required) and exported to the transmission network. For the project, this includes Merotherie Energy Hub and Elong Elong Energy Hub.
EnergyCo.	The Energy Corporation of New South Wales constituted by section 7 of the EUA Act as the NSW Government-controlled statutory authority responsible for the delivery of NSW's REZs.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
FDM	*Floodplain Development Manual* (Department of Planning, Infrastructure and Natural Resources (DIPNR) 2005).
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunamis.
Flood affectation	The extent to which a property or area of land is affected by flooding.
Flood fringe area	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood immunity	Relates to the level at which a particular structure would be clear of a certain flood event.
Flood prone land	Land susceptible to flooding by the Probable Maximum Flood. Note that the flood prone land is synonymous with flood liable land.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event (i.e. flood prone land).
Floodplain Risk Management Plan	A management plan developed in accordance with the principles and guidelines in the *Floodplain Development Manual* (FDM), (DIPNR 2005). Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
Floodway area	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flow velocity	A measure of how fast how fast water is moving, for example, metres per second (m/s).
FPA	Flood Planning Area. The area of land below the Flood Planning Level and thus subject to flood planning controls.
FPLs	Flood Planning Levels. The combination of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.

Term	Meaning
Freeboard	A factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted Flood Planning Level and the peak height of the flood used to determine the Flood Planning Level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change. Freeboard is included in the Flood Planning Level.
GSDM	Generalised Short Duration Method. A method prescribed by BoM for estimating the Probable Maximum Precipitation for catchments up to 1,000 square kilometres in area.
Hazard	A source of potential harm or a situation with a potential to cause loss. In relation to the *NSW Floodplain Development Manual* (FDM), (DIPNR 2005) the hazard is flooding which has the potential to cause damage to the community.
Hydraulics	The term given to the study of water flow in waterways, in particular the evaluation of flow parameters such as water level and velocity.
Hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
Hydrology	The term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of discharge hydrographs for a range of floods.
Hyetograph	A graph which shows how rainfall intensities or depths vary with time during a storm burst. A design hyetograph shows the distribution of rainfall over a design storm burst.
IFD	Intensity-Frequency-Duration.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Inbank area	The area of a creek or watercourse below its top of bank levels.
Inundation	The spreading of a flood over an area.
IPCC	Intergovernmental Panel on Climate Change.
LGA	Local government area.
LiDAR	Light detection and ranging. A form of aerial survey used to measure ground elevations.
Local drainage	Smaller scale drainage systems in urban areas. Commonly defined as areas where the depth of inundation along overland flow paths is less than 150 millimetres during a 1% AEP storm.
m	Metres. Used to define a length.
m AHD	Metres above Australian Height Datum. Used to define an elevation above Australian Height Datum.
m^2	Square metres. Used to define an area.
m^3	Cubic metres. Used to define a volume.

Term	Meaning
m^3/s	Cubic metres per second. Used to quantify a flowrate.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Major overland flow	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam. Also referred to as overland flooding.
Mathematical/ computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
Merits based approach	The merits based approach weighs social, economic and environmental impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well-being of the State's rivers and floodplains.
Operation area	The area that would be occupied by permanent components of the project, including transmission line easements, transmission lines and towers, energy hubs, switching stations, communications infrastructure, access roads to the switching stations and energy hubs and permanent access tracks to the easements.
Overland flooding	Refer major overland flow.
Peak discharge	The maximum discharge occurring during a flood event.
Peak flood level	The maximum water level occurring during a flood event.
Permanent operational infrastructure	Refers to the areas where the physical infrastructure would be located and the areas where the operational activities would occur. This includes all proposed infrastructure elements such as the proposed transmission line (overhead) and structures, any new switching stations and energy hubs infrastructure or permanent access tracks. For the transmission line, this would also comprise the easements.
PMF	Probable maximum flood. The flood that occurs as a result of the Probable Maximum Precipitation (PMP) on a study catchment. The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically feasible to provide complete protection against this event. The PMF defines the extent of flood prone land (i.e. the floodplain).
PMP	Probable maximum precipitation. The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a catchment hydrologic model which simulates the conversion of rainfall to runoff.
Pre-project conditions	Conditions (within the study area) prior to the construction of the Central West Orana Renewable Energy Zone (REZ) project. This includes details of projects that are presently under construction or will be constructed prior to the Central West Orana REZ project.
Proponent	EnergyCo
Project	The construction and operation of the overall Central West Orana REZ project inclusive of all activities impacting areas within the overall project boundary.
PRM	Probabilistic rational method.
Probability	A statistical measure of the expected chance of flooding (see annual exceedance probability).

Term	Meaning
Renewable energy zone	An area with high energy potential where planned transmission
Representative Concentration Pathway	A greenhouse gas concentration trajectory adopted by the Intergovernmental Panel on Climate Change.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the *NSW Floodplain Development Manual* (DIPNR 2005) it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
RL	Reduced level. The reduced level is the vertical distance between an elevation and an adopted datum plane such as the Australian Height Datum (AHD).
Runoff	The amount of rainfall which actually ends up as stream flow, also known as rainfall excess.
Scour	The erosion of material by the action of flowing water.
SEARs	Secretary's Environmental Assessment Requirements and specifications for an environmental assessment prepared by the Secretary of the NSW Department of Planning and Environment under Division 4.1 of the Environmental Planning and Assessment Act 1979 (NSW).
SES	NSW State Emergency Services.
Spoil	Surplus excavated material.
Stage	Equivalent to water level (measured with reference to a specified datum).
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil/waste.
Substation	A facility used to increase or decrease voltages between incoming and outgoing lines (e.g. 330 kV to 500 kV)
Surcharge	Overflow from a creek, waterbody, overland flow or drainage system.
Surface water	Water flowing or held in streams, rivers and other water bodies in the landscape.
Switching station	A facility used to connect two or more distinct transmission lines of the same designated voltage.
Transmission line easement	An area surrounding and including the transmission lines which is a legal 'right of way' and allows for ongoing access and maintenance of the lines. Landowners can typically continue to use most of the land within transmission line easements, subject to some restrictions for safety and operational reasons.
Workforce accommodation camps	Areas that would be constructed and operated during construction to house the construction workforce.

ES1 EXECUTIVE SUMMARY

Overview

This technical paper deals with the findings of an investigation which was undertaken to assess flood related issues associated with the construction and operation of the Central West Orana Renewable Energy Zone (the project). **Figure 1.1** in **Section 1.3** of this technical paper shows the extent of the project.

This technical paper has been prepared to support the preparation of the Environmental Impact Statement (EIS) for the overall project. **Section 1** provides an overview of the project as well as an outline of the purpose and structure of this technical paper. **Section 2** contains an outline of relevant government legislation, policies and guidelines that were taken into consideration in the assessment, while **Section 3** provides details of the methodology that was adopted in the definition of flood behaviour in the vicinity of the project and also the impact that it would have on flood behaviour.

This technical paper addresses the Secretary's Environmental Assessment Requirements (SEARs).

Existing environment

The project is located within catchments that can broadly be divided into those located to the east and west of the Great Dividing Range. The catchments to the east of the Great Dividing Range form part of the coastal Hunter River system, while those that are located to its west form part of the inland Macquarie River system.

Section 4 of this technical paper contains a brief description of the characteristics of the catchments through which the project runs, as well as a description of the nature of mainstream and local catchment flooding under present day (or pre-project) conditions for events ranging between 10% and 0.2% Annual Exceedance Probability (AEP), as well as the Probable Maximum Flood (PMF). Mainstream and local catchment flooding have been collectively termed ‘flooding’ within this technical paper.

While the sites of the proposed New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub are not impacted by mainstream flooding, they are all presently inundated to varying degrees by overland flow that is conveyed along a number of local drainage lines that run through each of the sites. The thirteen sites where the 330 kV switching stations are proposed to be located are also not impacted by mainstream flooding. However, twelve of the thirteen sites would be inundated by overland flow due to local catchment runoff to varying degrees (the exception being switching station M1).

The corridors that would contain the proposed 330 kV and 500 kV transmission lines cross a number of perennial and non-perennial watercourses, the largest of which is the Talbragar River. The 330 kV and 500 kV transmission lines also cross Cumbo Creek, Wilpinjong Creek, Spring Flat Creek, Moolarben Creek, Sportsmans Creek, Curryall Creek, Yellow Waterholes Gully, Four Mile Creek, Turill Creek, Cockabutta Creek, Patricks Creek, Sandy Creek, Tallawang Creek, Stubbo Creek and Copes Creek.

Impacts during construction

An assessment was carried out of the flood risk associated with the construction of the project, as well as the potential impacts that proposed construction activities could have on flood behaviour.

Potential flood risk to construction activities

Table 5.1 at the end of **Section 5** of this technical paper provides a summary of the assessed flood risk at each construction work area and their associated activities, while **Figure 5.1** (6 sheets) of this technical paper shows the extent to which floods of varying magnitude affect each construction work area.

The assessment found that with the exception of the switching station M1 construction work area, all of the locations that have been identified for the proposed construction facilities are affected by either mainstream or local catchment flooding to varying degrees.

While the majority of the construction support sites would be subject to flooding during a 10% AEP storm event, depths of inundation are generally relatively shallow and of a short duration nature. The exception is the northern portion of the Elong Elong construction work area, where depths of inundation during a 10% AEP event would exceed 1 metre due to mainstream flooding from Laheys Creek, increasing to more than 2 metres during a 1% AEP event.

Inundation of the construction work areas by flooding has the potential to:

- cause damage to the project works and delays in construction programming
- pose a safety risk to construction workers
- detrimentally impact the downstream waterways through the transport of sediments and construction materials by floodwaters
- obstruct the passage of floodwater and overland flow through the provision of temporary measures such as site sheds, stockpiles and temporary fencing, which in turn could exacerbate flooding conditions in areas outside the construction footprint.

A broad outline of potential mitigation measures aimed at managing the risk of flooding to construction facilities is provided in **Section 7** of this technical paper.

Potential impacts of the proposed construction activities on flood behaviour

Construction activities have the potential to exacerbate flooding conditions when compared to both existing and operational conditions. This is because construction activities typically impose a larger footprint on the floodplain due to the need to provide temporary structures, such as ancillary sites, outside the operational footprint which would be removed following the completion of construction activities.

A qualitative assessment was carried out of the potential impacts that construction activities could have on flood behaviour, the key findings of which are summarised in **Table 5.1** at the end of **Section 5** of this technical paper.

The assessment found that:

i. construction activities within the northern portion of the Elong Elong construction work area have the potential to impact on mainstream flooding in Laheys Creek
ii. construction activities within the New Wollar. Merotherie and Elong Elong construction work areas all have the potential to impact on local catchment flooding

iii. the crossing of watercourses by temporary access roads that would be required to construct the transmission lines within the 330 kV and 500 kV construction work areas have the potential to obstruct the conveyance of flow, which in turn may impact on the extent and depth of inundation and flow velocities in the watercourses and their overbank areas

iv. each of the 330 kV switching stations with the exception of Switching Station M1, have the potential to impact on local catchment flooding to varying degrees.

While the findings of the assessment provide an indication of the potential impacts of construction activities on flood behaviour, further investigation would need to be undertaken during detailed design as layouts and staging diagrams are further developed. Consideration would also need to be given to setting an appropriate hydrologic standard for mitigating the impacts of construction activities on flood behaviour, taking into account their temporary nature and therefore the likelihood of a flood of a given AEP occurring during the construction period.

Section 7 of this technical paper outlines a range of measures which would be implemented to mitigate the potential construction related impacts of the project.

Impacts during operation

An assessment was carried out of the flood risk to the project and the impact it would have on flood behaviour during its operation if appropriate mitigation measures are not incorporated into its design.

For the purpose of the assessment, the operational related features of the project were divided into the following five components:

- New Wollar Switching Station
- Merotherie Energy Hub
- Elong Elong Energy Hub
- transmission line corridors that would contain the 500 kV and 330 kV networks of the project
- thirteen 330 kV switching stations that would connect the energy generated from renewable energy generation and storage projects into the 500 kV network infrastructure.

Further details of each of the project elements listed above are provided in Chapter 3 of the EIS Main Report, while the location of each project element is shown on **Figures 4.2** to **4.4** of this technical paper (6 sheets each).

New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub

As noted, while the sites of the New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub are not impacted by mainstream flooding, they are all presently inundated to varying degrees by flow that is conveyed along a number of local drainage lines that run through each of the sites. A series of diversion channels and culverts would be installed to convey local catchment runoff through and around the site in order to manage the impact of flooding on the switchyards, transformers, control buildings and associated infrastructure. The diversion channels and culverts would be designed to achieve the hydrologic standards that are set out in **Table 3.1** in **Section 3.2** of this technical paper. A typical arrangement of these diversion channels and culverts is shown on **Figures 6.1a**, **6.3a** and **6.5a** for the New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub, respectively.

The New Wollar Switching Station and the energy hubs all have the potential to impact on flooding and drainage patterns due to:

i. an increase in the rate and volume of runoff from the substation pads, access roads and other hardstand areas within the switching station and energy hubs, which in turn has the potential to increase the rate and volume of runoff being conveyed in the receiving drainage lines

ii. the redirection of flow along diversion channels and culverts that are proposed to control runoff through the switching station and energy hubs, which in turn has the potential to result in a redistribution of flows in the receiving drainage lines.

In order to assess the impact that the New Wollar Switching Station and the energy hubs would have on flood behaviour, the structure of the flood models representing pre-project conditions were adjusted to incorporate details of the proposed works. The increase in runoff associated with new hardstand areas and the redirection of flow associated with the proposed diversion channels and culverts were also incorporated into the flood model.

For the purpose of this assessment, no allowance has been made for stormwater detention or other flow control measures. In this regard, the assessment provides an indication of the upper bound estimate of the potential impact that the New Wollar Switching Station and the energy hubs would have on flood behaviour in the receiving drainage lines in the absence of such controls.

The assessment found that once constructed, the New Wollar Switching Station and the energy hubs would generally have only a minor impact on flood behaviour in areas outside the project footprint. The following residual impacts on flood behaviour have been identified:

i. At Merotherie Energy Hub, peak flood levels would be increased:

   - along a drainage line which lies to its north by a maximum of 0.05 and 0.06 metres during a 10% and 1% AEP event, respectively. The impacted area includes a local access road that runs to the north of the energy hub, where existing depths of inundation occur to a maximum of between 0.4 metres and 0.5 metres during a 10% and 1% AEP event, respectively.

   - along a drainage line that runs to its east as well as a section of Merotherie Road where peak flood levels would be increased by a maximum of 0.23 metres during both a 10% and 1% AEP event.

   Further refinement of the drainage strategy for the Merotherie Energy Hub would be undertaken during detailed design, with the aim of managing the impact that it would have on the frequency and depth of inundation along Merotherie Road and the local access road that runs to its north.

ii. Peak flow velocities would be increased:

   - along the drainage line that discharges from the eastern corner of the New Wollar Switching Station by a maximum of 50 per cent during both a 10% and 1% AEP event, with the resulting peak flow velocities exceeding 1 metre per second in a number of locations

   - along the drainage line that runs to the east of the existing Wollar Substation and north of the New Wollar Switching Station by a maximum of 30 per cent during a 1% AEP event, with the resulting peak flow velocities occurring to a maximum of 1 metre per second

- along a drainage line to the north of the Merotherie Energy Hub by a maximum of 30 per cent during both a 10% and 1% AEP event, with the resulting peak flow velocities reaching a maximum of 1.5 metres per second.
- along a drainage line that runs to the east of the Merotherie Energy Hub by a maximum of 40 per cent during both a 10% and 1% AEP event. The resulting peak flow velocity would reach 1 metre per second in a number of areas.

The above increases in peak flow velocities have the potential to result in an increase in scour and erosion over the impacted areas. Further refinement of the drainage strategy for the New Wollar Switching Station and the Merotherie Energy Hub would be undertaken during detailed design, with the aim of managing increases in flows that would otherwise lead to adverse impacts on flow velocities and hence the scour potential in the receiving drainage lines.

iii. The duration of inundation during a 10% and 1% AEP event would be increased by more than 1 hour at:

- the two drainage lines that run to the east of the New Wollar Switching Station, as well as the two drainage lines to the north and east of the Merotherie Energy Hub, where increases in peak flow velocities are identified under item ii. above.
- Two drainage lines that are located to the north-east of the Elong Elong Energy Hub, where the duration of inundation would be increased by 1.8 and 1.2 hours during a 10% and 1% AEP event, respectively.

The above increases in the duration of inundation are primarily due to an increase in both the rate and volume of runoff discharging to these drainage lines, which also leads to an increase in the extent of inundation. Further refinement of the drainage strategy for the New Wollar Switching Station and the energy hubs would be undertaken during detailed design, with the aim of minimising changes in the distribution of flows and increased runoff from the new hardstand areas that would otherwise lead to adverse impacts on the duration and extent of inundation in the receiving drainage lines.

330kV and 550kV transmission line corridors

While the transmission line towers would have a footprint of up to 25 metres by 25 metres, their obstruction to floodwaters would be confined to the area of the footings and tower legs that support each structure. The footings of the transmission line structures would generally be constructed level with the existing ground but may protrude up to 0.5 metres above the existing ground levels in some locations. Due to the relatively small footprint of the footings and legs of the transmission line towers, their impact on the depth and velocity of floodwaters would be confined to a relatively localised area in their immediate vicinity.

During detailed design, scour protection measures would be incorporated into the design of the transmission line towers where it is required to manage localised increases in flow velocities and scour potential around their footings.

Existing tracks along the transmission line corridors would be upgraded and new tracks constructed to enable access to the 330 kV and 500 kV network infrastructure. The upgraded or new access tracks would typically be seven metres wide and would generally follow existing ground levels so as not to impede the movement of overland flow and floodwaters.

Drainage control measures such as cross banks, level spreaders and lined waterway crossings would be incorporated into the upgraded or new access tracks to manage runoff and the impact it could have on scour to the tracks and surrounding areas.

330 kV switching stations

The assessment found that while none of the sites of the proposed 330 kV switching stations are impacted by mainstream flooding, all sites with the exception of switching station M1 are presently inundated by overland flow due to local catchment runoff to varying degrees.

A series of diversion channels and culverts would be installed to convey local catchment runoff through and around the sites of the 330 kV switching stations in order to manage the impact of flooding on the switchyards, transformers, control buildings and associated infrastructure. The diversion channels and culverts would be designed to achieve the hydrologic standards that are set out in **Table 3.1** in **Section 3.2** of this technical paper.

During detailed design, detailed layouts of the switching station sites would be developed that would include measures to control external runoff around each site, as well as the discharge of runoff from each site into the receiving drainage lines. These detailed site layouts would also be used to undertake an assessment of the impact that each switching station would have on flooding and drainage patterns and to identify the scope of measures that would be required to manage any resulting adverse impacts on the depth, velocity and duration of inundation external to their footprint.

Impact of future climate change on flood behaviour

Projected changes in the intensity of flood-producing rainfall have the potential to impact on the characteristics of flooding in the vicinity of the project. The potential impacts of future climate change on flooding were assessed in accordance with the recommended procedures set out in *Australian Rainfall and Runoff* (Geoscience Australia, 2019).

As set out in **Section 3.7** of this technical paper, increases of 10 and 30 per cent were adopted as upper and lower bound estimates of the impact of future climate change on design rainfall intensities under current climatic conditions. An increase of 10 per cent in 1% AEP design rainfall intensities is approximately equal to a 0.5% AEP design storm, while an increase of 30 per cent is approximately equal to a 0.2% AEP design storm under current climatic conditions.

The increase in rainfall intensities attributable to future climate change has the potential to impact on the project due to an increase in:

i. the risk of flooding to the switchyards, transformers, control buildings and associated infrastructure that is relied upon for the safe operation of the switching stations and energy hubs

ii. the frequency and extent to which the drainage systems that are proposed to control runoff from the switching stations and energy hubs would be surcharged

iii. the frequency and depth of inundation to roads and tracks that are used to access the switching stations, energy hubs and transmission line infrastructure.

In order to manage the impact that flood behaviour under future climate change conditions could have on the safe operation of the switching stations and energy hubs, the substations containing the switchyards, transformers, control buildings and associated infrastructure would be located a minimum 0.5 metres above the 1% AEP peak flood level. A check would also be made during detailed design to ensure that the function of the switching stations and energy hubs is not impacted by flooding under future climate change conditions.

The impact that the construction of the New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub would have on flood behaviour during a 0.5% AEP and 0.2% AEP event were compared to those during a 1% AEP event in order to provide an indication of the impact that the project could have on flood behaviour under future climate change conditions. Based on this comparison, it was found that there would be either no change, or relatively minor increases in flood impacts attributable to the project under both the lower and upper bound future climate change scenarios.

Management of impacts

Section 7 of this technical paper sets out the set of measures that will be adopted during the detailed design phase to manage the flood risk to the project, as well as the impact it would have on flood behaviour through:

i. documenting procedures and measures that are aimed at managing the risk of flooding to the project, as well as the potential for adverse impacts on existing flood behaviour within its vicinity

ii. identifying appropriate design standards for managing the flood risk during the construction and operational phases of the project

iii. including procedures aimed at reducing the flooding threat to human safety and infrastructure

iv. including controls that are aimed at mitigating the impact of the project (during construction and operation) on flood behaviour.

While the findings of the assessment presented in **Section 5.2** of this technical paper provide an indication of the potential impact construction activities would have on flood behaviour, further investigations would need to be undertaken during detailed design with the benefit of more detailed site layouts and staging diagrams. **Table 7.1** in **Section 7** contains a range of potential measures which could be implemented in order to reduce the impact of construction activities on flood behaviour.

The assessment of flood behaviour during the operation of the project has provided an understanding of the scale and nature of the flood risk to the project infrastructure, as well as its impact on flooding in surrounding areas. A broad outline of measures which would need to be implemented during detailed design in order to manage the project related flood risks and impacts are outlined in **Table 7.1** in **Section 7** of this technical paper. The design of the project would need to incorporate measures that are aimed at:

i. minimising adverse impacts on surrounding development for flood up to 1% AEP event

ii. assessment of impacts during floods up to the PMF in the context of impacts on critical infrastructure and flood hazard

iii. minimising the potential for an increase in the wetting up or scour and erosion of areas downstream of the project.

1 INTRODUCTION

1.1 Background

New South Wales (NSW) is currently undergoing an energy sector transformation that will change how we generate and use energy. The NSW Government is leading the development of Renewable Energy Zones (REZs) across NSW to deliver renewable energy generation and storage projects, supported by transmission infrastructure. A REZ connects renewable energy generation and energy storage systems to transmission infrastructure via energy hubs, requiring the coordination of power generation, power storage and transmission infrastructure. By doing so, REZs capitalise on economies of scale to deliver clean, affordable and reliable electricity for homes, businesses and industry in NSW.

The Central-West Orana REZ was formally declared on 5 November 2021 under the Electricity Infrastructure Investment Act 2020. As NSW's first REZ, the Central-West Orana REZ will play a pivotal role in underpinning NSW's transition to a clean, affordable and reliable energy sector. The Central-West Orana REZ declaration (November 2021) provides for an initial intended network capacity of three gigawatts. The NSW Government is proposing to amend the declaration to increase the intended network capacity to six gigawatts, which would allow for more renewable energy from solar, wind and storage projects to be distributed through the NSW transmission network.

The proposed amendment is consistent with the NSW Network Infrastructure Strategy (EnergyCo, 2023) which identifies options to increase network capacity to 4.5 gigawatts initially under Stage 1 (which would be based on the infrastructure proposed in this assessment) and up to six gigawatts by 2038 under Stage 2 (which would require additional infrastructure beyond the scope of this assessment, and subject to separate approval). The proposed amendment also supports recent modelling by the Consumer Trustee in the draft 2023 Infrastructure Investment Objectives Report (AEMO, 2023) showing more network capacity will be needed to meet NSW's future energy needs as coal-fired power stations progressively retire.

Energy Corporation of NSW (EnergyCo), a NSW Government statutory authority, has been appointed as the Infrastructure Planner under the Electricity Infrastructure Investment Act 2020, and is responsible for the development and delivery of the Central-West Orana REZ. EnergyCo is responsible for coordinating REZ transmission, generation, firming and storage projects to deliver efficient, timely and coordinated investment.

EnergyCo is seeking approval for the construction and operation of new electricity transmission infrastructure and new energy hubs and switching stations that are required to connect energy generation and storage projects within the Central-West Orana REZ to the existing electricity network (the project).

1.2 Purpose of this technical paper

This technical paper assesses the potential impacts to flooding from the construction and operation of the project and has been prepared to support and inform the Environmental Impact Statement (EIS).

This technical paper has been prepared to address the relevant Secretary's environmental assessment requirements (SEARs) for the project issued by the Secretary of the NSW Department of Planning and Environment (DPE) for the project on 7 October 2022, as well as the supplementary SEARs on 2 March 2023. The SEARs relevant to the assessment of flooding are presented in **Table 1.1**.

TABLE 1.1
SEARS RELEVANT TO THIS ASSESSMENT

Reference	Requirement	Where addressed in this technical paper
Water and Soils	An assessment of the potential flooding impacts and risk of the project.	Chapters 5 and 6.

1.3 Project overview

The project comprises the construction and operation of new electricity transmission infrastructure, energy hubs and switching stations within the Central-West Orana REZ. The project would enable 4.5 gigawatts of new network capacity to be unlocked by the mid-2020s (noting the NSW Government's proposal to amend the Central-West Orana REZ declaration to allow for a transfer capacity of six gigawatts), and enable renewable energy generators within the Central-West Orana REZ who are successful in their bids to access the new transmission infrastructure to export electricity onto the National Electricity Market (NEM). A detailed description of the project, including a description of key project components, the construction methodology and how it would be operated is provided in Chapter 3 of the EIS.

1.3.1 Features

The project would comprise the following key features:

- a new 500 kV switching station (the New Wollar Switching Station), located at Wollar to connect the project to the existing 500 kV transmission network
- around 90 kilometres of twin double circuit 500 kV transmission lines and associated infrastructure to connect two energy hubs to the existing NSW transmission network via the New Wollar Switching Station
- energy hubs at Merotherie and Elong Elong (including potential battery storage at the Merotherie Energy Hub) to connect renewable energy generation projects within the Central-West Orana REZ to the 500 kV infrastructure
- around 150 kilometres of single circuit, double circuit and twin double circuit 330 kV transmission lines, supported on towers, to connect renewable energy generation projects within the Central-West Orana REZ to the two energy hubs
- thirteen switching stations along the 330 kV network infrastructure at Cassilis, Coolah, Leadville, Merotherie, Tallawang, Dunedoo, Cobbora and Goolma, to transfer the energy generated from the renewable energy generation projects within the Central-West Orana REZ onto the project's 330 kV network infrastructure
- underground fibre optic communication cables along the 330 kV and 500kV transmission lines between the energy hubs and switching stations

- a maintenance facility within the Merotherie Energy Hub to support the operational requirements of the project
- microwave repeater sites at locations along the alignment, as well as outside of the alignment at Botobolar, to provide a communications link between the project and the existing electricity transmission and distribution network. The Botobolar site would be subject to assessment at the submissions report stage.
- establishment of new, and upgrade of existing access tracks for transmission lines, energy hubs, switching stations and other ancillary works areas within the construction area (such as temporary waterway crossings, laydown and staging areas, earthwork material sites with crushing, grinding and screening plants, concrete batching plants, brake/winch sites, site offices and workforce accommodation camps)
- property adjustment works to facilitate access to the transmission lines and switching stations. These works include the relocation of existing infrastructure on properties that are impacted by the project
- utility adjustments required for the construction of the transmission network infrastructure, along with other adjustments to existing communications, water and wastewater utilities. This includes adjustments to Transgrid's 500kV transmission lines 5A3 (Bayswater to Mount Piper) and 5A5 (Wollar to Mount Piper) to provide a connection to the existing NSW transmission network, including new transmission line towers along the Transgrid network along the frontage of the New Wollar Switching Station, and other locations where there is an interface with Transgrid’s network.

1.3.2 Location

The project is located in central-west NSW within the Warrumbungle, Mid-Western Regional, Dubbo Regional and Upper Hunter Local Government Areas (LGAs). It extends north to south from Cassilis to Wollar and east to west from Cassilis to Goolma. The location of the project is shown in **Figure 1.1** over the page.

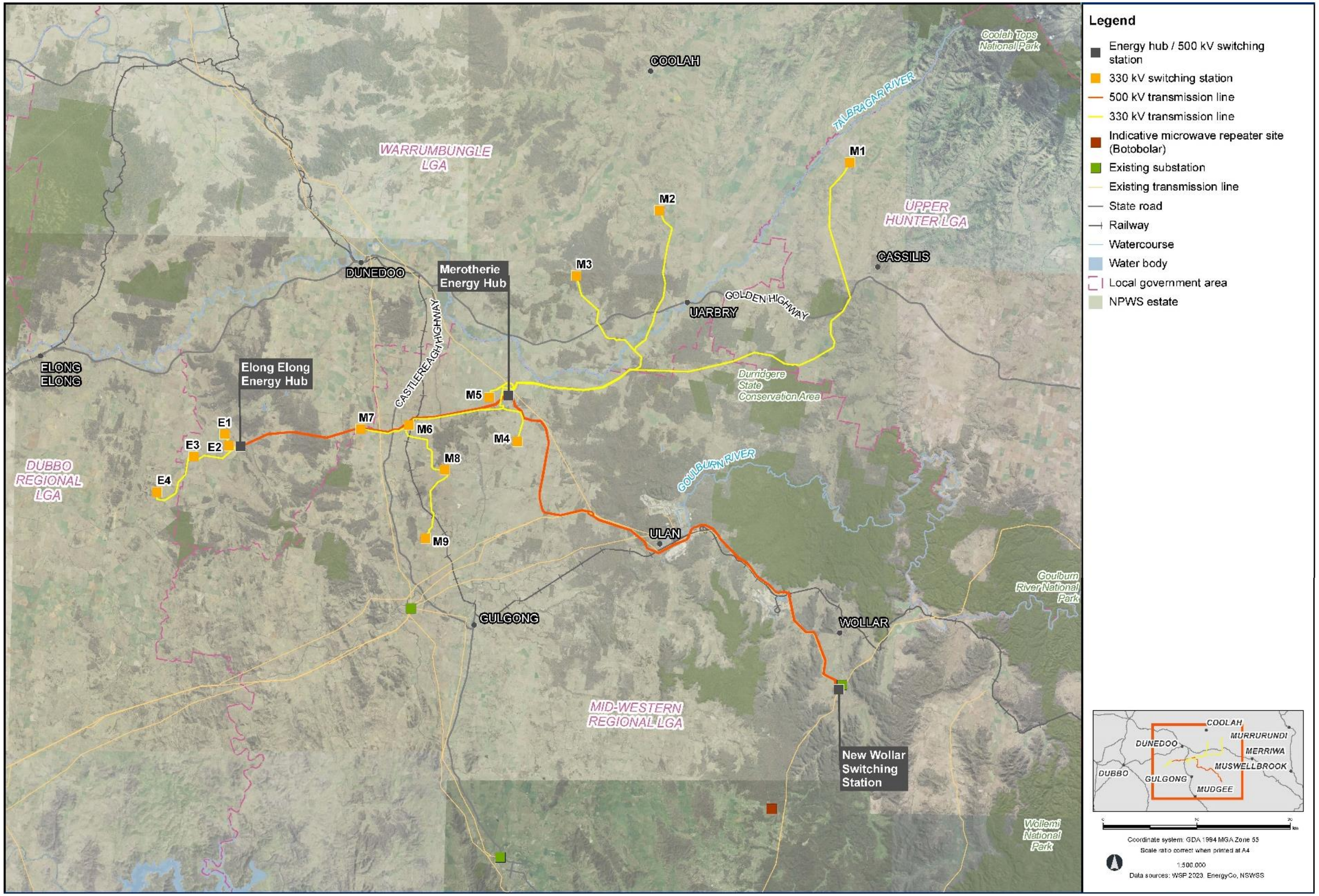

Figure 1.1 – The project

1.3.3 Timing

Construction of the project would commence in the second half of 2024, subject to NSW Government and Commonwealth planning approvals, and is estimated to take about four years. The project is expected to be commissioned/energised (i.e. become operational) in late 2027.

1.3.4 Construction

Key construction activities for the project would occur in the following stages:

- enabling works
- construction works associated with the transmission lines
- construction works associated with energy hubs and switching stations
- pre-commissioning and commissioning of the project
- demobilisation and rehabilitation of areas disturbed by construction activities.

Excavation and land forming works within the construction area would be required for transmission line tower construction, site preparation works at the energy hubs and switching station sites to provide level surfaces, to create trenches for drainage, earthing, communications infrastructure and electrical conduits, and to construct and upgrade access tracks.

Construction vehicle movements would comprise heavy and light vehicles transporting equipment and plant, construction materials, spoil and waste from construction facilities and workforce accommodation camp sites. There would also be additional vehicle movements associated with construction workers travelling to and from construction areas and accommodation camp sites. These movements would occur daily for the duration of construction.

To support the construction of the project a number of construction compounds would be required including staging and laydown facilities, concrete batching plants, workforce accommodation camps and construction support facilities. The main construction compounds would be established as enabling works and demobilised at the completion of construction. The size of the construction workforce would vary depending on the stage of construction and associated activities. During the peak construction period, an estimated workforce of up to around 1,800 people would be required.

1.3.5 Operation

During operation, the project would transfer high voltage electricity from the Central West-Orana REZ to the NEM. Permanent project infrastructure would be inspected by field staff and contractors on a regular basis, with other operational activities occurring in the event of an emergency (as required). Regular inspection and maintenance activities are expected to include:

- regular inspection (ground and aerial) and maintenance of electrical equipment and easements
- fault and emergency response (unplanned maintenance)
- general building, asset protection zone and landscaping maintenance
- fire detection system inspection and maintenance
- stormwater maintenance

- remote asset condition monitoring
- network infrastructure performance monitoring.

Operation of the project would require the establishment of transmission line easements. These easements would be around 60 metres for each 330kV transmission line and 70 metres for each 500kV transmission lines. Where network infrastructure is collocated, easement widths would increase accordingly (for example, a twin double circuit 500kV transmission line would have an easement about 140 metres wide). Vegetation clearing would be required to some extent for the full width of the transmission line easement, depending on the vegetation types present.

1.4 Structure of this technical paper

The structure and content of this flooding technical paper is as follows:

- **Chapter 1** provides an introduction to this technical paper (this chapter)
- **Chapter 2** provides an overview of the regulatory context for the assessment, including an overview of the flood related legislation, policy and guidelines that apply to the project
- **Chapter 3** sets out the methodology that has been adopted in the definition of flood behaviour in the vicinity of the project and also the impact that the project would have on flood behaviour. The chapter also contains a summary of the criteria and standards that have been adopted for the assessment based on consideration of the relevant government legislation, policies and guidelines.
- **Chapter 4** describes the existing environment as it relates to flooding, including a brief description of the catchments within which the project is located and which form the study area for the assessment. This chapter of the paper also provides a description of flood behaviour in the vicinity of the project under present day (i.e. pre-project) conditions.
- **Chapter 5** describes the potential flood risks to the project and its impact on flood behaviour during its construction.
- **Chapter 6** describes the potential flood risks to the project and its impact on flood behaviour during the operation of the project. The chapter also presents the findings of an assessment of the potential impact of future climate change on flood behaviour.
- **Chapter 7** provides recommended mitigation and management measures to avoid, minimise and manage any potential flood related risks and impacts associated with the construction and/or operation of the project.
- **Chapter 8** contains a list of references cited in this paper.
- **Annexure A** contains a series of figures that show the layout of the hydrologic and hydraulic models that were developed in order to define flood behaviour in the vicinity of the project.
- **Annexure B** contains a series of figures which show flooding patterns across the project for design storms with annual exceedance probabilities (AEPs) of 0.5% (1 in 200) and 0.2% (1 in 500).
- **Annexure C** contains a series of figures that show the indicative extent and depth of inundation in the vicinity of the New Wollar Switching Station, Merotherie Energy Hub and the Elong Elong Energy Hub during a 0.5% and 0.2% AEP event.

- **Annexure D** contains a series of figures that show maximum flow velocities and durations of inundation in the vicinity of the New Wollar Switching Station, Merotherie Energy Hub and the Elong Elong Energy Hub during a 10% and 1% AEP event.
- **Annexure E** contains a series of figures that show the hazard vulnerability classification in the vicinity of the New Wollar Switching Station, Merotherie Energy Hub and the Elong Elong Energy Hub during a 1% AEP event.

The figures that are referred to in **Chapters 4, 5** and **6** are located after **Chapter 8** of this technical paper.

2 LEGISLATIVE AND POLICY CONTEXT

This chapter summarises the legislation, guidelines and policies governing the approach to the flooding assessment. Relevant commonwealth, state and local government legislation, guidelines and policies are discussed in **Sections 2.1**, **2.2** and **2.3**, respectively.

2.1 Commonwealth guidelines

2.1.1 Australian Rainfall and Runoff

Australian Rainfall and Runoff (ARR) is a national guideline for the estimation of design flood characteristics in Australia. The application of the procedures, inputs and parameters set out in ARR is an important component in the provision of reliable and robust estimates of design flood behaviour to ensure that projects such as the Central West Orana REZ are planned, designed, constructed and operated in a manner that best manages flood risk.

The third edition of ARR was released in 1987 (ARR 1987) (Institute of Engineers Australia (IEAust) 1987), while a fourth edition of ARR was issued in 2019 (ARR 2019) (Geoscience Australia (GA) 2019). The hydrologic and hydraulic models (collectively referred to as 'flood models') that were relied upon for the present investigation were developed using the procedures set out in ARR 2019.

ARR 2019 includes:

- procedures for the derivation of design rainfall intensities, temporal rainfall distributions and rainfall losses for application to hydrologic models that define the rainfall runoff process
- guidance on the development of hydraulic models, including the procedures for the derivation of blockage factors to apply to culverts and small bridges, that define how runoff is conveyed in waterways and across the land
- guidance on how design rainfall intensities could be impacted by future climate change.

In regards to the last dot point, ARR 2019 contains a series of tables that are available through the *ARR 2019 Data Hub* of projected temperature increase and corresponding increase in rainfall intensity with varying representative concentration pathway (**RCP**)[1] and projection date. The values have been derived based on an analysis of the predicted temperature increase from global climate models across each of the eight Natural Resource Management (**NRM**) clusters set out in the Commonwealth Science Industrial Research Organisation's (CSIRO's) *Future Climates Tool* website.

Based on a projection date of 2090, ARR 2019 shows that:

- for a RCP of 4.5, the predicted rise in temperature is 1.9^{o}C, which corresponds to an increase in rainfall intensity of between 9.5 and 10.8 per cent across the study area
- for a RCP of 8.5, the predicted rise in temperature is 3.7^{o}C, which corresponds to an increase in rainfall intensity of between 19.7 and 22.8 per cent across the study area.

[1] RCPs are a measure of greenhouse gas concentration trajectories and are used to described different climate futures that are considered possible depending on the level of future greenhouse gas emissions. The RCPs are named according to the radiative forcing values (W m-2) in the year 2100 relative to pre-industrial values.

2.2 State legislation, policies and guidelines

2.2.1 Environmental Planning and Assessment Act 1979

The Environmental Planning and Assessment Act 1979 (EP&A Act) and associated regulations set out the system of environmental planning and assessment for the state of New South Wales.

The project was declared to be Critical State significant infrastructure (CSSI) under section 5.13 of the EP&A Act by the (then) Minister for Planning on 23 November 2020. Under Section 5.14 of the EP&A Act, the approval of the Minister for Planning is required for SSI (including CSSI), and an EIS has been prepared under Division 5.2 of the EP&A Act.

In July 2009, the NSW Minister for Planning issued a list of directions to local councils under section 117(2) of the EP&A Act. These directions were later amended on 14 July 2021 as part of the NSW Government's update of its Flood Prone Land package. *Direction 4.3 - Flood Prone Land* (Direction 4.3) applies to all councils that contain flood prone land within their LGA and requires that:

A planning proposal must include provisions that give effect to and are consistent with:

- *(a) the NSW Flood Prone Land Policy,*
- *(b) the principles of the Floodplain Development Manual 2005,*
- *(c) the Considering flooding in land use planning guideline 2021, and*
- *(d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.*

A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones.

A planning proposal must not contain provisions that apply to the flood planning area which:

- *(a) permit development in floodway areas,*
- *(b) permit development that will result in significant flood impacts to other properties,*
- *(c) permit development for the purposes of residential accommodation in high hazard areas,*
- *(d) permit a significant increase in the development and/or dwelling density of that land,*
- *(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,*
- *(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,*
- *(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or*
- *(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.*

A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which:

(a) permit development in floodway areas,

(b) permit development that will result in significant flood impacts to other properties,

(c) permit a significant increase in the dwelling density of that land,

(d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,

(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or

(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.

For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.

Direction 4.3 also states that a planning proposal may be inconsistent with the terms of this direction only if the planning proposal authority can satisfy the Secretary of the Department of Planning and Environment (or their nominee) that:

(a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant Council in accordance with the principles and guidelines of the Floodplain Development Manual 2005, or

(b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the Floodplain Development Manual 2005 or

(c) the planning proposal is supported by a flood and risk impact assessment accepted by the relevant planning authority and is prepared in accordance with the principles of the Floodplain Development Manual 2005 and consistent with the relevant planning authorities' requirements, or

(d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority.

As with Planning Circular PS 21-006, Direction 4.3 specifically relates to planning proposals under Part 3 of the EP&A Act. However, it is relevant to the project under Division 5.2 of the EP&A Act in that it sets out the approach to establishing flood-related planning controls for surrounding development and is therefore an important consideration in assessing the impact of the project on existing flood risk as well as the future development potential for land outside the project footprint.

2.2.2 Floodplain development manual

The *Floodplain Development Manual* (FDM) (DIPNR 2005) incorporates the NSW Government's Flood Prone Land Policy, the primary objectives of which are to reduce the impact of flooding and flood liability on owners and occupiers of flood prone property and to reduce public and private losses resulting from floods, whilst also recognising the benefits of use, occupation and development of flood prone land.

The FDM forms the NSW Government's primary technical guidance for the development of sustainable strategies to support human occupation and use of the floodplain, and promotes strategic consideration of key issues including safety to people, management of potential damage to property and infrastructure and management of cumulative impacts of development. Importantly, The FDM promotes the concept that proposed developments be treated on their merit rather than through the imposition of rigid and prescriptive criteria.

Flood and floodplain risk management studies undertaken by local councils as part of the NSW Government's Floodplain Management Program are carried out in accordance with the merits-based approach set out in the FDM. A similar merits-based approach has been adopted in the assessment of the impacts that the project could have on existing flood behaviour and also in the development of a range of potential measures that are aimed at mitigating the impact of the project on the existing flooding. In accordance with the FDM, the hydraulic and hazard categorisation of the floodplain was considered when assessing the impact that the project could have on existing flood behaviour, as well as the impact of flooding to the project and its users.

2.2.3 Guideline on development controls on flood prone land

In July 2021 the NSW Government issued Planning Circular PS 21-006 *Considering flooding in land use planning: guidance and statutory requirements*. The circular provides advice on a package of changes regarding how land use planning considers flooding and flood-related constraints. The package includes:

- an amendment to clause 7A of Schedule 4 to the *Environmental Planning and Assessment Regulation 2000* (the Regulation)
- a revised local planning direction regarding flooding issued under section 9.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act)
- two local environmental plan clauses which introduce flood related development controls
- a new guideline: *Considering Flooding in Land Use Planning (2021)* (the guideline)
- revoking the *Guideline on Development Controls on Low Flood Risk Areas (2007)*.

While Planning Circular PS 21-006 specifically relates to planning proposals under Part 3 of the EP&A Act, it is relevant to the project, which falls under Division 5.2 of the EP&A Act, in that it sets out the approach to establishing flood-related planning controls for surrounding development and is therefore an important consideration in assessing the impact of the project on existing flood risk, as well as the future development potential of land outside the project footprint.

Planning proposals are required to be consistent with directions issued under section 9.1 of the EP&A Act. *Local Planning Direction 4.3—Flooding* requires, among other matters, a planning proposal to be consistent with the principles of the FDM. The direction has been revised to remove the need to obtain exceptional circumstances to apply flood-related residential development controls above the 1% AEP flood event. It also ensures that planning proposals consider the flood risks and do not permit residential accommodation in high hazard areas and other land uses on flood prone land where the development cannot effectively evacuate. The direction also makes provision for special flood considerations where councils have chosen to adopt the optional *Special flood considerations* clause in an LEP. The revised direction will apply to planning proposals that have not been issued with a gateway determination under section 3.34(2) of the EP&A Act.

The guideline supports the principles of the FDM and provides advice to councils on land-use planning on flood prone land. It provides councils with greater flexibility in defining the areas to which flood-related development controls apply, with consideration of defined flood events, freeboards, low-probability/high-consequence flooding and emergency management considerations. The guideline and the FDM state that a defined flood event (DFE) of 1% AEP, or a historic flood of similar scale, plus a freeboard should generally be used as the minimum level for setting residential flood planning levels (FPL). Choosing different DFEs and freeboards requires justification based on a merits-based assessment that is consistent with the floodplain risk management process and principles of the FDM. Special flood considerations apply to sensitive and hazardous development in areas between the flood planning area (FPA) and the PMF and to land that may cause a particular risk to life and other safety considerations that require additional controls. These controls relate to the management of risk to life and the risk of hazardous industry/hazardous storage establishments to the community and the environment in the event of a flood.

A similar merits-based approach to that described in the guideline has been adopted in the assessment of the impacts that the project would have on existing flood behaviour and also in the development of a range of potential measures which would be aimed at mitigating the impact of the project on the existing environment. Consistent with the guideline, the assessment that is presented in this technical paper has taken into consideration floods larger than the 1% AEP event, up to the PMF.

2.2.4 Floodplain risk management guidelines on climate change

Scientific evidence shows that climate change is expected to lead to an increase in flood producing rainfall intensities and sea levels. The significance of these effects on flood behaviour would vary depending on geographic location and local topographic conditions. Given the location and elevation of the project footprint and the watercourses that it crosses, future sea level rise would not impact on flood behaviour in its vicinity. Consideration of flood behaviour under future climate change has therefore focused on potential increases in rainfall intensities. Current guidance on the impact of future climate change on increased rainfall intensities and how this has been taken into consideration in the flood assessment for the project is outlined below.

The NSW Government's *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007) recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities of between 10 and 30 per cent. Under current climatic conditions, increasing the 1% AEP design rainfall intensities by 10 per cent would produce about a 0.5% AEP flood; and increasing those rainfalls by 30 per cent would produce about a 0.2% AEP flood. On current projections, the increase in rainfalls within the design life of the project is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit.

Based on the recommendations set out in DECC 2007, the 0.5% AEP and 0.2% AEP design storms were adopted as being analogous to an increase in 1% AEP design rainfall intensities of 10 and 30 per cent respectively. This range of potential increases also encompasses the values given in ARR 2019, which suggests a potential increase in rainfall intensities of between 9.5% and 22.8% by 2090 for Representative Concentration Pathways (RCPs) of between 4.5 and 8.5.

2.2.5 Local Flood Plans

The NSW State Emergency Services (SES) has prepared the following local flood plans for each of the local government areas within which the project is located:

- *Mid-Western Regional Local Flood Plan* (SES, 2013)
- *Dubbo City Local Flood Plan* (SES, 2013)
- *Warrumbungle Shire Local Flood Plan* (SES, 2007)
- *Upper Hunter Shire Local Flood Plan* (SES, 2013)

Each of the above documents provides a plan for the operation of emergency response to flooding within the respective local government areas. The local flood plana set out the preparedness measures, the process for carrying out response operations and the coordination of immediate recovery measures from flooding. The local flood plans also include a brief overview of the existing flood risk within the respective local government area.

2.3 Council policies and guidelines

2.3.1 Local environmental plans

As mentioned, the project is located in the local government areas of Mid-Western Regional Council, Dubbo Regional Council, Warrumbungle Shire Council and Upper Hunter Shire Council. The *Mid-Western Regional Local Environmental Plan 2012*, *Dubbo Regional Local Environmental Plan 2021*, *Warrumbungle Local Environmental Plan 2013* and the *Upper Hunter Local Environmental Plan 2013* each contain flood planning clauses that apply to the determination of a Part 4 development application by a consent authority under the EP&A Act. While not a mandatory requirement of the project under Division 5.2 of the EP&A Act, the flood planning clauses in the respective Local Environmental Plans (LEPs) have been taken into consideration in establishing the approach to assessing the impact of the project on flood behaviour.

Clause 5.21 of all four council LEPs titled ‘Flood planning” state the following:

“(1) The objectives of this clause are as follows -

(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 flood function and behaviour on the land, taking into account projected changes as a result of climate change,

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development -

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters -

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,

(b) the intended design and scale of buildings resulting from the development,

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause -

***Considering Flooding in Land Use Planning Guideline** means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.*

***flood planning area** has the same meaning as it has in the Floodplain Development Manual.*

***Floodplain Development Manual** means the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005."*

In May 2021, the NSW Government issued the Standard Instrument (Local Environmental Plans) Amendment (Flood Planning) Order 2021 that sets out changes to the flood planning clauses of the Local Environmental Plans of the respective councils that took effect on 14 July 2021. The updates to the above flood planning clauses under the Standard Instrument (Local Environmental Plans) Amendment (Flood Planning) Order 2021 are aimed at supporting better management of flood risk and building greater resilience in communities located on floodplains during floods greater than 1% AEP up to the PMF. The assessment that is presented in this technical paper has taken into consideration floods larger than the 1% AEP event, up to the PMF and is therefore considered to be consistent with the updates to clause 5.21.

Mid-Western Regional Council, Dubbo Regional Council, Warrumbungle Shire Council and Upper Hunter Shire Council have all prepared Development Control Plans (DCPs) to guide development in accordance with their respective Local Environmental Plans. As with the flood planning clauses of the LEPs for each council, the requirements set out in their respective DCPs are not applicable to the project under Division 5.2 of the EP&A Act. However, the flood related requirements of the respective DCPs have been taken into consideration in establishing the approach to assessing the impact of the project on existing flood behaviour

3 METHODOLOGY

This chapter describes the methodology that was used to undertake the flooding assessment.

3.1 Key tasks

The key tasks comprising the flooding assessment were broadly as follows:

- Review of available data and existing flood studies of the catchments within which the project is located
- Development of a set of hydrologic and hydraulic models (collectively referred to as 'flood models') of the catchments that are located within the study area
- Flood modelling and preparation of figures showing flood behaviour under present day (i.e. pre-project) conditions for design floods with AEPs of 10%, 5%, 1%, 0.5% and 0.2%, as well as the PMF
- Assessment of the potential impact of the project (both during its construction and operation) on flood behaviour for the aforementioned design flood events
- Assessment of the impact future climate change would have on flood behaviour under operational conditions
- Assessment of potential measures that are aimed at mitigating the risk of flooding to the project and its impact on existing flood behaviour.

The following sections of this paper set out the methodology which was adopted in the assessment of flood behaviour under pre-project conditions, and during both the construction and operational phases of the project.

3.2 Study area

The study area for the flooding assessment comprised the catchments within which the project is located, which can be broadly divided into those located to the east and west of the Great Dividing Range. The catchments to the east of the Great Dividing Range form part of the coastal Hunter River system, while those that are located to its west form part of the inland Macquarie River system.

Section 4.1 lists the catchments within which the project is located, each of which are described in **Section 4.2**.

3.3 Summary of adopted assessment criteria and standards

Table 3.1 sets out the flood-related assessment criteria and standards that have been established for the project with due consideration of the policies and guidelines outlined in the preceding sections of this technical paper.

In accordance with the FDM, the hydrologic standards adopted are based on matching the level of protection to the likelihood and consequence of flooding. A merits-based approach has been adopted in the assessment of the impacts the project would have on existing flood behaviour and also in the development of a range of potential measures which are aimed at mitigating its impact on the existing environment.

TABLE 3.1
SUMMARY OF ADOPTED ASSESSMENT CRITERIA AND STANDARDS

Aspect	Requirement
Flood risks to the project	
Impact of flooding on proposed construction activities	• Construction related flood risks need to be evaluated in the context of the construction period in order to set requirements that are commensurate to the period of time that the risk exposure occurs. To this end, this technical paper identifies the risks associated with each construction activity such that informed decisions can be made on the flood criteria that are set as part of the Construction Environmental Management Plan (CEMP) for the project.
Energy hubs and switching stations	• The bench level of substations that are located within the new energy hubs and switching stations are to be located a minimum of 0.5 metres above the peak 1% AEP flood level. • The function of the new energy hubs and switching stations is not to be impeded by floodwaters during a 0.5% AEP event.
Upgrade of existing roads	• As a minimum, the upgrade of the existing roads that service the new energy hubs and switching stations is to ensure that the existing level of flood immunity (i.e. the magnitude of flood that does not cause inundation to the travel lanes) is not reduced by the project.
Transmission lines	• Where transmission line structures are located in an area that is affected by mainstream flooding, consideration shall be given for the protection of the structure from damage by floodwaters and water-borne flood debris. Mitigation measures shall be included to account for dynamic and impact loading on foundations, as well as scour to the material around the structures • The design of the transmission lines is to ensure that minimum conductor operating clearances are maintained above predicted flood levels.
Impact of future climate change on flooding to the project	• The assessment of the potential impact future climate change could have on flood behaviour in the vicinity of the project was based on increases in 1% AEP design rainfall intensities ranging between 10 and 30 per cent in accordance with the NSW Government's *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007). [1] • Due to the elevation of the land on which the project is located, the rise in sea level due to future climate change is not relevant to the flood assessment.

Continued over

Aspect	Requirement
Impact of the project on flood behaviour	
Impact of construction activities on flood behaviour	• Construction related flood impacts are to be evaluated in the context of the construction period in order to set requirements that are commensurate to the period of time that the exposure to the potential impacts occurs. To this end, this technical paper identifies the potential impacts associated with the project such that informed decisions can be made on the flood criteria that are set as part of the Construction and Environment Management Plan (**CEMP**).
Impact of project on existing flood behaviour	• Floods up to 1% AEP in magnitude are to be considered in the assessment of measures that are required to mitigate any adverse impacts of the project on existing flood behaviour as a result of changes in the depth, velocity, extent or duration of flooding. • Changes in flood behaviour for larger floods up to the PMF event are also to be assessed in order to identify impacts on critical infrastructure (such as hospitals, police stations and NSW State Emergency Services headquarters) and vulnerable development (such as aged care facilities and schools), as well as to identify potentially significant changes in flood hazard as a result of the project.
Impact of the project on flood behaviour under future climate change conditions	• The assessment of the impact the project would have on flood behaviour under future climate change conditions was based on assessing the effect of the project on pre-project flood behaviour during a 0.5 % and 0.2 % AEP event.[1]

1. For the purpose of this assessment, the 0.5% and 0.2% AEP design storm events were adopted as being analogous to increases in 1% AEP design rainfall intensities of 10 and 30 per cent, respectively.

3.4 Definition of flood behaviour under pre-project conditions

In order to define the nature of flooding across the study area a set of flood models were developed covering the project as a whole, while a set of more detailed flood models were also developed of the areas in the vicinity of the New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub (referred to herein as the '**project wide flood models**' and '**local flood models**', respectively).

The definition of flood behaviour under pre-project conditions was based on present day catchment conditions and does not include upgrades to local roads that are proposed to be carried out as part of early works to facilitate access to the energy hubs during both construction and operation of the project.

Flood behaviour in the vicinity of the project was defined for a range of events with AEPs of between 10% and 0.2%, as well as the PMF. Figures were prepared for each event showing the indicative extent and depth of inundation, as well as the direction and relative velocity of flow. Figures were also prepared showing the hydraulic and hazard categorisation during a 1% AEP event, which were defined based on industry best practice and the procedures set out in the FDM.

The following sections provide an overview of the approach that was adopted to develop the project wide and local flood models. A description of flood behaviour in the vicinity of the project, including a summary of the figures that show flooding behaviour under pre-project conditions is presented in **Section 4.3**.

3.4.1 Project wide flood models

In order to define flood behaviour across the entire project the hydrologic modelling approach needed to be capable of generating inflows to the hydraulic model at a suitable level of resolution to define flooding and drainage patterns along the numerous drainage lines that cross the project. The 'rainfall-on-grid' approach that is built into the TUFLOW software was used for this purpose.

The 'rainfall-on-grid' approach involves the application of rainfall excess (obtained from applying losses to design rainfall depths) to a two-dimensional hydraulic model covering the entire catchment. The routing of runoff (rainfall excess) is simulated across each grid cell within the hydraulic model. The use of a two-dimensional hydraulic model in this way integrates both the hydrologic and hydraulic modelling aspects of defining flood behaviour into a single model.

Table 3.2 lists the eight TUFLOW models that were developed of the catchments that contribute flow to the drainage lines that cross the project, the extents of which are shown on **Figure A.1** (9 sheets) in **Annexure A**.

TABLE 3.2
TUFLOW MODELS

TUFLOW Model	Model Extent (km^2)	Catchments	Project Elements
Wollar Creek TUFLOW Model	473	Wollar Creek, Barigan Creek, Cumbo Creek and Wilpinjong Creek	New Wollar Substation 500 kV transmission line
Goulburn River TUFLOW Model	238	Goulburn River Sportsmans Hollow Creek	500 kV transmission line
Murrumbline Creek TUFLOW Model	123	Murrumbline Creek, Curryall Creek and Wagrobil Creek	330 kV transmission line
Four Mile Creek TUFLOW Model	167	Four Mile Creek	330 kV transmission line
Talbragar River TUFLOW Model	1,072	Talbragar River, Bounty Creek, Norfolk Island Creek, Turee Creek and Cainbil Creek	330 kV switching stations M1, M2, M3 and M4 500 kV transmission line 330 kV transmission line
Tallawang Ridge TUFLOW Model	185	Tallawang Creek, Tucklan Creek, Huxleys Creek and White Creek	330 kV switching stations M5, M6, M7, M8 and M9 500 kV transmission line
Sandy Creek TUFLOW Model	220	Sandy Creek and Lahey Creek	Elong Elong Energy Hub 330 kV switching stations E1, E2, E3 and E4 500 kV transmission line 330 kV transmission line
Cudgegong River TUFLOW Model	89	Uamby Creek, Molly Creek and Goolma Creek	330 kV transmission line

In the absence of suitable stream gauge data or previous studies within the study area[2] the results of the project wide flood models were validated based on comparison against those based on a traditional rainfall-runoff routing model incorporating a lumped sub-catchment approach (**XP-RAFTS**), as well as the Probabilistic Rational Method (**PRM**) and Regional Flood Frequency Estimation Model (**RFFEM**) that are set out in the 1987 and 2019 editions of *Australian Rainfall and Runoff*, respectively.

All eleven of the project wide flood models incorporated a grid cell size of 10 m by 10 m as it provided an appropriate level of definition of features that influence the passage of flow over the natural surface whilst also maintaining a reasonable simulation run time. A 10 m by 10 m grid cell size requires data to be sampled at a 5 m spacing, which corresponds to the resolution of the photogrammetric survey that has been used in areas where LIDAR survey was not available.

Rainfall depths for design storms with AEPs of 10%, 5%, 1%, 0.5% and 0.2% were obtained from the Bureau of Meteorology (**BoM**) website using the procedures outlined in ARR 2019 for storm durations ranging between 30 minutes and 24 hours under current climatic conditions. Rainfall depths obtained from the BoM website were converted into rainfall hyetographs using the temporal patterns presented in ARR 2019.

Estimates of Probable Maximum Precipitation (**PMP**) were derived using the Generalised Short Duration Method (**GSDM**) as described in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (BoM, 2003). This method is recommended in ARR 2019 for the estimation of extreme rainfall depths for catchments up to 1,000 square kilometres in area and storm durations up to six hours.

Adopted values for initial and continuing loss were derived using the procedures set out in ARR 2019. As the catchments draining to the project are predominantly pervious in nature, the storm losses derived using the procedures in ARR 2019 for pervious surfaces were applied to the full extent of the TUFLOW models.

The downstream boundary of each of the eleven TUFLOW models comprised a normal depth calculation. The model extent was selected to ensure the boundary was located a sufficient distance downstream to prevent any influence on flood behaviour within the vicinity of the project.

The main physical parameter in TUFLOW is hydraulic roughness, which is required to represent each of the surfaces comprising the in-bank areas of watercourses and overland flow paths in the two-dimensional domain. In addition to the energy lost by bed friction, obstructions to flow also dissipate energy by forcing water to change direction and velocity, and by forming eddies. Hydraulic modelling traditionally represents all of these effects via the surface roughness parameter known as “Manning’s n”.

For the present application of the TUFLOW models, the surface roughness parameter is not only relevant in defining flood depths and velocities along watercourses and overland flow paths in the traditional hydraulic modelling sense, it also needs to reflect the routing of runoff from the catchment at a grid-based level in a hydrologic modelling sense.

[2] While stream flow data is available from gauging stations that are located on the Talbragar River at Dunedoo and Elong Elong, the data either covers an insufficient length of time or is located too far downstream of the study area for model calibration purposes. The data from the station at Dunedoo covers less than seven years while the station at Elong Elong is located approximately 60 kilometres further downstream of the downstream limit of the Talbragar River within the study area.

The surface roughness parameter is depth dependant and the depths that are relevant to the routing of flows at a grid-based level (in a hydrologic modelling sense) are comparatively shallower than those when flow has concentrated along watercourses and overland flow paths (in a hydraulic modelling sense). Therefore, the surface roughness parameter that was applied to the TUFLOW model was varied with depth in order to reflect both the hydrologic and hydraulic related aspects of the modelling task.

A range of surface roughness parameters were assessed and the resulting peak flow estimates were compared to those based on a RAFTS model, as well as peak flow estimates based on the RFFEM and PRM. **Table 3.3** lists the surface roughness parameters that were adopted based on the findings of this assessment.

TABLE 3.3
ASSESSED SURFACE ROUGHNESS PARAMETERS

Depth (m)	Manning's n value
<0.2	0.3
0.2 – 0.3	0.3 - 0.08
>0.3	0.08

3.4.2 Local flood models

In order to define flood behaviour in the vicinity of the New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub, and to also provide a suitable basis for assessing the impact that the switching station and energy hubs would have on flood behaviour, a set of local flood models were developed using the DRAINS hydrologic and TUFLOW hydraulic modelling software.

The RAFTS sub-model within the DRAINS hydrologic model was used to convert rainfall patterns to runoff and generate design discharge hydrographs which were applied as inflow boundaries to the hydraulic model, which was then used to define flooding patterns in terms of the depth and velocity of flow along overland flow paths and within watercourses. The DRAINS models that were developed of the New Wollar Switching Station, Merotherie Energy Hub and Elong Elong Energy Hub are referred to in this technical paper as the **New Wollar**, **Merotherie** and **Elong Elong DRAINS models**. Similarly, the TUFLOW models that were developed of the same three areas are referred to in this technical paper as the **New Wollar**, **Merotherie** and **Elong Elong TUFLOW models**.

Figures A.2, **A.3** and **A.4** in **Annexure A** show the layout of the New Wollar, Merotherie and Elong Elong DRAINS models. Sub-catchment boundaries were digitised based on contour information derived from the available detailed and LIDAR survey data. Sub-catchment slopes used as input to the RAFTS sub-model were derived using the vector averaged slope.

Consistent with the approach described in **Section 3.4.1**, the procedures set out in ARR 2019 were used to derive the design rainfall intensities, temporal patterns and losses that were used in the New Wollar, Merotherie and Elong Elong DRAINS models. Estimates of Probable Maximum Precipitation (PMP) were derived using the Generalised Short Duration Method (GSDM) as described in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (BoM, 2003).

The layout of the New Wollar, Merotherie and Elong Elong TUFLOW models are shown on **Figures A.5**, **A.6** and **A.7** in **Annexure A**.

Grid elevations in the New Wollar, Merotherie and Elong Elong TUFLOW models were based on detailed ground survey that had been collected by EnergyCo, which was supplemented with LIDAR survey data across the remainder of the two-dimensional model domain that was captured in 2021.

Discharge hydrographs that were generated by the New Wollar, Merotherie and Elong Elong DRAINS model were applied at the inflow boundaries of the TUFLOW model. These comprised both inflows applied at the external TUFLOW model boundary and internal point source and region inflows[3] as shown on **Figures A.5**, **A.6** and **A.7**.

The downstream boundaries of the New Wollar, Merotherie and Elong Elong TUFLOW models comprised a normal depth calculation. The model extent was selected to ensure the boundary was located a sufficient distance downstream to prevent any influence on flood behaviour within the vicinity of the project corridor.

Hydraulic roughness values adopted for design purposes were selected based on site inspection, past experience and values contained in the engineering literature (refer **Table 3.4**).

TABLE 3.4

"BEST ESTIMATE" OF HYDRAULIC ROUGHNESS VALUES

Surface Treatment	Manning's n Value
Reinforced concrete pipes and box culverts	0.015
Roads	0.02
Remnant cleared pasture land	0.05
Light vegetation	0.07
Trees and scrub	0.09
Dense vegetation	0.12
Riparian vegetation	0.04 – 0.08

[3] In parts of the model area, inflow hydrographs were applied over individual regions called "Rain Boundaries". The Rain Boundaries act to "inject" flow into the one and two-dimensional domains of the TUFLOW model, firstly at a point which has the lowest elevation, and then progressively over the extent of the Rain Boundary as the grid in the two-dimensional model domain becomes wet as a result of overland flow.

3.5 Assessment of construction related impacts

A qualitative assessment was made of the construction related issues associated with flooding along the project based on indicative construction areas and activities as provided in the current design. The locations of construction work areas, including compounds, support facilities and workforce accommodation camps were overlaid onto the indicative flood extents for events with AEPs of 10%, 1%, 0.2% as well as the PMF. This provided an understanding of the likelihood that flooding could occur in the vicinity of construction activities.

The potential flood risk to construction activities, as well as their impact on existing flood behaviour were assessed based on an understanding of flood behaviour under pre-project conditions during a 1% AEP event.[4] Consideration was also given to the potential for localised overland flooding to occur in construction areas.

Section 5 of this technical paper deals with the impact that flooding could have on construction activities. It also includes an assessment of the impact that construction activities could have on flood behaviour external to the project footprint.

3.6 Assessment of operational related impacts

Commensurate with the potential flood impacts, as well as the current level of design development, a quantitative assessment has been carried out of the impact that the New Wollar Switching Station, the Merotherie Energy Hub and the Elong Elong Energy Hub would have on flood behaviour. For other operational elements of the project, a qualitative assessment has been made of the potential flood related impacts based on an understanding of existing flood behaviour, as well as the general nature of the proposed operational works.

The structure of the local flood models that were originally developed to define flood behaviour under pre-project conditions in the vicinity of the New Wollar Switching Station, the Merotherie Energy Hub and the Elong Elong Energy Hub were adjusted to incorporate details of the project under operational conditions. The IL-CL sub model within DRAINS was used to model the increase in runoff from new hardstand areas and to generate a revised set inflow hydrographs to apply to the TUFLOW models representing operational (i.e. post-project) conditions. Proposed diversion channels and culverts were also incorporated into the TUFLOW models representing post-project conditions to reflect the impact that these would have in redirecting flows around the New Wollar Switching Station and energy hubs.

In order to consider the combined impact of the project and its early works on flood behaviour, upgrades to Merotherie Road and Dapper Road that are proposed to respectively facilitate access to the Merotherie and Elong Elong Energy Hubs were incorporated into the flood models representing post-project conditions.

For the purpose of the assessment, no allowance has been made for stormwater detention or other flow control measures. In this regard, the assessment provides an indication of the upper bound estimate of the potential impacts that the energy hubs could have on flood behaviour in the receiving drainage lines in the absence of such controls.

The assessed design of the project would be subject to further development during detailed design.

[4] While the 1% AEP event has been adopted for the purpose of the preliminary assessment, as per the design criteria set out in **Table 3.1**, the management of flood impacts during the construction of the project will need to consider the period of risk exposure in establishing an appropriate flood standard.

The results of modelling a range of events with AEPs of between 10% and 0.2%, as well as the PMF were used to prepare a series of figures showing flooding patterns under operational conditions and afflux diagrams[5] showing the impact the project would have on flood behaviour.

Section 6 of this technical paper deals with the impact that flooding could have on the project as well as the impact that it could have on flood behaviour during its operation.

3.7 Impact of future climate change on flood behaviour

The following sections describe the approach that was adopted to assess the potential impact of future climate change on flooding to the project, as well as the impact that the project may have on flood behaviour under future climate change conditions. The findings of this assessment are contained in **Section 6.3** of this technical paper.

3.7.1 Impact of future climate change on flooding to the project

Based on the adopted assessment criteria set out in **Table 3.1**, the following scenarios were adopted as being representative of the likely lower and upper estimates of future climate change related impacts over the design life of the project:

- Scenario 1 – based on an assumed 10 per cent increase in currently adopted 1% AEP design rainfall intensities.
- Scenario 2 – based on an assumed 30 per cent increase in currently adopted 1% AEP design rainfall intensities.

3.7.2 Impact of the project on flood behaviour under future climate change conditions

The predicted impact that the project may have on flood behaviour under potential future climate change conditions was based on assessing its effect on pre-project flood behaviour during a 0.5% and 0.2% AEP event as proxies for assessing the sensitivity to an increase in rainfall intensity on the 1% AEP event due to future climate change.

[5] Afflux is an increase in peak flood levels caused by a change in floodplain or catchment conditions. A positive afflux represents an increase and conversely a negative afflux represents a decrease in peak flood levels when compared to pre-project conditions.

4 EXISTING ENVIRONMENT

4.1 Catchment overview

The catchments within which the project is located can be broadly divided into those located to the east and west of the Great Dividing Range. The catchments to the east of the Great Dividing Range form part of the coastal Hunter River system, while those that are located to its west form part of the inland Macquarie River system.

Table 4.1 lists the catchments of the Hunter River and Macquarie River systems within which the project is located, the extent of which are shown on **Figure 4.1** (8 sheets).

TABLE 4.1
CATCHMENTS WITHIN WHICH THE PROJECT IS LOCATED

Major River System	Catchments Relevant to the Project
Hunter River	Wollar Creek Goulburn River Murrumbline Creek Four Mile Creek
Macquarie River	Talbragar River Coolaburragundy River Tucklan Creek Sandy Creek Slap Dash Creek

Section 4.2 provides a brief description of each of the catchments that are listed in **Table 4.1**, including their main tributaries and key drainage features in the vicinity of the project. **Section 4.3** provides an overview of the nature of mainstream flooding and major overland flow in the vicinity of the project under present day (i.e. pre-project) conditions. Mainstream flooding and major overland flow have collectively been termed 'flooding' within this technical paper.

4.2 Catchment description

4.2.1 Wollar Creek

Wollar Creek is about 35 kilometres long and has a total catchment area of approximately 530 square kilometres. From its headwaters near Totnes Valley, the creek flows in a northerly direction through the township of Wollar to its confluence with the Goulburn River.

Barigan Creek and Wilpinjong Creek are the main tributaries to Wollar Creek and join the main arm of the watercourse to the south and north of the township of Wollar, respectively.

The upper catchment area, around Totnes Valley, is still largely in its natural forested state. Closer to the township of Wollar, the steep valleys give way to more gently undulating terrain that has been cleared for pastoral and mining land uses. The Wilpinjong Coal Mine and the western portion of the Moolarben Coal Mine are located between 8 and 16 kilometres to the northwest of Wollar within the Wilpinjong Creek catchment.

The existing Wollar Substation is located to the west of Wollar Creek about 5 kilometres to the south of the township of Wollar. An access road connecting the existing Wollar Substation with Barigan Road crosses Wollar Creek via a concrete causeway with eight 750 mm diameter low flow pipes. Wollar Creek is also crossed by a 40 metre long bridge structure at Wollar Road in Wollar.

Due to clearing for pastoral purposes, only small sections of riparian vegetation remain along the portion of Wollar Creek where it runs between the existing Wollar Substation and Wollar Road.

Figure 4.1, sheets 2 and 3 show that the project crosses Wollar Creek, Wilpinjong Creek, Spring Flat Creek (a tributary of Wollar Creek) and Cumbo Creek (a tributary of Wilpinjong Creek).

4.2.2 Goulburn River

The Goulburn River is the largest tributary of the Hunter River with a catchment area of approximately 8,600 square kilometres. From its headwaters in Ulan. the Goulburn River flows in an easterly direction to its confluence with the Hunter River to the south of Denman.

The Goulburn River starts at the confluence of Moolarben Creek and Sportsmans Hollow Creek, approximately 300 metres to the north (downstream) of where the Sandy Hollow-Gulgong Railway Line crosses Moolarben Creek.

The catchments of Moolarben Creek and Sportsmans Hollow Creek typically comprise natural forest in their upper reaches and cleared pastoral land in their middle and lower reaches. The Moolarben Creek catchment also includes the Moolarben Coal Mine in its eastern portion.

An online dam has been constructed on Moolarben Creek approximately 1,100 metres to the south (upstream) of the Sandy Hollow-Gulgong Railway Line (denoted Moolarben Dam on **Figure 4.1**, sheet 2). The section of Goulburn River to the north of the confluence of Moolarben Creek and Sportsmans Hollow Creek has been realigned in order to divert it around the Ulan Coal Mine.

Figure 4.1, sheet 3 shows that the project crosses Moolarben Creek to the south (upstream) of the Sandy Hollow-Gulgong Railway Line and Sportsmans Hollow Creek at two locations.

4.2.3 Murrumbline Creek

Murrumbline Creek is about 17 kilometres long and has a total catchment area of approximately 160 square kilometres. Murrumbline Creek starts at the confluence of Sawpit Creek and Sandy Creek where it runs in a southerly direction to its confluence with the Goulburn River.

The catchment typically comprises natural forest with some cleared pastoral land that is predominantly located in the upper reaches. The Durridgere State Conservation Area covers the middle portion of the catchment.

Riparian vegetation remains along significant lengths of Murrumbline Creek and its tributaries, the largest of which are Pipeclay Creek, Curryall Creek and Wagrobil Creek.

Figure 4.1, sheet 4 shows that the project crosses Murrumbline Creek in its upper reach, as well as Curryall Creek, Wagrobil Creek and Yellow Waterholes Gully, all of which are tributaries of Murrumbline Creek.

4.2.4 Four Mile Creek

Four Mile Creek is about 28 kilometres long and has a total catchment area of approximately 170 square kilometres. From its headwater in Cassilis, Four Mile Creek flows in a southerly direction to its confluence with the Munmurra River, which is a major tributary of the Goulburn River.

While a large proportion of the catchment has been cleared for pastoral purposes, riparian vegetation remains along significant lengths of Four Mile Creek and its tributaries, the largest of which are Turill Creek, Kurrajong Creek and Ironbark Creek.

Figure 4.1, sheets 4 and 5 show that the project corridor crosses Four Mile Creek at two locations in its lower reach, as well as Turill Creek.

The Golden Highway crosses Four Mile Creek to the east (downstream) of the project corridor via a 40 metre long bridge structure.

4.2.5 Talbragar River

The Talbragar River is a major tributary of the Macquarie River with a catchment area of approximately 4,960 square kilometres (Cardno 2012). From its headwaters in the Coolah Tops National Park, the Talbragar River flows in a westerly direction through the townships of Dunedoo, Elong Elong and Ballimore to its confluence with the Macquarie River about 5 kilometres north of Dubbo.

The Talbragar River catchment typically comprises a mix of remnant bushland and cleared pastoral land, while the flatter areas along the overbanks of the river are also used for growing crops.

Figure 4.1, sheet 4 shows that the Merotherie Energy Hub is proposed to be located about 3.5 kilometres to the south of where Merotherie Road crosses the Talbragar River in a 23 m long bridge structure.

Figure 4.1, sheets 4 and 5 also show that to the east (upstream) of Merotherie Road the project corridor crosses the Talbragar River at two locations, as well as a number of its tributaries that comprise Cainbil Creek, Back Creek, Moreton Bay Creek, Salty Creek, Brown Creek and White Creek.

4.2.6 Tucklan Creek

Tucklan Creek is about 20 kilometres long and has a total catchment area of approximately 138 square kilometres. From its headwaters in Tallawang, Tucklan Creek runs in a northerly direction to its confluence with the Talbragar River about 10 kilometres to the west (downstream) of the township of Dunedoo.

The catchment typically comprises remnant bushland in its upper reaches, particularly along its western portion. Cleared pastoral and crop farming are the dominant land-use types in the middle and lower reaches of the catchment.

Figure 4.1, sheet 7 shows that the project corridor crosses Tucklan Creek and one of its tributaries, Patricks Creek in their upper reaches.

4.2.7 Sandy Creek

Sandy Creek is about 30 kilometres long and has a total catchment area of approximately 282 square kilometres. From its headwaters to the west of the Goodiman State Conservation Area, Sandy Creek runs in a northerly direction to its confluence with the Talbragar River about 15 kilometres to the east (upstream) of the township of Elong Elong.

The catchment typically comprises remnant bushland in its upper reaches with some cleared pastoral land in the middle and lower reaches. The Tuckland State Forest and Durridgere State Conservation Area is located along the western portion of the catchment.

The largest tributary of Sandy Creek is Laheys Creek which joins its main arm about 7 kilometres upstream of its confluence with the Talbragar River. Despite the extent of cleared pastoral land within the catchment, remnant riparian vegetation remains along significant lengths of Sandy Creek and Laheys Creek.

Figure 4.1, sheet 7 shows that the Elong Elong Energy Hub is proposed to be located on Dapper Road, about 1.2 kilometres to the west of its intersection with Spring Ridge Road. Spring Ridge Road crosses Laheys Creek immediately north of its intersection with Dapper Road via a causeway. **Figure 4.1**, sheet 7 also shows that the project crosses Sandy Creek at two locations to the west, and Laheys Creek at two locations to the east of the Elong Elong Energy Hub.

4.2.8 Wialdra Creek

Wialdra (also referred to as Wyaldra) Creek is about 29 kilometres long and has a total catchment area of approximately 750 square kilometres. From its headwaters in Cope, Wialdra Creek runs in an easterly direction to the north of the township of Gulgong to its confluence with the Cudgegong River immediately to the south (downstream) of where it is crossed by the Gulgong – Mary Vale Railway. Cudgegong River drains to Lake Burrendong, which is located in the headwaters of the Macquarie River.

Cooyal Creek is the largest tributary of Wialdra Creek, comprising approximately 56 per cent of its total catchment. Slapdash Creek is another significant tributary that joins Wialdra Creek to the north-east of Gulgong.

The catchment of Wialdra Creek mainly comprises cleared pastoral land with some remnant bushland present in its upper reaches, including the eastern portions of the Durridgere State Conservation Area and Munghorn Gap Nature Reserve, as well as the Cope State Forest. The township of Gulgong is located within the lower reach of the catchment.

Figure 4.1, sheets 7 and 8 show that the section of the project between the Merotherie and Elong Elong Energy Hubs crosses Copes Creek, which is a tributary of Wialdra Creek, as well as Tallawang Creek (at two locations) and Stubbo Creek, both of which are tributaries of Slapdash Creek.

4.3 Description of existing flood behaviour

The following sections of this technical working paper provide a brief description of patterns of both mainstream flooding and major overland flow in the vicinity of both the construction and operational components of the project under present day (i.e. pre-project) conditions.

The following figures are also referred to in the following discussion:

- **Figures 4.2**, **4.3** and **4.4** (6 sheets each) show the indicative extent and depth of inundation in the vicinity of the project footprint for a 10% and 1% AEP design storm, as well as the PMF event, respectively.
- **Figures 4.5a**, **4.5b** and **4.5c** show the indicative extent and depth of inundation due to major overland flow in the vicinity of the New Wollar Stitching Station for a 10% and 1% AEP design storm, as well as the PMF event, respectively. Corresponding extents and depths of inundation in the vicinity of the Merotherie Energy Hub are provided in **Figures 4.6a**, **4.6b** and **4.6c**, while corresponding extents and depths of inundation in the vicinity of the Elong Elong Energy Hub are provided in **Figures 4.7a**, **4.7b** and **4.7c**.
- **Annexure B** contains a series of figures that show the indicative extent and depth of inundation in the vicinity of the project footprint for design storms with AEPs of 0.5% and 0.2%.
- **Annexure C** contains a series of figures showing the indicative extent and depth of inundation in the vicinity of the New Wollar Stitching Station, Merotherie Energy Hub and Elong Elong Energy Hub for design storms with AEPs of 0.5% and 0.2%, noting that these two storm events have been used as proxies for assessing the impact that the project would have on flood behaviour under potential future climate change conditions (refer to **Section 6.3** for further details).
- **Annexure D** contains a series of figures showing maximum flow velocities and durations of inundation in the vicinity of the New Wollar Stitching Station, as well as the Merotherie and Elong Elong Energy Hubs for design storms with AEPs of 10% and 1%. These data have principally been used to assess the impact that the proposed energy hubs and new substations would have on flow velocities (and hence scour potential) and durations of inundation.
- **Annexure E** contains a series of figures that show the hazard vulnerability classification in the vicinity of the New Wollar Switching Station, Merotherie Energy Hub and Elong Energy Hub for a 1% AEP storm event.

Flood behaviour has been defined using the hydrologic and hydraulic models that are described in **Section 3.3**.

4.3.1 Wollar Creek

Up to 1% AEP

Both the existing Wollar Substation and the New Wollar Switching Station are not impacted by mainstream flooding from Wollar Creek during a 1% AEP event (refer **Figure 4.3**, sheet 2). A number of local drainage lines presently convey flow through the site of the proposed New Wollar Switching Station where depths of flow occur to a maximum of a 0.2 metres during storms up to 1% AEP in intensity with the exception of a series of contour channels that run through the southern portion of the site where depths of inundation occur to a maximum of 0.6 metres in a number of locations (refer **Figure 4.5b**).

The existing access road that runs between Barrigan Road and the existing Wollar Substation would be overtopped by floodwaters where it crosses Wollar Creek to a maximum depth of 1.7 metres over a length of 150 metres during a 10% AEP event, increasing to a maximum depth of more than 3 metres over a length of 340 metres during a 1% AEP event. The depth and velocity of flow along the section of the existing access road where it crosses Wollar Creek would be hazardous to vehicles and persons during storms more frequent than 10% AEP.

During a 1% AEP event, flooding along the section of Spring Flat Creek that crosses the corridor containing the proposed 500 kV transmission line (**500 kV transmission line corridor**) occurs to a maximum depth of 2 metres and over a width of about 250 metres. The transmission line corridor would be inundated to a maximum depth of 3 metres and over a width of about 170 metres where it crosses Cumbo Creek, and would be inundated to a maximum depth of 2 metres and over a width of about 360 metres were it crosses Wilpinjong Creek (refer **Figure 4.3**, sheets 2 and 3).

PMF

Both the existing Wollar Substation and the New Wollar Switching Station are not impacted by mainstream flooding from Wollar Creek during the PMF (refer **Figure 4.4**, sheet 2).

During the PMF, depths of flow along the local drainage lines that presently convey flow through the site of the proposed New Wollar Switching Station would exceed 1 metre in a number of locations (refer **Figure 4.5c**).

The existing access road that runs between Barrigan Road and the existing Wollar Substation would be overtopped by floodwater where it crosses Wollar Creek to a maximum depth of more than 10 metres and over a length of approximately 700 metres during the PMF.

Widespread flooding would occur along the proposed 500 kV transmission line corridor where it runs between the New Wollar Switching Station and the Merotherie Energy Hub, including over a 400 metre length where it crosses Spring Flat Creek, increasing to length of 1,500 metres and 6,200 metres where it crosses Cumbo Creek and Wilpinjong Creek, respectively (refer **Figure 4.4**, sheets 2 and 3).

4.3.2 Goulburn River

Up to 1% AEP

During a 10% AEP event, flooding along Moolarben Creek occurs over a width of 140 metres and a maximum depth of 3 metres where it crosses the proposed 500 kV transmission line corridor to the south (upstream) of the Sandy Hollow-Gulgong Railway Line, increasing to a width of 250 metres and a maximum depth of over 4 metres during a 1% AEP event (refer to sheets 2 and 3 of **Figures 4.2** and **4.3**).

Flooding along the lower reach of Sportsmans Hollow Creek where it is crossed by the proposed 500 kV transmission line corridor occurs over a width of 90 metres and to a maximum depth of 2 metres during a 10% AEP event, increasing to a width of 110 metres and to a maximum depth of 3 metres during a 1% AEP event. Flooding along the upper reach of Sportsmans Hollow Creek where it is crossed by the proposed 500 kV transmission line corridor is comparatively more confined, occurring over a width of less than 40 metres and a depth of up to 1.9 metres and 2.3 metres during a 10% AEP and 1% AEP event, respectively (refer to sheet 2 of **Figures 4.2** and **4.3**).

PMF

Widespread flooding would occur along the proposed 500 kV transmission line corridor, including over a 500 metre length and to a maximum depth of 10 metres where it crosses Moolarben Creek, and a length of 420 metres and 320 metres where it crosses the lower and upper reaches of Sportsmans Creek, respectively (refer to **Figure 4.4**, sheets 2 and 3).

4.3.3 Murrumbline Creek

Up to 1% AEP

During a 10% AEP event, flow in Murrumbline Creek surcharges the inbank area of its main channel and inundates its western overbank over a width of about 40 metres and a depth of 0.7 metres where it is crossed by the proposed 330 kV transmission line corridor that runs between the Merotherie Energy Hub and Switching Station M1, increasing to 50 metres and a depth of 1.2 metres during a 1% AEP event (refer to sheets 3 and 6 of **Figures 4.2** and **4.3**).

Flow in Wagrobil Creek is mainly confined to the inbank area of its main channel where it is crossed by the proposed 330 kV transmission line corridor that runs between the Merotherie Energy Hub and Switching Station M1 during floods up to 1% AEP in magnitude. During a 10% AEP event, flooding in Wagrobil Creek where it is crossed by the proposed 330 kV transmission line corridor occurs over a width of 50 metres and to a maximum depth of 2 metres, increasing to a width of 70 metres and a maximum depth of 3 metres during a 1% AEP event (refer to sheets 3 and 6 of **Figures 4.2** and **4.3**).

Flooding along the reaches of Curryall Creek and Yellow Waterholes Gully where they are crossed by the 330 kV transmission line corridor where it runs between the Merotherie Energy Hub and Switching Station M1 is typically less than 1 metre during events up to 1% AEP in magnitude (refer to sheets 3 and 6 of **Figure 4.3**).

PMF

Widespread flooding would occur along the proposed 330 kV transmission line corridor, including over a 200 metre length where it crosses Murrumbline Creek, a 400 metre length where it crosses Wagrobil Creek, a 320 metre length where it crosses Curryall Creek and a 80 metre length where it crosses Yellow Waterholes Gully (refer to sheets 3 and 6 of **Figure 4.4**).

4.3.4 Four Mile Creek

Up to 1% AEP

During floods up to 1% AEP in magnitude, flow in Four Mile Creek is mainly confined to the inbank area of its main channel where it is crossed by the proposed 330 kV transmission line corridor to the south (downstream) of its confluence with Turill Creek. During a 10% AEP event, flooding in Four Mile Creek at the aforementioned location occurs over a width of 60 metres and to a maximum depth of 7 metres, increasing to a width of 100 metres and a maximum depth of 8.5 metres during a 1% AEP event (refer to sheet 6 of **Figures 4.2** and **4.3**).

During a 10% AEP event, flow in the reach of Four Mile Creek where it is crossed by the proposed 330 kV transmission line corridor to the north (upstream) of its confluence with Turill Creek surcharges the inbank area of its main channel where it inundates its western overbank over a width of about 30 metres and a maximum depth of 1 metre, increasing to a width of 35 metres and a depth of 1.9 metres during a 1% AEP event (refer to sheet 6 of **Figures 4.2** and **4.3**).

Flooding along the upper reach of Turill Creek where it is crossed by the proposed 330 kV transmission line corridor occurs over a width of about 25 metres and a maximum depth of 1.5 metres during a 1% AEP event (refer to sheet 6 of **Figure 4.3**).

The eastern portion of the Neelys Lane workforce accommodation camp is impacted by mainstream flooding from Ironbark Creek and one of its tributaries. During a 1% AEP event, depths of inundation across the eastern portion of the Neelys Lane workforce accommodation camp would exceed 1.5 metres in a number of locations. Flooding from Ironbark Creek and its tributary would also inundate sections of Ulan Road to the north and south of the site (refer to sheet 6 of **Figure 5.1**).

PMF

Widespread flooding would occur along the proposed 330 kV transmission line corridor, including over 220 metre and 300 metre lengths where it crosses Four Mile Creek upstream and downstream of its confluence with Turill Creek, respectively, as well as over 210 metre length where it crosses the upper reach of Turill Creek (refer to sheet 6 of **Figure 4.4**).

4.3.5 Talbragar River

Up to 1% AEP

While the site of the proposed Merotherie Energy Hub is not impacted by mainstream flooding from the Talbragar River, a number of major overland flow paths run in a north-easterly direction through the site, where depths of inundation occur to a maximum of 1.2 metres, but are typically less than 0.5 metres during events up to 1% AEP in magnitude (refer to sheet 4 of **Figure 4.3** and **Figure 4.6b**).

The section of Merotherie Road where it runs between the Golden Highway and the Merotherie Energy Hub is frequently inundated by flow in the Talbragar River and Cainbil Creek. During a 10% AEP event, flooding to Merotherie Road at its crossings of the Talbragar River and Cainbil Creek occurs over a length of about 1,700 metres and a maximum depth of 1 metre, increasing to a length of 1,750 metres and a depth of 2 metres during a 1% AEP event (refer to sheet 4 of **Figure 4.3**). The depth and velocity of flow along the section of Merotherie Road where it crosses the Talbragar River and Cainbil Creek would be hazardous to vehicles and persons during storms more frequent than 10% AEP.

During a 1% AEP event, flooding in the Talbragar River occurs over a width of about 1,200 metres where it is crossed by the proposed 330 kV transmission line corridor where it runs between the Merotherie Energy Hub and Switching Stations M1, M2 and M3. During the same event the section of the 330 kV transmission line corridor that runs between the Merotherie Energy Hub and Switching Stations M1, M2 and M3 would be inundated over a length of about 2,300 metres where it crosses Cockabutta Creek upstream of its confluence with the Talbragar River (refer to sheet 4 of **Figure 4.3**).

PMF

Flooding along the major overland flow paths that run through the site of the proposed Merotherie Energy Hub exceed 1 metre in a number of locations (refer to sheet 4 of **Figure 4.4**).

The section of Merotherie Road where it crosses the Talbragar River and Cainbil Creek would be inundated over a length of more than 5,000 metres and to depths up to 10 metres (refer to sheet 4 of **Figure 4.4**). Widespread flooding would also occur along the proposed 330 kV transmission line corridor where it runs between the Merotherie Energy Hub and Switching Stations M1, M2 and M3, including over a length of 4,500 metres and a maximum depth of 10 metres where it crosses Cockabutta Creek upstream of its confluence with the Talbragar River (refer to sheet 4 of **Figure 4.4**).

While the proposed locations of the 330 kV switching stations are not impacted by mainstream flooding from the Talbragar River or its tributaries, all sites with the exception of switching station M1 are presently inundated by overland flow or local catchment runoff to varying degrees.

4.3.6 Tucklan Creek

Up to 1% AEP

During a 1% AEP event, flooding along the reach of Tucklan Creek where it is crossed by the proposed 500 kV transmission line corridor where it runs between the Merotherie and Elong Elong Energy Hubs occur over a width of about 50 metres and to a maximum depth of 3 metres (refer sheet 5 of **Figure 4.3**). During the same event, flooding along the reach of Patricks Creek that is crossed by the proposed 500 kV transmission line corridor occurs to depths that are typically less than 0.3 metres.

PMF

Flooding along the reach of Tucklan Creek where it is crossed by the proposed 500 kV transmission line corridor where it runs between the Merotherie and Elong Elong Energy Hubs occurs over a width of 90 metres and to a maximum depth of 5 metres. Flooding along the reach of Patricks Creek that is crossed by the proposed 500 kV transmission line corridor exceeds 1 metre in a number of locations (refer sheet 5 of **Figure 4.4**).

4.3.7 Sandy Creek

Up to 1% AEP

While the site of the proposed Elong Elong Energy Hub is not impacted by mainstream flooding from Laheys Creek a number of major overland flow path runs in a northerly direction through its middle and western portions where depths of flow will exceed 0.5 metres in a number of locations during a 1% AEP event (refer sheet 5 of **Figure 4.3** and **Figure 4.7b**).

The section of Spring Ridge Road to the west of the site of the proposed Elong Elong Energy Hub is frequently inundated by flow in Laheys Creek. During a 10% AEP event, flooding to Spring Ridge Road at its crossings of Laheys Creek occurs over a length of about 940 metres and a maximum depth of 3.3 metres, increasing to a length of 970 metres and a maximum depth of 4 metres during a 1% AEP event. The depth and velocity of flow along the section of Spring Ridge Road at its crossings of Laheys Creek would be hazardous to vehicles and persons during storms more frequent than 10% AEP.

During a 10% AEP event, flooding along the reach of Sandy Creek where it is crossed by the proposed 330 kV transmission line corridor to the west of the Elong Elong Energy Hub occurs over a width of about 110 metres and a maximum depth of 2.4 metres, increasing to a width of about 240 metres and a maximum depth of about 3.3 metres during a 1% AEP event (refer sheet 5 of **Figures 4.2** and **4.3**).

PMF

Flooding along the major overland flow paths that run through the site of the proposed Elong Elong Energy Hub exceed 1 metre in a number of locations (refer **Figure 4.7c**)).

The section of Spring Ridge Road where it runs along Laheys Creek to the north and south of its intersection with Dapper Road would be inundated over a length of about 10 kilometres and depths of up to 9 metres (refer sheet 5 of **Figure 4.4**).

Widespread flooding would also occur to the proposed 330 kV and 500 kV transmission line corridors where they run to the east and west of the Elong Elong Energy Hub, including over a length of 1,200 metres where the proposed 330 kV transmission line corridor crosses Sandy Creek (refer sheet 5 of **Figure 4.4**).

4.3.8 Wialdra Creek

Up to 1% AEP

During a 1% AEP event, flooding along the lower reach of Tallawang Creek where it is crossed by the proposed 330 kV transmission line corridor that runs in a southerly direction from the Merotherie Energy Hub to Switching Station M9 occurs over a width of about 200 metres and to a maximum depth of 5 metres (refer sheet 5 of **Figure 4.3**). During the same event, flooding along the upper reach of Tallawang Creek where it is crossed by the proposed 500 kV transmission line corridor that runs between the Elong Elong and Merotherie Energy Hubs occurs to a maximum depth of 2 metres, but is confined to a width of about 20 metres (refer sheet 5 of **Figure 4.3**).

Depths of inundation in the upper reaches of Copes Creek and Stubbo Creek where they are crossed by the proposed 500 kV transmission line corridor are typically less than 1 metre (refer sheet 5 of **Figure 4.3**).

PMF

Flooding along the lower reach of Tallawang Creek where it is crossed by the proposed 330 kV transmission line corridor occurs over a width of about 1,200 metres and to a maximum depth of more than 12 metres. Flooding would also occur along sections of the proposed 500 kV transmission line corridor, including over a length of about 200 metres where it crosses the upper reach of Tallawang Creek, 170 m where it crosses Stubbo Creek and 150 metres where it crosses Copes Creek (refer sheet 5 of **Figure 4.4**).

5 CONSTRUCTION IMPACT ASSESSMENT

This chapter provides an assessment of the flood risk associated with the construction of the project, as well as an overview of the potential impacts that the proposed construction activities could have on flood behaviour. For the purpose of this assessment, the construction footprint has been split into the following areas of work:

- An area of work associated with the construction of the New Wollar Switching Station, including its associated construction compound (referred to in this technical paper as the **New Wollar construction work area**)
- An area of work associated with the construction of the Merotherie Energy Hub including the associated accommodation camp for construction workforce (denoted the **Merotherie Road workforce accommodation camp**) and construction compound (collectively referred to in this technical paper as the **Merotherie construction work area**).
- An area of work associated with the construction of the Elong Elong Energy Hub, including its associated construction compound (referred to in this technical paper as the **Elong Elong construction work area**)
- Areas along the transmission line corridors for the construction of the proposed 500 kV and 330 kV networks and associated access tracks (referred to in this technical paper as the **proposed 500 kV network** and **proposed 330 kV network construction work areas**)
- Areas for construction of the 330 kV switching stations (referred to in this technical paper as **switching stations M1** to **M9** and **E1** to **E4 construction work areas**)
- An area adjacent to Neelys Lane, Cassilis to construct temporary accommodation camps for the construction workforce (referred to in this technical paper as the **Neelys Lane workforce accommodation camp**).

5.1 Potential flood risks at construction work areas

Without the implementation of appropriate management measures, the inundation of the construction work areas by floodwater has the potential to:

- cause damage to the proposed works and delays in construction programming
- pose a safety risk to construction workers
- detrimentally impact the downstream waterways through the transport of sediments and construction materials by floodwater
- obstruct the passage of floodwater and overland flow, which in turn could exacerbate flooding conditions in areas located outside the construction footprint.

Table 5.1 at the end of this chapter provides a summary of the proposed activities, as well as the assessed flood risk at each construction work area, while **Figure 5.1** (6 sheets) shows the extent to which floods of varying magnitude affect each construction work area across the extent of the project.

Construction facilities

Temporary construction facilities that would be required to support the construction of the project would include:

- three main construction compounds containing a range of facilities that are proposed to be located within the New Wollar, Merotherie and Elong Elong construction work areas

- a series of smaller construction support facilities at each of the thirteen 330 kV switching stations
- two workforce accommodation camps at Merotherie Road, Merotherie and Neelys Lane, Cassilis.

The construction compounds and support facilities at the sites of the energy hubs and switching stations would include offices, staff amenities, parking, as well as areas to store plant, equipment, materials, waste and potable water tanks. Secure perimeter fencing would be provided around each construction ancillary facility. **Table 5.1** lists the construction ancillary facilities within each work area and construction zone, together with a summary of their potential flood affectation. The three main construction compounds would also include cement silos, borrow pits, screening plants, aggregate bins, helicopter landing pad, testing laboratories, and wastewater treatment plants.

The Merotherie Road and Neelys Lane workforce accommodation camps would include demountable accommodation and office buildings, staff amenities (including food and catering facilities, fitness and recreational facilities, laundry, bathroom and first aid facilities), utilities, storage areas for waste, equipment, fuels and materials, generators and wastewater treatment plant.

With the exception of the Switching Station M1 construction work area, all of the locations that have been identified for the proposed construction facilities are affected by either mainstream or local catchment flooding to varying degrees (refer **Table 5.1**).

While the majority of the construction support sites would be subject to flooding during a 10% AEP storm event, depths of inundation are generally relatively shallow and of a short duration nature. The exception is the northern portion of the Elong Elong construction compound where depths of inundation during a 10% AEP event would exceed 1 metre due to mainstream flooding from Laheys Creek, increasing to more than 2 metres during a 1% AEP event.

Construction compounds and support facilities located on the floodplain, particularly in areas of high hazard[6], pose a safety risk to construction personnel and plant. It would therefore be necessary to locate site facilities outside high hazard areas with safe evacuation routes. All construction facility sites include land located outside areas of high hazard that would be suitable for site facilities. Detailed planning of the construction facility layouts will need to consider how safe evacuation routes are provided for construction personnel during a flood.

A broad outline of potential mitigation measures aimed at managing the risk of flooding to construction facilities is provided in **Section 7**.

[6] High hazard flooding is defined in the *Floodplain Development Manual* (Department of Planning, Infrastructure and Natural Resources (DIPNR) 2005) as flooding that is a possible danger to personal safety, where evacuation by trucks and able-bodied adults would be difficult and where there is potential for significant structural damage to buildings. High hazard flooding is initially categorised based on the depth and velocity of flooding, but can be revised through the provision of effective flood emergency planning and response procedures to reduce the consequences of flooding if there is sufficient warning time. High hazard flooding under DIPNR 2005 generally corresponds to a hazard vulnerability classification of H4 to H6 under the flood hazard vulnerability classifications presented in ARR 2019.

Spoil management and stockpile areas

The construction of the project would generate spoil, some of which would need to be temporarily stored in stockpile areas for reuse on site or disposed of according to the procedures set out in Chapter 3 of the EIS Main Report. It would also be necessary to temporarily store imported material such as road base to construct the access tracks and select material for construction of the pads for the energy hubs and switching stations.

Stockpiles located on the floodplain have the potential to obstruct floodwater and alter flooding patterns. Inundation of stockpile areas by floodwater can also lead to significant quantities of material being washed into the receiving drainage lines and waterways.

The locations within each construction work area where materials would be stored would be subject to detailed design and construction planning.

Earthworks

Earthworks would be required across all the construction work areas in order to construct the project, which would include:

- the installation of drainage channels, culverts and piped drainage systems to control runoff around and through the energy hubs and switching stations
- the construction of pads and access roads at the energy hubs and switching stations
- the construction of access tracks and associated drainage infrastructure along the transmission line corridors
- the installation of working platforms for piling machinery to install the footings for transmission line towers and for brake and winch machinery for stringing the transmission lines.

While the sites of the energy hubs and switching stations are not impacted by mainstream flooding, they would all be subject to inundation from local catchment flooding to varying degrees.

The transmission line corridors that comprise the 330 kV and 500 kV construction work areas cross the Talbragar River, as well as a number of perennial and non-perennial creeks, watercourses and local drainage lines. The transmission line corridors would be inundated by runoff that is conveyed in these creeks, watercourses and local drainage lines during frequent rainfall events.

The inundation of the earthworks within the energy hubs, switching stations and along the transmission line corridors by floodwater has the potential to cause scour of disturbed surfaces and the transport of sediment and construction materials into the receiving drainage lines and waterways. It would therefore be necessary to plan, implement and maintain measures that are aimed at managing the diversion of floodwater either through or around the construction areas. A broad outline of potential mitigation measures is provided in **Section 7**.

Transmission line construction

The construction of the transmission lines comprising the 500 kV and 330 kV networks would typically involve the construction of tower footings, erection of the towers and then the stringing of the transmission lines between each tower.

Temporary access tracks would be required to move machinery to each tower location, while working platforms would be required to support piling rigs and cranes to construct tower footings and erect the towers. Working platforms would also be required to support the brake and winch machinery that would be required to string the transmission lines.

The transmission lines for both the 500 kV and 330 kV network infrastructure would require spanning the Talbragar River, as well as a number of smaller perennial and non-perennial creeks and watercourses.

Generally, to limit the potential for impacts to and disturbance of these watercourses, the design of the transmission lines would include a transmission line tower on either side of, and as far away as practicable from each watercourse. A drone or helicopter would then be used to take a lead wire over the watercourse to allow cables to then be pulled and strung tower to tower. For some of the larger watercourses where it may be impractical to use a drone or helicopter, the use of watercraft may be required.

It is not envisaged that any access tracks or bridges would be required for these particular crossings due to the design and proposed construction method of the transmission line at these locations. While there would likely be the need for some temporary works on each side of the span to allow for the construction of the individual transmission line tower, it is likely that these would be at least 50 metres from the bank of the watercourse with appropriate environmental controls (such as erosion and sediment controls) implemented.

Where alternative access routes are impractical, the temporary access tracks may need to cross watercourses in areas that would be frequently inundated by flow. It would therefore be necessary to design and construct the temporary access roads to manage the potential for scour and transport of material into the watercourses, whilst also maintaining a passage for the conveyance of floodwater through the construction site. **Section 7** provides a summary of potential measures to manage these impacts.

5.2 Potential impacts of construction activities on flood behaviour

Construction activities have the potential to exacerbate flooding conditions when compared to both existing and operational conditions. This is because construction activities typically impose a larger footprint on the floodplain due to the need to provide temporary structures, such as ancillary sites, outside the operational footprint which would be removed following the completion of construction activities.

A qualitative assessment was carried out of the potential impacts that construction activities could have on flood behaviour, the key findings of which are summarised in **Table 5.1**.

The assessment found that:

i. construction activities within the northern portion of the Elong Elong construction work area has the potential to impact on mainstream flooding in Laheys Creek

ii. construction activities within the New Wollar, Merotherie and Elong Elong construction work areas as well as the Neelys Lane workforce accommodation camp all have the potential to impact on local catchment flooding

iii. the crossing of watercourses by temporary access roads that would be required to construct the transmission lines within the 330 kV and 500 kV construction work areas have the potential to obstruct the conveyance of flow, which in turn may impact on the extent and depth of inundation and flow velocities in the watercourses and their overbank areas

iv. each of the 330 kV switching stations with the exception of Switching Station M1, have the potential to impact on local catchment flooding to varying degrees.

While the findings of the assessment provide an indication of the potential impacts of construction activities on flood behaviour, further investigation would need to be undertaken during detailed design, as layouts and staging diagrams are further developed. Consideration would also need to be given to setting an appropriate hydrologic standard for mitigating the impacts of construction activities on flood behaviour, taking into account their temporary nature and therefore the likelihood of a flood of a given AEP occurring during the construction period.

Section 7 outlines a range of measures which will be implemented to mitigate the potential construction related impacts of the project.

TABLE 5.1
SUMMARY OF ASSESSED FLOOD RISKS AND POTENTIAL IMPACTS AT PROPOSED CONSTRUCTION WORK AREAS

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)		
New Wollar construction work area	Construction compound	More frequent than 10% AEP	✓	✓	✓	x	• Refer to **Figure 5.1**, sheet 2. • While the site of the New Wollar construction work area is not impacted by mainstream flooding, there are a number of drainage lines that convey local catchment runoff through the site. Depths of overland flow along these drainage lines are typically less than 0.2 m during a 1% AEP event, but reach up to 0.5 m in a number of locations. These drainage lines discharge to Wollar Creek which is located to the east of the site.	• Activities within the New Wollar construction work area have the potential to alter flooding and drainage patterns in the receiving drainage lines that discharge to Wollar Creek.
	Other areas	More frequent than 10% AEP	x	x	✓	✓		
Merotherie construction work area	Construction compound	More frequent than 10% AEP	✓	✓	✓	x	• Refer to **Figure 5.1**, sheet 4. • The proposed location of the construction compound in the north-eastern portion of the construction work area is impacted by mainstream flooding from Cockabutta Creek during events larger than 0.2% AEP in magnitude. • While the proposed location of the Merotherie Road workforce accommodation camp is not impacted by mainstream	• Activities within the Merotherie construction work area have the potential to alter flooding and drainage patterns in the receiving drainage lines that discharge to Cockabutta Creek.
	Merotherie Road workforce accommodation camp	More frequent than 10% AEP	✓	✓	x	x		
	Other areas	More frequent than 10% AEP	x	x	✓	✓		

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2): Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)	Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
							flooding, the site would be inundated by local catchment runoff that is conveyed along a series of drainage lines that run through the site, albeit to relatively shallow depths of 0.2 m or less during storms up to 1% AEP in intensity. • The construction work area is also inundated by local catchment runoff that is conveyed along a number of drainage lines that run through its middle and southern portions. The largest of these drainage lines runs through the southern portion of the site where depths of overland flow occur to a maximum of 0.8 m during a 1% AEP event.	
Elong Elong construction work area	Construction compound	More frequent than 10% AEP	✓	✓	✓	x	• Refer to **Figure 5.1**, sheet 5. • The northern portion of the Elong Elong construction work area would be impacted by mainstream flooding from Laheys Creek. During a 10% AEP event, depths of inundation across the northern portion of the site would exceed 1 metre, increasing to more than 2 metres during a 1% AEP event, both of which would be hazardous to construction personnel and machinery. Areas across the remainder of the site would	• Activities within the northern portion of the Elong Elong construction work area have the potential to obstruct the conveyance of flow in Laheys Creek during events more frequent than 10% AEP. Activities across the remainder of the site have the potential to alter flooding and drainage patterns in the drainage lines that presently run through the site.
	Other areas	More frequent than 10% AEP	x	x	✓	✓		

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2): Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)	Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
							be inundated by local catchment runoff that is conveyed along a number of drainage lines. Two of the larger drainage lines run through the middle and eastern portions of the site where depths of overland flow occur to a maximum of 1 m and 0.5 m during a 1% AEP event, respectively.	
500 kV network construction work area		More frequent than 10% AEP	x	✓	✓	✓	• Refer to **Figure 5.1**, sheets 2, 3, 4 and 5. • The 500 kV network construction work area crosses a number of perennial and non-perennial creeks, watercourses and local drainage lines. The construction work area would be inundated by runoff that is conveyed in these creeks, watercourses and local drainage lines during frequent rainfall events. • During a 1% AEP event, the 500 kV network construction work area would be inundated by floodwaters at a number of locations, including: ○ over a length of about 250 m and to a maximum depth of about 2 m where it crosses Spring Flat Creek	• Construction activities along the 500 kV network construction work area have the potential to obstruct the conveyance of flow in the creeks, watercourses and local drainage lines that cross the corridor.

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)		
							○ over a length of about 170 m and to a maximum depth of about 3 m where it crosses Cumbo Creek ○ over a length of about 360 m and to a maximum depth of about 2 m where it crosses Wilpinjong Creek ○ over a length of about 140 m and to a maximum depth of about 3 m where it crosses Moolarben Creek ○ over a length of about 110 m and to a maximum depth of about 3 m where it crosses the lower reach of Sportsmans Hollow Creek ○ over a length of about 40 m and to a maximum depth of about 2 m where it crosses the upper reach of Sportsmans Hollow Creek ○ over a length of about 50 m and to a maximum depth of about 3 m where it crosses Tucklan Creek ○ over a length that is less than 10 m and to a depth that is typically less than 0.3 m where it crosses Patricks Creek	

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2) Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)	Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
							○ over a length of about 200 m and to a depth of about 4 m where it crosses Laheys Creek ○ over a length of about 20 m and to a depth of about 2 m where it crosses Tallawang Creek ○ over a length of about 30 m and to a depth of about 1 m where it crosses Stubbo Creek ○ over a length of about 30 m and to a depth of about 1 m where it crosses Copes Creek.	
330 kV network construction work area		More frequent than 10% AEP	x	✓	✓	✓	• Refer to **Figure 5.1**, sheets 3, 4, 5 and 6. • The 330 kV network construction work area crosses a number of perennial and non-perennial creeks, watercourses and local drainage lines. The construction work area would be inundated by runoff that is conveyed in these creeks, watercourses and local drainage lines during frequent rainfall events. • During a 1% AEP event, the 330 kV network construction work area would be inundated	• Construction activities along the 330 kV network construction work area have the potential to obstruct the conveyance of flow in the creeks, watercourses and local drainage lines that cross the corridor.

Construction work area	Construction compound / other areas	Threshold of flooding[1]	Proposed construction activities[2]				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage & spoil management[4]	Earthworks [5]	Transmission line construction[6]		
							by floodwater at a number of locations, including: ○ over a length of about 50 m and to a maximum depth of more than 1 m where it crosses Murrumbline Creek ○ over a length of about 70 m and to a maximum depth of about 3 m where it crosses Wagrobil Creek ○ over a length of about 180 m and to a maximum depth that is less than 1 m where it crosses Curryall Creek ○ over a length of about 50 m and to a maximum depth that is less than 1 m where it crosses Yellow Waterholes Gully ○ over a length of about 100 m and to a maximum depth of more than 8 m where it crosses Four Mile Creek downstream of its confluence with Turill Creek ○ over a length of about 35 m and to a maximum depth of about 2 m where it crosses Four Mile Creek upstream of its confluence with Turill Creek	

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2) Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)	Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
							○ over a length of about 25 m and to a maximum depth of more than 1 m where it crosses Turill Creek ○ over a length of about 1,200 m and to a maximum depth of more than 3 m where it crosses the Talbragar River ○ over a length of about 2,300 m and to a maximum depth of more than 2 m where it crosses Cockabutta Creek at its confluence with the Talbragar River ○ over a length of about 110 m and to a depth of more than 2 m where it crosses Sandy Creek ○ over a length of about 200 m and to a depth of about 5 m where it crosses Tallawang Creek.	
Switching station M1		Not flooded	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 6. • Switching station M1 is located on a ridge line and is therefore not impacted by mainstream flooding or major overland flow.	• Activities within the Switching Station M1 construction work area would have a minimal effect on flood behaviour.
Switching station M2		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 6. • A local overland flow path runs through the western corner of the site of switching station M2 where depths of inundation are a	• Activities within the Switching Station M2 construction work area would have the potential to alter flooding and drainage patterns in

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2): Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)	Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
							maximum of 0.12 m during a 10% AEP event, increasing to 0.15 m during a 1% AEP event. • The remainder of the site is not impacted by mainstream flooding or major overland flow.	the overland flow path that runs through the western portion of the site.
Switching station M3		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 6. • While the site is not impacted by mainstream flooding or major overland flow it would be inundated by local catchment runoff from upslope areas to its east. Depths of inundation across the site would typically be less than 0.1 m during a 1% AEP event.	• Activities within the site are expected to have only a minor impact on flood behaviour given the minor nature of overland flow that is presently conveyed through the site.
Switching station M4		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 4. • While the site is not impacted by mainstream flooding or major overland flow, it would be inundated by local catchment runoff from upslope areas to its west. Runoff from these upslope areas is presently collected in a contour bank channel that is located within the western portion of the site where depths of flow occur to a maximum of 0.4 m during a 1% AEP event.	• Activities within the Switching Station M4 construction work area are expected to have only a minor impact on flooding behaviour given the minor nature of overland flow that is presently conveyed through the site.

Construction work area	Construction compound / other areas	Threshold of flooding[1]	Proposed construction activities[2]				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage & spoil management[4]	Earthworks [5]	Transmission line construction[6]		
Switching station M5		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 4. • While the site is not impacted by mainstream flooding it is presently inundated by flow that is conveyed along two local drainage lines that run through the middle and western portions of the site. Depths of flow along both of the drainage lines occur to a maximum of 0.2 m during a 1% AEP event.	• Activities within the Switching Station M5 construction work area would have the potential to alter flooding and drainage patterns in the two local drainage lines that run through the middle and western portions of the site.
Switching station M6		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 4. • While the site is not impacted by mainstream flooding it would be inundated by local catchment runoff from upslope areas to its north. Depths of inundation across the site would be typically less than 0.1 m during a 1% AEP event.	• Activities within the Switching Station M6 construction work area are expected to have only a minor impact on flooding behaviour given the minor nature of overland flow that is presently conveyed through the site.
Switching station M7		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 4. • While the site is not impacted by mainstream flooding it is presently inundated by flow that is conveyed along a local drainage line that runs through the middle of the site. Depths of flow along the drainage line occurs to a maximum of 0.5 m during a 1% AEP event.	• Activities within the Switching Station M5 construction work area would have the potential to alter flooding and drainage patterns in the local drainage lines that runs through the middle of the site.

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)		
Switching station M8		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 4. • While the site of switching station M8 is not impacted by mainstream flooding or major overland flow it would be inundated by runoff from upslope areas to its north. Depths of inundation across the site would be typically less than 0.1 m during a 1% AEP event.	• Activities within the Switching Station M8 construction work area are expected to have only a minor impact on flooding behaviour given the minor nature of overland flow that is presently conveyed through the site.
Switching station M9		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 4. • While the site of switching station M9 is not impacted by mainstream flooding or major overland flow, it would be inundated by local catchment runoff from upslope areas to its south. Depths of inundation across the site would typically be less than 0.15 m during a 1% AEP event.	• Activities within the Switching Station M9 construction work area are expected to have only a minor impact on flooding behaviour given the minor nature of overland flow that is presently conveyed through the site.
Switching station E1		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 5. • While the site is not impacted by mainstream flooding, a relatively localised area of the site would be impacted by flow that is conveyed along a major overland flow path that runs to its north-east. Depths of inundation along the north-eastern side of the site adjacent to the major overland flow path would occur to a maximum of 0.3 m during a 1% AEP event.	• Activities within the Switching Station E1 construction work area have the potential to obstruct flows and alter flooding and drainage patterns in the major overland flow path that is located to the north-east of the site, as well as the series of drainage lines that run

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2): Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)	Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
							• Minor drainage lines also run through the eastern and western portions of the site where depths of inundation would typically be less than 0.15 m during a 1% AEP event.	through its eastern and western portions.
Switching station E2		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 5. • While the site is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along two local drainage lines that run through the middle and eastern portions of the site. Depths of flow along both of the drainage lines occur to a maximum of 0.15 m during a 1% AEP event.	• Activities within the Switching Station E2 construction work area have the potential to obstruct flows and alter flooding and drainage patterns in the two local drainage lines that run through the site.
Switching station E3		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 5. • While the site is not impacted by mainstream flooding it is presently inundated by flow that is conveyed along a local drainage line that runs through the southern portion of the site. Depths of flow along the drainage line occurs to a maximum of 0.15 m during a 1% AEP event. • A contour bank channel presently runs through the middle of the site where depth of flow occur to a maximum of 0.3 m during a 1% AEP event.	• Activities within the Switching Station E3 construction work area have the potential to obstruct flows and alter flooding and drainage patterns in the local drainage line that runs through the site.

Construction work area	Construction compound / other areas	Threshold of flooding(1)	Proposed construction activities(2)				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities(3)	Material storage & spoil management(4)	Earthworks (5)	Transmission line construction(6)		
Switching station E4		More frequent than 10% AEP	✓	✓	✓	✓	• Refer to **Figure 5.1**, sheet 5. • While the site is not impacted by mainstream flooding it is presently inundated by flow that is conveyed along a local drainage line that runs through the north-western portion of the site. Depths of flow along the drainage line occur to a maximum of 0.3 m during a 1% AEP event.	• Activities within the Switching Station E4 construction work area have the potential to obstruct flows and alter flooding and drainage patterns in the local drainage line that runs through the north-western portion of the site.
Neelys Lane workforce accommodation camp		More frequent than 10% AEP	✓	✓	x	x	• Refer to **Figure 5.1**, sheet 6. • The proposed location of the workforce accommodation camp is not impacted by mainstream flooding, except for a localised area along its eastern side that would be inundated during the PMF by floodwaters from Ironbark Creek and one of its tributaries. • The proposed location of the workforce accommodation camp would be inundated by local catchment runoff that is conveyed along a series of drainage lines that run in an easterly direction through the site. Depths of inundation across the site are typically less than 0.2 m during storms up to 1% AEP in intensity except within an existing farm dam	• Activities within the Neelys Lane workforce accommodation camp have the potential to obstruct flows and alter flooding and drainage patterns in the drainage line that run through the northern and southern portions of the site.

Construction work area	Construction compound / other areas	Threshold of flooding[(1)]	Proposed construction activities[(2)]				Assessment of Flood Affectation	Potential impacts of construction activities on flood behaviour
			Site facilities[(3)]	Material storage & spoil management[(4)]	Earthworks[(5)]	Transmission line construction[(6)]		
							that is located in the northern portion of the site. • Flooding from Ironbark Creek and its tributary would also inundate sections of Ulan Road to the north and south of the site.	

1. The assessed threshold of flooding is based on pre-project conditions. Refer **Figure 5.1** (6 sheets) for flood extent mapping under pre-project conditions.
2. Refer to **Section 5.1** for a description of flood risks associated with each construction activity.
3. Site facilities include construction compounds, support facilities and workforce accommodation, which include site offices, staff amenities, storage of materials and parking.
4. Spoil management includes stockpiling and treatment of excavated material.
5. Earthworks includes construction of access roads and tracks and drainage works.
6. Transmission line construction includes working pads for piling machinery to install the footings of transmission line support towers as well as for machinery at brake and winch sites for the purpose of stringing the transmission lines.

6 OPERATIONAL IMPACT ASSESSMENT

This section provides an assessment of the flood risk to the project, as well as the impact it could have on flood behaviour during operation if appropriate mitigation measures are not incorporated into its design. The findings of an assessment into the potential impact of future climate change on flood behaviour under operational conditions are also presented.

6.1 Potential flood risk to the project and its impact on flood behaviour

For the purpose of the following discussion, the operational related features of the project have been divided into the following five components:

- New Wollar Switching Station
- Merotherie Energy Hub
- Elong Elong Energy Hub
- transmission line corridors that would contain the 500 kV and 330 kV networks of the project
- thirteen 330 kV switching stations that would connect the energy generated from renewable energy generation and storage projects onto the 500 kV network infrastructure.

Further details of each of the project elements listed above are provided in Chapter 3 of the EIS Main Report, while the location of each project element is shown on **Figures 4.2** to **4.4** (6 sheets each).

6.1.1 New Wollar Switching Station

<u>Impact of flooding on the New Wollar Switching Station</u>

As noted in **Section 4.3.1**, while the site of the New Wollar Switching Station is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along a number of local drainage lines that run through its northern, eastern and southern portions. A series of diversion channels and culverts would be installed to convey local catchment runoff through and around the site in order to manage the impact of flooding on the switchyards, transformers, control buildings and associated infrastructure. The diversion channels and culverts would be designed to achieve the hydrologic standards that are set out in **Table 3.1** in **Section 3.2** of this technical paper. A typical arrangement of these diversion channels and culverts is shown on **Figure 6.1a**.

<u>Impact of the New Wollar Switching Station on flood behaviour</u>

The New Wollar Switching Station has the potential to impact on flooding and drainage patterns due to:

i. an increase in the rate and volume of runoff from the substation pads, access roads and other hardstand areas within the switching station, which in turn has the potential to increase the rate and volume of runoff being conveyed in the receiving drainage lines
ii. the redirection of flow along diversion channels and culverts that are proposed to control runoff through the switching station, which in turn has the potential to result in a redistribution of flows in the receiving drainage lines.

In order to assess the impact of the New Wollar Switching Station on flood behaviour, the structure of the flood model representing pre-project conditions was adjusted to incorporate details of the proposed works. The increase in runoff associated with new hardstand areas and the redirection of flow associated with the proposed diversion channels and culverts were also incorporated into the flood model.

For the purpose of this assessment, no allowance has been made for stormwater detention or other flow control measures. In this regard, the assessment provides an indication of the upper bound estimate of the potential impacts that the New Wollar Switching Station could have on flood behaviour in the receiving drainage lines in the absence of such controls.

The following figures showing flooding patterns and impacts in the vicinity of the New Wollar Switching Station under operational conditions should be referred to when reading the following discussion:

- **Figures 6.1a, 6.1b** and **6.1c** show the indicative extent and depth of inundation in the vicinity of the New Wollar Switching Station under post-project conditions for design storms with AEPs of 10% and 1%, as well as the PMF event, respectively. **Figures C.4a** and **C.4b** in **Annexure C** respectively show corresponding results for design storms with AEPs of 0.5% and 0.2% AEP.
- **Figures 6.2a**, **6.2b** and **6.2c** show the impact that the New Wollar Switching Station would have on flood behaviour in terms of changes in peak flood levels for design storms with AEPs of 10% and 1%, as well as the PMF event, respectively.[7] **Figures C.5a** and **C.5b** in **Annexure C** respectively show corresponding results for design storms with AEPs of 0.5% and 0.2% AEP.
- **Figures D.4a** and **D.4b** in **Annexure D** show maximum flow velocities under post-project conditions in the vicinity of the New Wollar Switching Station during storms with AEPs of 10% and 1%, while **Figures D.5a** and **D.5b** in **Annexure D** show the impact that it would have in terms of changes in maximum flow velocities for the same design storm events.
- **Figures D.4c** and **D.4d** in **Annexure D** show the duration of inundation in the vicinity of the New Wollar Switching Station under post-project conditions during storms with AEPs of 10% and 1%, while **Figures D.5c** and **D.5d** in **Annexure D** show the impact that it would have in terms of changes in the duration of inundation for the same design storm events.

The key findings of the assessment of the impact that the New Wollar Switching Station would have on flood behaviour are summarised below.

Changes in peak flood levels and depths of inundation

There would be a general reduction in the depth of inundation along the drainage paths that run through the existing Wollar Substation that is located to the north of the switching station. This is due to a reduction in the catchment area draining to this location as the majority of the footprint of the New Wollar Switching Station is proposed to be diverted toward the drainage lines that run to its west.

[7] Changes in peak flood levels are denoted on the figure as “afflux”. An afflux of plus or minus 0.01 metres is considered to be within the order of accuracy of the hydraulic model. The figure also shows changes in the extent of inundation that would be caused by the construction of the project. A reduction in the extent of inundation is denoted “Land rendered flood free”, while an increase in the extent of inundation is denoted “Additional area of land flooded” as a result of the project.

Peak 1% AEP flood levels along the drainage line that discharges from the eastern corner of the New Wollar Switching Station would be increased by a maximum of 0.11 metres on existing depths of inundation that are typically less than 0.2 metres. The land that is impacted is cleared pastoral land that is zoned primary production. The increase in the depth of inundation would not impact on any structures or lead to a significant increase in the extent of inundation. Further discussion is provided below on how the increase in runoff in the area impacts on velocities and the duration of inundation.

There would also be an increase in peak flood levels along an existing drainage line that runs to the east of the existing Wollar Substation and the proposed access road that is located to the north of the New Wollar Switching Station. Peak 1% AEP flood levels would be increased by a maximum of 0.05 metres on existing depths that are typically less than 0.1 metres. These increases in the depth of inundation are due to a redistribution of flow that occurs as a result of the proposed access road and its associated drainage system.

During the PMF, depths of inundation along the drainage line that discharges from the eastern corner of the New Wollar Switching Station would be increased by a maximum of 0.25 metres, on existing depths of inundation that are typically between 0.4 and 0.7 metres. There would also be an increase in the depth of inundation along two drainage lines that run to the east of the existing Wollar Substation and the proposed access road that is located to the north of the New Wollar Switching Station by a maximum of 0.05 metres on existing depths of between 0.1 and 0.2 metres. These increases in PMF levels are considered to be minor in terms of the nature of land impacted and the relative increase in flood hazard.

Changes in flow velocities

During a 10% and 1% AEP event, changes in peak flow velocities along the drainage paths that run through the existing Wollar Substation to the north of the New Wollar Switching Station would be typically less than 10 per cent, with the exception of some localised areas where peak flow velocities would be increased by a maximum of 15 percent. Where the increase in peak flow velocities exceed 10 per cent, the resulting peak flow velocities would be less than 0.5 metres per second, which would still have a low potential for causing scour given the coverage of vegetation over the impacted area.

Peak flow velocities along the drainage line that discharges from the eastern corner of the New Wollar Switching Station would be increased by a maximum of 50 per cent during both a 10% and 1% AEP event, with the resulting peak flow velocities exceeding 1 metre per second in a number of locations. There would also be an increase in peak flow velocities along the drainage line that runs to the east of the proposed access road to the north of the New Wollar Switching Station. During a 1% AEP event, peak flow velocities would be increased by a maximum of 30 per cent, with the resulting peak flow velocities occurring to a maximum of 1 metre per second.

The above increases in peak flow velocities have the potential to result in an increase in scour and erosion in the drainage lines that run to the east of the New Wollar Switching Station and its access road. Further refinement of the drainage strategy for the New Wollar Switching Station would be undertaken during the detailed design, with the aim of managing increases in flows that would otherwise lead to adverse impacts on flow velocities and hence the scour potential in the receiving drainage lines.

Changes in the extent and duration of flooding

Changes in the duration of inundation would typically be less than 1 hour, with the exception of the two drainage lines that run to the east of the New Wollar Switching Station and its associated access road, where the duration of inundation would be increased by 1.1 hours during a 10% AEP event. The increase in the duration of inundation is due to an increase in runoff discharging to these drainage lines, which also leads to an increase in the extent of inundation.

Further refinement of the drainage strategy for the New Wollar Switching Station would be undertaken during the detailed design, with the aim of minimising changes in the distribution of flows and increased runoff from the new hardstand areas that would otherwise lead to adverse impacts on the duration and extent of inundation in the receiving drainage lines.

6.1.2 Merotherie Energy Hub

Impact of flooding on the Merotherie Energy Hub

As noted in **Section 4.3.1**, while the site of the Merotherie Energy Hub is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along a number of local drainage lines that run through the it. A series of diversion channels and culverts would be installed to convey local catchment runoff through and around the site in order to manage the impact of flooding on the switchyards, transformers, control buildings and associated infrastructure. The diversion channels and culverts would be designed to achieve the hydrologic standards set out in **Table 3.1** in **Section 3.2** of this technical paper. A typical arrangement of these diversion channels and culverts is shown on **Figure 6.1**.

Impact of the Merotherie Energy Hub on flood behaviour

The types of potential impacts associated with the Merotherie Energy Hub are similar to those described for the New Wollar Switching Station, namely:

i. an increase in the rate and volume of runoff from the substation pads, access roads and other hardstand areas, which in turn has the potential to increase the rate and volume of runoff being conveyed in the receiving drainage lines

ii. the redirection of flow along the diversion channels and culverts that are proposed to control runoff through the switching station, which in turn has the potential to result in a redistribution of flows in the receiving drainage lines.

In order to assess the impact of the Merotherie Energy Hub on flood behaviour, the structure of the flood model representing pre-project conditions was adjusted to incorporate details of the proposed works. The increase in runoff associated with new hardstand areas and the redirection of flow associated with the proposed diversion channels and culverts were also incorporated into the flood model.

For the purpose of this assessment no allowance has been made for stormwater detention or other flow control measures. In this regard, the assessment provides an indication of the upper bound estimate of the potential impacts that the energy hub could have on flood behaviour in the receiving drainage lines in the absence of such controls.

The following figures showing flooding patterns and impacts in the vicinity of the Merotherie Energy Hub under operational conditions should be referred to when reading the following discussion:

- **Figures 6.3a, 6.3b** and **6.3c** show the indicative extent and depth of inundation in the vicinity of the Merotherie Energy Hub under post-project conditions for design storms with AEPs of 10% and 1%, as well as the PMF event, respectively. **Figures C.6a** and **C.6b** in **Annexure C** respectively show corresponding results for design storms with AEPs of 0.5% and 0.2% AEP.
- **Figures 6.4a**, **6.4b** and **6.4c** show the impact that the Merotherie Energy Hub would have on flood behaviour in terms of changes in peak flood levels for design storms with AEPs of 5% and 1%, as well as the PMF event, respectively.[8] **Figures C.7a** and **C.7b** in **Annexure C** respectively show corresponding results for design storms with AEPs of 0.5% and 0.2% AEP.
- **Figures D.6a** and **D.6b** in **Annexure D** show maximum flow velocities under post-project conditions in the vicinity of the Merotherie Energy Hub during storms with AEPs of 10% and 1%, while **Figures D.7a** and **D.7b** in **Annexure D** show the impact that it would have in terms of changes in maximum flow velocities for the same design storm events.
- **Figures D.6c** and **D.6d** in **Annexure D** show the duration of inundation in the vicinity of the Merotherie Energy Hub under post-project conditions during storms with AEPs of 10% and 1%, while **Figures D.7c** and **D.7d** in **Annexure D** show the impact that it would have in terms of changes in the duration of inundation for the same design storm events.

The key findings of the assessment that the impact of the Merotherie Energy Hub would have on flood behaviour are summarised below.

Changes in peak flood levels and depths of inundation

During a 10% and 1% AEP event, increases in peak flood levels in areas outside the operational footprint of the Merotherie Energy Hub would be less than 0.01 metres, with the exception of the following locations:

i. a drainage line to its north, where peak flood levels would be increased by a maximum of 0.05 and 0.06 metres during a 10% and 1% AEP event, respectively. The impacted area includes a local access road that runs to the north of the energy hub, where existing depths of inundation occur to a maximum of between 0.4 metres and 0.5 metres during a 10% and 1% AEP event.

ii. a drainage line that runs to its east, where peak flood levels would be increased by a maximum of 0.23 metres during both a 10% and 1% AEP event. These increases in peak flood levels, which are mainly confined to the road corridor of Merotherie Road, are due to an increase in runoff from the site in combination with the level of the proposed access road to the energy hub at its intersection with Merotherie Road.

iii. two drainage lines to its south, where there will be localised increases in peak flood levels by a maximum of 0.07 and 0.11 metres during a 10% and 1% AEP event, respectively. The impacted area presently comprises cleared pastoral land that is zoned primary production, where existing depths of inundation occur to a maximum of between 0.2 metres and

[8] Changes in peak flood levels are denoted on the figure as “afflux”. An afflux of plus or minus 0.01 metres is considered to be within the order of accuracy of the hydraulic model. The figure also shows changes in the extent of inundation that would be caused by the construction of the project. A reduction in the extent of inundation is denoted “Land rendered flood free”, while an increase in the extent of inundation is denoted “Additional area of land flooded” as a result of the project.

0.4 metres during a 10% and 1% AEP event. These increases in peak flood levels are due to the build-up of flow immediately upstream of the proposed southern access road to the energy hub.

During the PMF, depths of inundation would be increased along an access road that is located to the north of the Merotherie Energy Hub by a maximum of 0.24 metres on an existing depth of 0.8 metres. Depths of inundation would also be increased along the section of Merotherie Road where it runs to the east of the energy hub by a maximum of 0.25 metres on an existing depth of 0.9 metres. There would also be localised increases in peak flood levels along the southern boundary of the energy hub by a maximum of 0.6 metres on an existing depth of 1.3 metres, with impacts confined to cleared pastoral land that is zoned primary production.

Further refinement of the drainage strategy for the energy hub would be undertaken during detailed design, with the aim of managing the impact it would have on the frequency and depth of inundation along Merotherie Road and the local access road that runs to its north.

Changes in flow velocities

During a 10% and 1% AEP event, increases in peak flow velocities in the receiving drainage lines downstream of the Merotherie Energy Hub would typically be less than 10 per cent, with the exception of the following locations:

i. a drainage line to its north, where peak flow velocities would be increased by a maximum of 30 per cent during both a 10% and 1% AEP event. The resulting peak flow velocities would typically be less than 0.7 metres per second, which would have a low potential for causing scour given the general coverage of vegetation over the impacted area. The exception is where this drainage line crosses a local access road to the north of the energy hub, where the resulting peak flow velocities (of up to 1.5 metres per second) would have the potential to increase scour of the road surface.

ii. a drainage line that runs to the east of the energy hub where peak flow velocities would be increased by a maximum of 40 per cent during both a 10% and 1% AEP event. The resulting peak flow velocity would reach 1 metre per second in a number of areas.

The above increases in peak flow velocities have the potential to result in an increase in scour and erosion in the drainage lines that run to the north and east of the Merotherie Energy Hub. Further refinement of the drainage strategy for the energy hub would be undertaken during detailed design, with the aim of managing increases in flows that would otherwise lead to adverse impacts on flow velocities and hence the scour potential in the receiving drainage lines.

Changes in the extent and duration of flooding

The two drainage lines to the north and east of the Merotherie Energy Hub where increases in peak flow velocities are identified in the previous section, would also experience an increase in the duration and extent of inundation. Further refinement of the drainage strategy for the energy hub would be undertaken during detailed design, with the aim of minimising changes in the distribution of flow and increased runoff from hardstand that would otherwise lead to adverse impacts on the duration and extent of inundation in the receiving drainage lines.

6.1.3 Elong Elong Energy Hub

<u>Impact of flooding on the Elong Elong Energy Hub</u>

As noted in **Section 4.3.7**, while the site of the Elong Elong Energy Hub is not impacted by mainstream flooding from Laheys Creek which runs to its west, it is presently inundated by local catchment runoff that is conveyed along a number of drainage lines that run in a northerly direction through its eastern and western portions.

A series of diversion channels and culverts would be installed to convey local catchment runoff through and around the site in order to manage the impact of flooding on the switchyards, transformers, control buildings and associated infrastructure. The diversion channels and culverts would be designed to achieve the hydrologic standards set out in **Table 3.1** in **Section 3.2** of this technical paper. A typical arrangement of these diversion channels and culverts is shown on **Figure 6.3a**.

<u>Impact of the Elong Elong Energy Hub on flood behaviour</u>

The types of potential impacts associated with the Elong Elong Energy Hub are similar to those described for the New Wollar Switching Station, namely:

i. an increase in the rate and volume of runoff caused by the increase in impervious area associated with switchyard pads, buildings, access roads and other hardstand areas, which in turn has the potential to increase the rate and volume of runoff being conveyed in the receiving drainage lines

ii. the redirection of flow along the diversion channels and culverts that are proposed to control runoff around the energy hub, which in turn has the potential to result in a redistribution of flows in the receiving drainage lines.

In order to assess the impact of the Merotherie Energy Hub on flood behaviour, the structure of the flood model representing pre-project conditions was adjusted to incorporate details of the proposed works. The increase in runoff associated with new hardstand areas and the redirection of flow associated with the proposed diversion channels and culverts were also incorporated into the flood model.

For the purpose of this assessment no allowance has been made for stormwater detention and other flow control measures. In this regard, the assessment provides an indication of the upper bound estimate of the potential impacts that the energy hub could have on flood behaviour in the receiving drainage lines in the absence of such controls.

The following figures showing flooding patterns and impacts under operational conditions should be referred to when reading the following discussion:

- **Figures 6.5a, 6.5b** and **6.5c** show the indicative extent and depth of inundation in the vicinity of the Elong Elong Energy Hub under post-project conditions for design storms with AEPs of 10% and 1%, as well as the PMF event, respectively. **Figures C.8a** and **C.8b** in **Annexure C** respectively show corresponding results for design storms with AEPs of 0.5% and 0.2% AEP.
- **Figures 6.6a**, **6.6b** and **6.6c** show the impact that the Elong Elong Energy Hub would have on flood behaviour in terms of changes in peak flood levels for design storms with AEPs of

5% and 1%, as well as the PMF event, respectively.[9] **Figures C.9a** and **C.9b** in **Annexure C** respectively show corresponding results for design storms with AEPs of 0.5% and 0.2% AEP.

- **Figures D.8a** and **D.8b** in **Annexure D** show maximum flow velocities under post-project conditions in the vicinity of the Elong Elong Energy Hub during storms with AEPs of 10% and 1%, while **Figures D.9a** and **D.9b** in **Annexure D** show the impact that it would have in terms of changes in maximum flow velocities for the same design storm events.
- **Figures D.8c** and **D.8d** in **Annexure D** show the duration of inundation under post-project conditions in the vicinity of the Elong Elong Energy Hub during storms with AEPs of 10% and 1%, while **Figures D.9c** and **D.9d** in **Annexure D** show the impact that it would have in terms of changes in the duration of inundation for the same design storm events.

The key findings of the assessment of the impact that the Elong Elong Energy Hub would have on flood behaviour are summarised below.

Changes in peak flood levels and depths of inundation

Changes in peak 1% AEP flood levels downstream of the energy hub would typically be less than 0.01 metres, with the exception of a series of drainage lines that are located to its north-east, where peak flood levels would be increased by between 0.02 and 0.06 metres. While the impacted area would extend about 300 metres to the north of the operational boundary of the energy hub, the increases in peak flood levels are considered minor relative to the existing depths of inundation of between 0.1 and 0.5 metres, and given the nature of the land that is affected (i.e. cleared pastoral land zone primary production). While increases in peak 10% AEP flood levels would be similar to those during a 1% AEP event, they would extend over a smaller area.

During the PMF, depths of inundation along the series of drainage lines that are located to the north-east of the Elong Elong Energy Hub would be increased by a maximum of 0.15 metres on existing depths of between 0.4 and 1 metres. These increases in PMF levels are considered to be minor in terms of the nature of land impacted and the relative increase in flood hazard.

Changes in flow velocities

Changes in peak flow velocities in areas downstream (north) of the energy hub would typically be less than 10 per cent, with the exception of a single drainage line that is located to its north-east, where peak flow velocities would be increased by a maximum of 60 per cent during a 10% and 1% AEP event. The resulting peak flow velocities would be less than 0.5 metres per second, which would still have a low potential for causing scour given the coverage of vegetation over the impacted area.

The area identified above where there would be an increase in peak flow velocities forms part of the construction footprint. Any temporary works undertaken in this area to support the construction of the energy hub would therefore need to be rehabilitated in order to ensure a suitable level of vegetation coverage that can withstand the predicted increases in flow velocities in this area.

[9] Changes in peak flood levels are denoted on the figure as “afflux”. An afflux of plus or minus 0.01 metres is considered to be within the order of accuracy of the hydraulic model. The figure also shows changes in the extent of inundation that would be caused by the construction of the project. A reduction in the extent of inundation is denoted “Land rendered flood free”, while an increase in the extent of inundation is denoted “Additional area of land flooded” as a result of the project.

Changes in the extent and duration of flooding

Changes in the duration of inundation would typically be less than 1 hour, with the exception of two drainage line to the north-east of the energy hub where the duration of inundation would be increased by 1.8 and 1.2 hours during a 10% and 1% AEP event, respectively. The increase in the duration of inundation is due to an increase in runoff discharging to the drainage line from the energy hub, which also leads to an increase in the extent of inundation.

Further refinement of the drainage strategy for the energy hub would be undertaken during detailed design, with the aim of minimising changes in the distribution of flows and increased runoff from the energy hub that would otherwise lead to adverse impacts on the duration and extent of inundation in the affected drainage line.

6.1.4 Transmission line corridors

Permanent infrastructure located within the transmission line corridors would comprise the 330 kV and 500 kV transmission lines that would be supported on a series of transmission line towers, as well as existing and new tracks that would be used to access the 330 kV and 500 kV network infrastructure.

Transmission line support structures

While the transmission line towers would have a footprint of up to 25 metres by 25 metres, their obstruction to floodwaters would be confined to the area of the footings and tower legs that support each structure. The dimensions of the footings would be subject to further development during detailed design but is likely to range from bored piles that are 1.5 metres in diameter to raft pads measuring 30 metres by 30 metres that would be located in mine subsidence areas. The footings of the transmission line structures would generally be constructed level with the existing ground but may protrude up to 0.5 metres above the existing ground level in some locations. The footprint of the tower leg that extends from each footing would be up to 1.5 metres in diameter.

While the obstruction caused by the footings and legs of the transmission line towers have the potential to lead to an increase in the depth and velocity of floodwaters, impacts would be confined to a relatively localised area in the vicinity of each tower.

During detailed design, scour protection measures would be incorporated into the design of the transmission line towers where it is required to manage localised increases in flow velocities and scour potential around their footings.

Access roads and tracks

Existing tracks along the transmission line corridors would be upgraded and new tracks constructed to enable access to the 330 kV and 500 kV network infrastructure.

The upgraded or new access tracks would typically be seven metres wide and would generally follow existing ground levels so as not to impede the movement of overland flow and floodwaters.

Drainage control measures such as cross banks, level spreaders and lined waterway crossings would be incorporated into the upgraded or new access tracks to manage runoff and the impact it could have on scour to the tracks and surrounding areas. These drainage control measures would be implemented in accordance with the following guidelines:

- *Guidelines for the Planning, Construction and Maintenance of Tracks* (Department of Land & Water Conservation, 1994)
- *Managing Urban Stormwater: Soils and Construction – Volume 2C Unsealed Roads* (Department of Environment and Climate Change, 2008).

6.1.5 330 kV switching stations

Impact of flooding on the 330kV switching stations

Table 6.1 at the end of this section contains a summary of the assessed level of flood risk to each of the thirteen sites where the 330 kV switching stations are proposed to be located. The assessment presented in **Table 6.1** shows that while none of the sites are impacted by mainstream flooding, all sites with the exception of switching station M1 are presently inundated by overland flow or local catchment runoff to varying degrees.

A series of diversion channels and culverts would be installed to convey local catchment runoff through and around the sites of the 330 kV switching stations in order to manage the impact of flooding on the switchyards, transformers, control buildings and associated infrastructure. The diversion channels and culverts would be similar to those described in **Section 6.1.1** for the New Wollar Switching Station and would be designed to achieve the hydrologic standards that are set out in **Table 3.1** in **Section 3.2** of this technical paper.

Impact of the 330 kV switching stations on flood behaviour

The potential ways in which the 330 kV switching stations could impact on flooding and drainage patterns are the same as those listed in **Section 6.1.1** for the New Wollar Switching Station, namely as a result of:

i. an increase in the rate and volume of runoff caused by the increase in impervious area associated with switchyard pads, buildings, access roads and other hardstand areas, which in turn has the potential to increase the rate and volume of runoff being conveyed in the receiving drainage lines
ii. the redirection of flow along the diversion channels and culverts that are proposed to control runoff around the energy hub, which in turn has the potential to result in a redistribution of flows in the receiving drainage lines.

During detailed design, detailed layouts of the switching station sites will be developed which would inform the layout of drainage measures that are aimed at controlling external runoff around each site, as well as the discharge of runoff from each site into the receiving drainage lines. These detailed site layouts will also be used to undertake an assessment of the impact that each switching station would have on flooding and drainage patterns and to identify the scope of measures that would be required to manage any resulting adverse impacts on the depth, velocity and duration of inundation external to their footprint.

TABLE 6.1
ASSESSED LEVEL OF FLOOD RISK AT PROPOSED SWITCHING STATION SITES

Location	Switching Station Identifier(1)	Threshold of Flooding(2)	Assessment of Flood Affectation
Cassilis	M1	Not flooded	Switching station M1 is located on a ridge line and is therefore not impacted by mainstream flooding or major overland flow.
Coolah	M2	More frequent than 10% AEP	An overland flow path runs through the western corner of the site of switching station M2, where depths of inundation are a maximum of 0.12 m during a 10% AEP event, increasing to 0.15 m during a 1% AEP event. The remainder of the site of switching station M2 is not impacted by mainstream flooding or major overland flow.
Leadville	M3	More frequent than 10% AEP	While the site of switching station M3 is not impacted by mainstream flooding or major overland flow, it would be inundated by runoff from upslope areas that lie to its east. Depths of inundation across the site would be typically less than 0.1 m during a 1% AEP event.
Merotherie	M4	More frequent than 10% AEP	While the site of switching station M4 is not impacted by mainstream flooding or major overland flow, it would be inundated by runoff from upslope areas that lie to its west. Runoff from these upslope areas is presently collected in a contour bank channel that is located within the western portion of the site where depths of flow occur to a maximum of 0.4 m during a 1% AEP event.
	M5	More frequent than 10% AEP	While the site of switching station M5 is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along two local drainage lines that run through its middle and western portions. Depths of flow in both of the drainage lines occur to a maximum of 0.2 m during a 1% AEP event.
Tallawang	M6	More frequent than 10% AEP	While the site of switching station M6 is not impacted by mainstream flooding or major overland flow, it would be inundated by runoff from upslope areas that lie to its north. Depths of inundation across the site would be typically less than 0.1 m during a 1% AEP event.
Dunedoo	M7	More frequent than 10% AEP	While the site of switching station M7 is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along a local drainage line that runs through its middle portion. Depths of flow in the drainage line occurs to a maximum of 0.5 m during a 1% AEP event.
Tallawang	M8	More frequent than 10% AEP	While the site of switching station M8 is not impacted by mainstream flooding or major overland flow, it would be inundated by runoff from upslope areas that lie to its north. Depths of inundation across the site would be typically less than 0.1 m during a 1% AEP event.

Location	Switching Station Identifier(1)	Threshold of Flooding(2)	Assessment of Flood Affectation
Tallawang	M9	More frequent than 10% AEP	While the site of switching station M9 is not impacted by mainstream flooding or major overland flow, it would be inundated by runoff from upslope areas that lie to its south. Depths of inundation across the site would typically be less than 0.15 m during a 1% AEP event.
Cobbora	E1	More frequent than 10% AEP	While the site of switching station E1 is not impacted by mainstream flooding, a relatively localised area would be impacted by flow that is conveyed along a major overland flow path that runs to its north-east. Depths of inundation along the north-eastern side of the site adjacent to the major overland flow path would occur to a maximum of 0.3 m during a 1% AEP event. Minor drainage lines also run through the eastern and western portions of the site, where depths of inundation would typically be less than 0.15 m during a 1% AEP event.
	E2	More frequent than 10% AEP	While the site of switching station E2 is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along two local drainage lines that run through its middle and eastern portions. Depths of flow along both of the drainage lines occur to a maximum of 0.15 m during a 1% AEP event.
	E3	More frequent than 10% AEP	While the site of switching station E3 is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along a local drainage line that runs through its southern portion. Depths of flow along the drainage line occurs to a maximum of 0.15 m during a 1% AEP event. A contour bank channel presently runs through the middle of the site, where depths of flow occur to a maximum of 0.3 m during a 1% AEP event.
Goolma	E4	More frequent than 10% AEP	While the site of switching station E4 is not impacted by mainstream flooding, it is presently inundated by flow that is conveyed along a local drainage line that runs through its north-western portion. Depths of flow along the drainage line occur to a maximum of 0.3 m during a 1% AEP event.

1. Refer to **Figures 4.2**, **4.3** and **4.4** (6 sheets each) for locations of switching station identifiers.
2. The assessed threshold of flooding is based on pre-project conditions. Refer **Figures 4.2**, **4.3** and **4.4** (6 sheets each) for flood extent mapping under pre-project conditions.

6.2 Consistency with council and state government flood related plans

Based on the assessment of flood impacts associated with the project that is presented in **Section 6.1** of this technical paper, the project is expected to have only a minor impact on peak flood levels during a 1% AEP design storm event, as well as the PMF. As a result, the project is not expected to have a significant impact on the extent of the flood planning area and therefore the area of land to which clause 5.21 of *Mid-Western Regional Local Environmental Plan 2012*, *Dubbo Regional Local Environmental Plan 2021*, *Warrumbungle Local Environmental Plan 2013* and the *Upper Hunter Local Environmental Plan 2013* would apply.

Given the minor and localised nature of the changes in both peak flood levels and flow velocities that would be attributable to the project, it can also be concluded that it would not increase the overall flood hazard in existing development for all storms up to 1% AEP in intensity. It would also not have an adverse impact on NSW State Emergency Service's emergency response arrangements as set out in the local flood plans for each local government area that are listed in **Section 2.2.5**.

6.3 Impact of future climate change on flood behaviour

Impact of flood behaviour under future climate change conditions on the project

As noted in **Section 2.2.4**, scientific evidence shows that climate change is expected to lead to an increase in flood producing rainfall intensities. **Table 6.2** shows the impact that a 30 per cent increase in rainfall intensities would have on the AEP of a design storm event of a given rainfall intensity under current climatic conditions. From inspection of **Table 6.2**, a storm of a rainfall intensity that has a 1 in 100 chance of occurring in a year under current climatic conditions (1% AEP), will have a 1 in 20 chance of occurring in a given year under future climate change conditions (5% AEP). Similarly, a storm of a rainfall intensity that has a 1 in 10 chance of occurring in a year under current climatic conditions (10% AEP), will have a 1 in 5 chance of occurring in a given year under future climate change conditions (20% AEP).

TABLE 6.2
APPROXIMATE CHANGE IN DESIGN AEP BASED ON A
30 PER CENT INCREASE IN RAINFALL INTENSITIES

Current Climatic Conditions	Future Climate Change Conditions
20% (1 in 5)	50% (1 in 2)
10% (1 in 10)	20% (1 in 5)
5% (1 in 20)	10% (1 in 10)
1% (1 in 100)	5% (1 in 20)
0.2% (1 in 500)	1% (1 in 100)

The increase in rainfall intensities attributable to future climate change has the potential to impact on the project due to an increase in:

i. the risk of flooding to the switchyards, transformers, control buildings and associated infrastructure that is relied upon for the safe operation of the switching stations and energy hubs

ii. the frequency and extent to which the drainage systems that are proposed to control runoff from the switching stations and energy hubs would be surcharged

iii. the frequency and depth of inundation to roads and tracks that are used to access the switching stations, energy hubs and transmission line infrastructure.

In order to manage the impact that flood behaviour under future climate could have on the safe operation of the switching stations and energy hubs, the substations containing the switchyards, transformers, control buildings and associated infrastructure would be located a minimum 0.5 metres above the 1% AEP peak flood level. A check would also be made during detailed design to ensure that the function of the switching stations and energy hubs is not impacted by flooding under future climate change conditions.

Impact of the project on flood behaviour under future climate change conditions

As noted in **Section 3.6.2**, the 0.5% AEP and 0.2% AEP storms have been used as proxies to assess the impact that a 10 and 30 per cent increase in 1% AEP rainfall intensities would have on flood behaviour. The assessment was based on the results that are presented in the following figures:

- **Figure 6.2b** shows the impact that the New Wollar Switching Station would have on flood behaviour during a 1% AEP event, while **Figures C.5a** and **C.5b** in **Annexure C** respectively show corresponding impacts during a 0.5% and 0.2% AEP event.
- **Figure 6.4b** shows the impact that the Merotherie Energy Hub would have on flood behaviour during a 1% AEP event, while **Figures C.7a** and **C.7b** in **Annexure C** respectively show corresponding impacts during a 0.5% and 0.2% AEP event.
  Figure 6.6b shows the impact that the Elong Elong Energy Hub would have on flood behaviour during a 1% AEP event, while **Figures C.9a** and **C.9b** in **Annexure C** respectively show corresponding impacts during a 0.5% and 0.2% AEP event.

Based on a comparison of the results that are presented in the above figures, it was found that there would be either no change, or relatively minor increases in flood impacts attributable to the project under both the lower and upper bound future climate change scenarios. For example:

i. at the New Wollar Switching Station there would be no change in the flood impacts during a 1% AEP flood that are attributable to the project under the lower and upper bound future climate change scenarios.

ii. at the Merotherie Energy Hub:

   - peak 1% AEP flood levels to the north of the energy hub would be increased by a maximum of 0.06 metres under current climatic conditions, compared with 0.07 and 0.08 metres under the lower and upper bound future climate change scenarios
   - there would be no change in flood impacts to the east of the energy hub under the lower and upper bound future climate change scenarios
   - peak 1% AEP flood levels to the south of the energy hub would be increased by a maximum of 0.11 metres under current climatic conditions, compared with 0.14 and 0.08 metres under the lower and upper bound future climate change scenarios.

iii. at the Elong Elong Energy Hub, peak 1% AEP flood levels to its north would be increased by a maximum of 0.06 metres under current climatic conditions, compared with 0.07 and 0.08 metres under the lower and upper bound future climate change scenarios.

7 MANAGEMENT OF IMPACTS

Table 7.1 sets out the environmental management measures that would be implemented to manage flood related impacts during the construction and operation of the project.

TABLE 7.1
FLOODING RELATED MITIGATION AND MANAGEMENT MEASURES

ID	Mitigation and management measure	Applicable area
Construction – flooding		
FL01	Detailed construction planning would consider flood risk at construction sites and support facilities, including: • reviewing construction site layouts and staging construction activities in order to avoid or minimise obstruction of overland flow paths and limiting the extent of flow diversion required • designing the layout of construction facilities and implementing stormwater management controls during their establishment in order to manage the impact of flooding on construction personnel, equipment and materials. • identifying and applying measures to not worsen flood impacts on the community and on other property and infrastructure during construction up to and including the 1% AEP flood event where reasonable and feasible. Where warranted by the scale and nature of the proposed works this would include flood modelling and assessment to assess the extent of potential impacts and therefore the scope of mitigation measures that may be required • measures to mitigate alterations to local runoff conditions due to construction activities.	All
FL02	Spoil stockpiles would be located in areas which are not subject to frequent inundation by floodwater, ideally outside the 10% AEP flood extent. The exact level of flood risk accepted at stockpile sites would depend on the duration of stockpiling operations, the type of material stored, the nature of the receiving drainage lines and also the extent to which it would impact flooding conditions in adjacent development.	All
FL03	Construction compounds and workforce accommodation camps would be located outside high flood hazard areas based on a 1% AEP flood.	Construction compounds and workforce accommodation camps
FL04	Flood emergency management measures for construction of the project would be prepared and incorporated into relevant environmental and/or safety management documentation. This would include: • contingency planning for construction facilities that are located in areas that are inundated by mainstream flooding during a 1% AEP event	All

	• for construction facilities located within the floodplain the identification of how flood related risks to personal safety and damage to construction facilities and equipment will be managed • procedures to monitor accurate and timely weather data, and disseminate warnings to construction personnel of impending flood producing rain	
Operation – flooding		
FL05	The impact of the project on flood behaviour would be confirmed during detailed design. This would include consideration of future climate change.	All
FL06	The project would be designed to minimise adverse flood related impacts on: i. surrounding development for storms up to 1% AEP in intensity ii. critical infrastructure, vulnerable development or increases in risk to life due to a significant increase in flood hazard for floods up to the PMF.	All
FL07	The energy hubs and switching stations would be designed to manage adverse impacts on the receiving drainage lines as a result of changes in the depth, velocity, extent and duration of flow during storms up to 1% AEP in intensity.	Energy hubs and switching stations
FL08	The energy hubs and switching stations, including their access road connections to existing roads, would be designed to ensure that the existing level of flood immunity of the road network is maintained and increases in flood depths and hazards along the road network are minimised.	Energy hubs and switching stations
FL09	Localised increases in flow velocities at drainage outlets and waterway crossings would be mitigated through the provision of scour protection and energy dissipation measures.	All

8 REFERENCES

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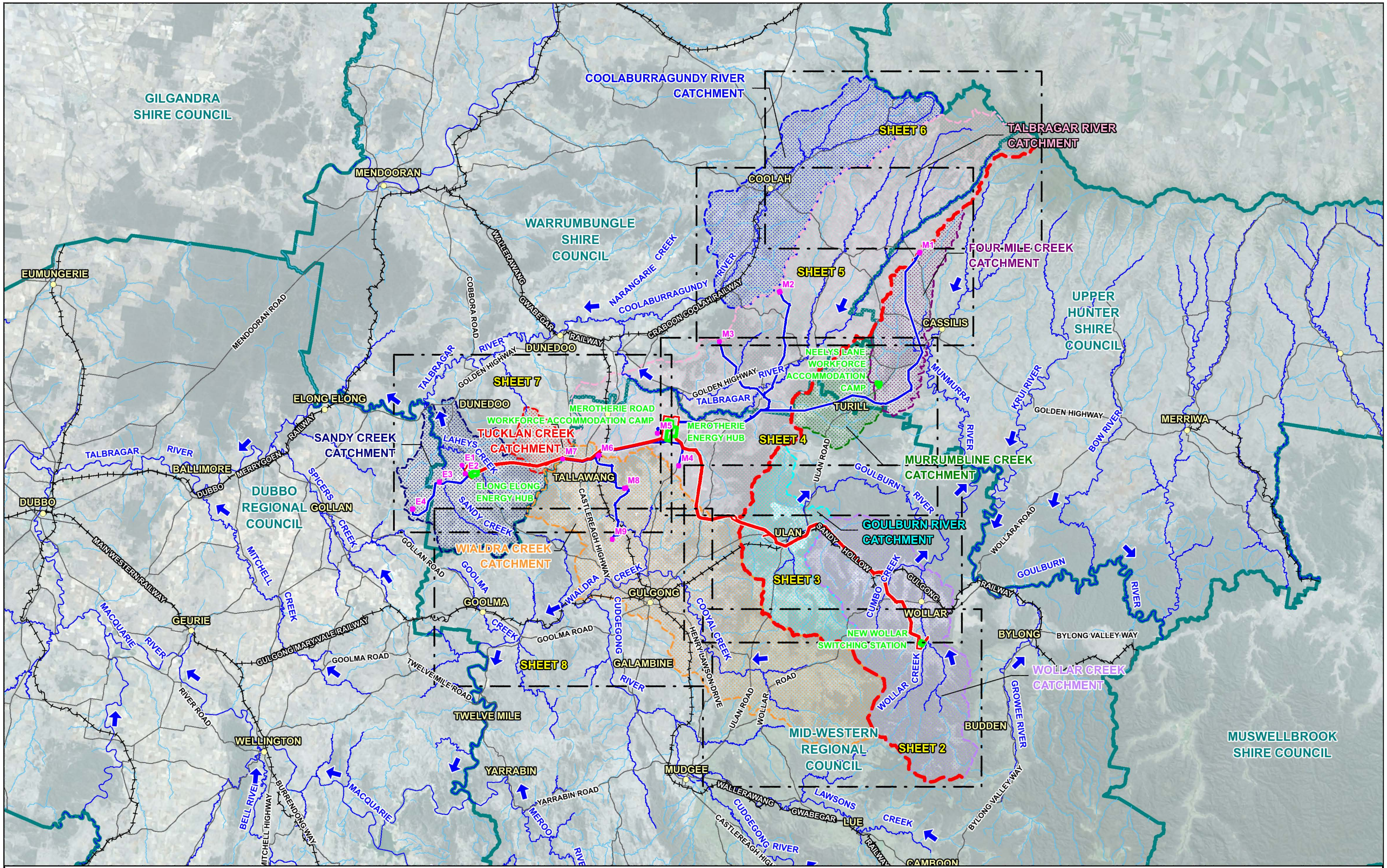
FIGURES



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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Local Government Area (LGA) Boundary
- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads
- Great Dividing Range Catchment Divide

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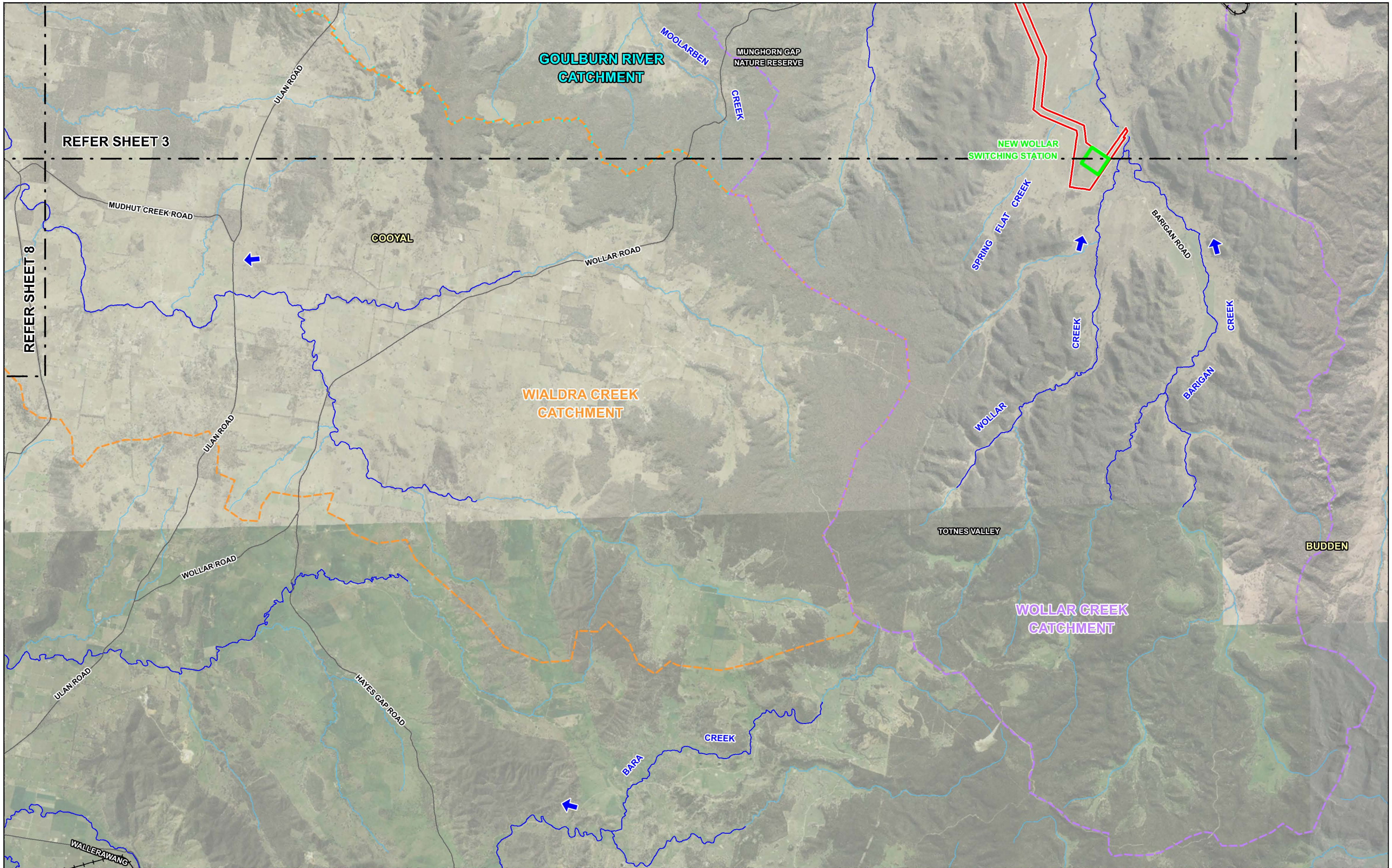
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 1 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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Scale: 1:100,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

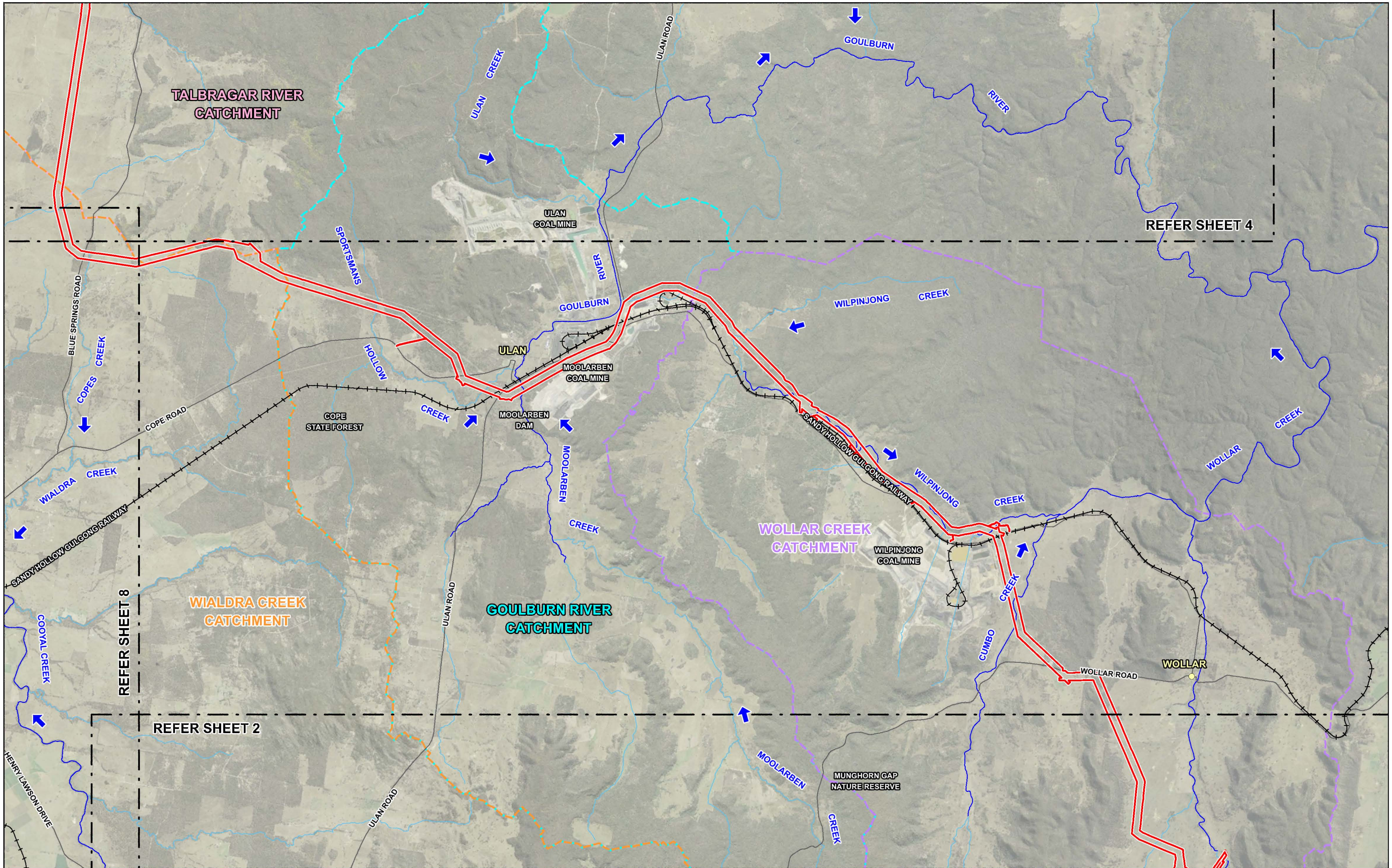
LEGEND

- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 2 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

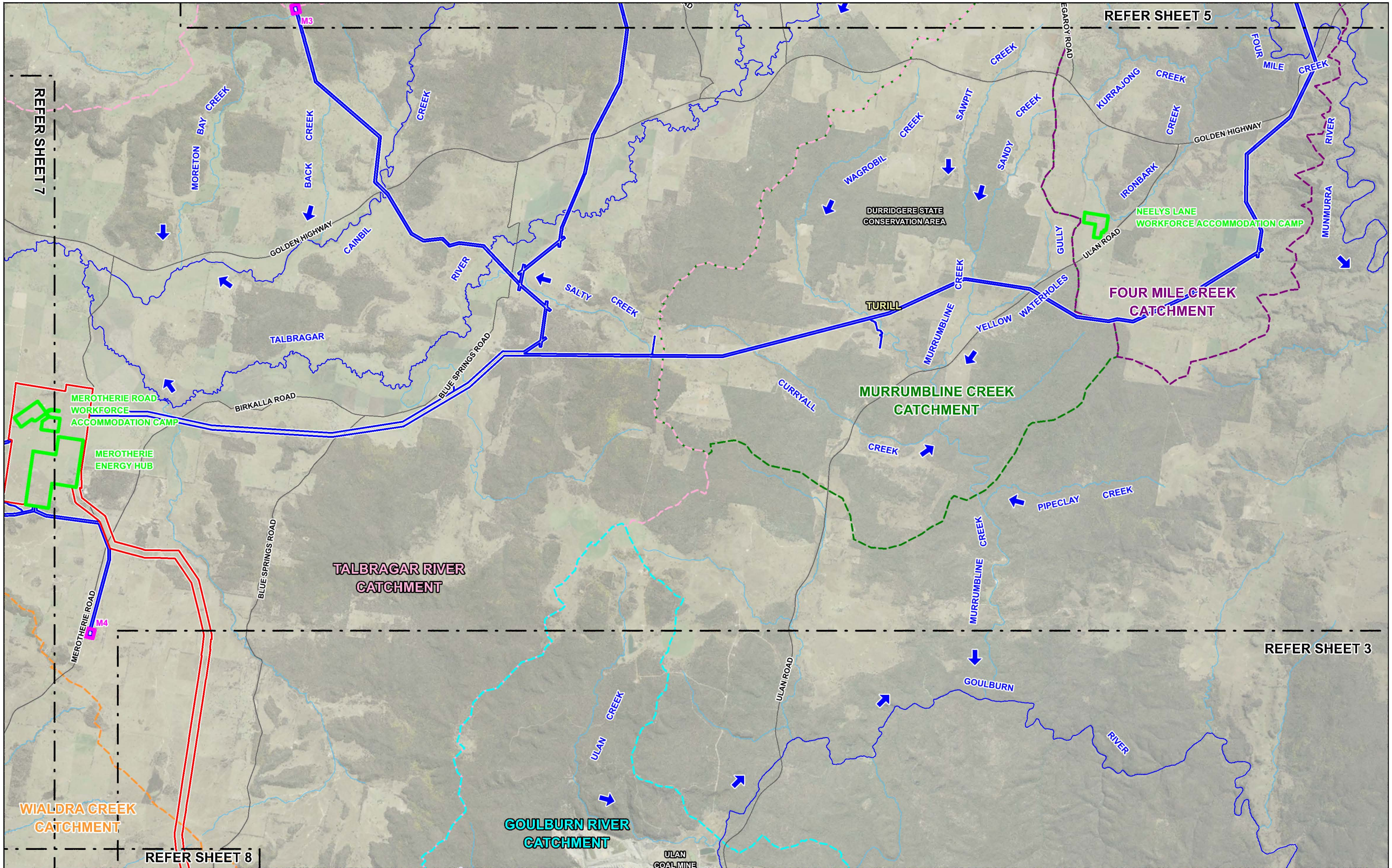
- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 3 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

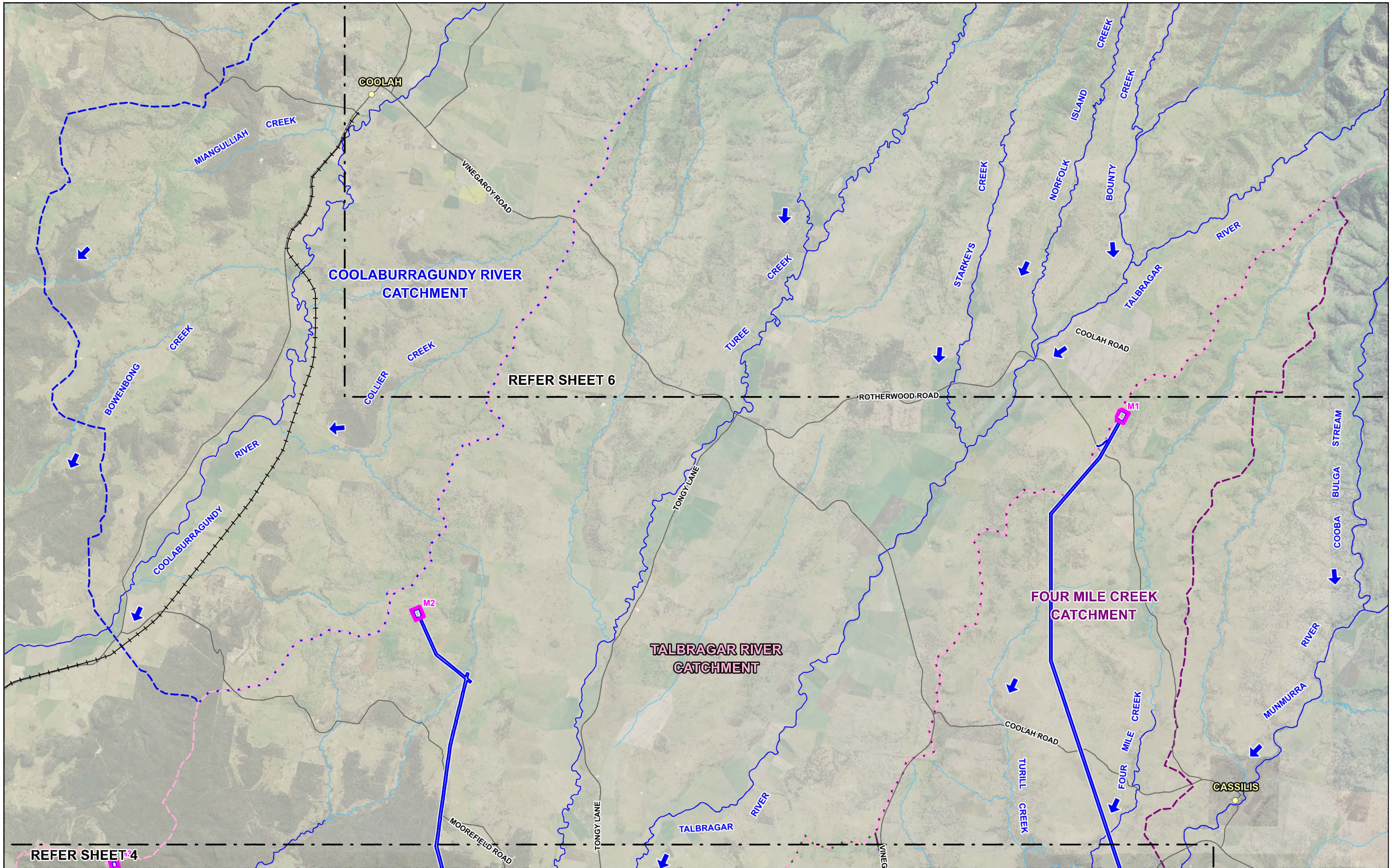
- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 4 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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Scale: 1:100,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

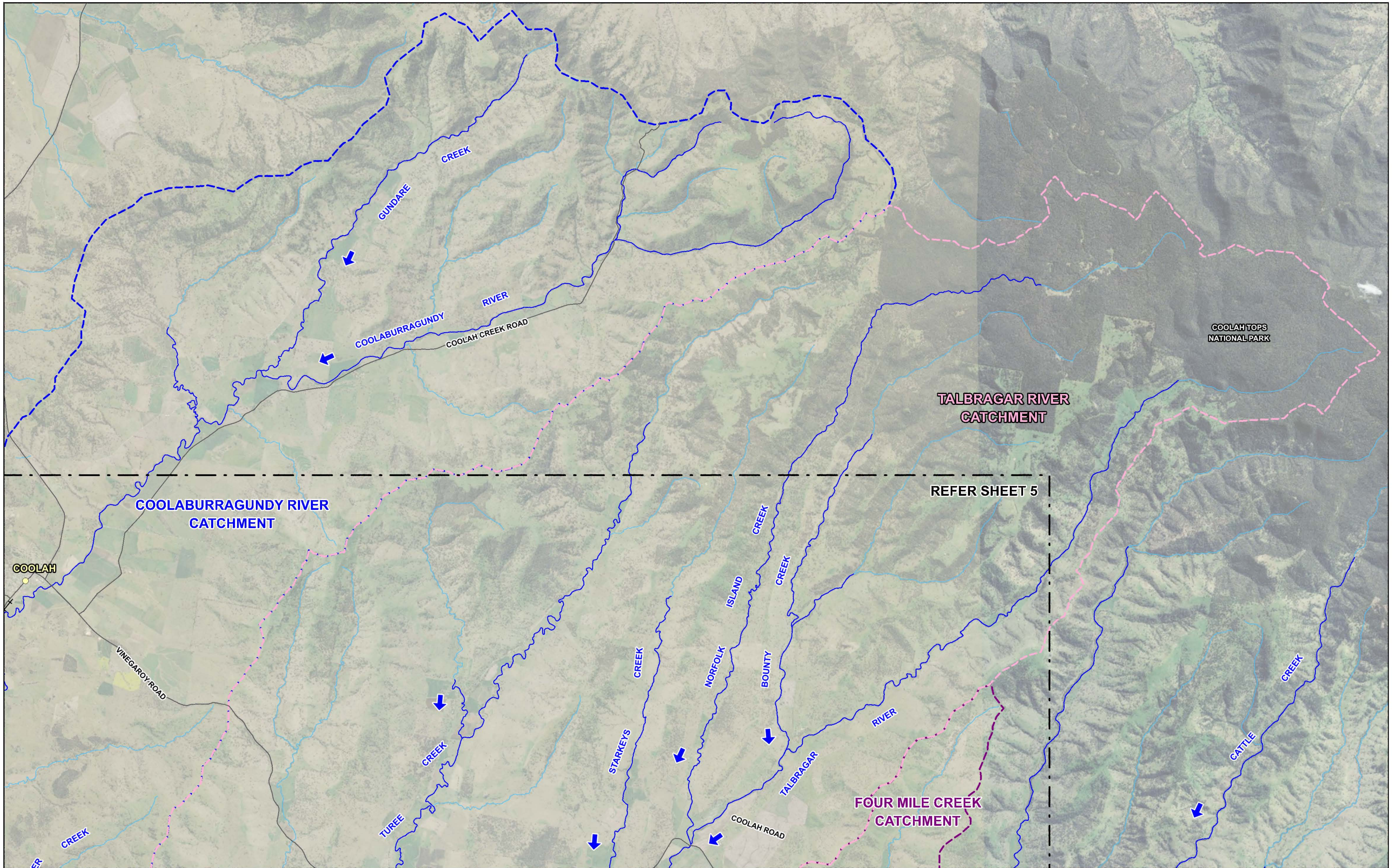
LEGEND

- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 5 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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Scale: 1:100,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

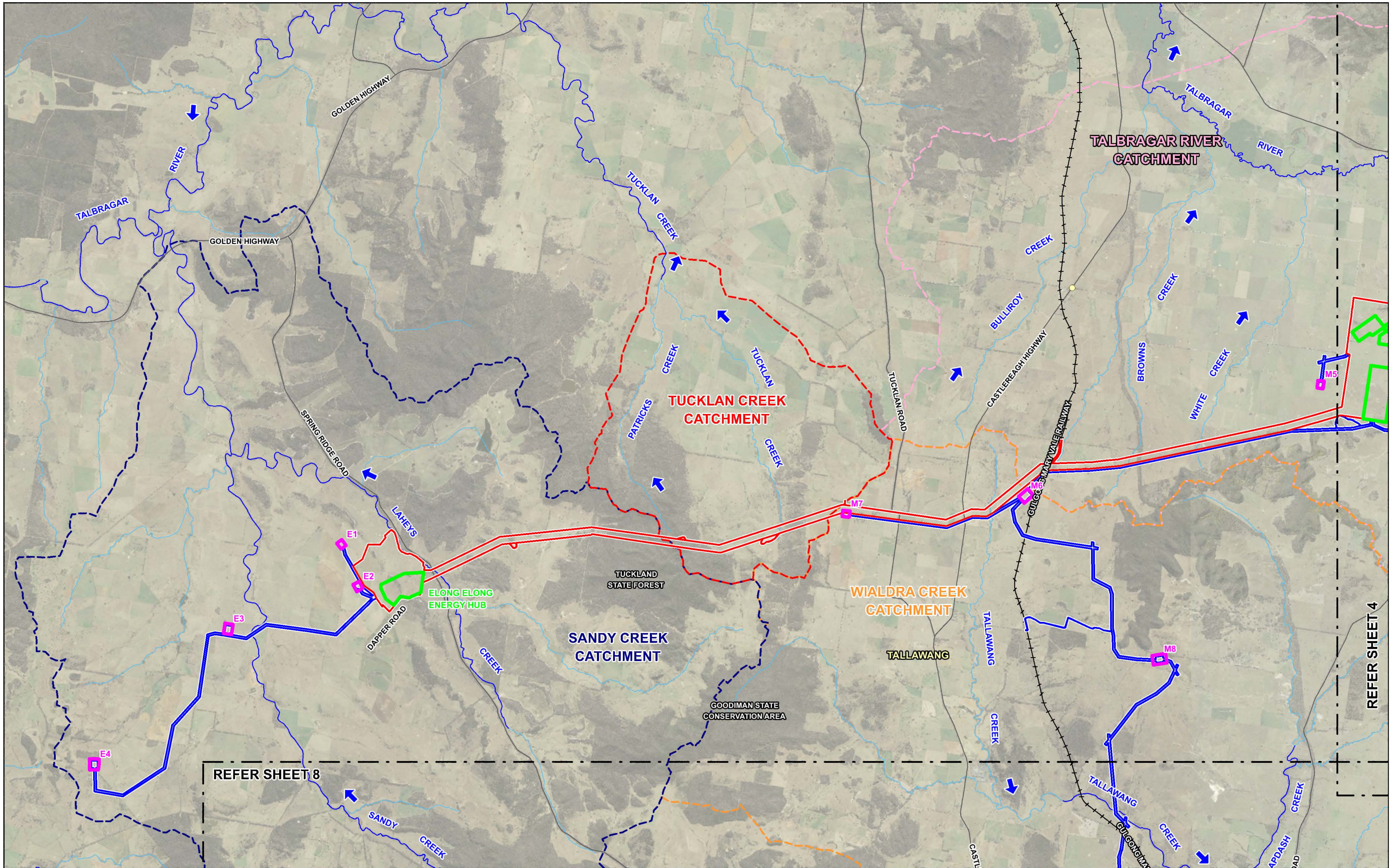
LEGEND

- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 6 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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Scale: 1:100,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

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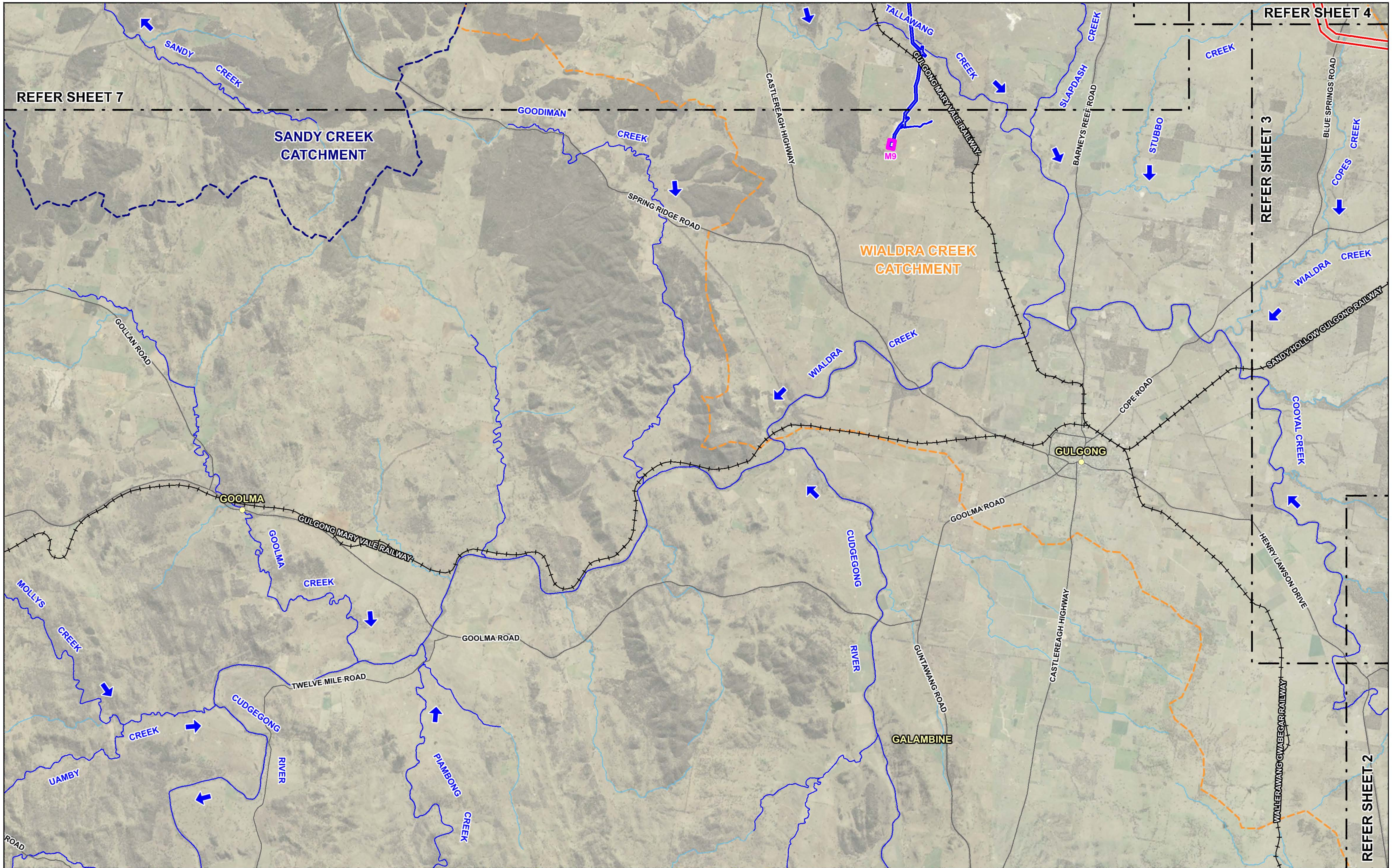
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 7 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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Scale: 1:100,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

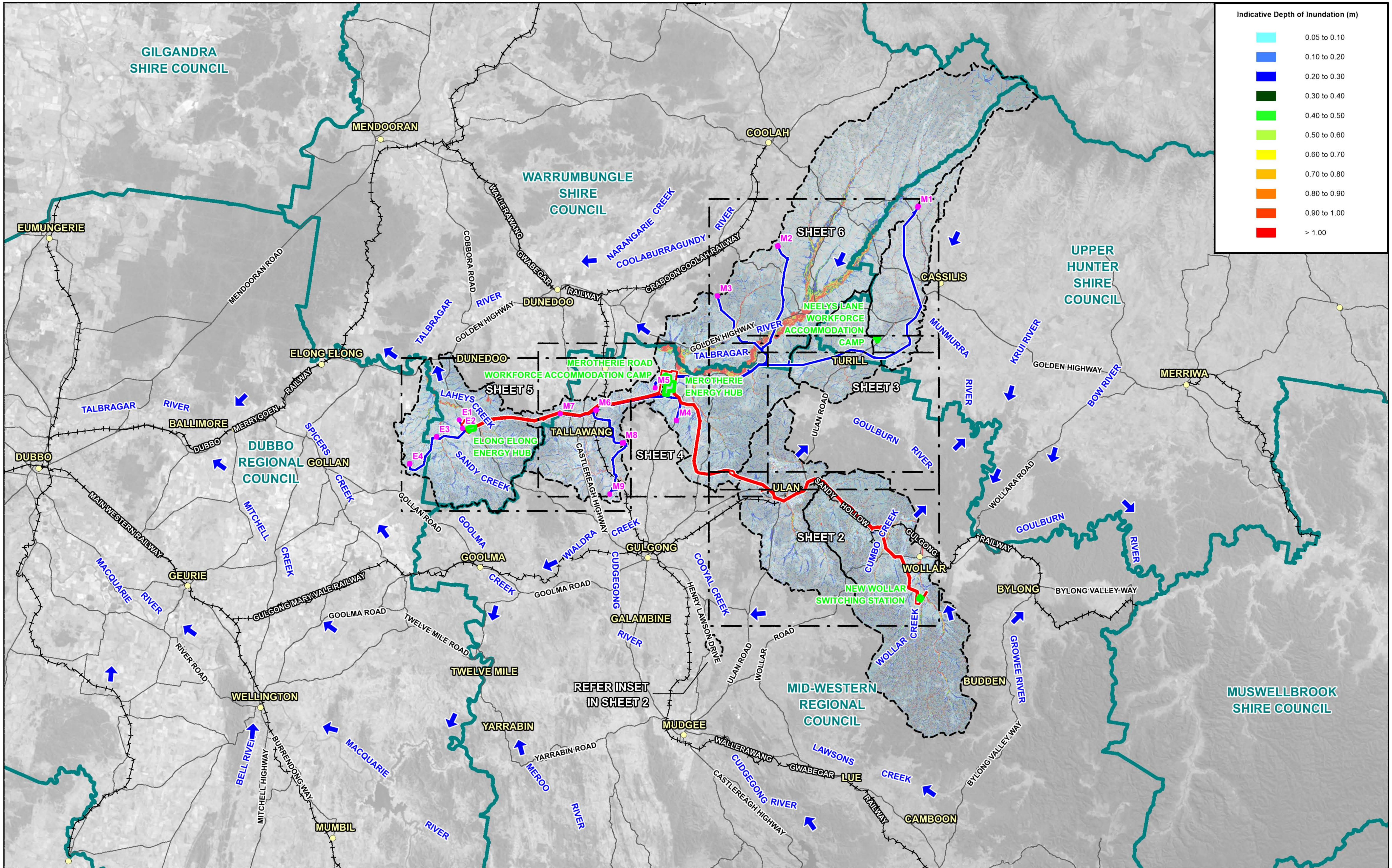
LEGEND

- Perennial Watercourses
- Non-Perennial Watercourses
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.1
(Sheet 8 of 8)

CATCHMENT PLAN AND EXISTING DRAINAGE FEATURES



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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Local Government Area (LGA) Boundary
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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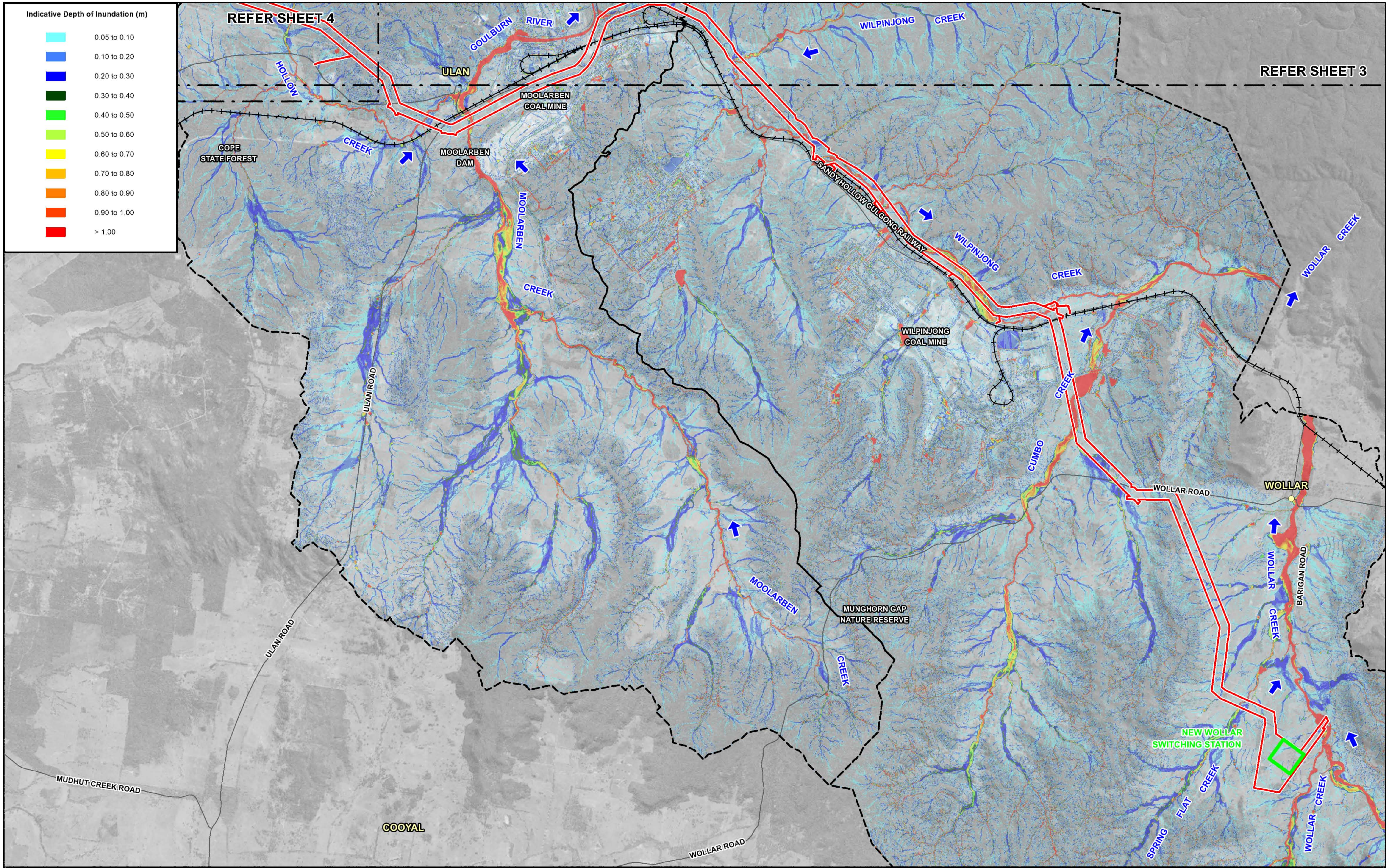
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 1 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



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Scale: 1:80,000

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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

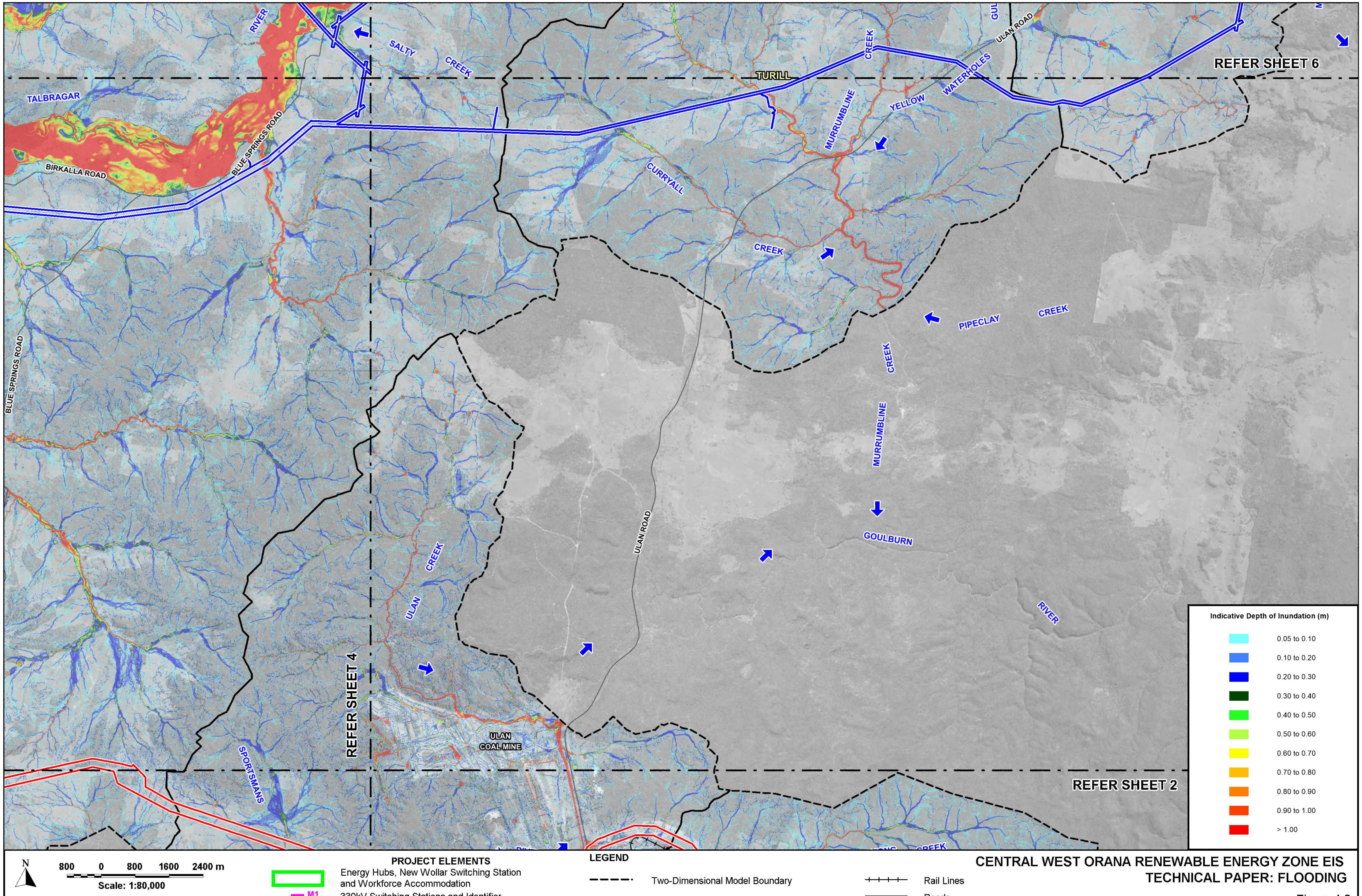
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 2 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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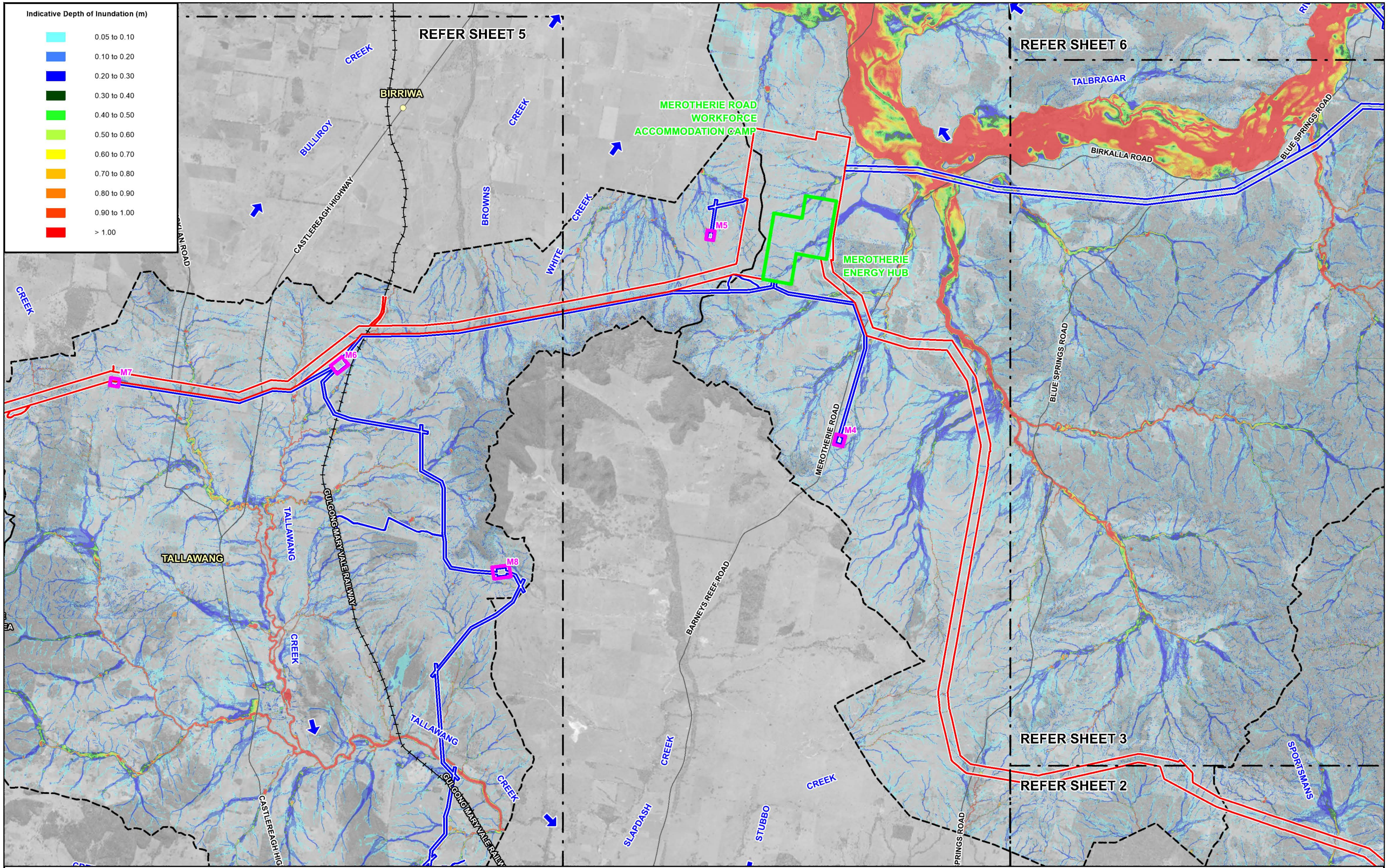
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 3 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



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Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
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- 330kV Transmission Line Corridor

LEGEND

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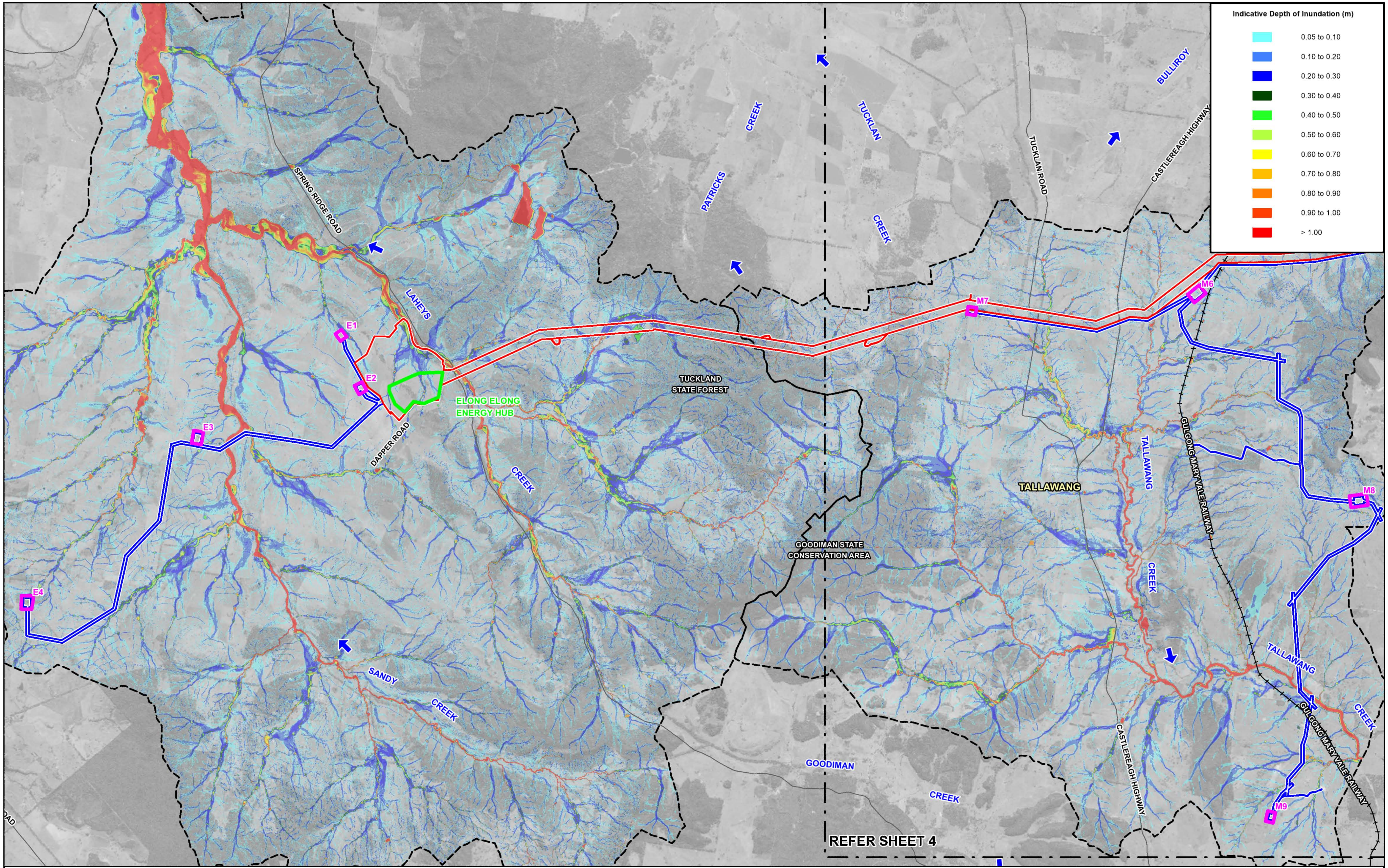
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 4 of 6)
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
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- 330kV Transmission Line Corridor

LEGEND

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- Rail Lines
- Roads

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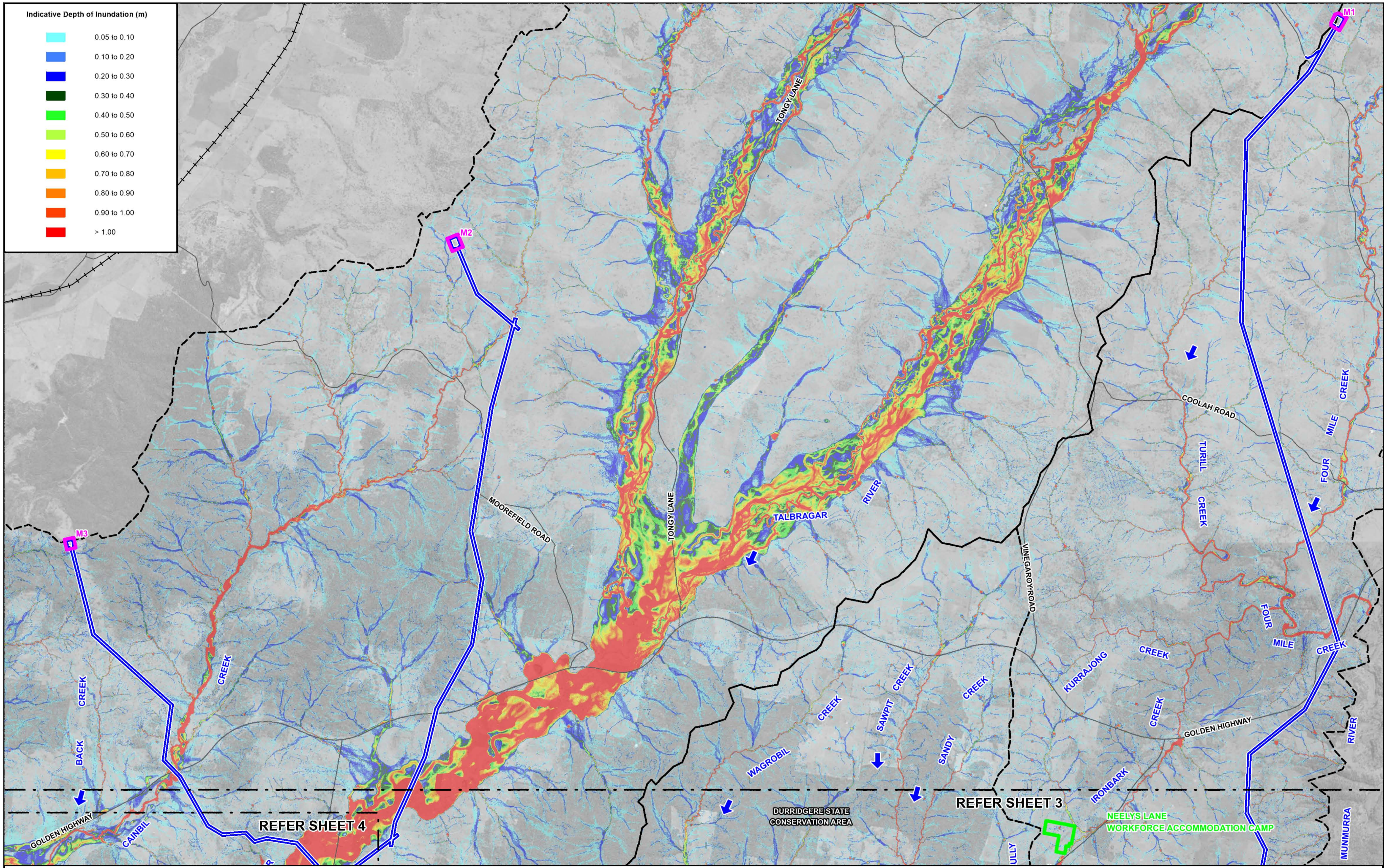
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 5 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



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Scale: 1:80,000

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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
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- 330kV Transmission Line Corridor

LEGEND

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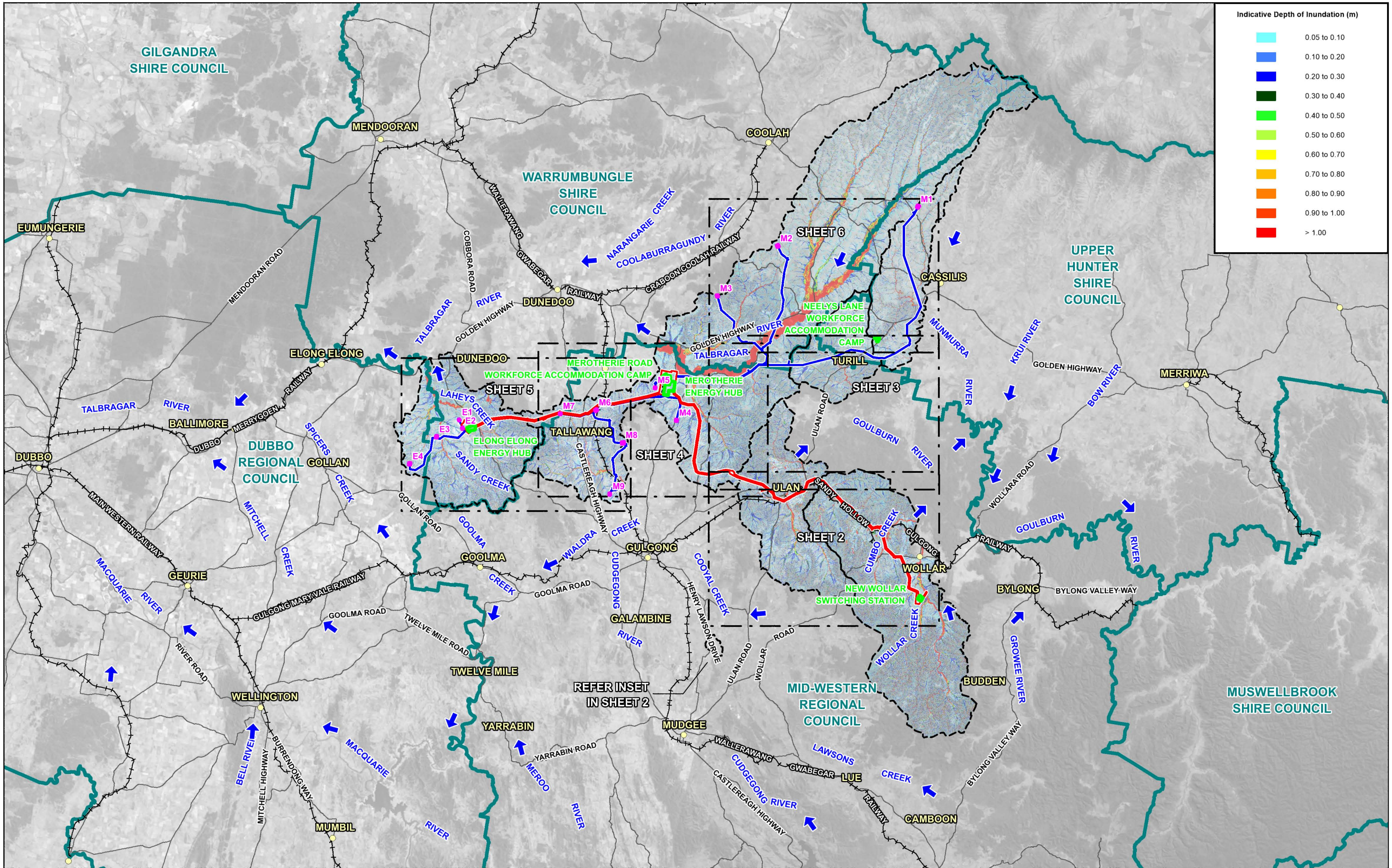
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 6 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



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Scale: 1:500,000

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PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
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- 330kV Transmission Line Corridor

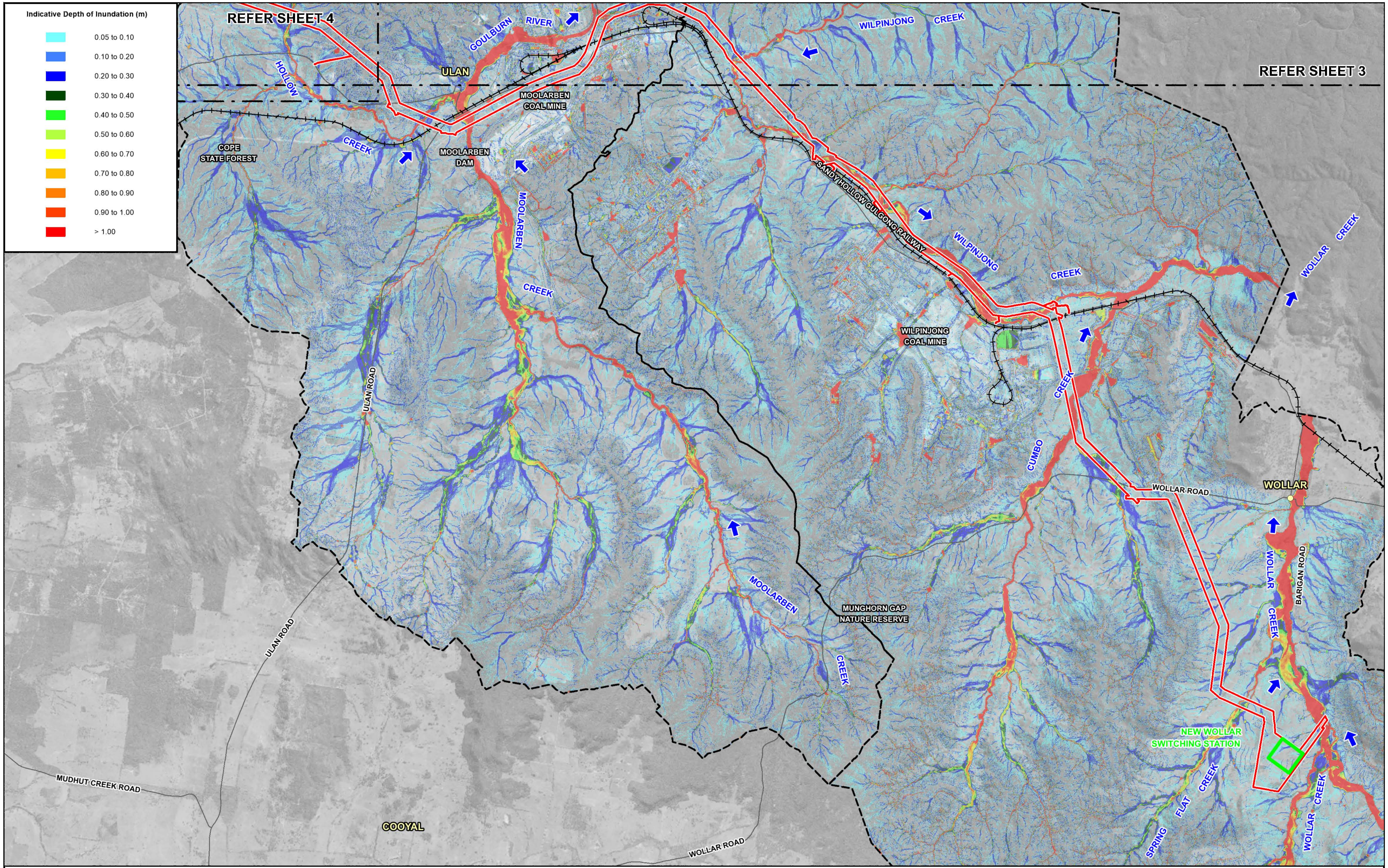
LEGEND

- Local Government Area (LGA) Boundary
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.3
(Sheet 1 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
1% AEP



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Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

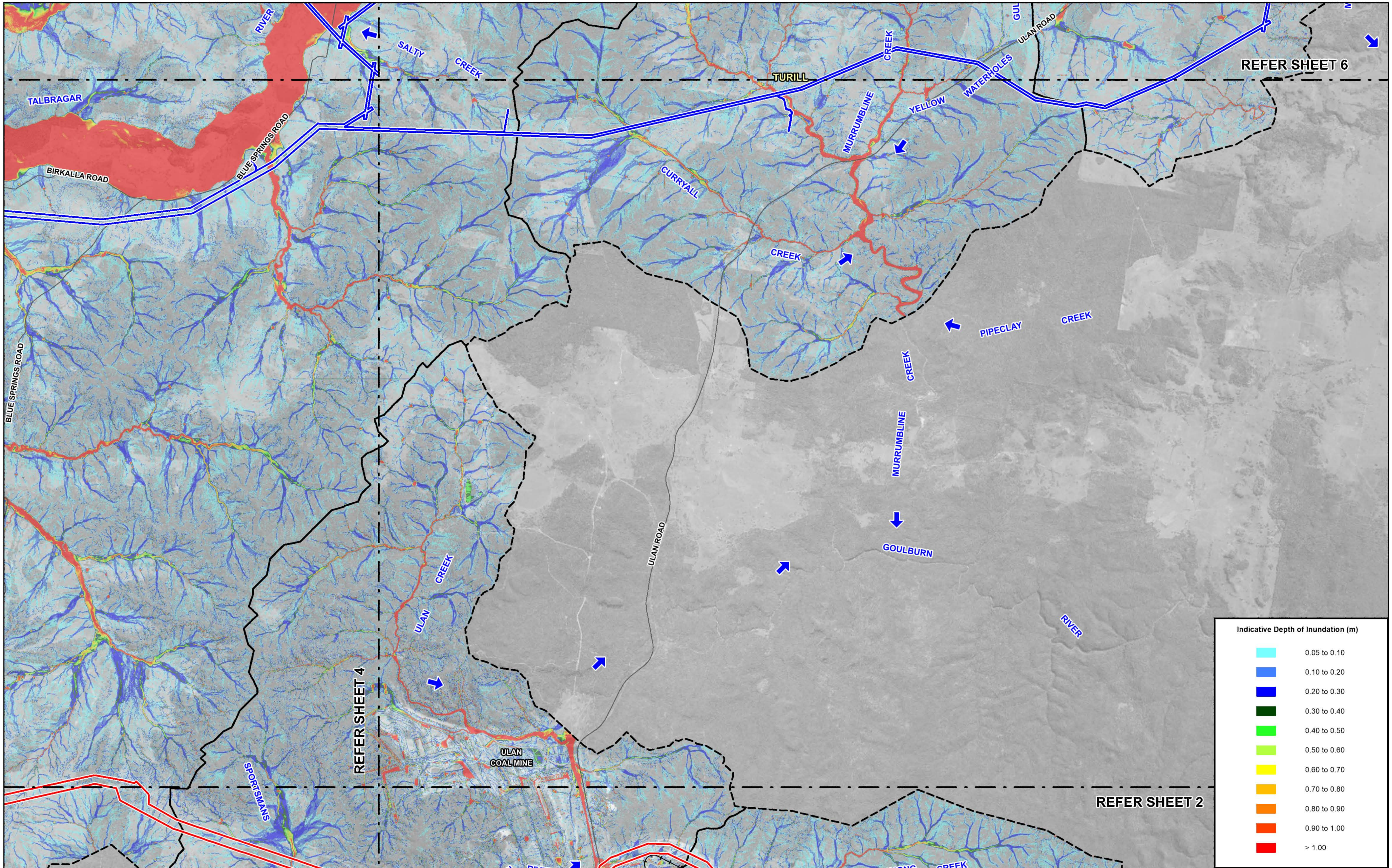
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.3
(Sheet 2 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
1% AEP



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Scale: 1:80,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
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- 330kV Transmission Line Corridor

LEGEND

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- Rail Lines
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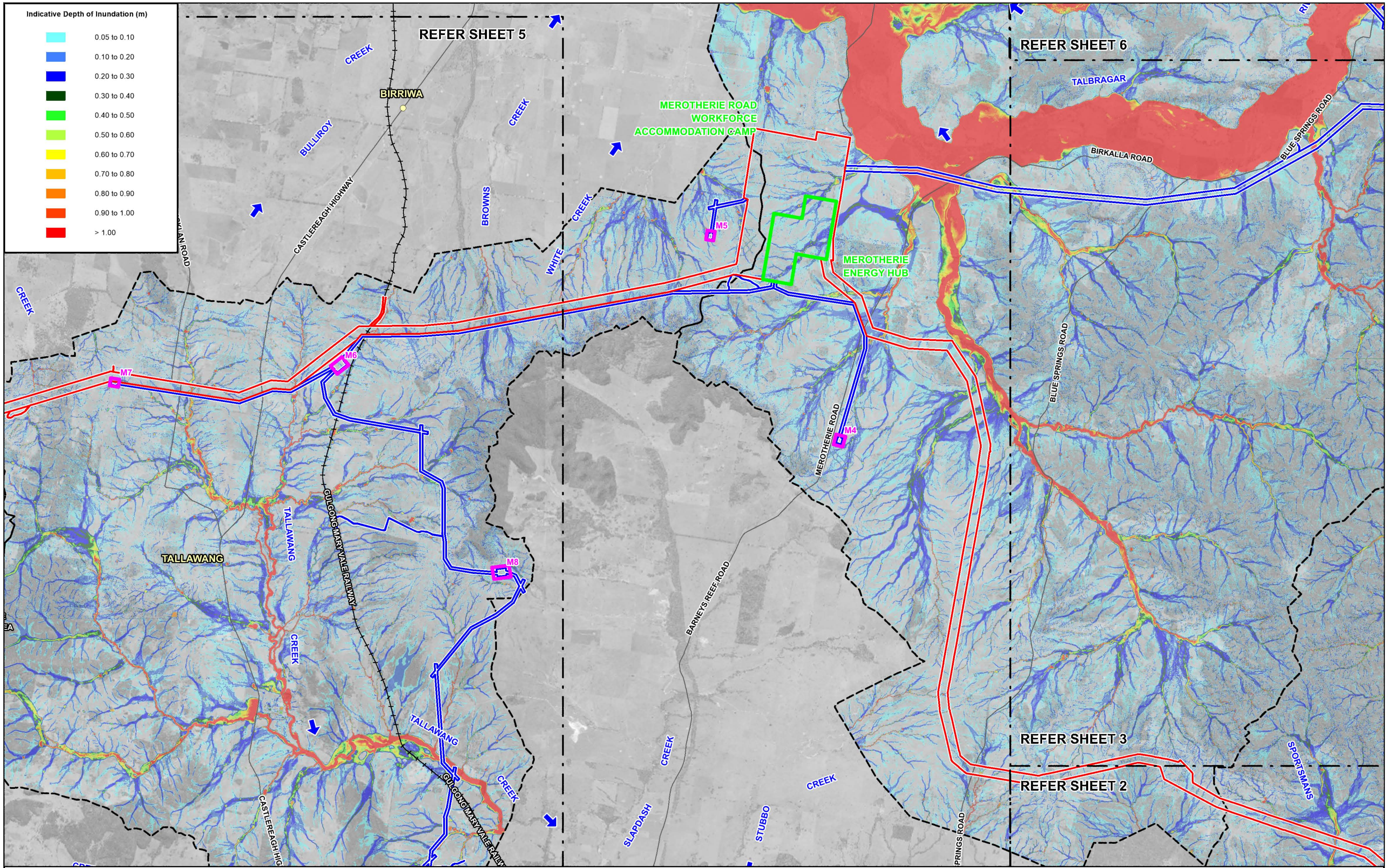
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.3
(Sheet 3 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
1% AEP



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Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
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- 330kV Transmission Line Corridor

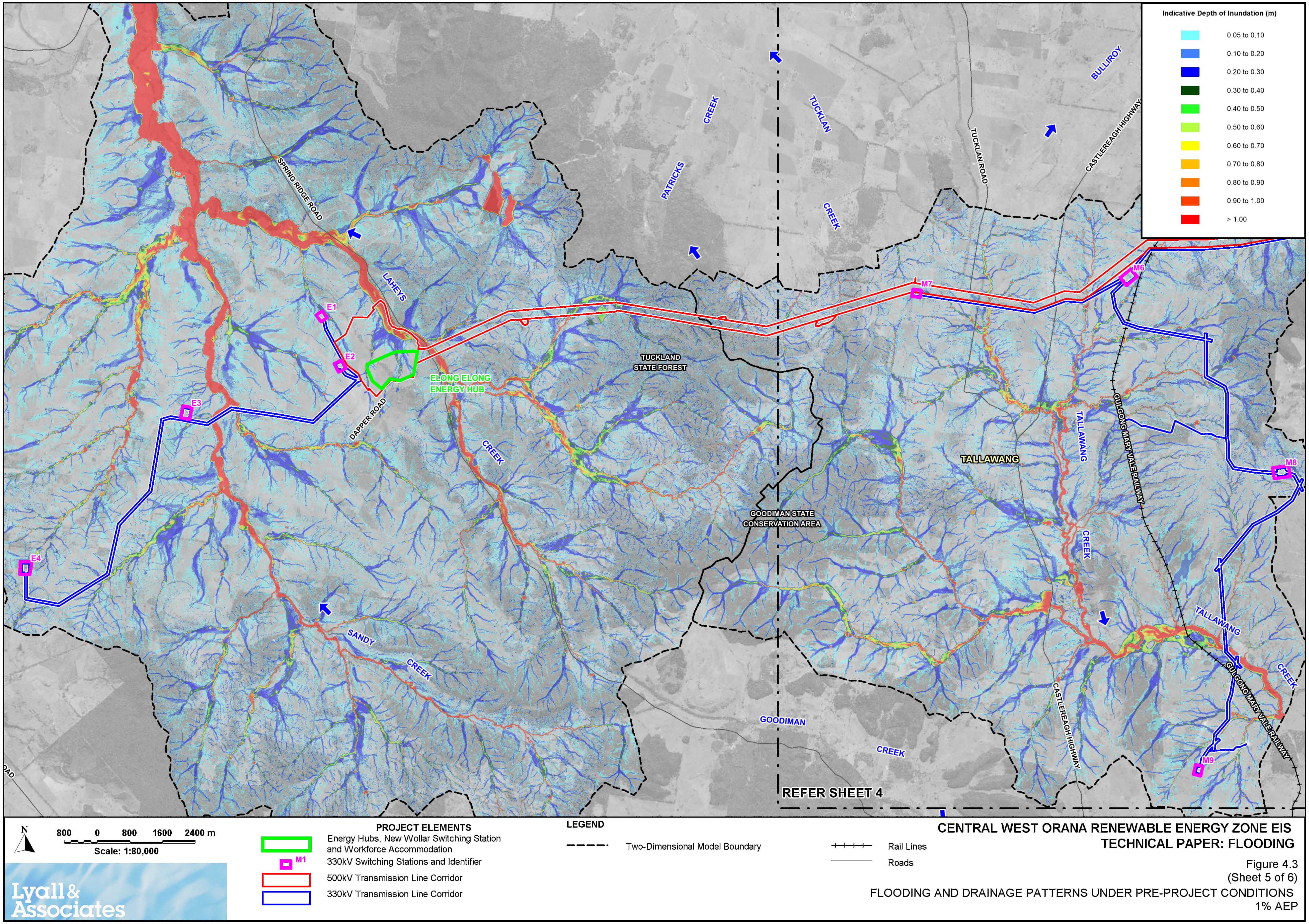
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

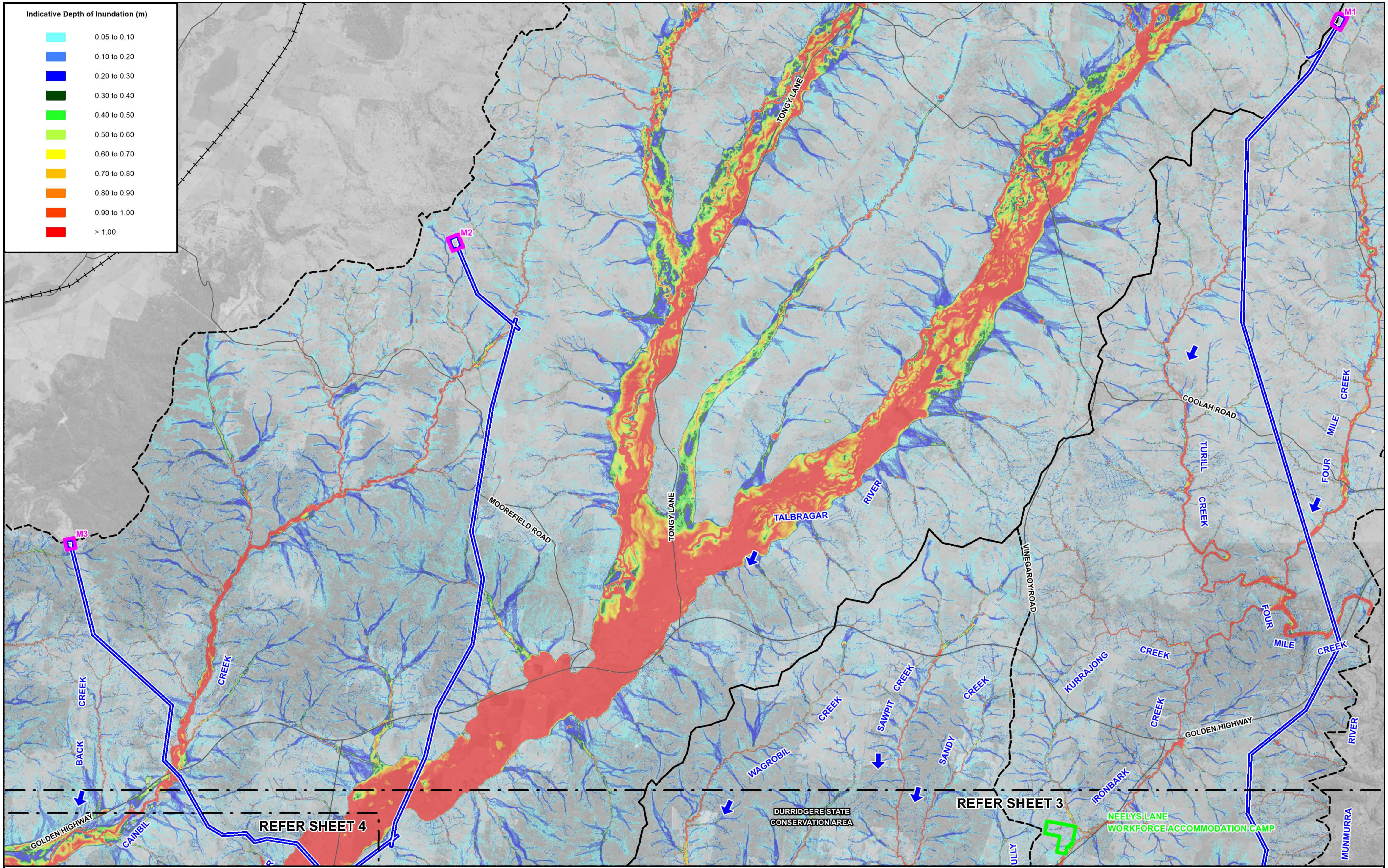
Figure 4.3
(Sheet 4 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
1% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.3
(Sheet 5 of 6)
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
1% AEP



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Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

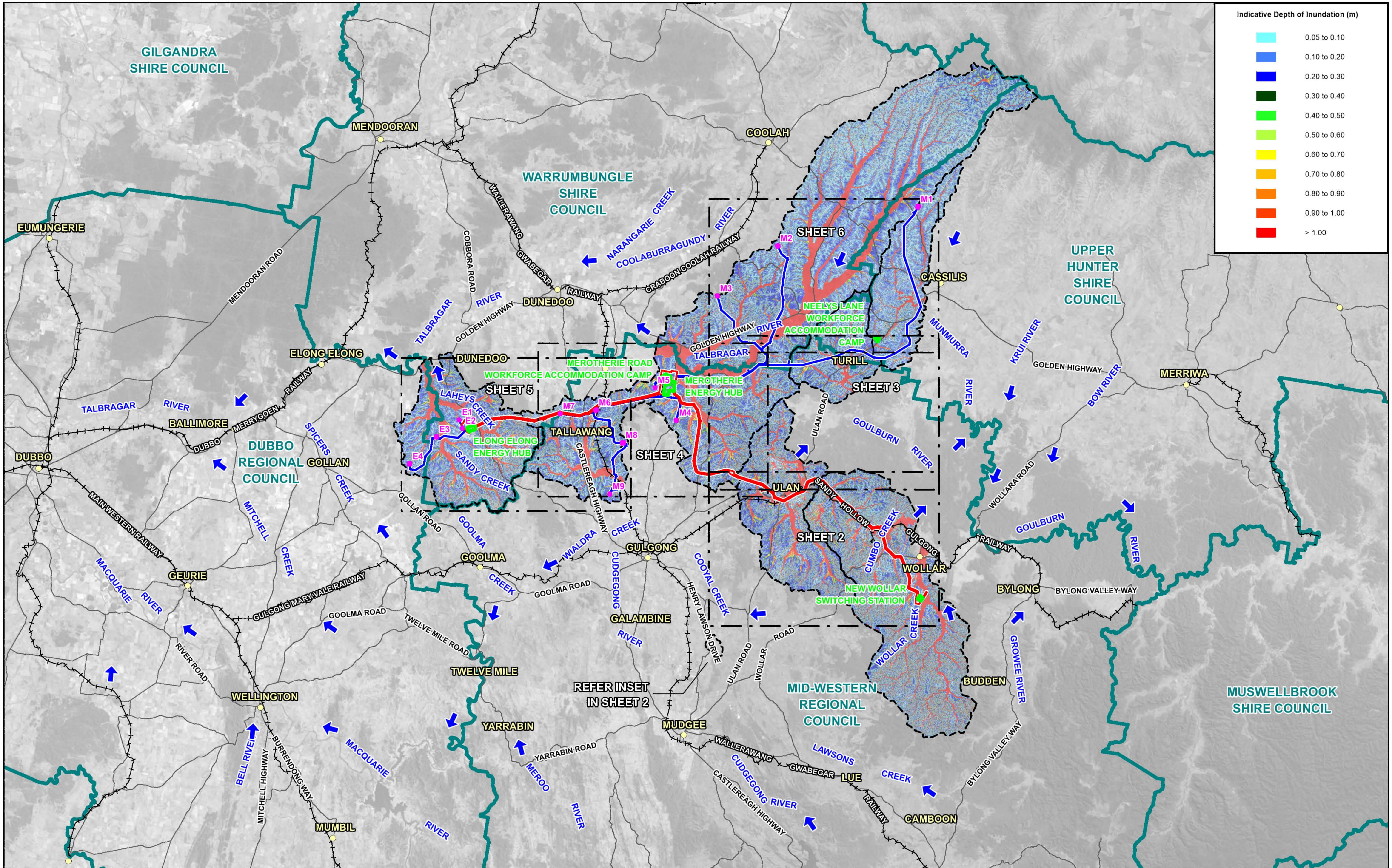
- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.3
(Sheet 6 of 6)
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
1% AEP



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Scale: 1:500,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Local Government Area (LGA) Boundary
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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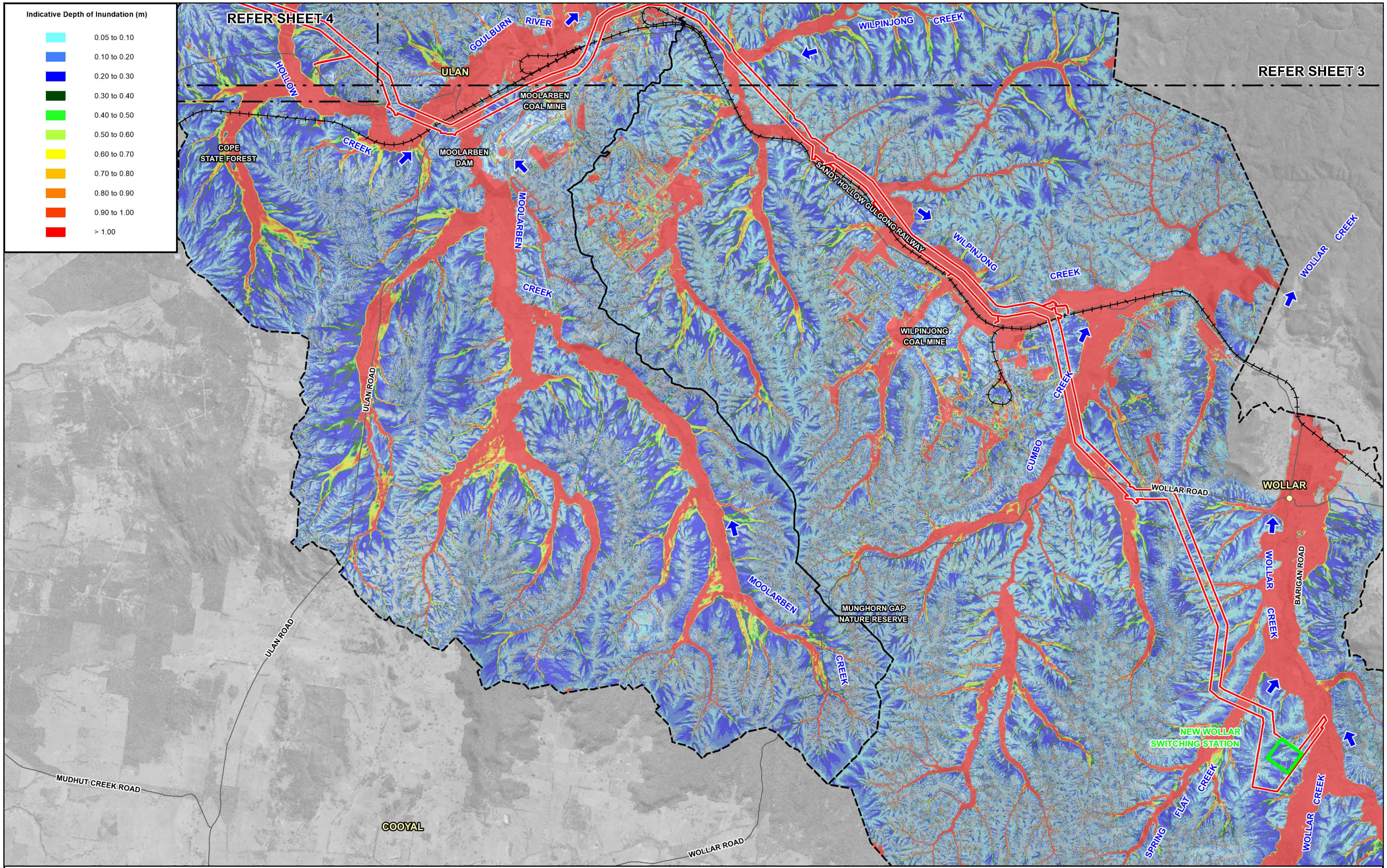
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.4
(Sheet 1 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
PMF



PROJECT ELEMENTS

Energy Hubs, New Wollar Switching Station and Workforce Accommodation

M1 330kV Switching Stations and Identifier

500kV Transmission Line Corridor

330kV Transmission Line Corridor

LEGEND

Two-Dimensional Model Boundary

Rail Lines

Roads

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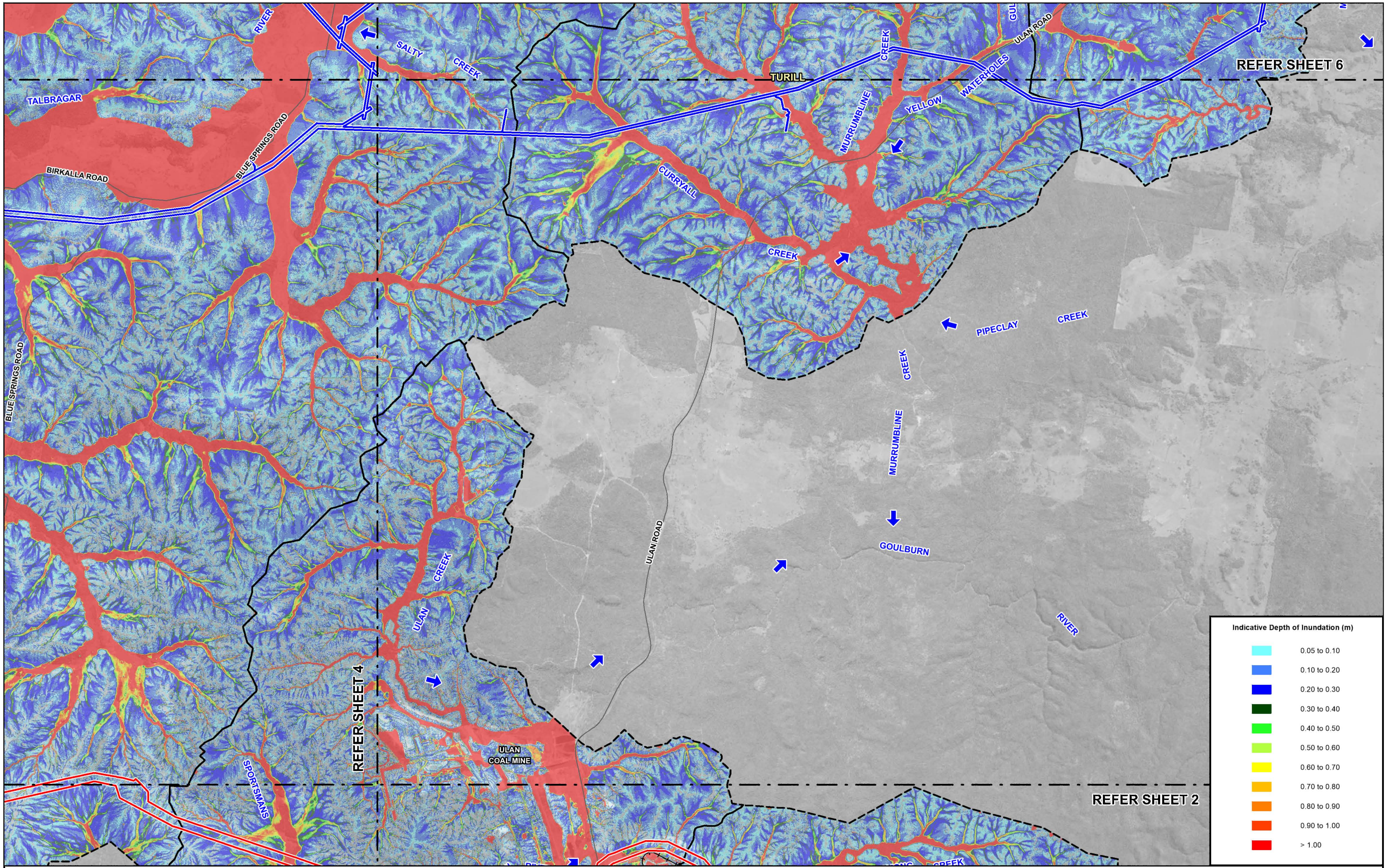
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.4
(Sheet 2 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
PMF



N
800 0 800 1600 2400 m
Scale: 1:80,000

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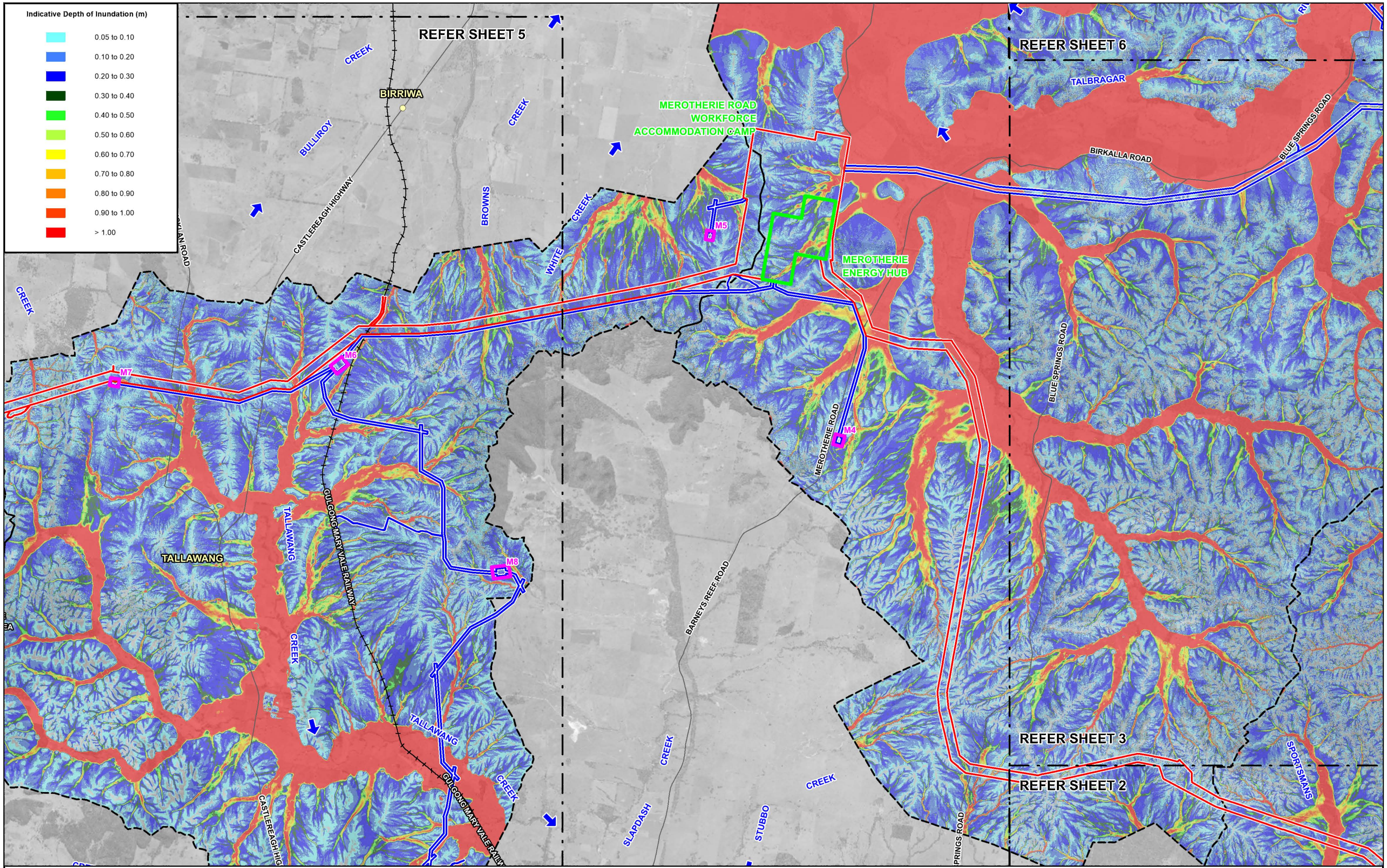
PROJECT ELEMENTS
- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.4
(Sheet 3 of 6)
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
PMF



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800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

Energy Hubs, New Wollar Switching Station and Workforce Accommodation

M1 330kV Switching Stations and Identifier

500kV Transmission Line Corridor

330kV Transmission Line Corridor

LEGEND

Two-Dimensional Model Boundary

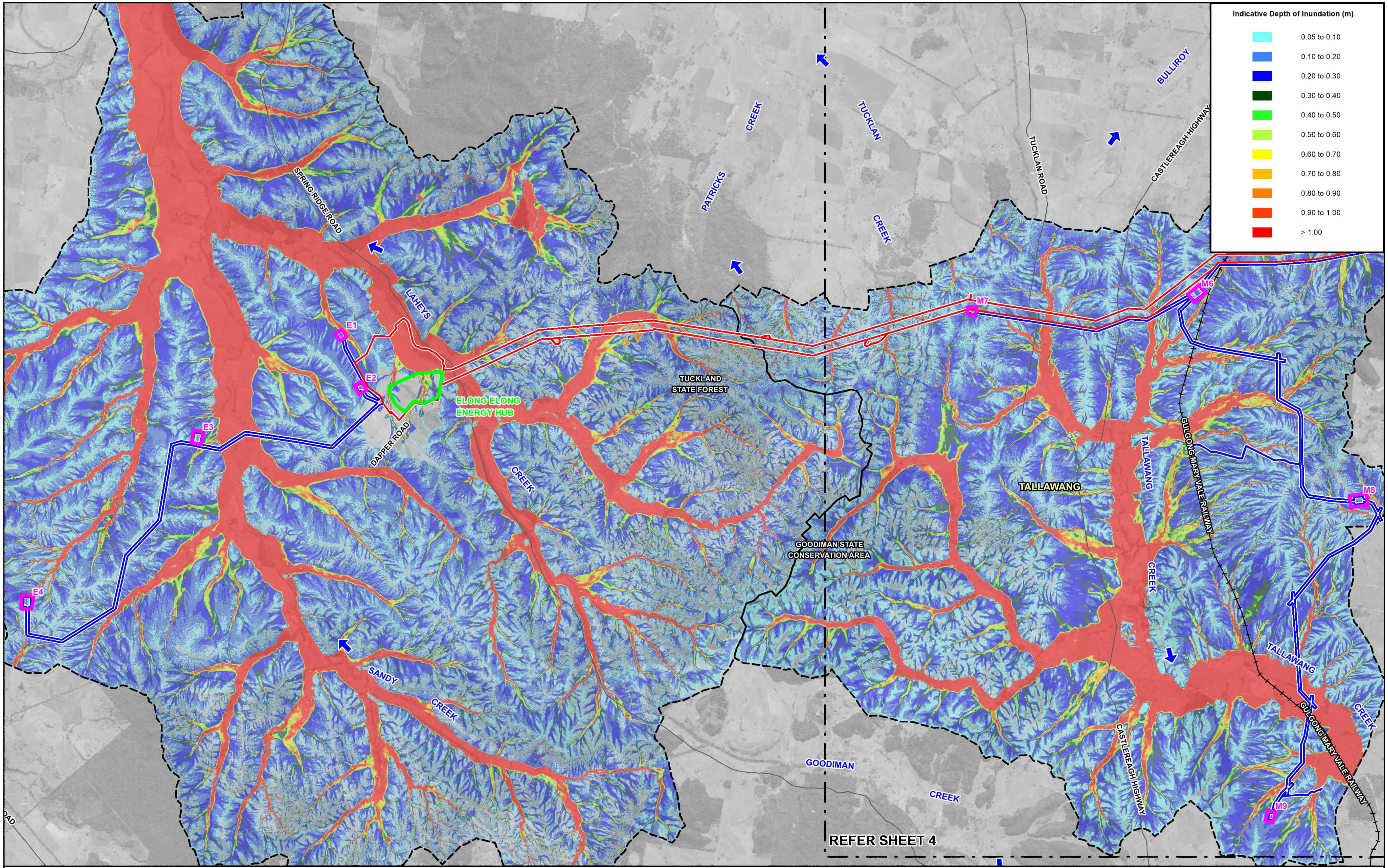
Rail Lines

Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.4
(Sheet 4 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
PMF



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800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

Energy Hubs, New Wollar Switching Station and Workforce Accommodation

M1 330kV Switching Stations and Identifier

500kV Transmission Line Corridor

330kV Transmission Line Corridor

LEGEND

Two-Dimensional Model Boundary

Rail Lines

Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

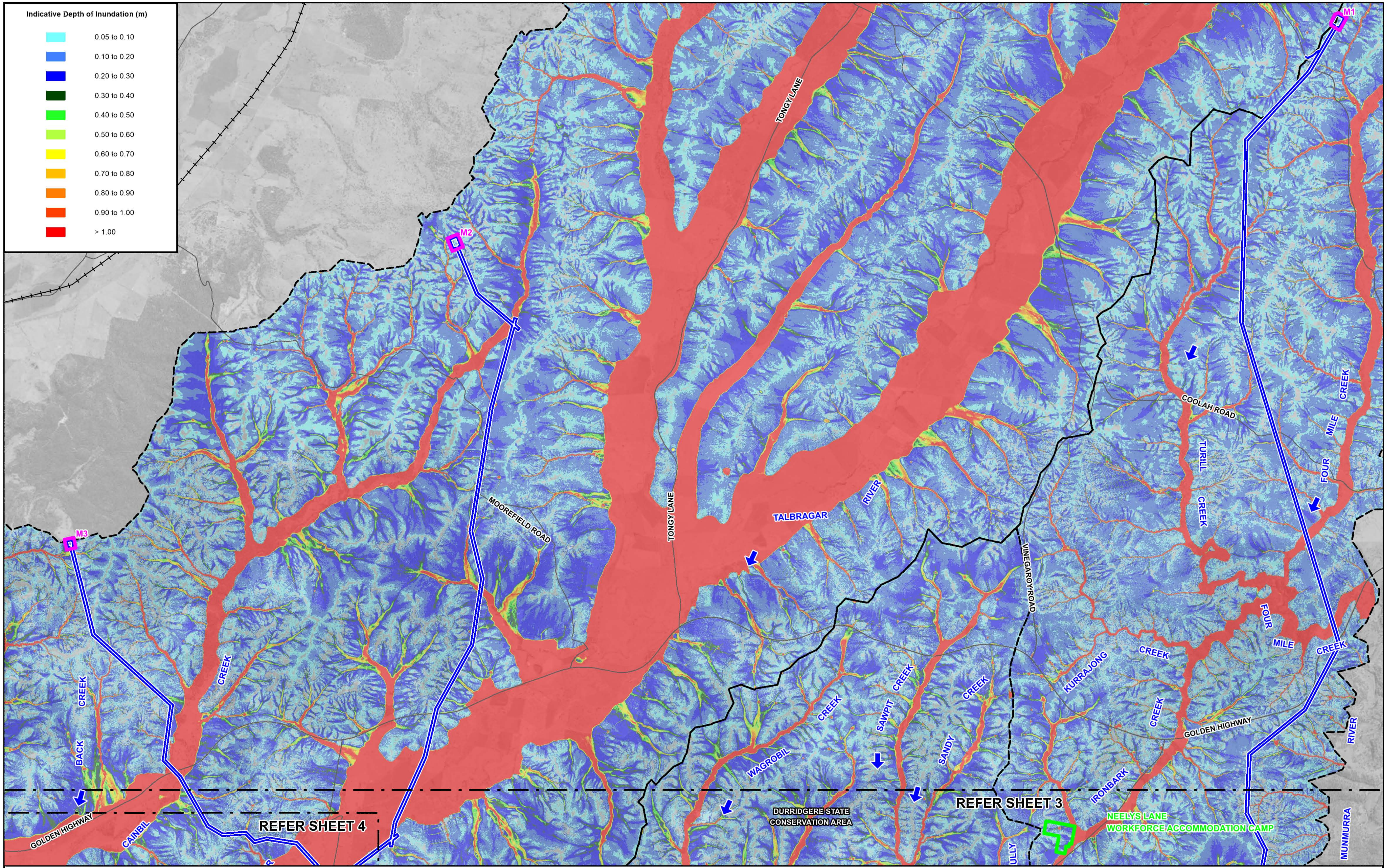
TECHNICAL PAPER: FLOODING

Figure 4.4

(Sheet 5 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS

PMF



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Scale: 1:80,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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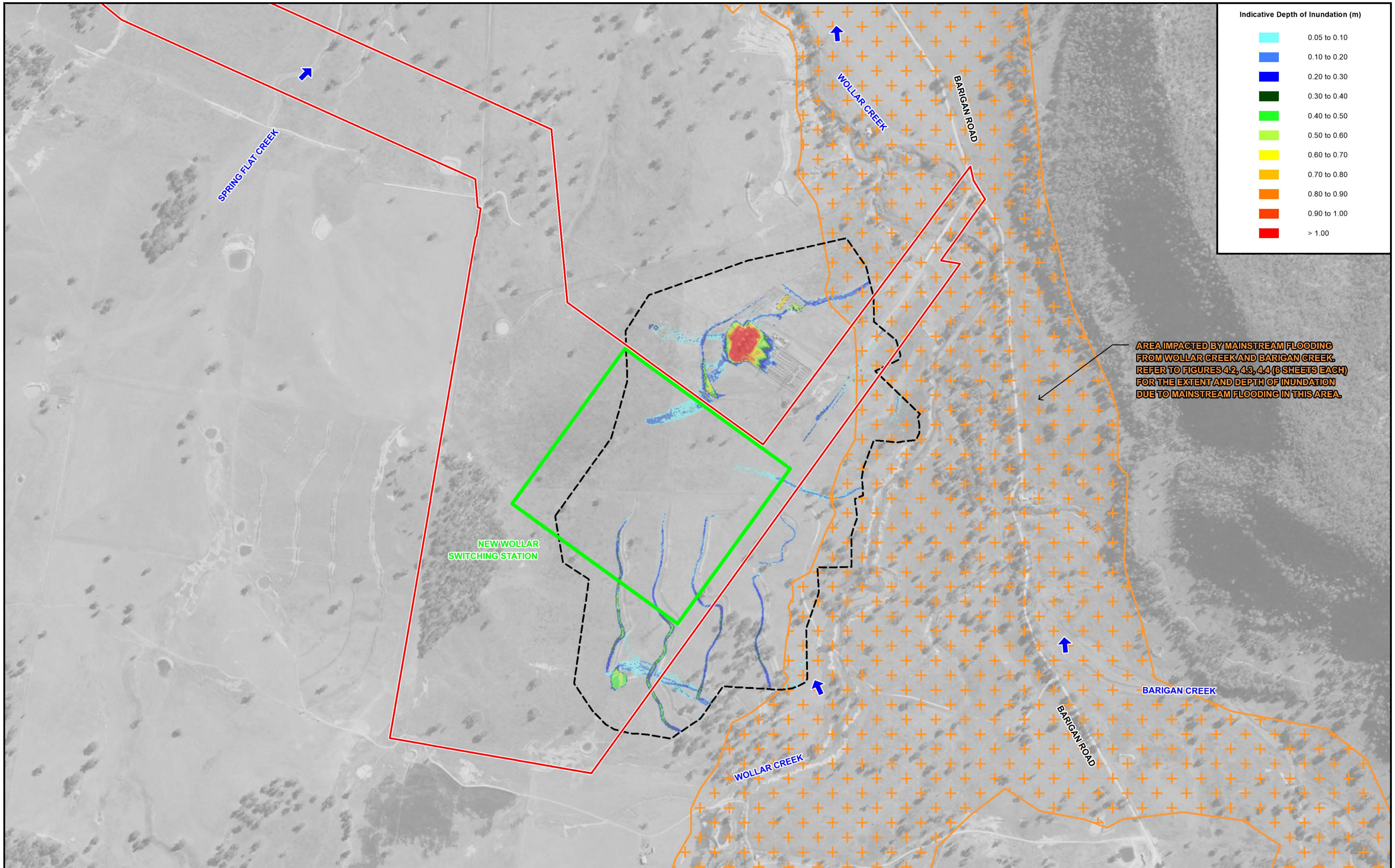
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.4
(Sheet 6 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
PMF



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100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

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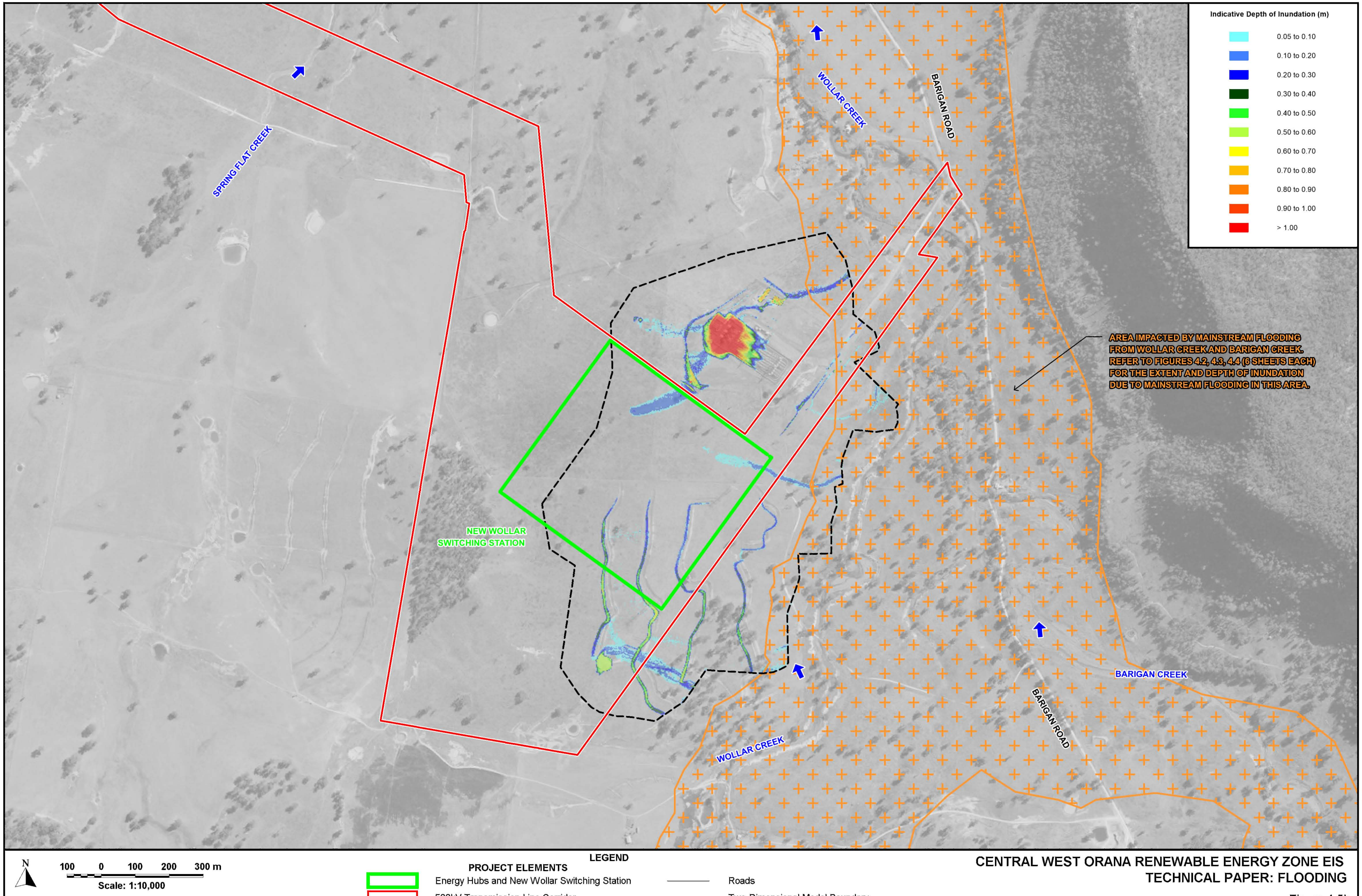
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.5a

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



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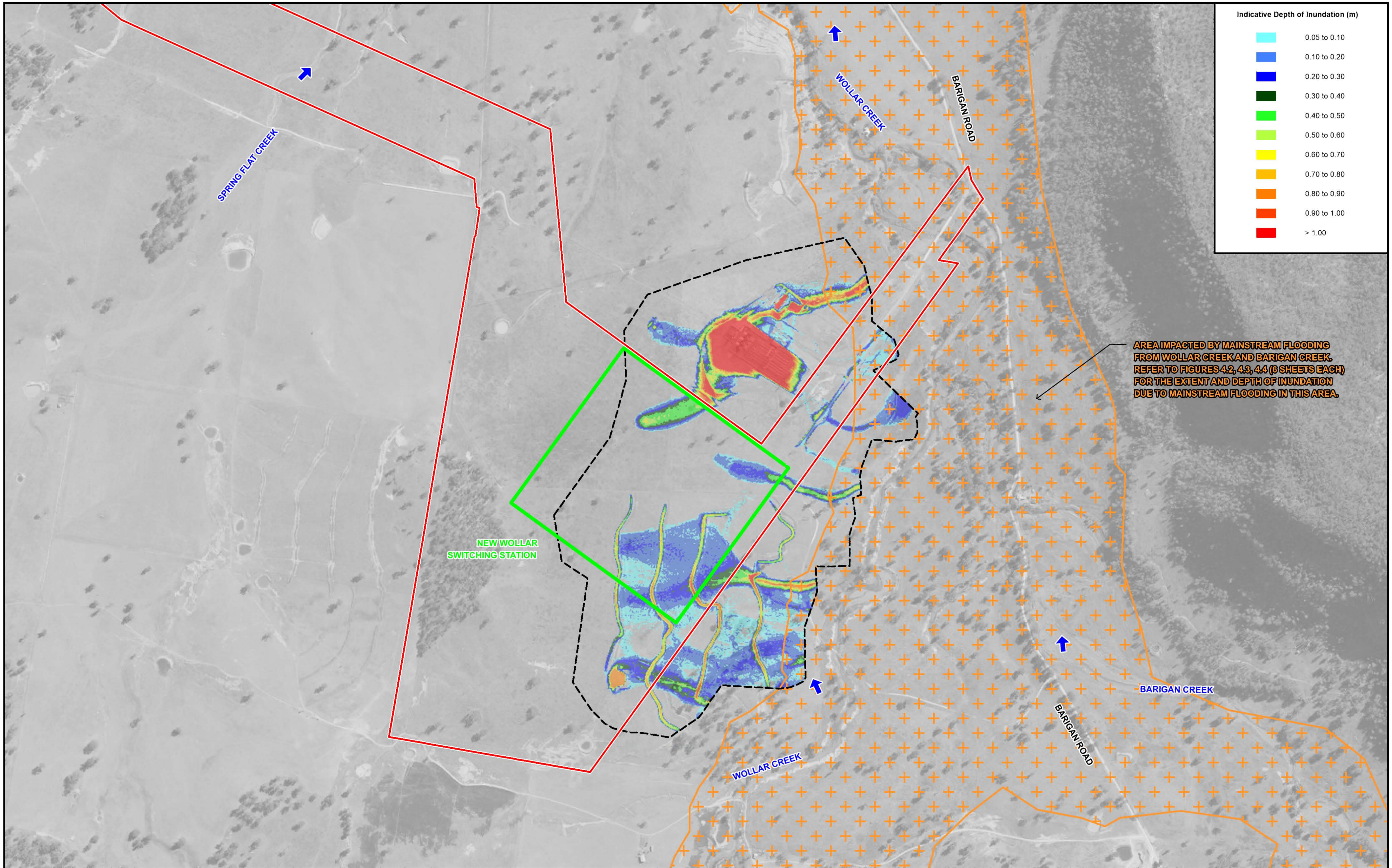
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.5b

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

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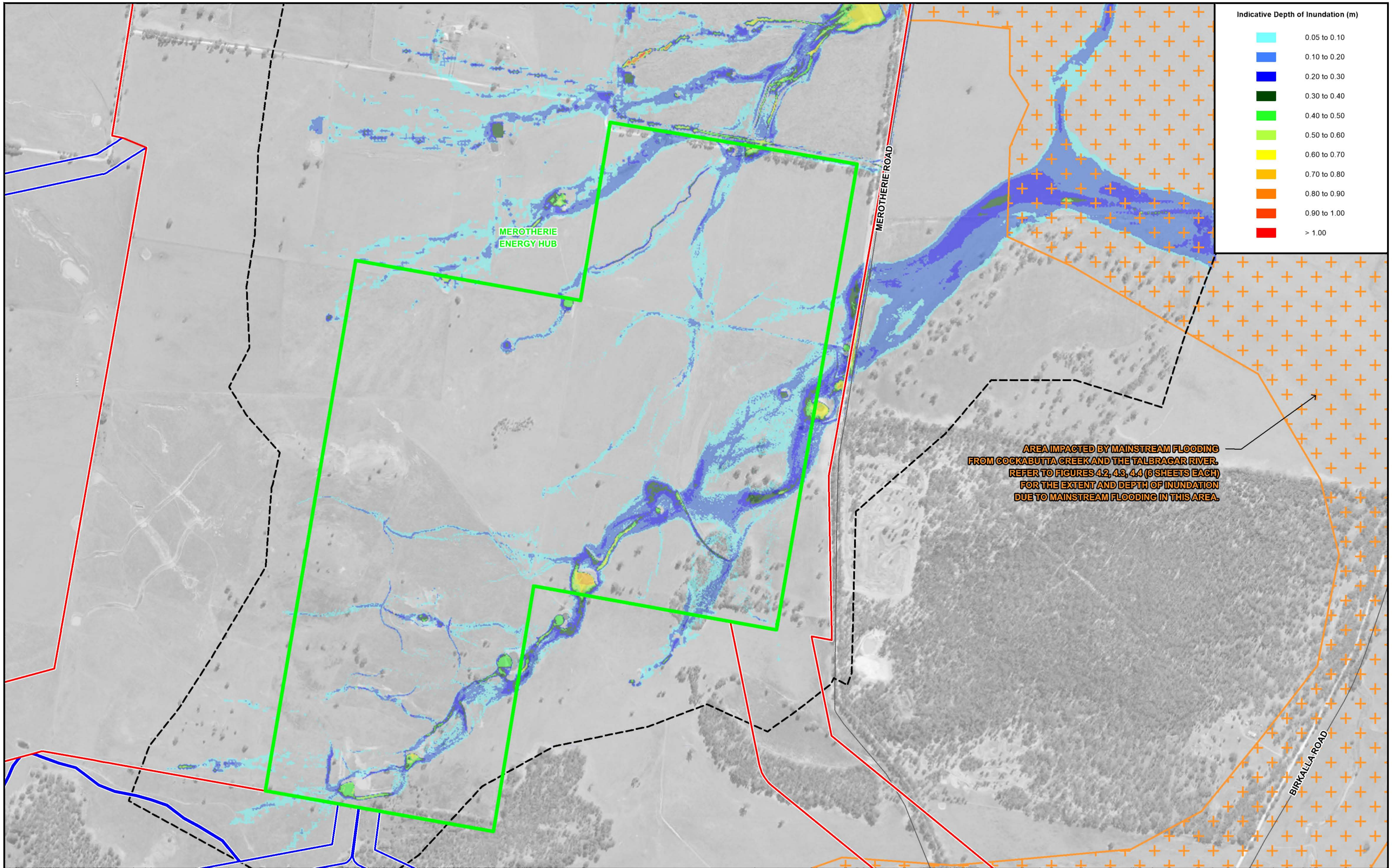
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.5c

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
PMF



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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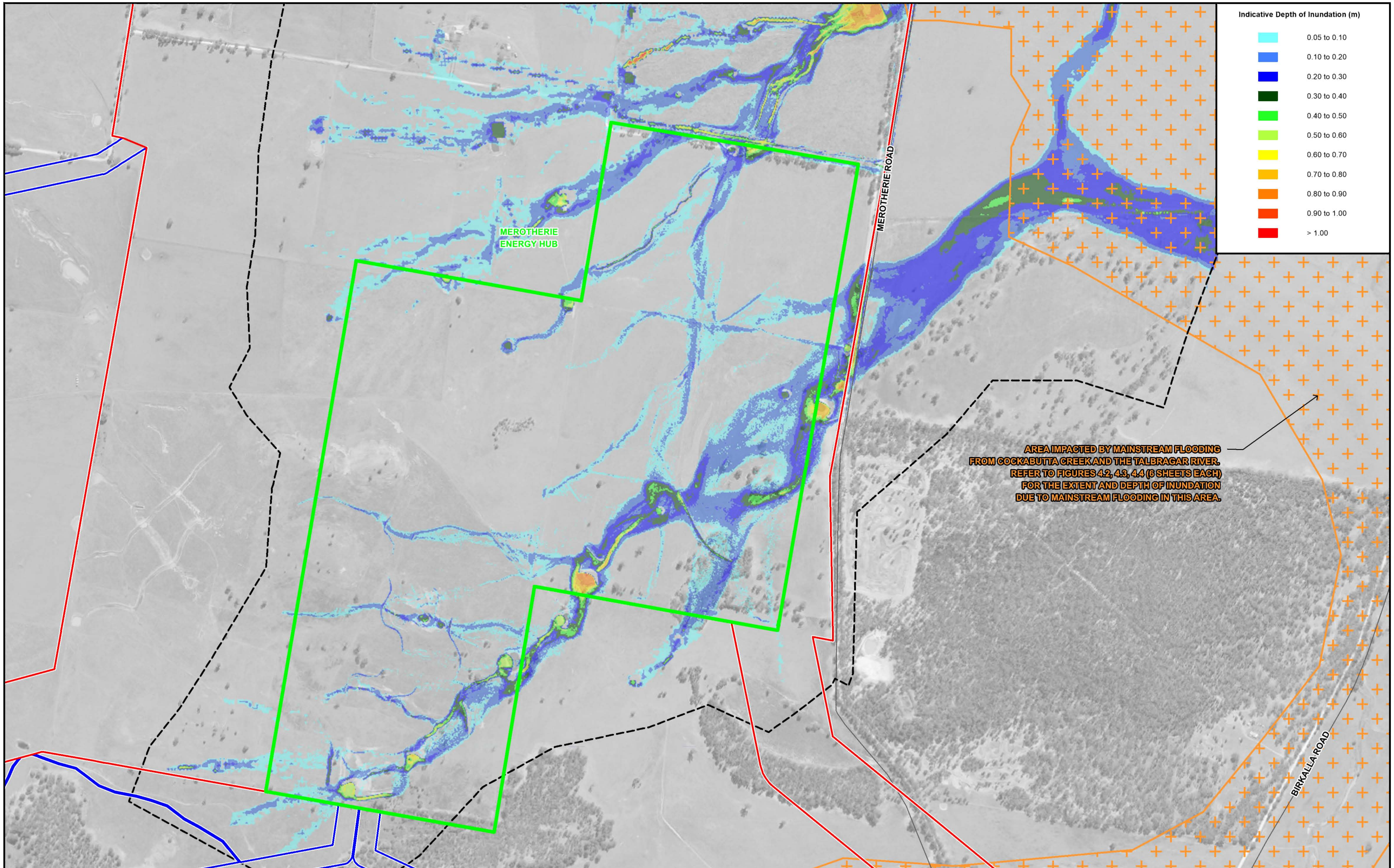
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.6a

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

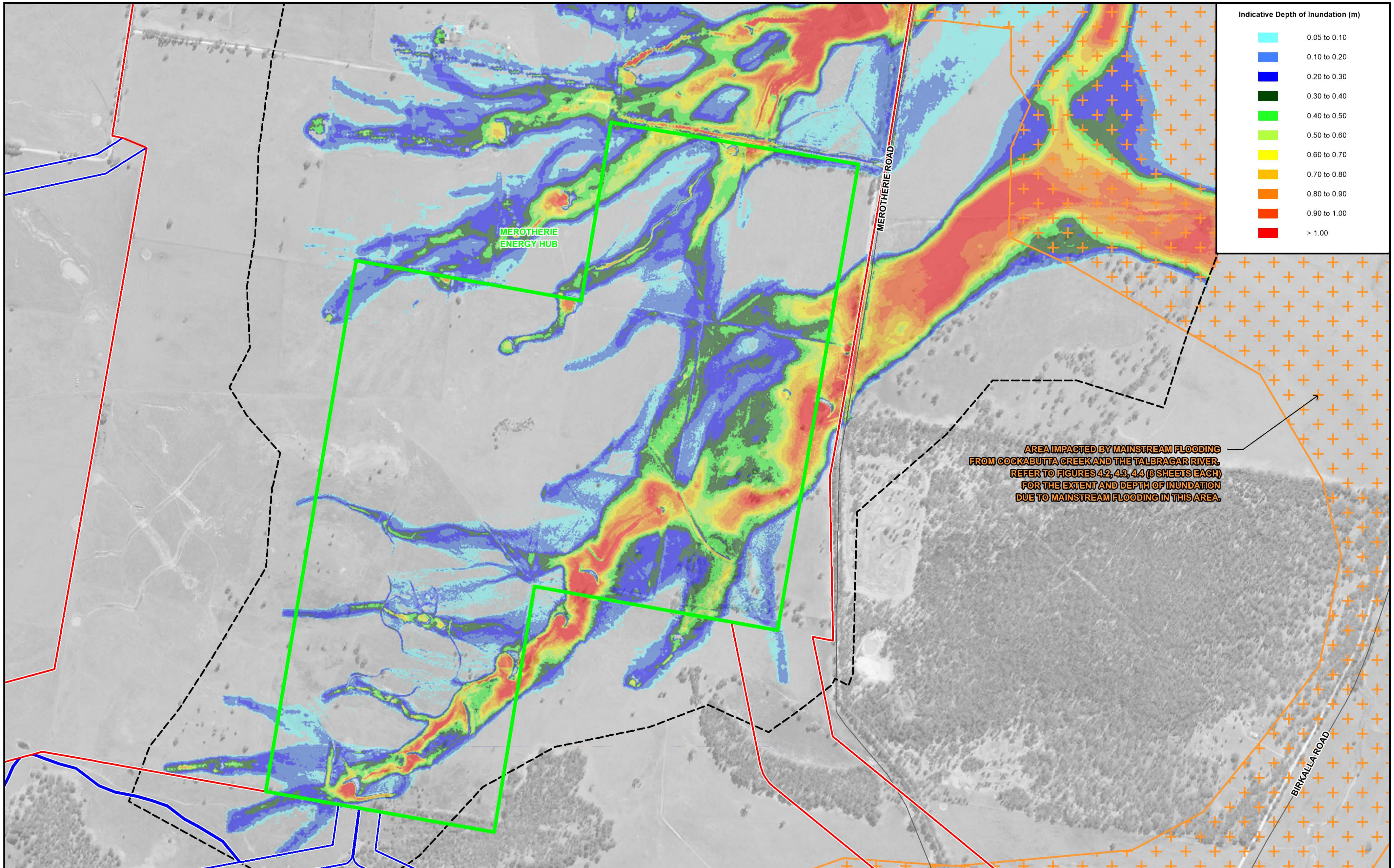
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.6b

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP



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Scale: 1:10,000

LEGEND

PROJECT ELEMENTS
- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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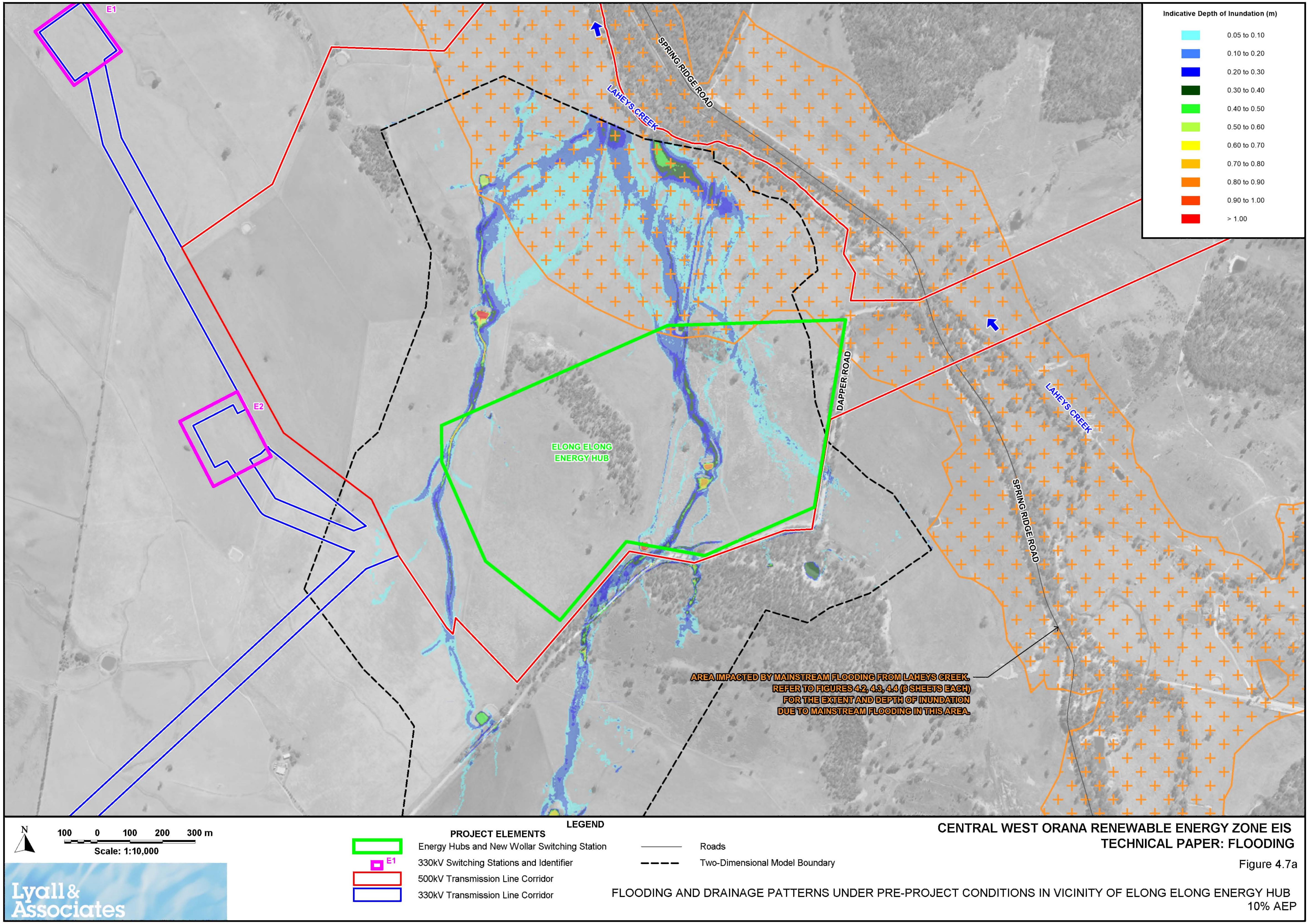
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.6c

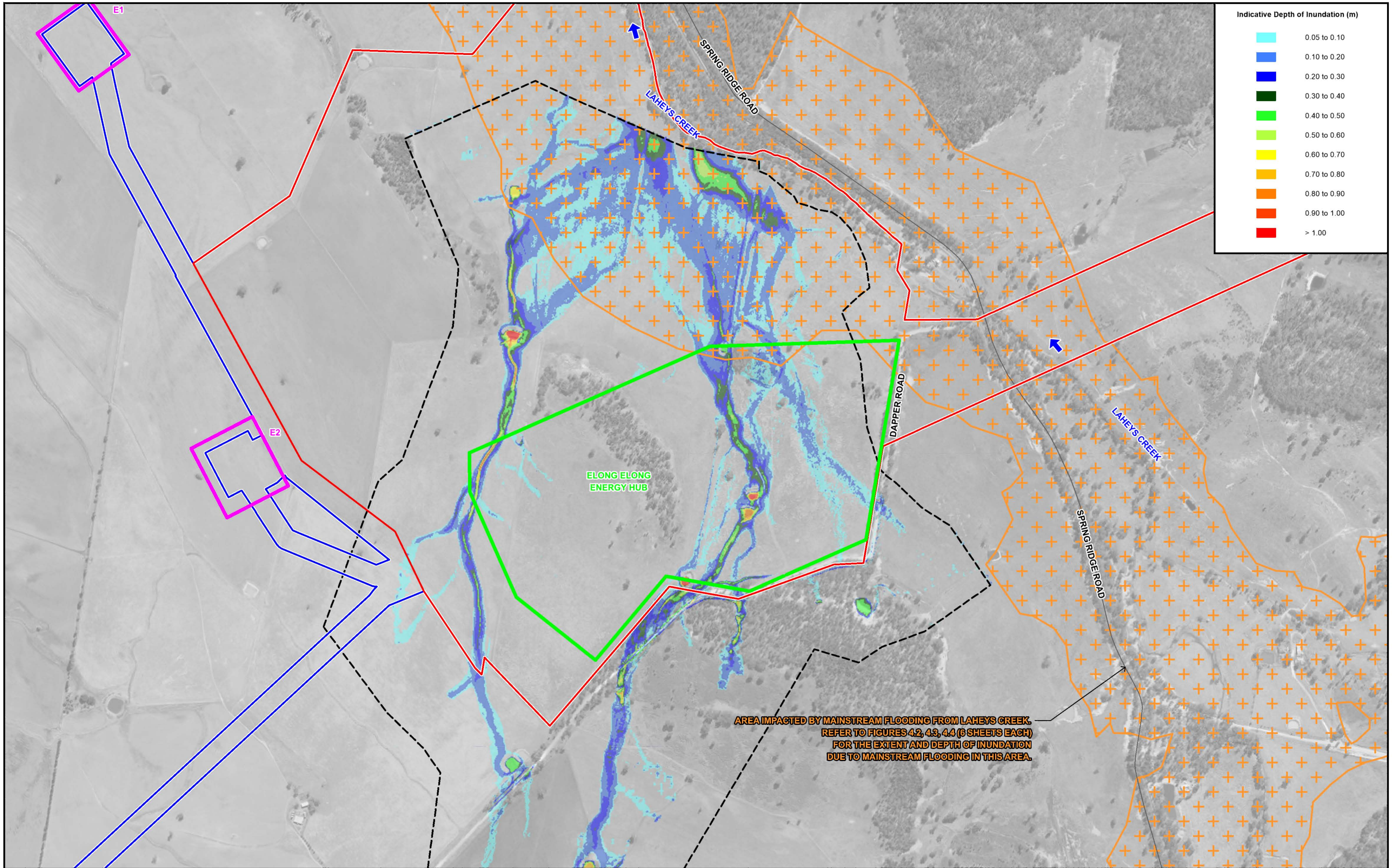
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
PMF



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.7a

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

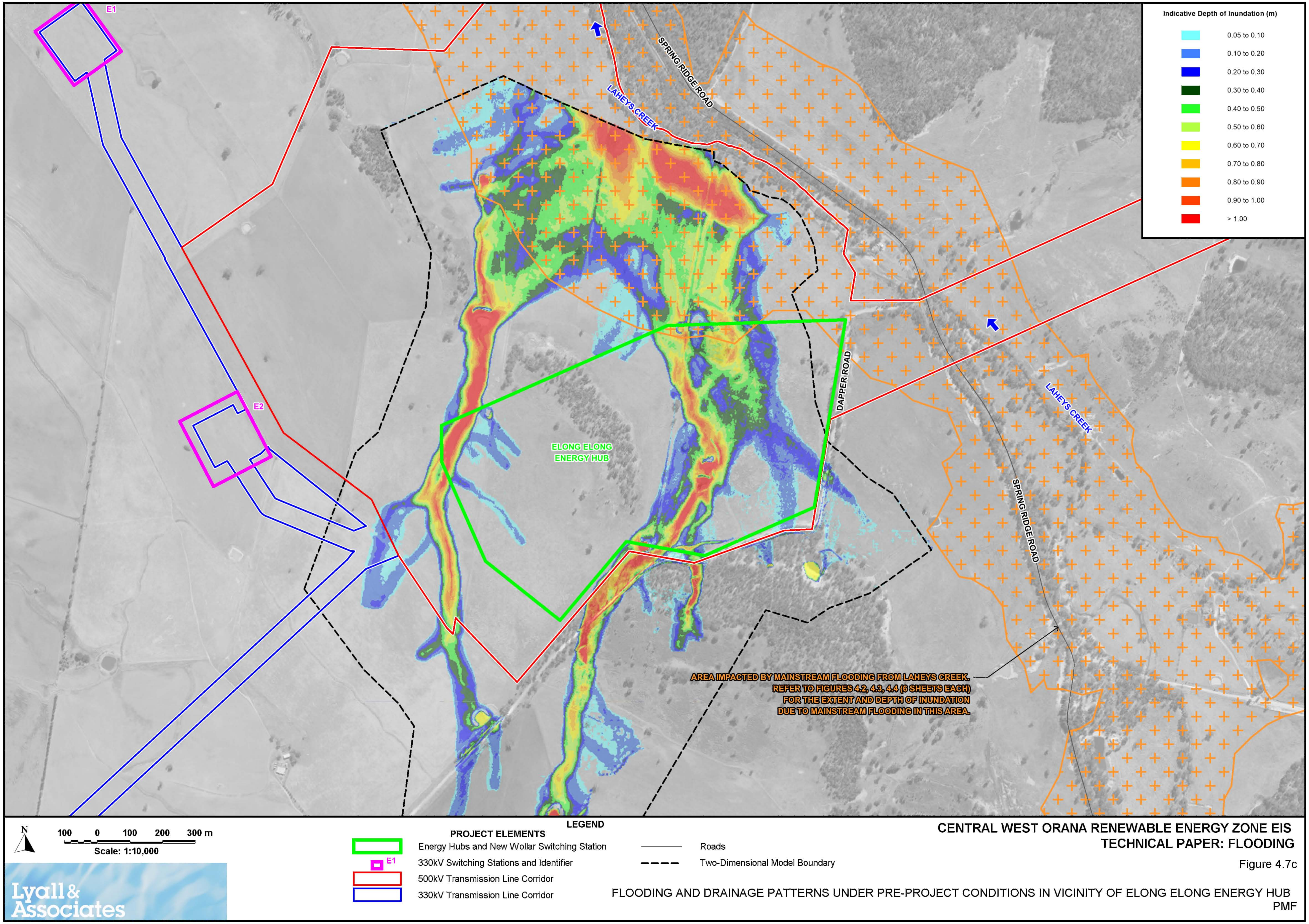
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.7b

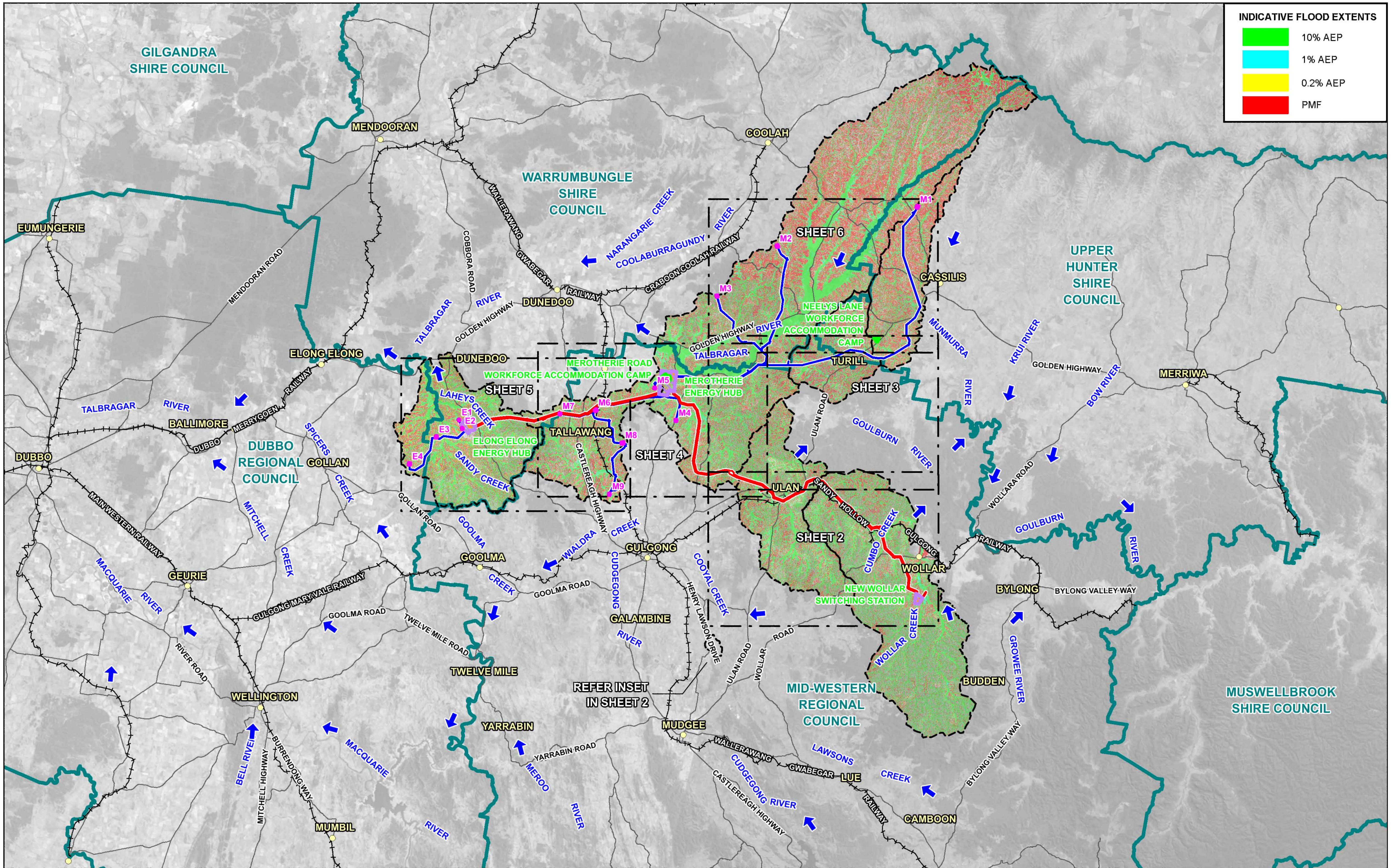
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.7c

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
PMF



N

5000 0 5000 10000 15000 m

Scale: 1:500,000

Lyall & Associates

LEGEND

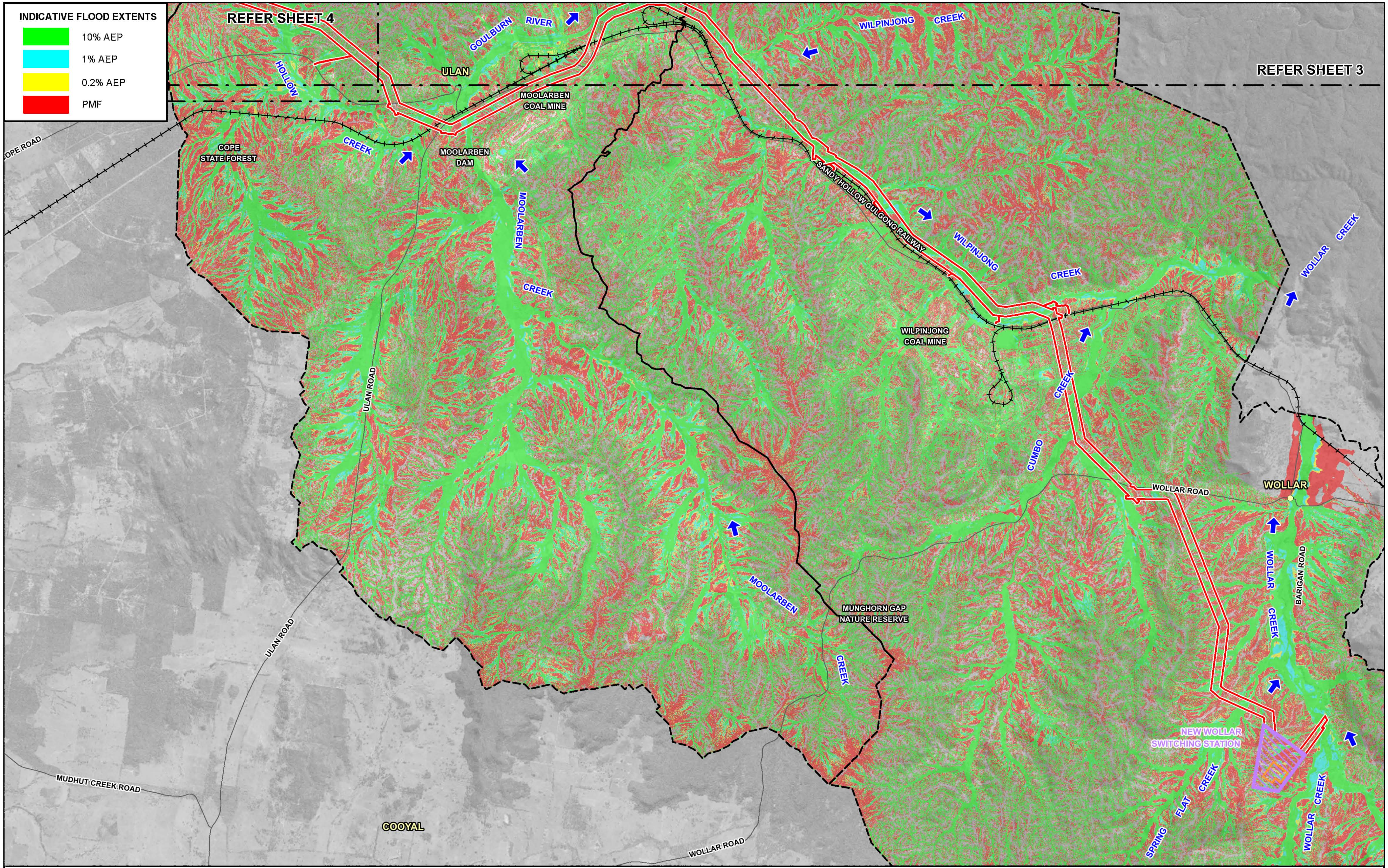
CONSTRUCTION WORK AREAS

- Energy Hubs and New Wollar Switching Station
- 500kV Network
- 330kV Network
- M1 330kV Switching Station and Identifier
- Workforce Accommodation Camp
- Construction Compound
- Rail Lines
- Roads
- Two-Dimensional Model Boundary
- Local Government Area (LGA) Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 5.1
(Sheet 1 of 6)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS



N

800 0 800 1600 2400 m

Scale: 1:80,000

LEGEND

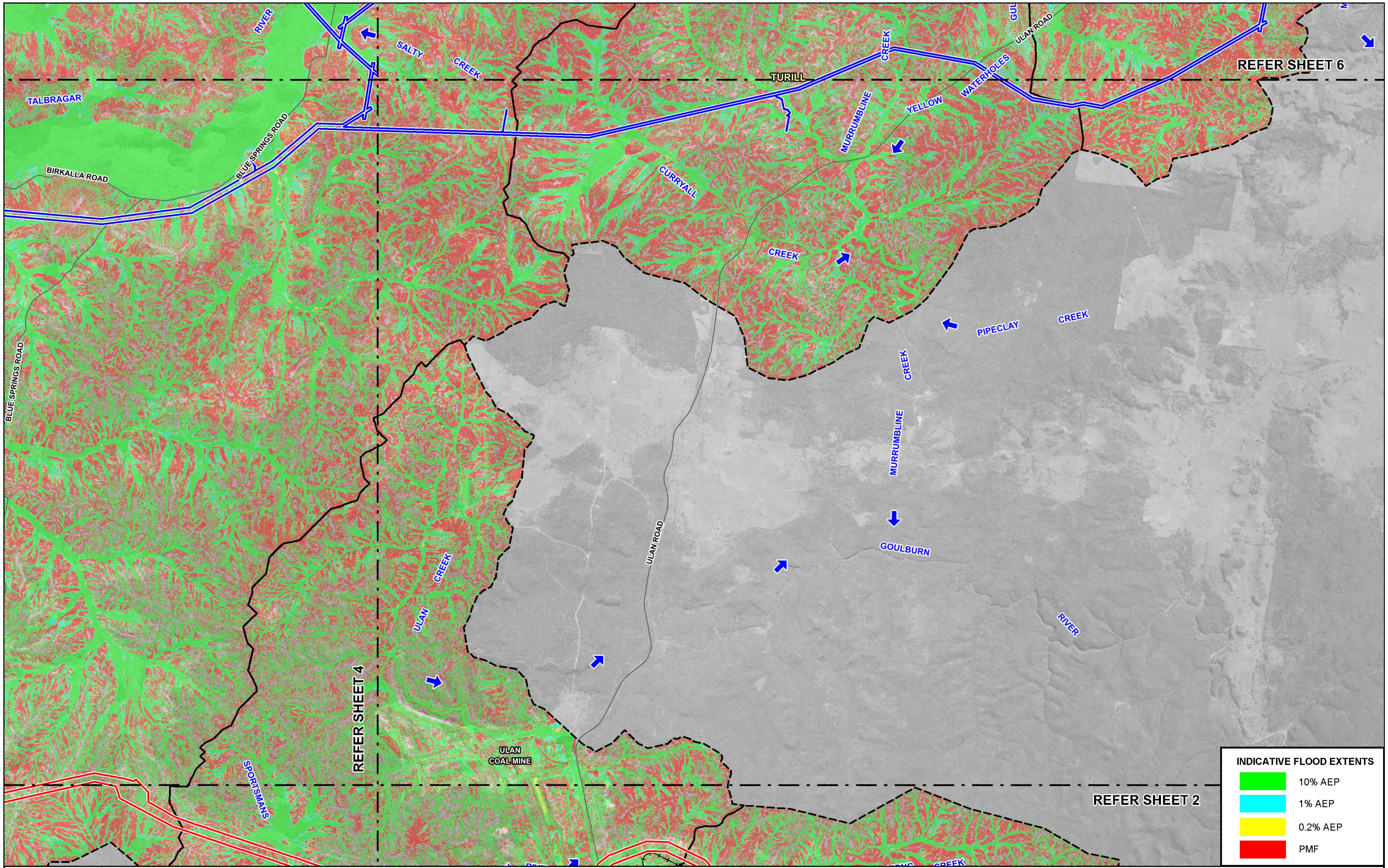
CONSTRUCTION WORK AREAS

Energy Hubs and New Wollar Switching Station	330kV Switching Station and Identifier (M1)
500kV Network	Workforce Accommodation Camp
330kV Network	Construction Compound
Rail Lines	Roads
Two-Dimensional Model Boundary	

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 5.1
(Sheet 2 of 6)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

LEGEND

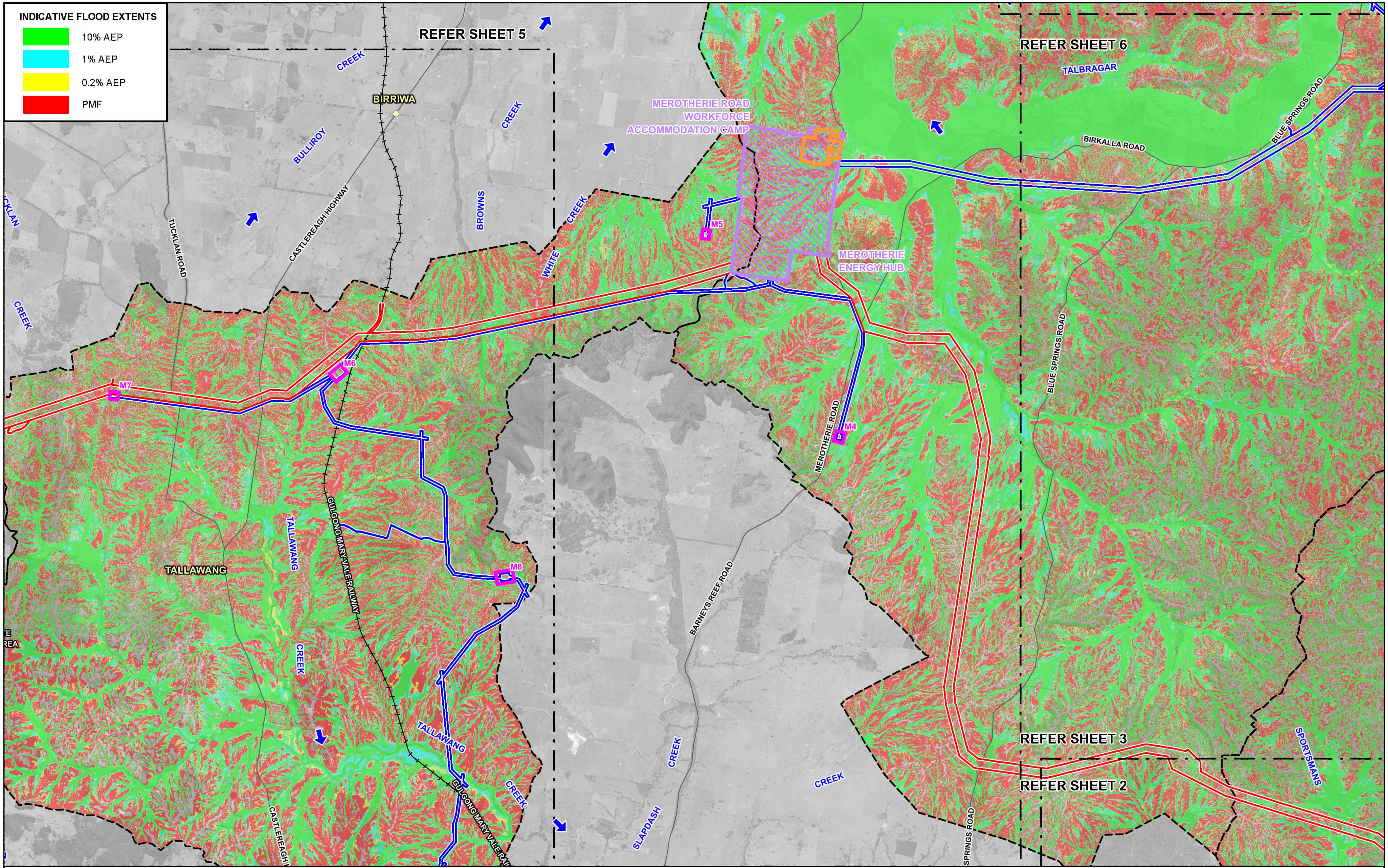
CONSTRUCTION WORK AREAS

- Energy Hubs and New Wollar Switching Station
- 500kV Network
- 330kV Network
- M1 330kV Switching Station and Identifier
- Workforce Accommodation Camp
- Construction Compound
- Rail Lines
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 5.1
(Sheet 3 of 6)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS



N
800 0 800 1600 2400 m
Scale: 1:80,000

LEGEND

CONSTRUCTION WORK AREAS

- Energy Hubs and New Wollar Switching Station
- 500kV Network
- 330kV Network
- M1 330kV Switching Station and Identifier
- Workforce Accommodation Camp
- Construction Compound
- Rail Lines
- Roads
- Two-Dimensional Model Boundary

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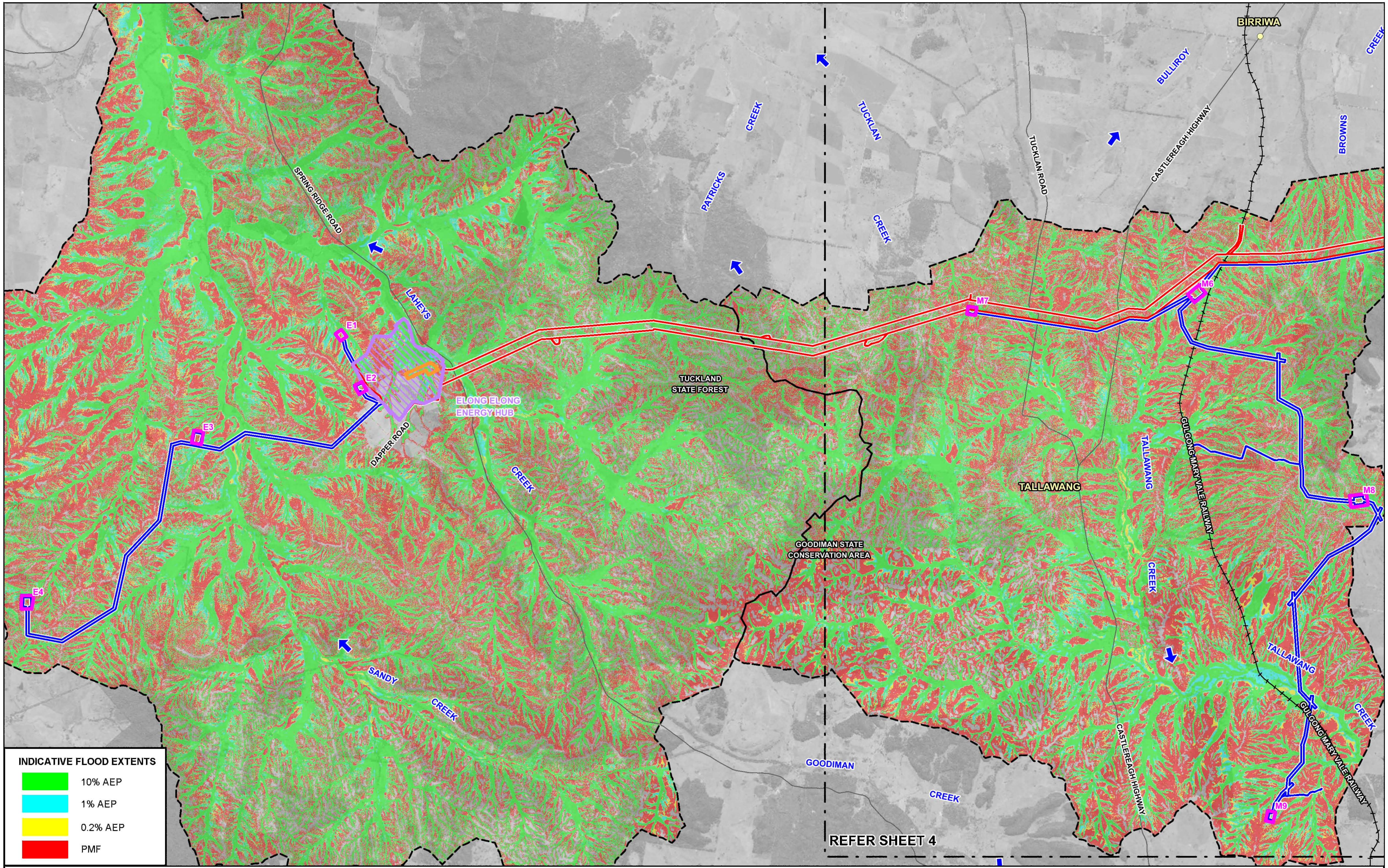
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 5.1
(Sheet 4 of 6)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS



N

800 0 800 1600 2400 m

Scale: 1:80,000

LEGEND

CONSTRUCTION WORK AREAS

- Energy Hubs and New Wollar Switching Station
- 500kV Network
- 330kV Network
- M1 330kV Switching Station and Identifier
- Workforce Accommodation Camp
- Construction Compound
- Rail Lines
- Roads
- Two-Dimensional Model Boundary

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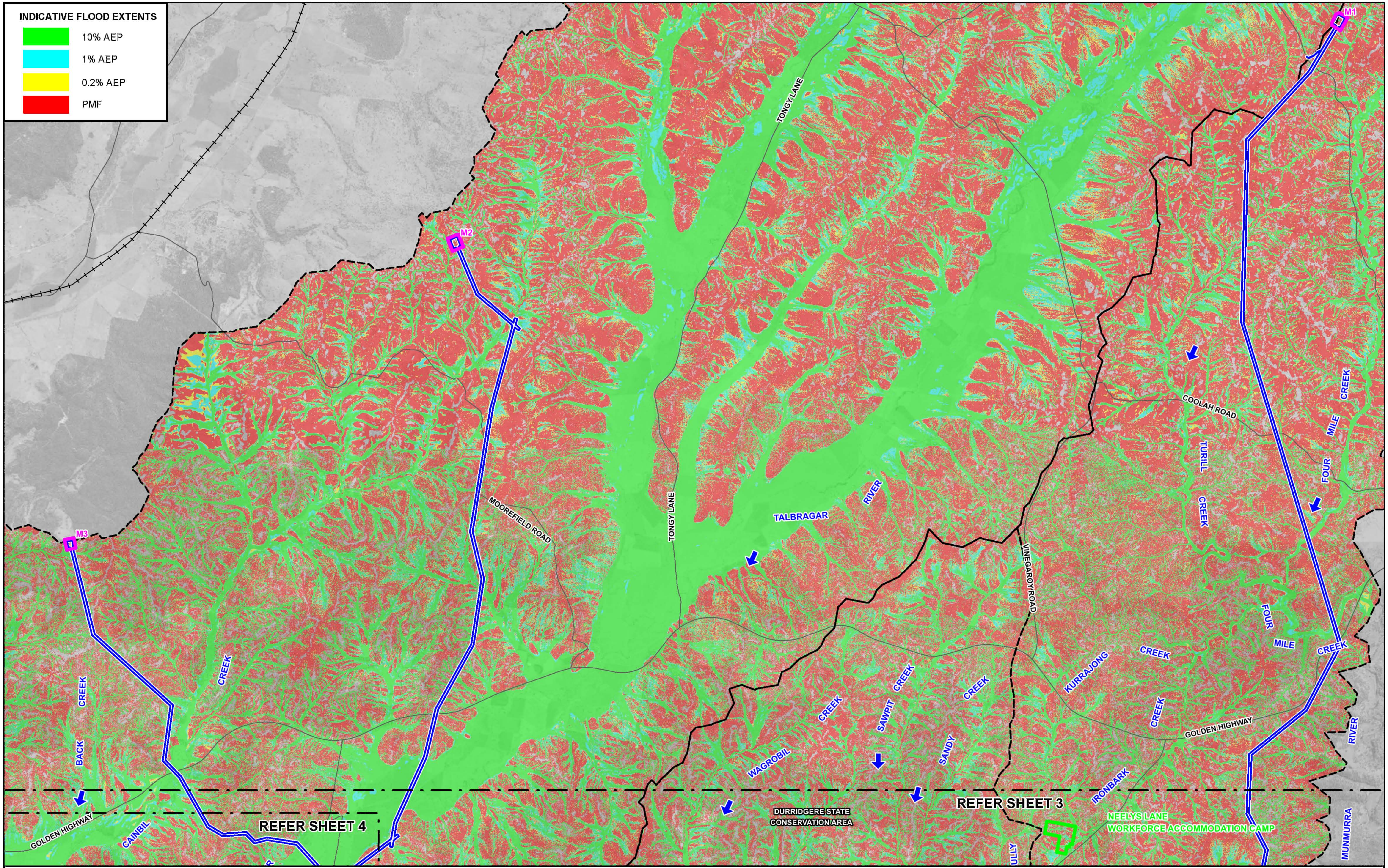
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 5.1
(Sheet 5 of 6)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

LEGEND

CONSTRUCTION WORK AREAS

Energy Hubs and New Wollar Switching Station

500kV Network

330kV Network

M1 330kV Switching Station and Identifier

Workforce Accommodation Camp

Construction Compound

Rail Lines

Roads

Two-Dimensional Model Boundary

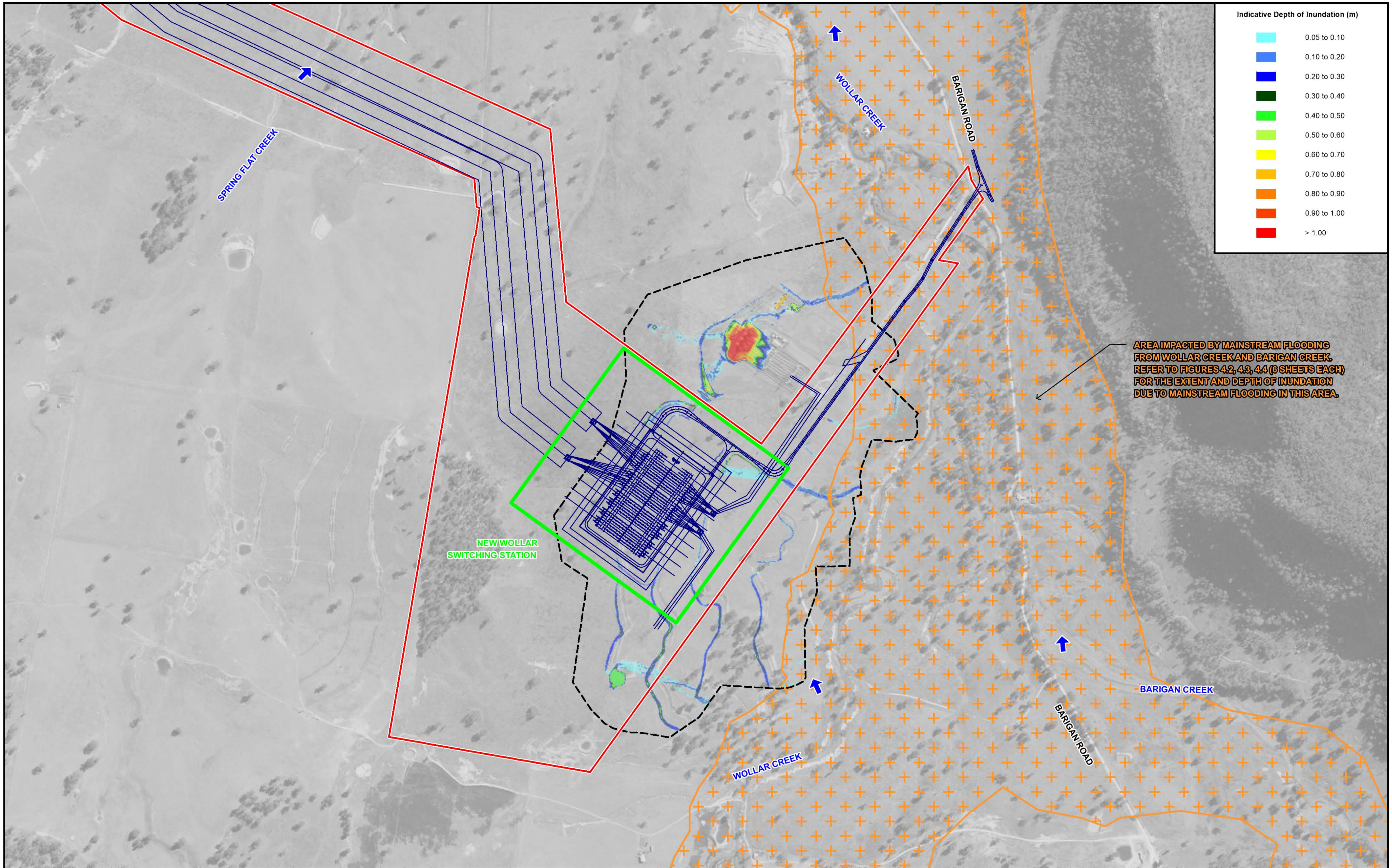
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure 5.1

(Sheet 6 of 6)

INDICATIVE FLOOD EXTENTS IN VICINITY OF PROPOSED CONSTRUCTION WORK AREAS



N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Operational Infrastructure

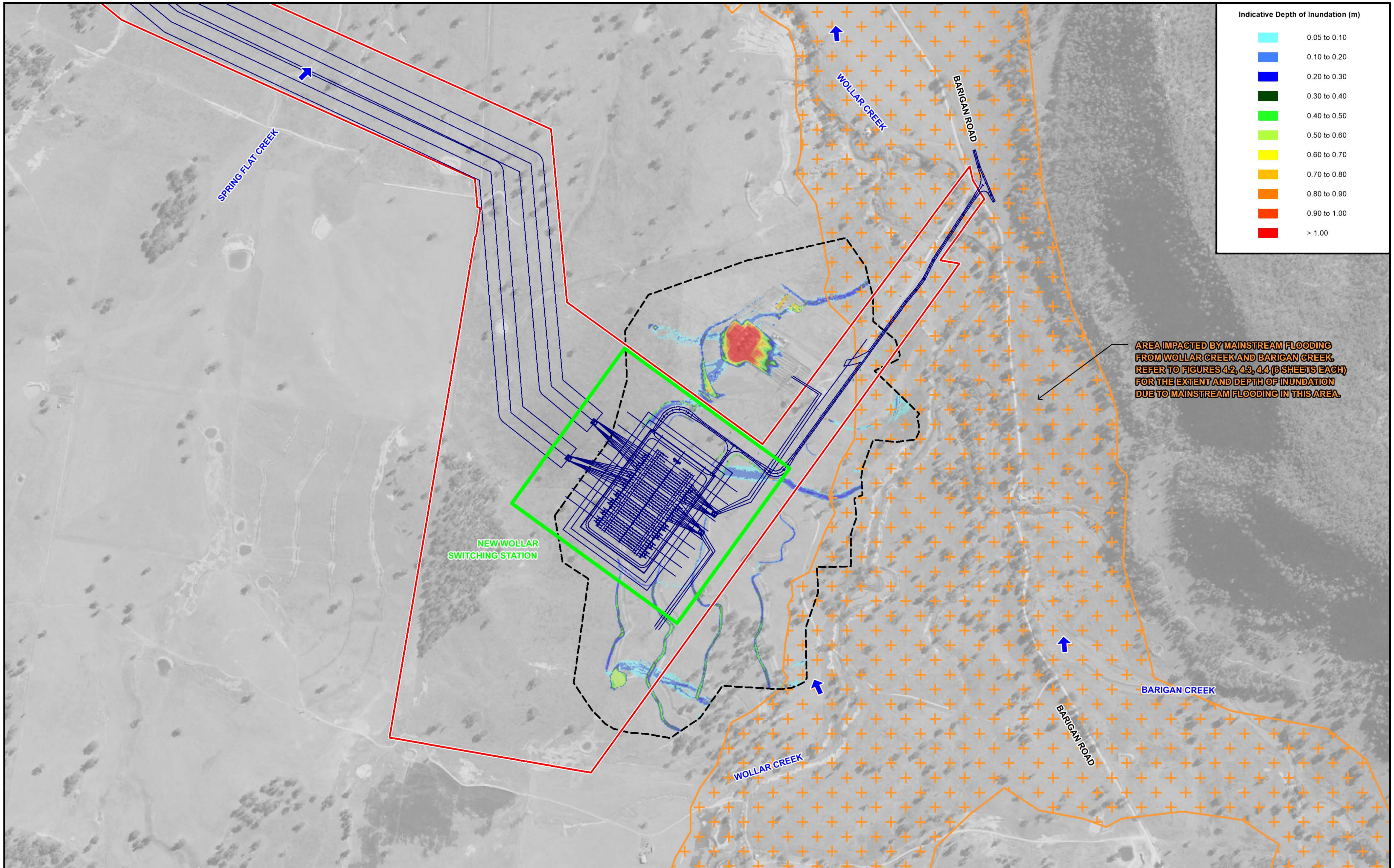
Roads

Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.1a

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

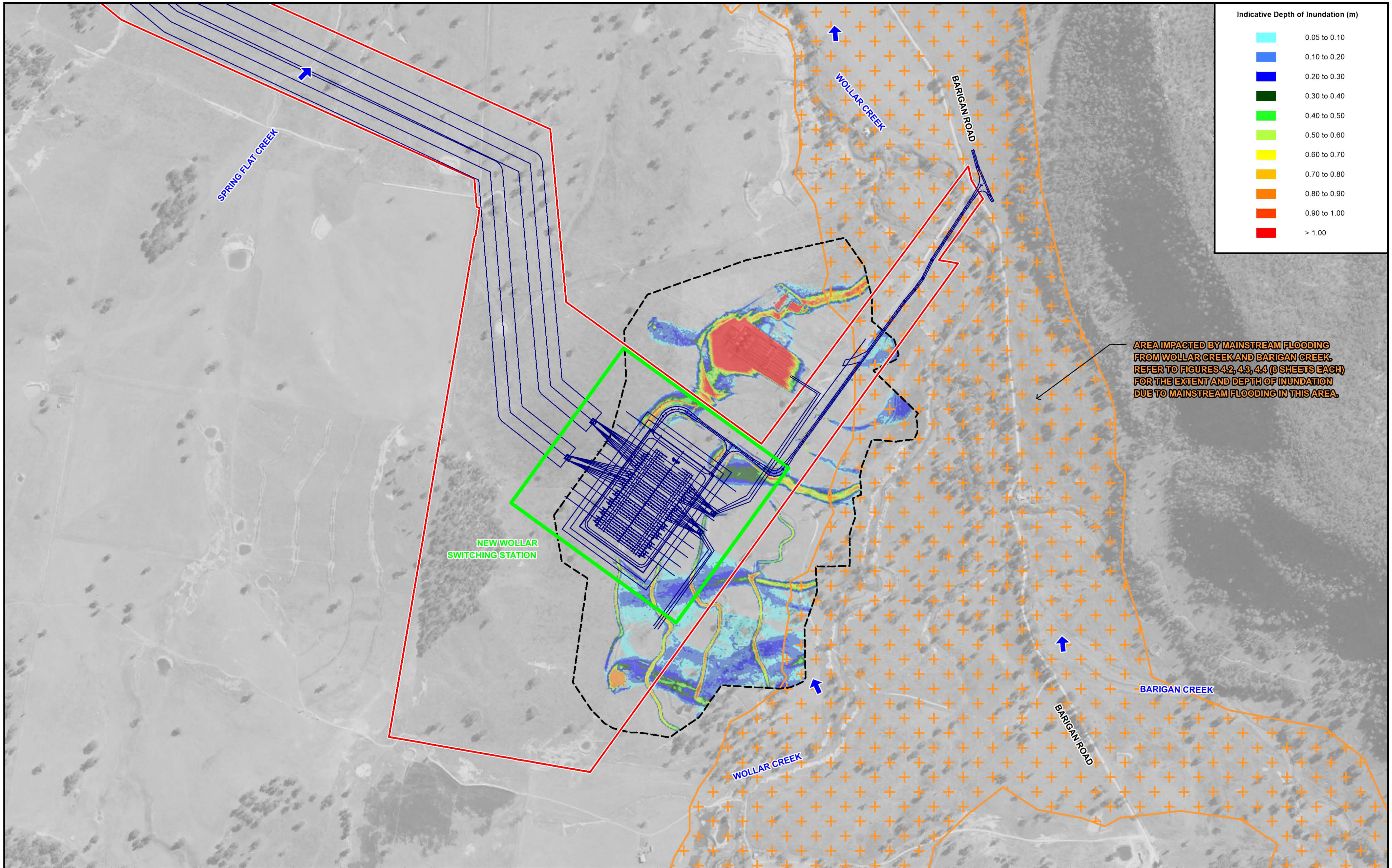
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.1b

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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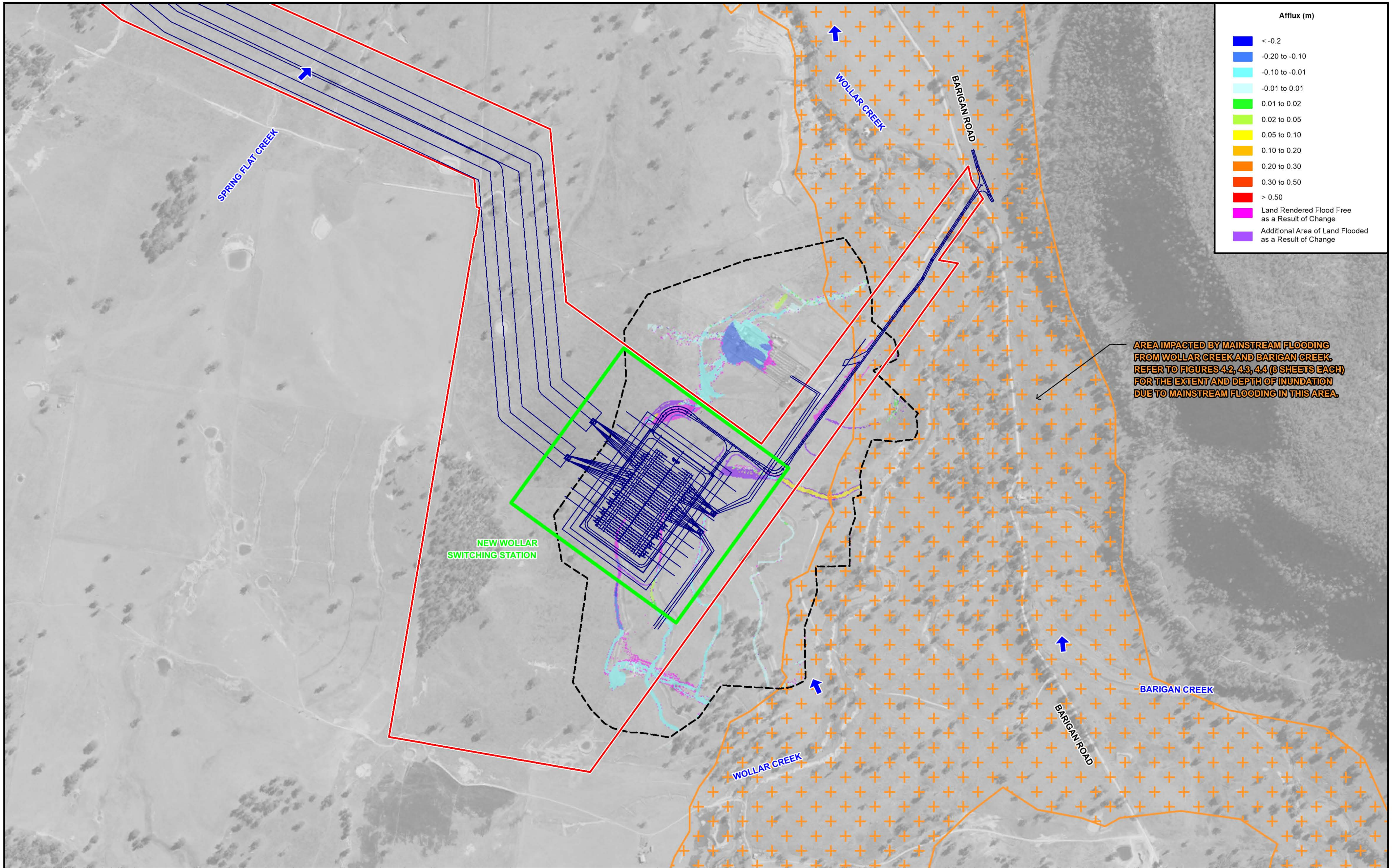
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.1c

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
PMF



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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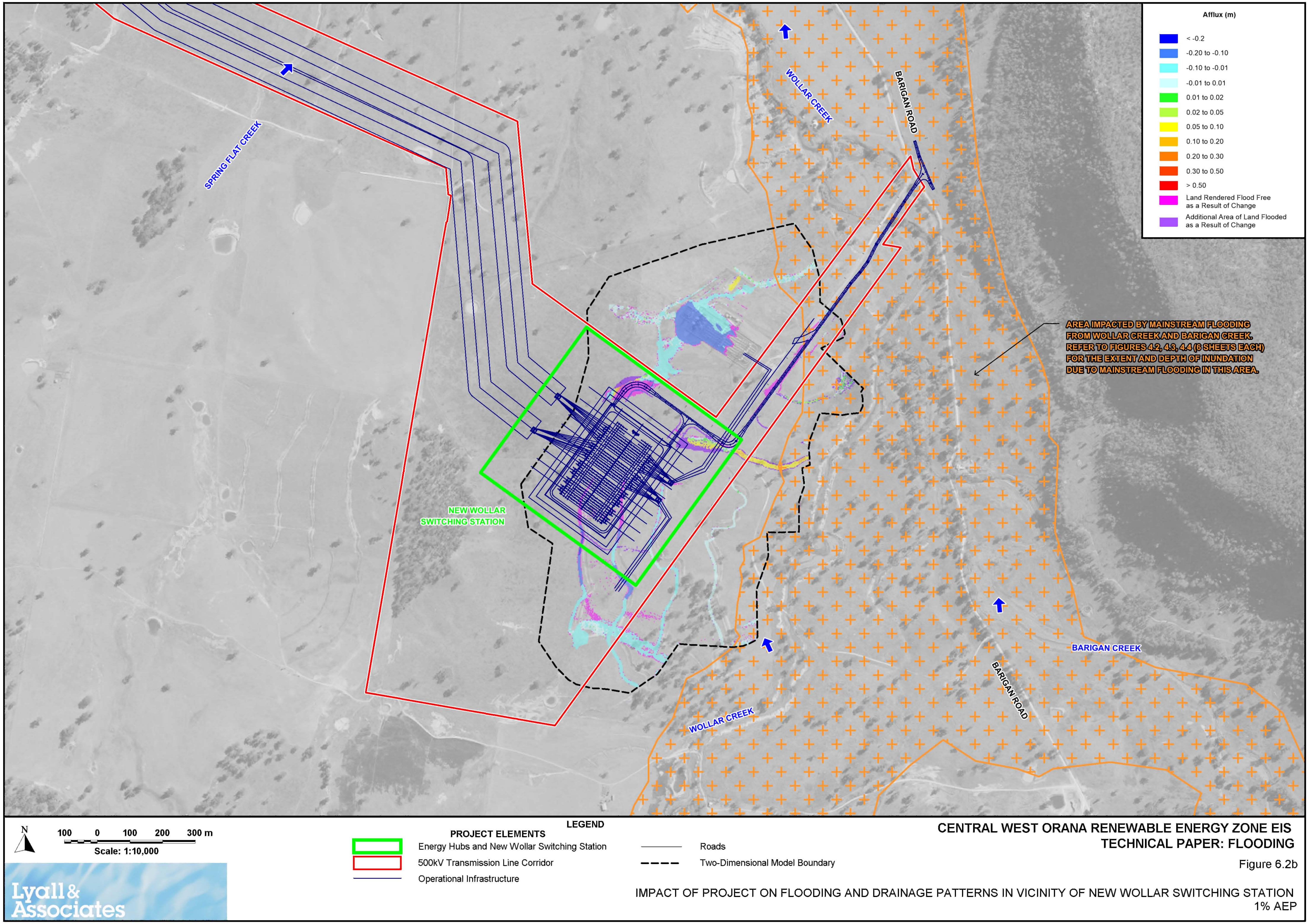
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.2a

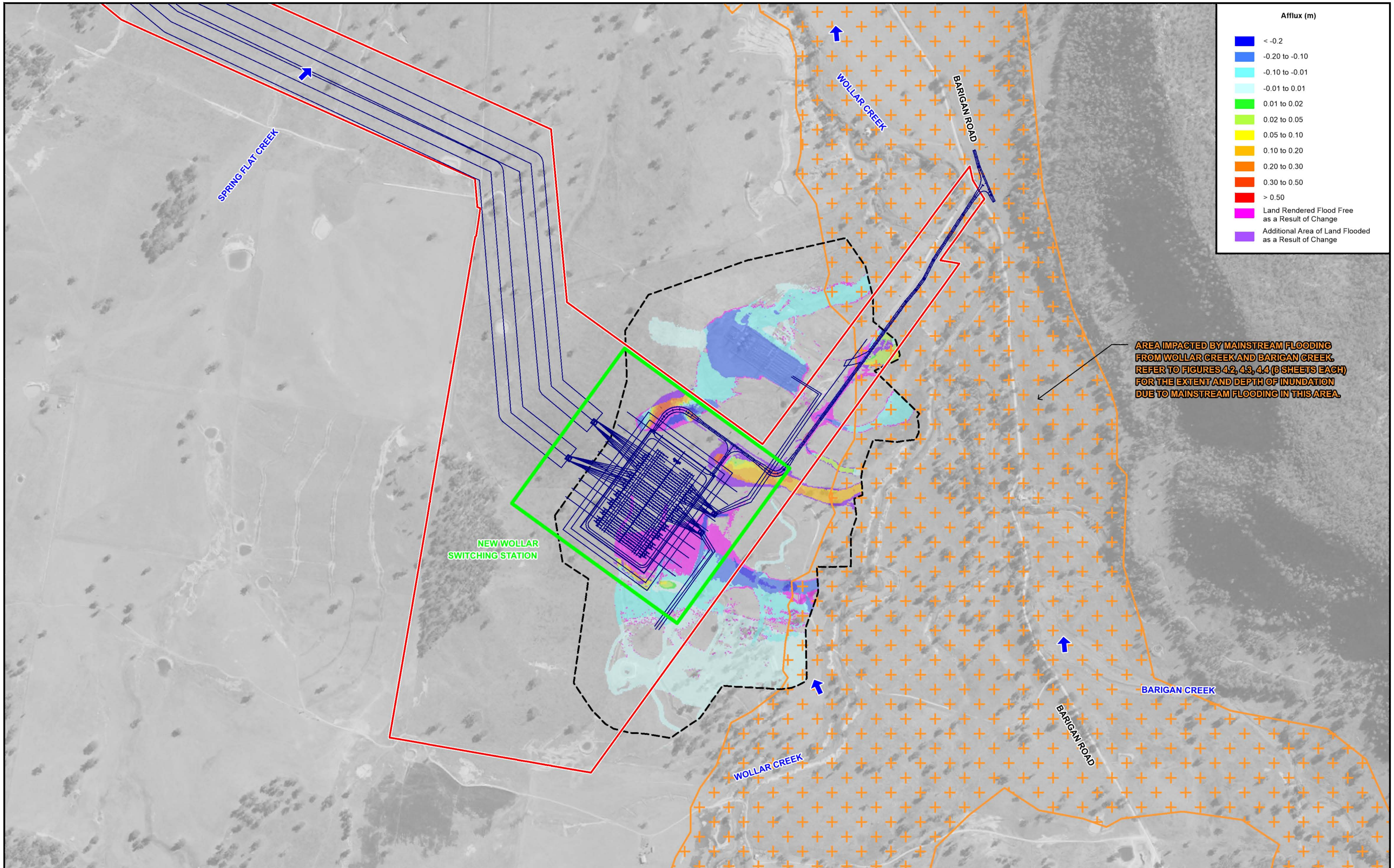
IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.2b

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Operational Infrastructure

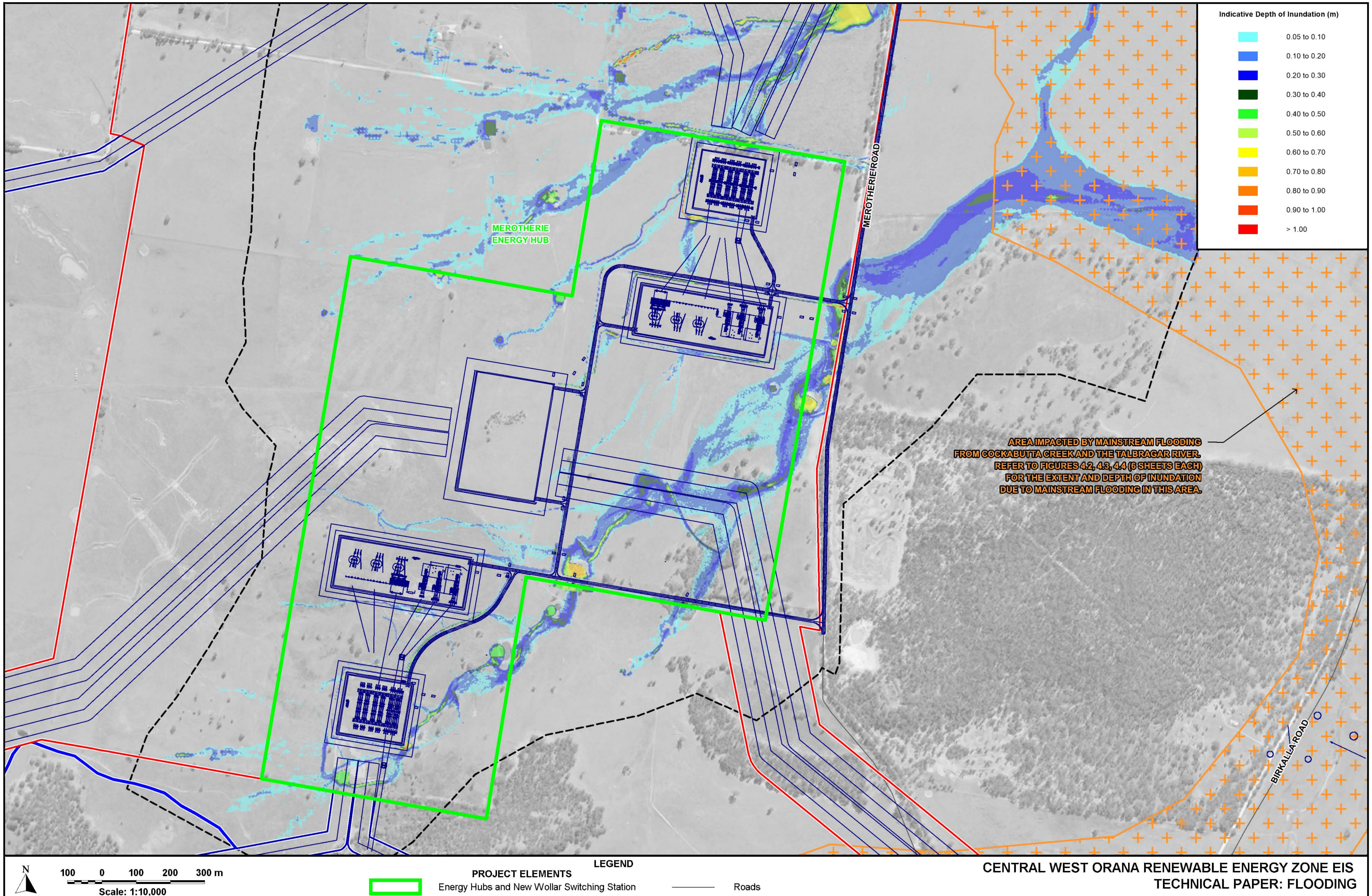
Roads

Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.2c

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF NEW WOLLAR SWITCHING STATION
PMF



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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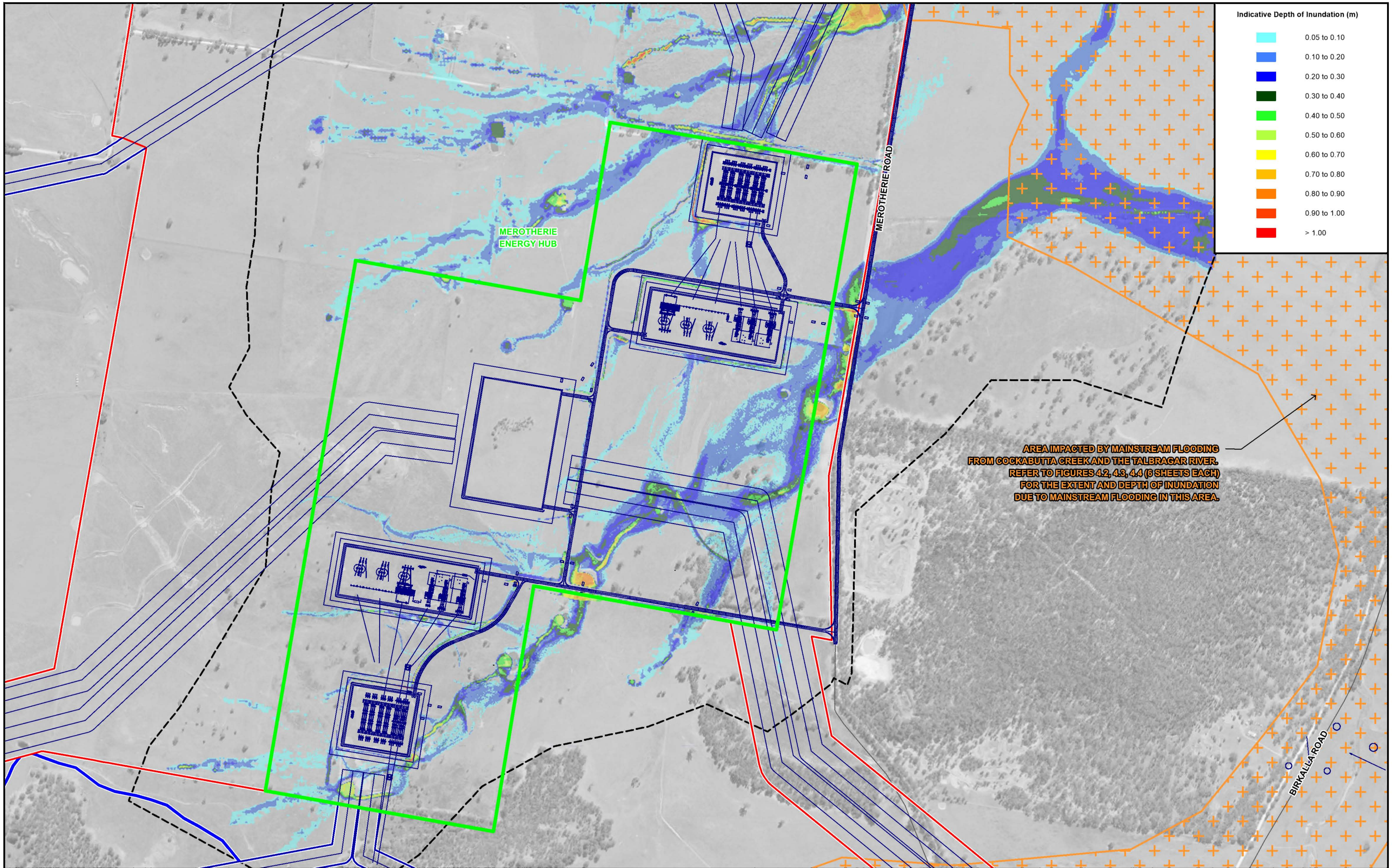
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.3a

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Operational Infrastructure

Roads

Two-Dimensional Model Boundary

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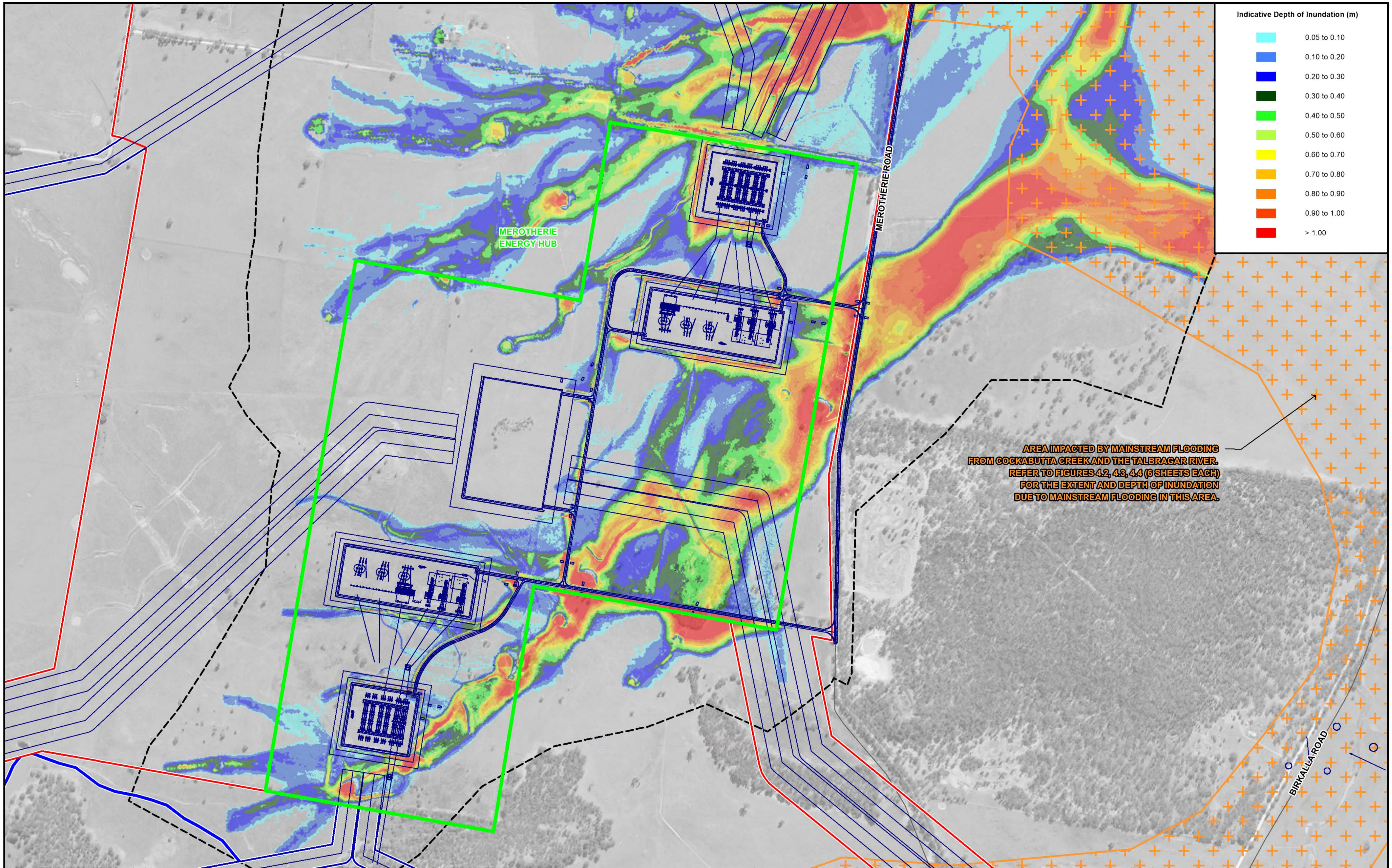
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure 6.3b

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB

1% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.3c

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
PMF

N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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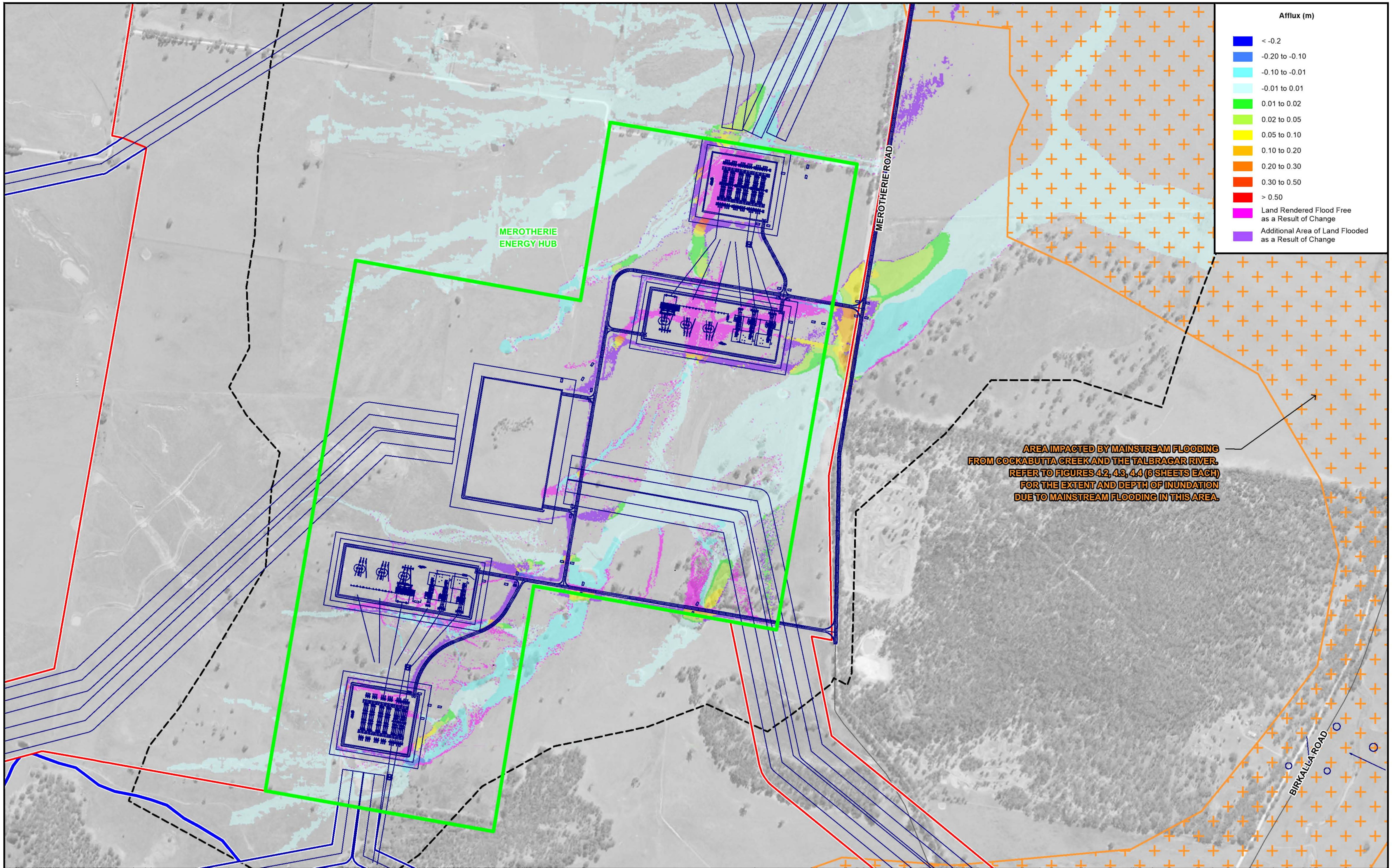
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.4a

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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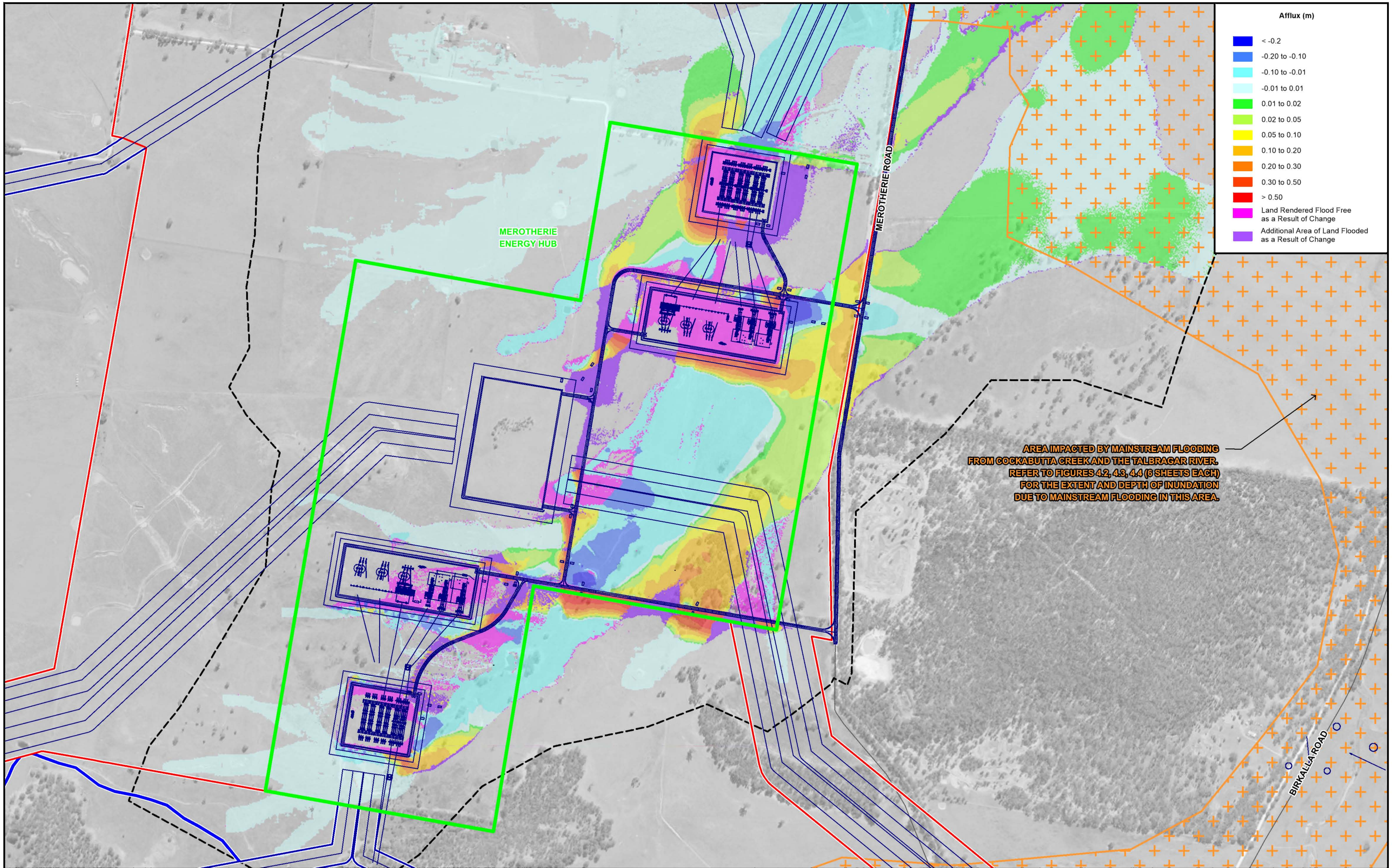
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.4b

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP



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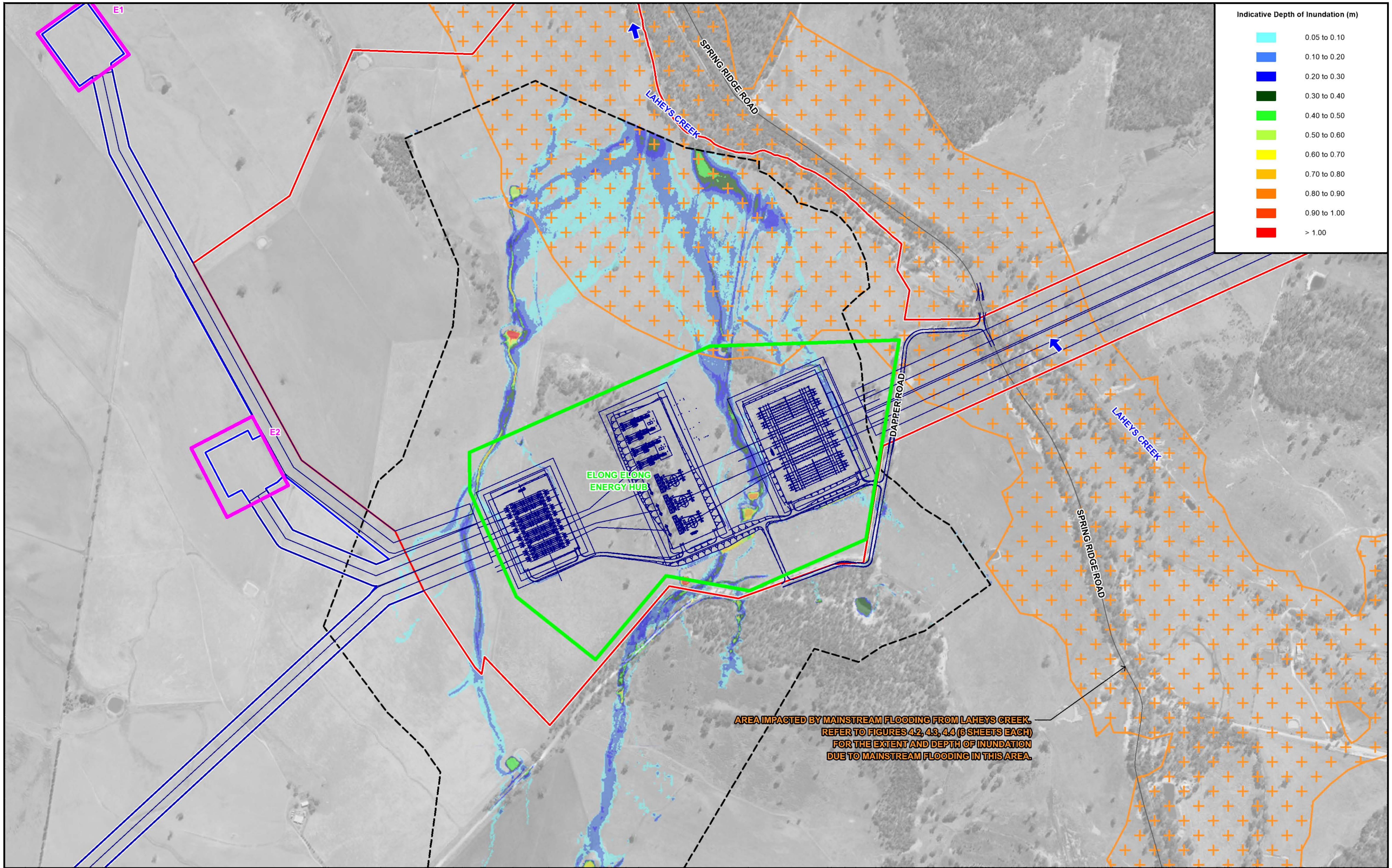
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.4c

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF MEROTHERIE ENERGY HUB
PMF



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

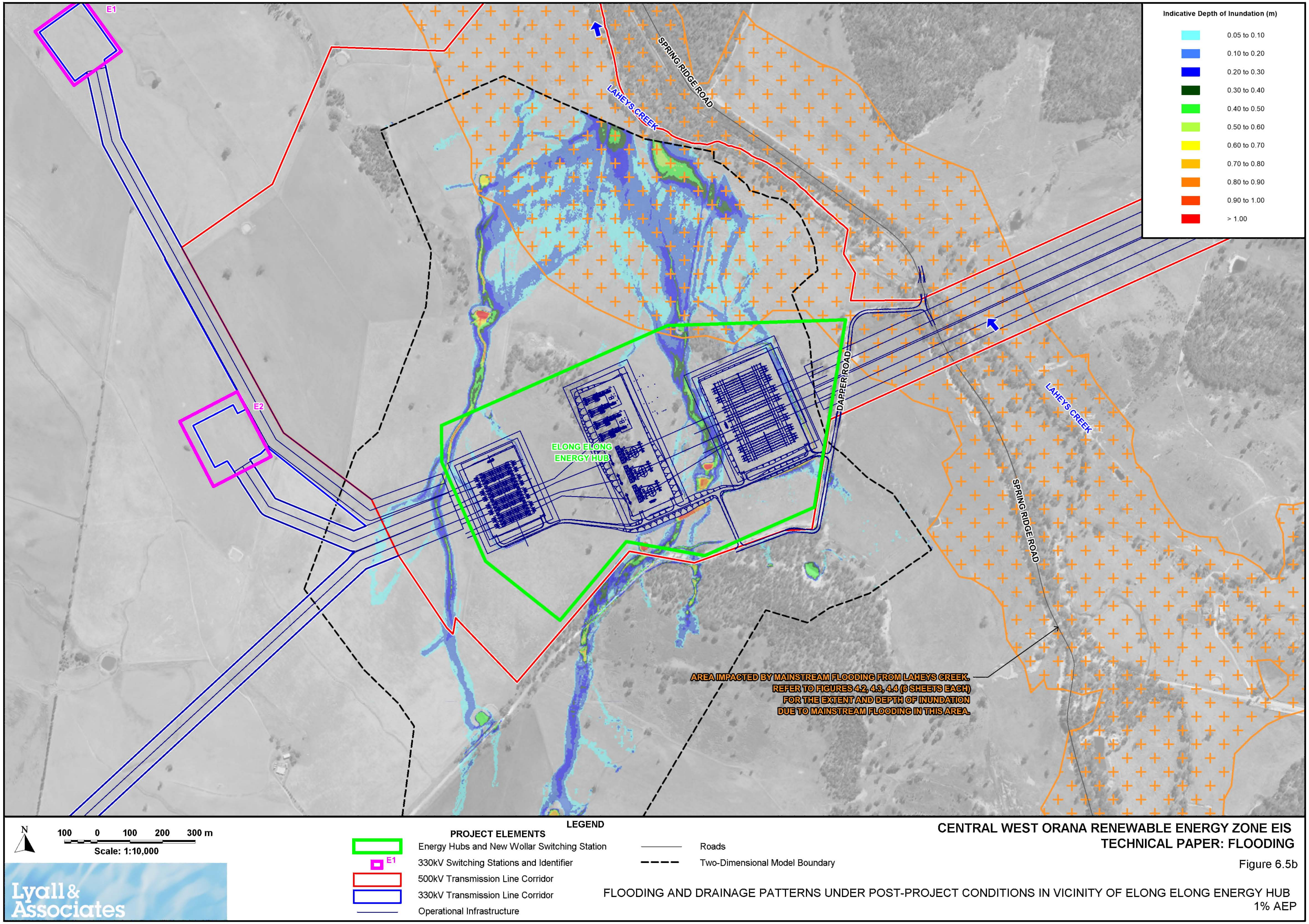
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.5a

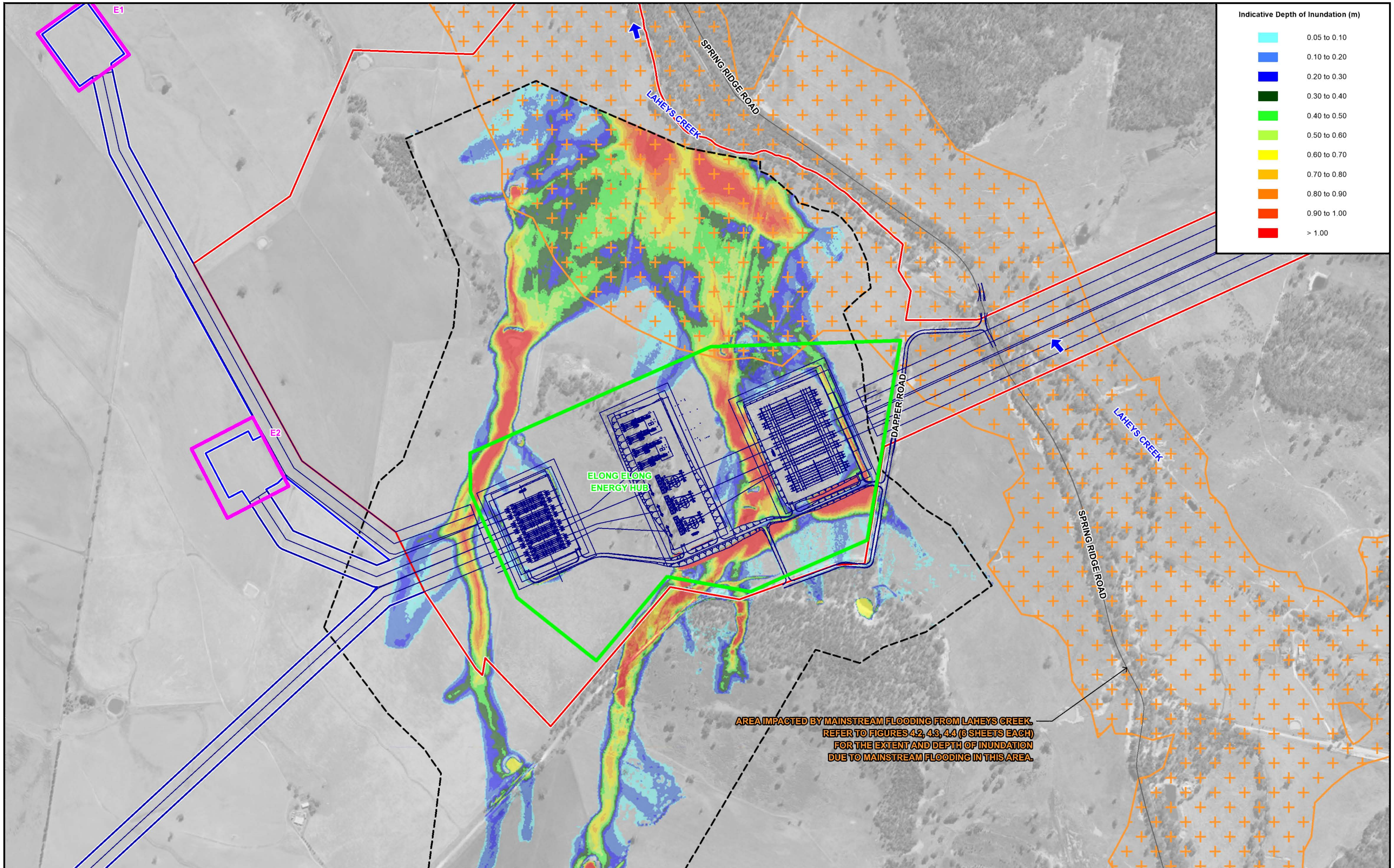
FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.5b

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

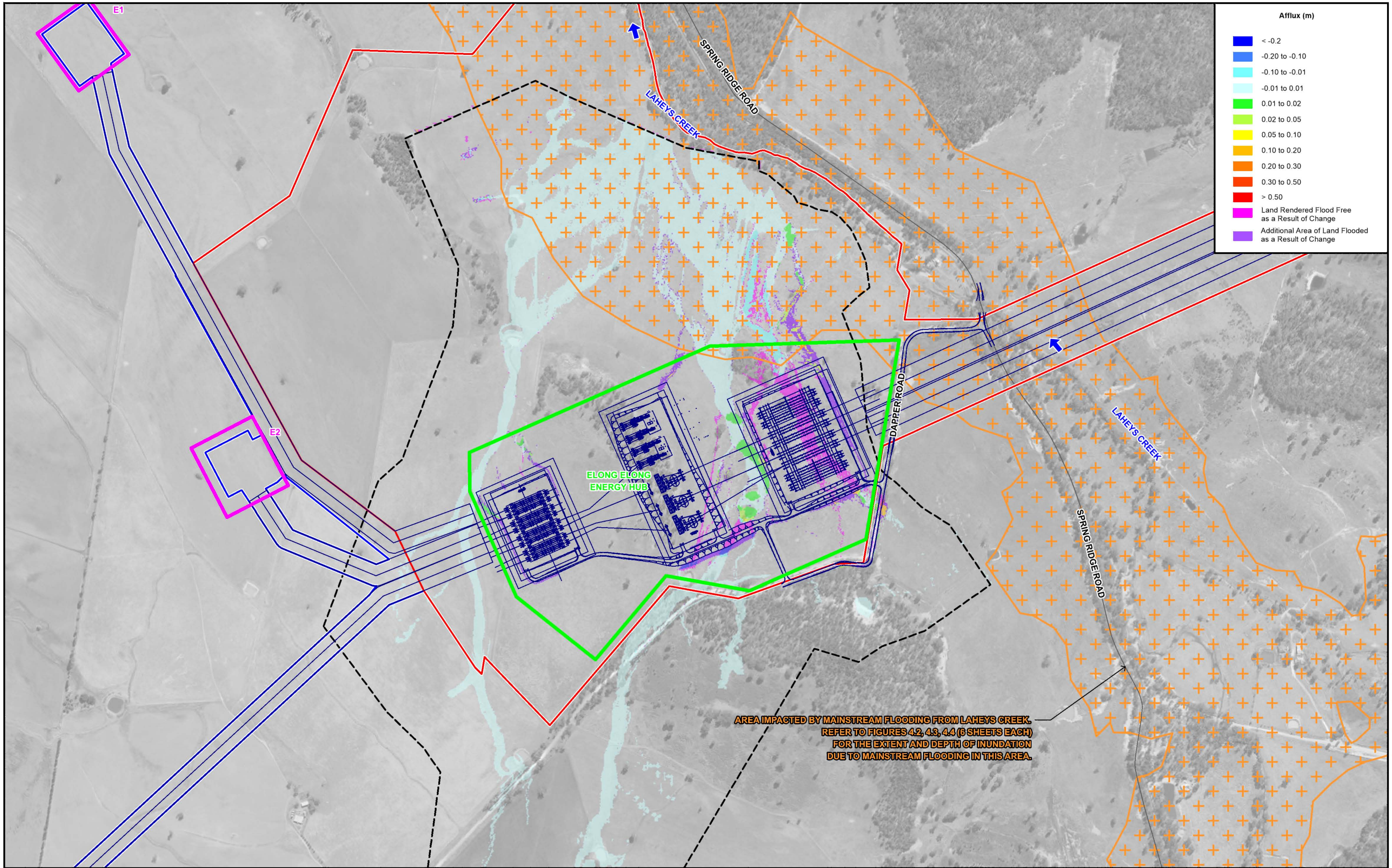
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.5c

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
PMF



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

E1 330kV Switching Stations and Identifier

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Operational Infrastructure

Roads

Two-Dimensional Model Boundary

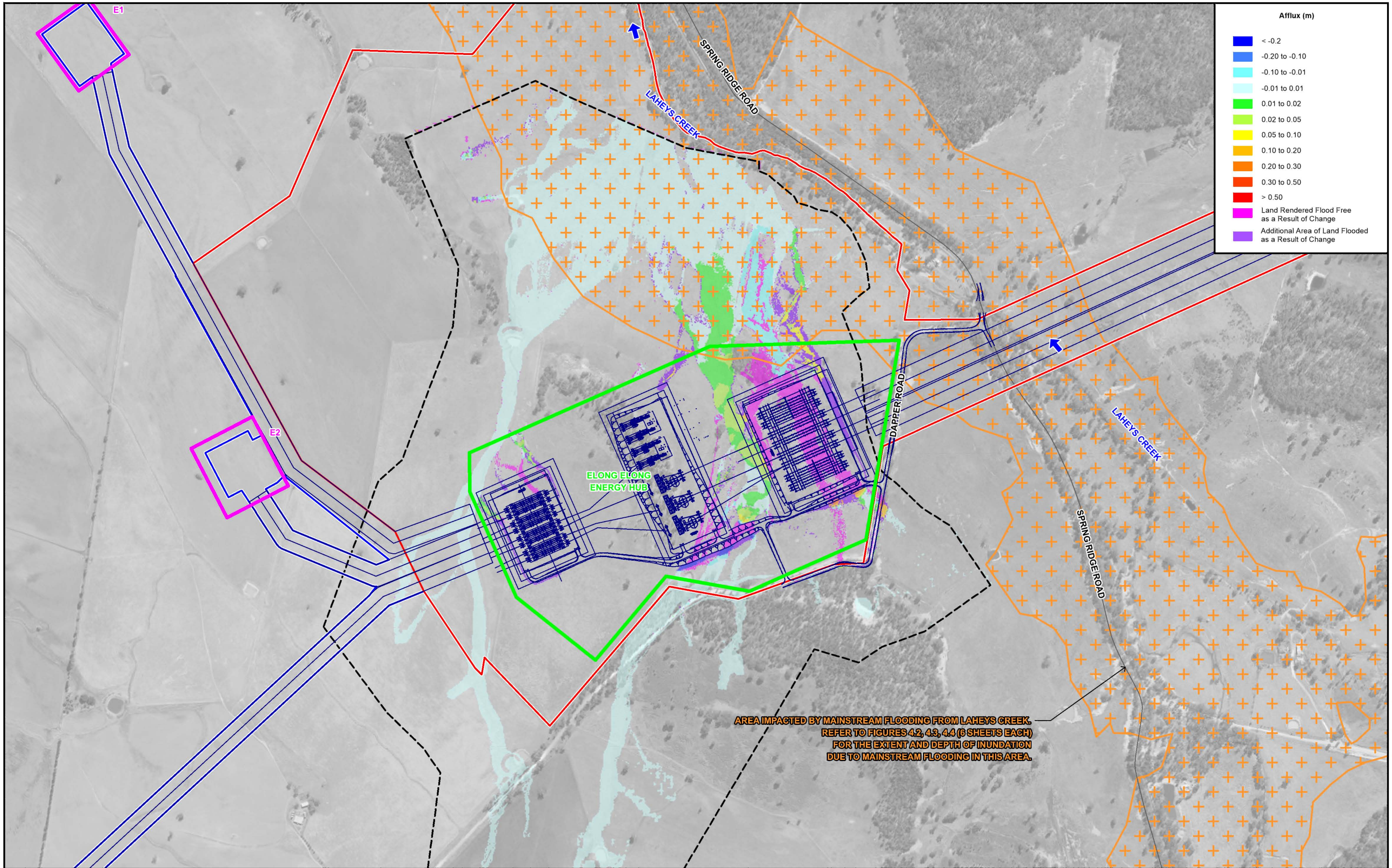
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure 6.6a

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF ELONG ELONG ENERGY HUB

10% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

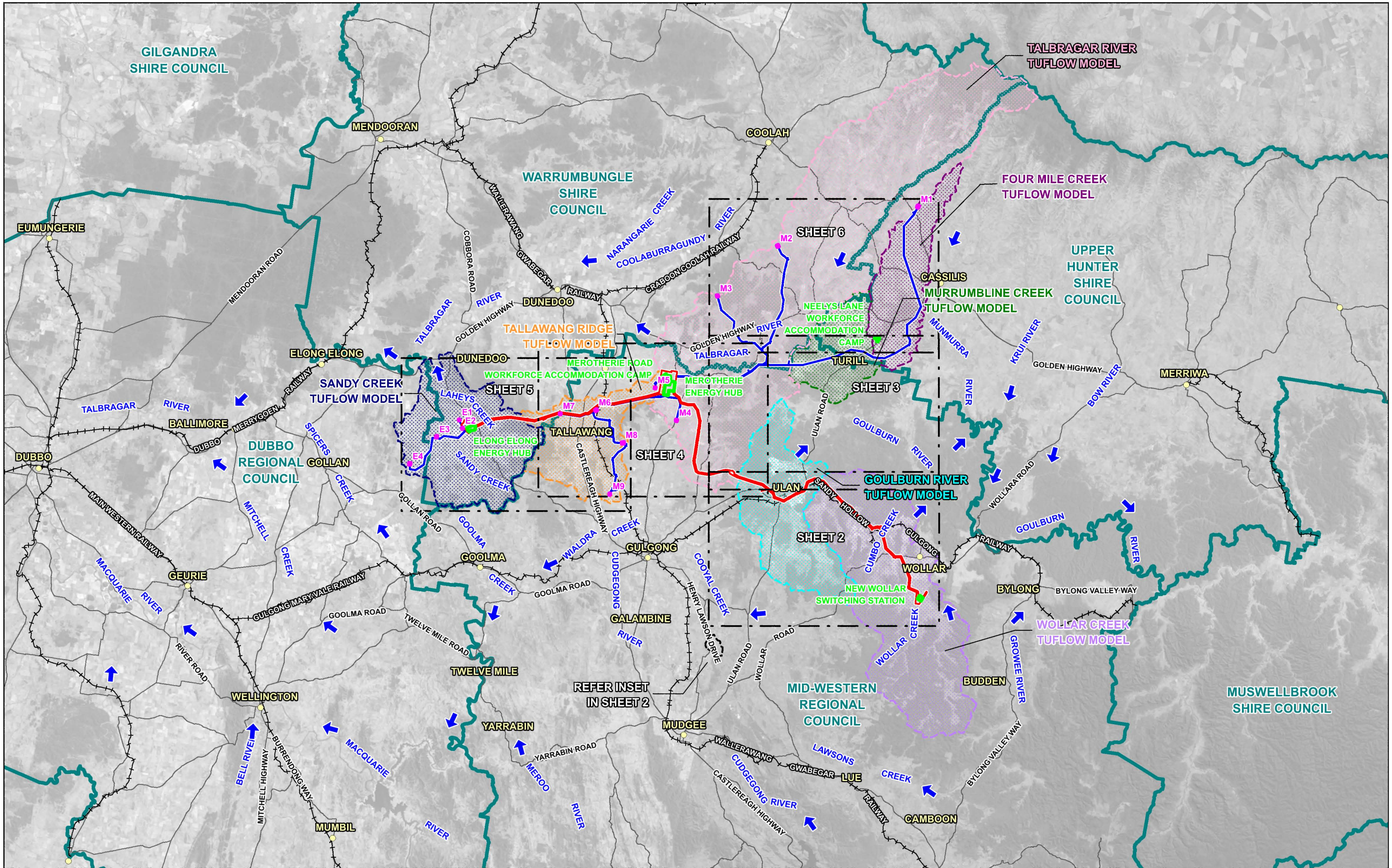
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 6.6b

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP

ANNEXURE A

FIGURES SHOWING THE LAYOUT OF THE HYDROLOGIC AND HYDRAULIC MODELS



5000 0 5000 10000 15000 m	Scale: 1:500,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Local Government Area (LGA) Boundary
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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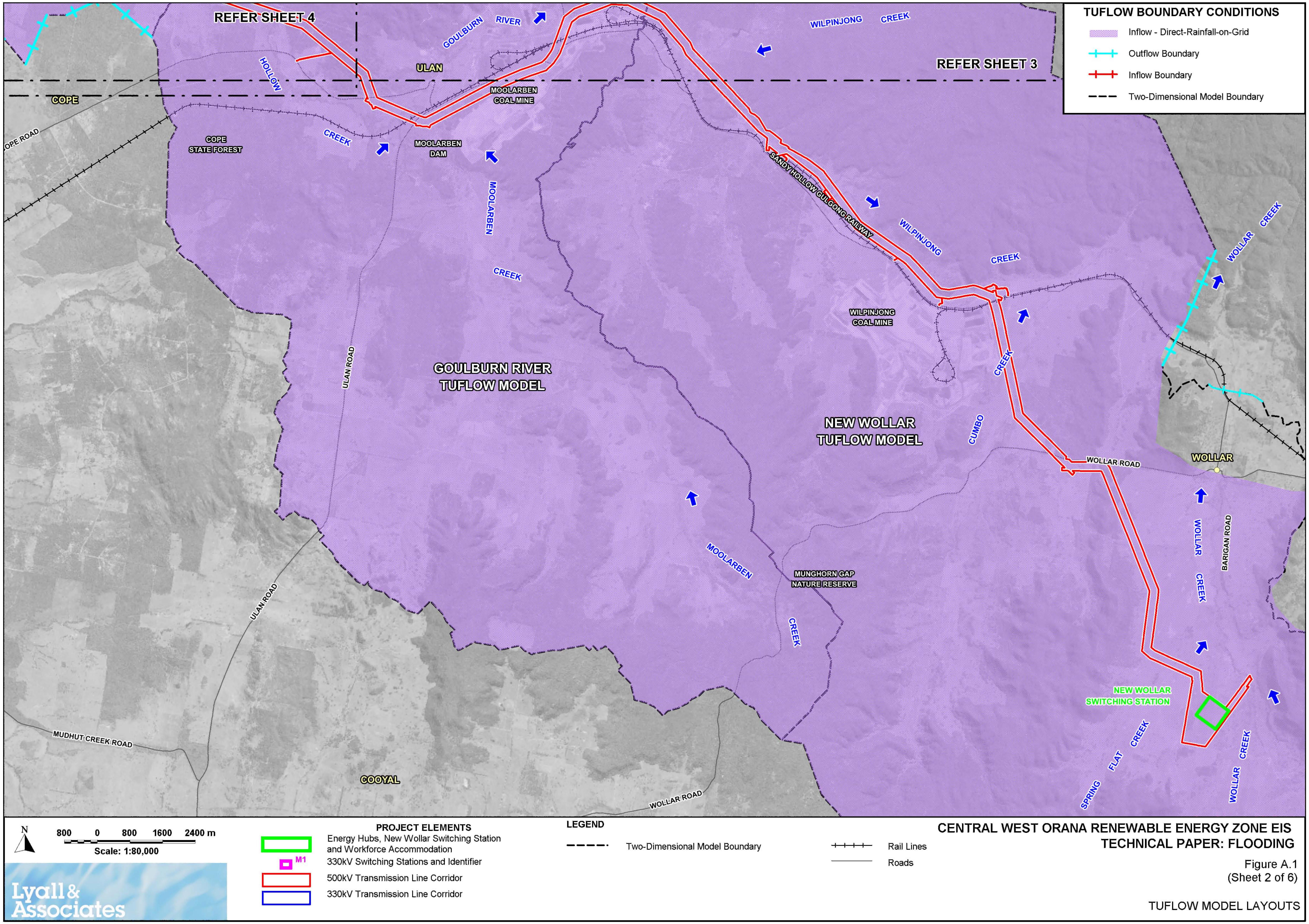
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.1
(Sheet 1 of 6)

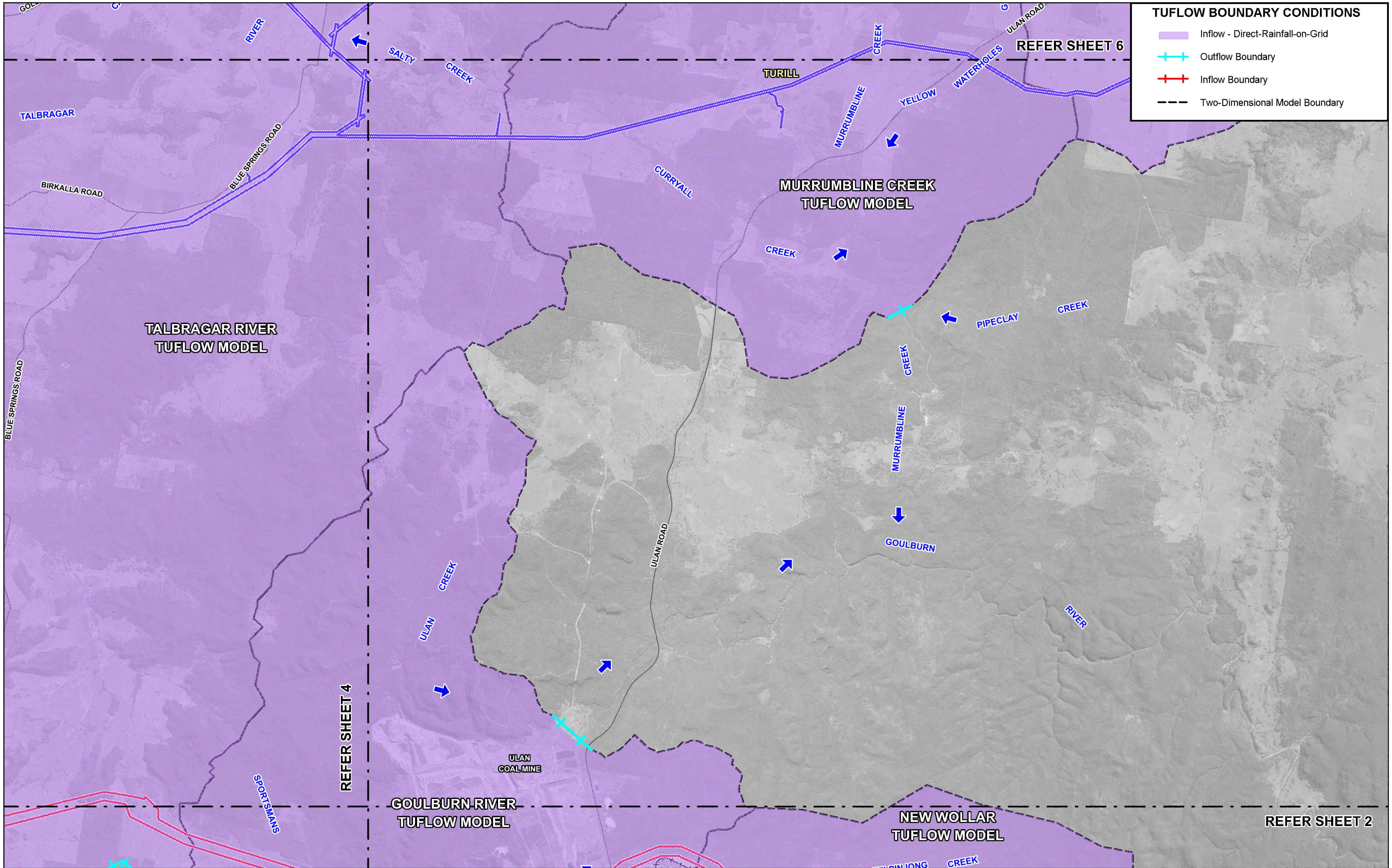
TUFLOW MODEL LAYOUTS



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.1
(Sheet 2 of 6)

TUFLOW MODEL LAYOUTS



N

800 0 800 1600 2400 m

Scale: 1:80,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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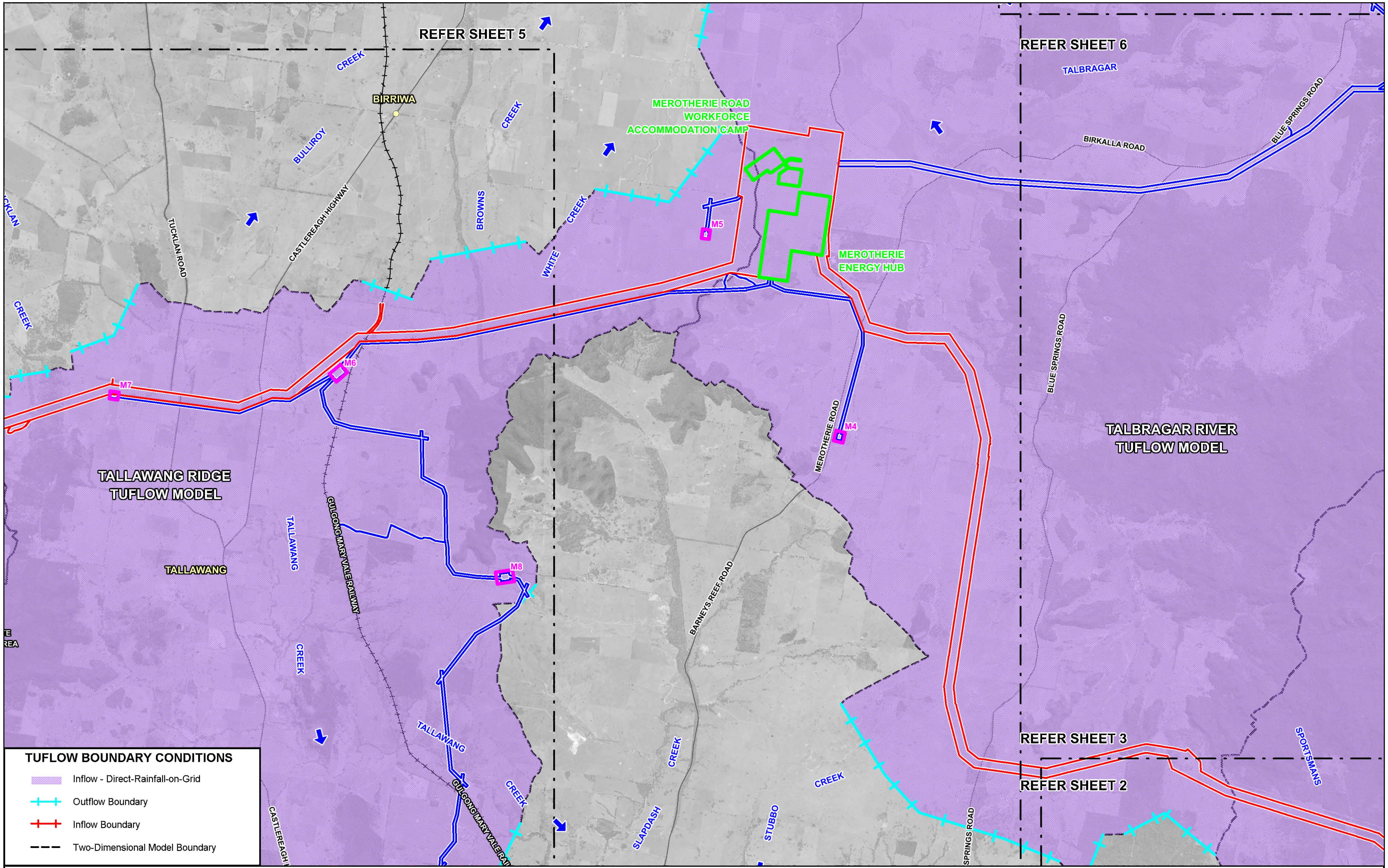
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure 4.2
(Sheet 3 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
10% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

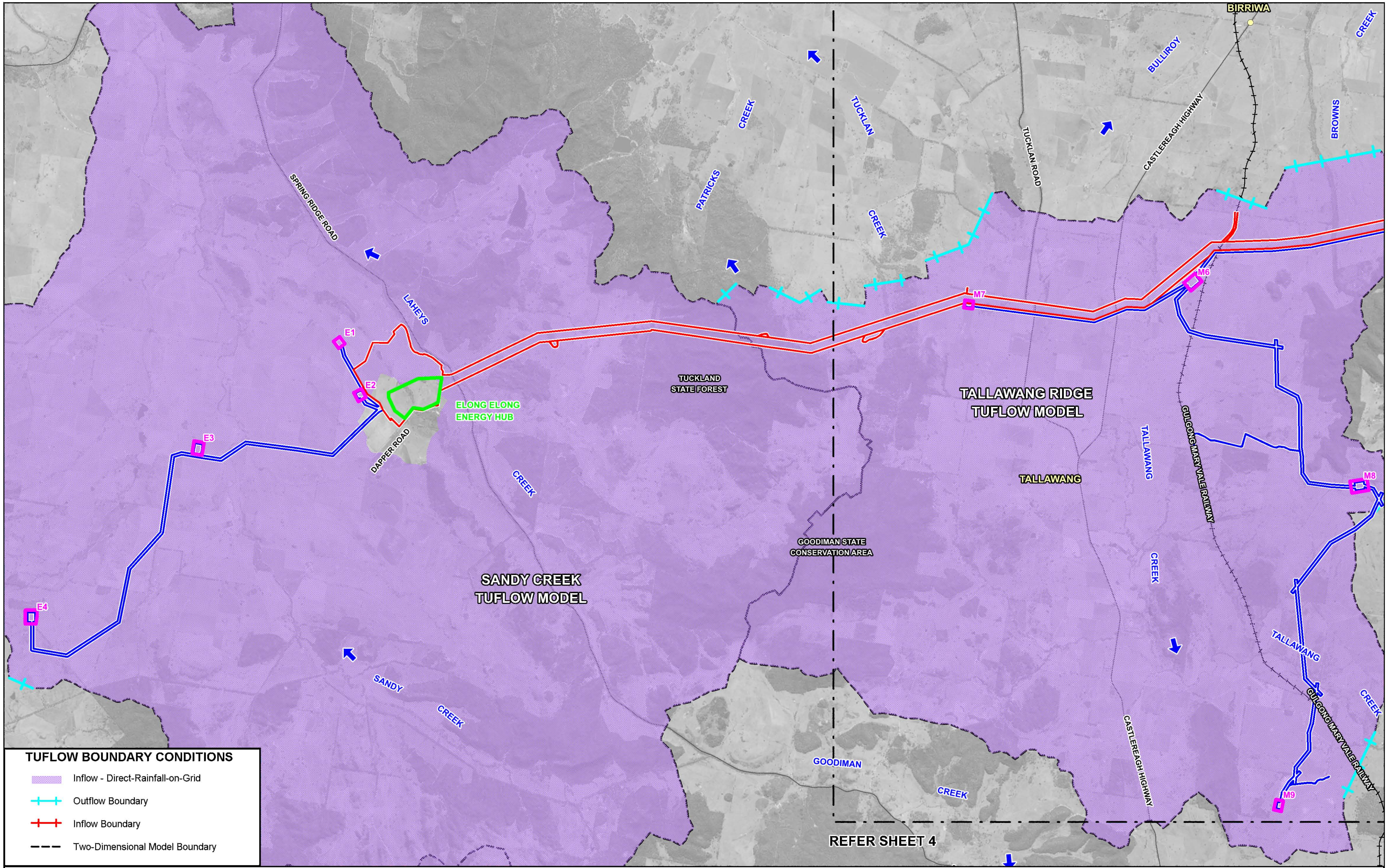
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.1
(Sheet 4 of 6)

TUFLOW MODEL LAYOUTS



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

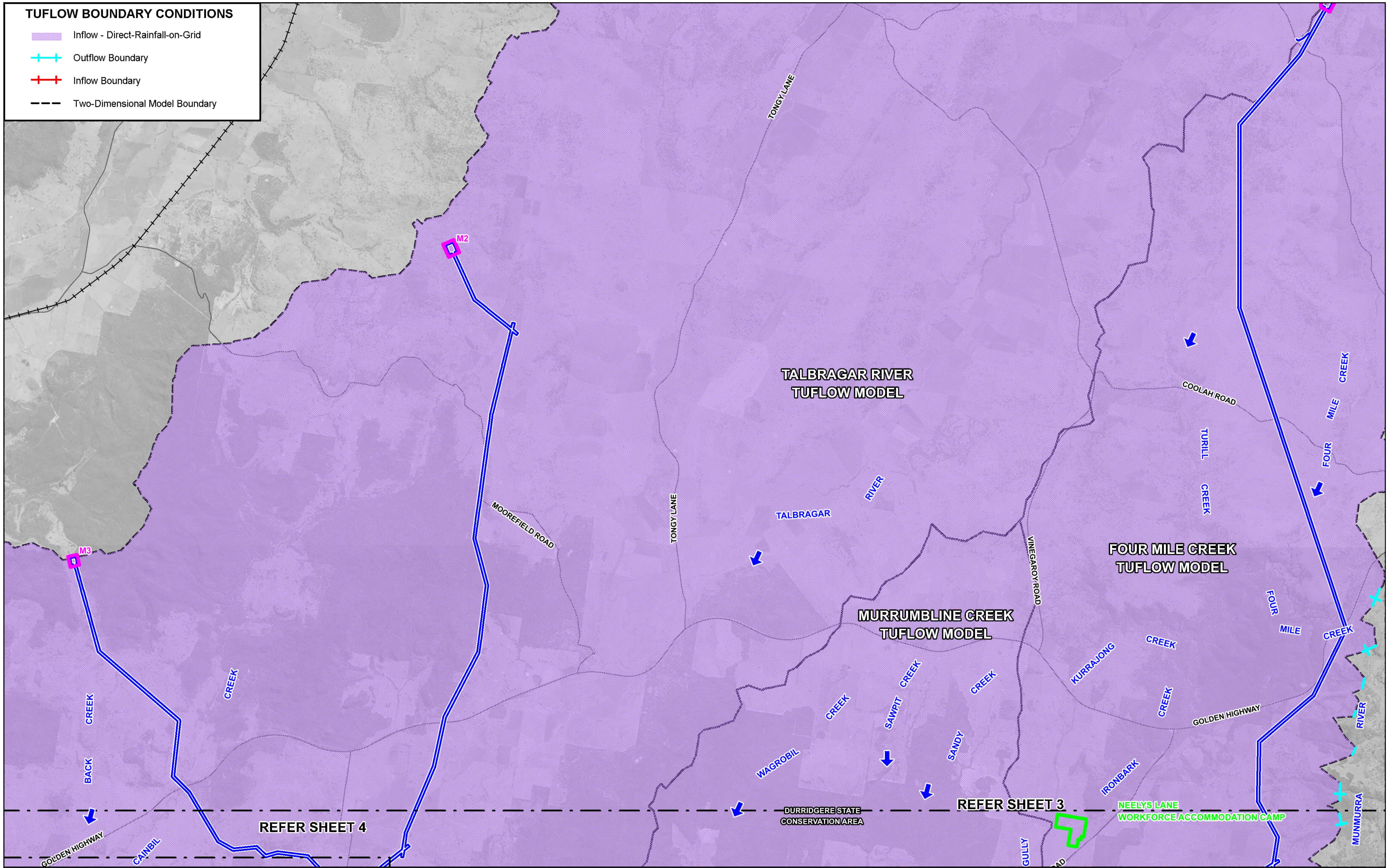
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.1
(Sheet 5 of 6)

TUFLOW MODEL LAYOUTS



N

800 0 800 1600 2400 m

Scale: 1:80,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

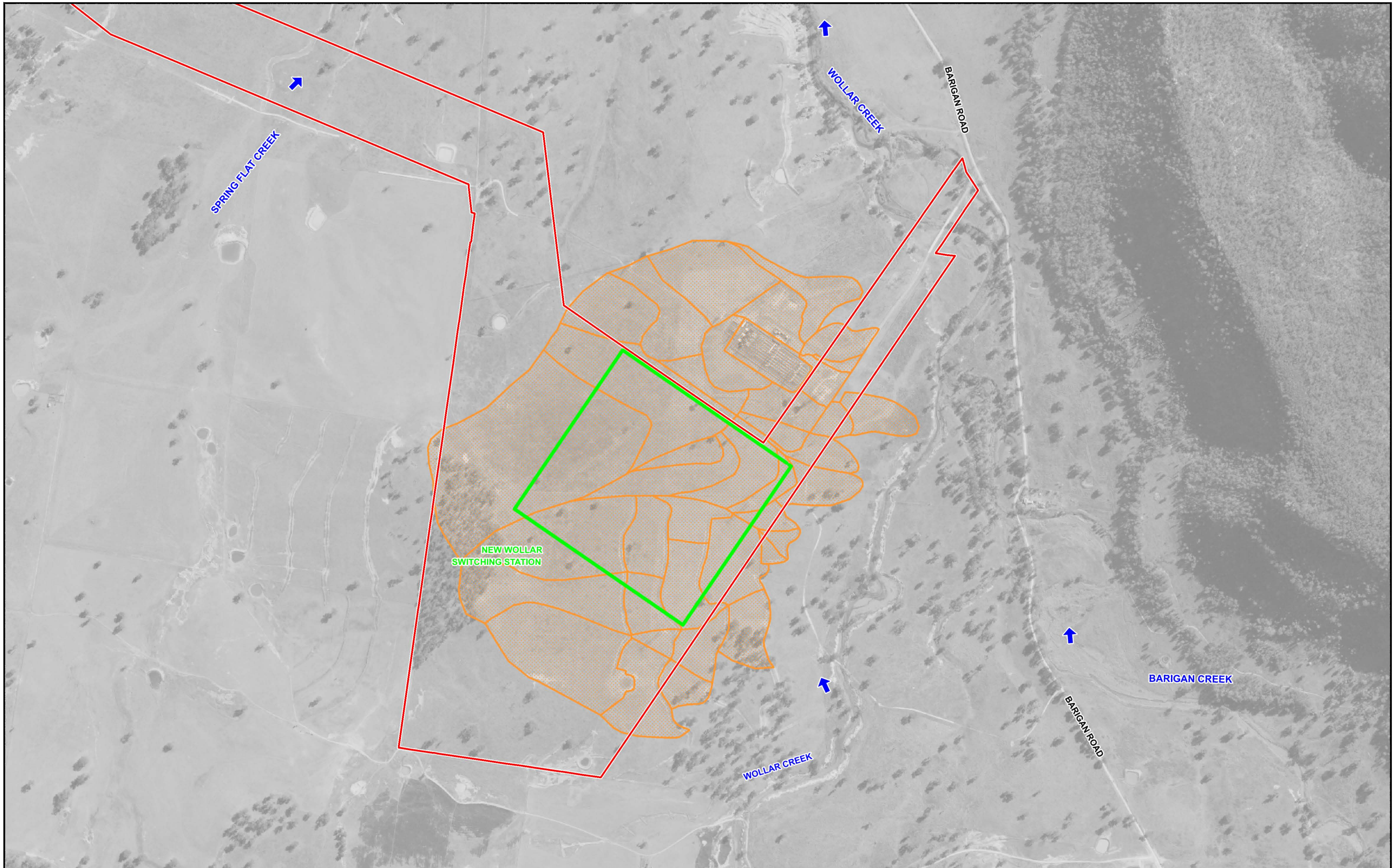
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.1
(Sheet 6 of 6)

TUFLOW MODEL LAYOUTS



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

RAFTS Sub-Catchment Extent

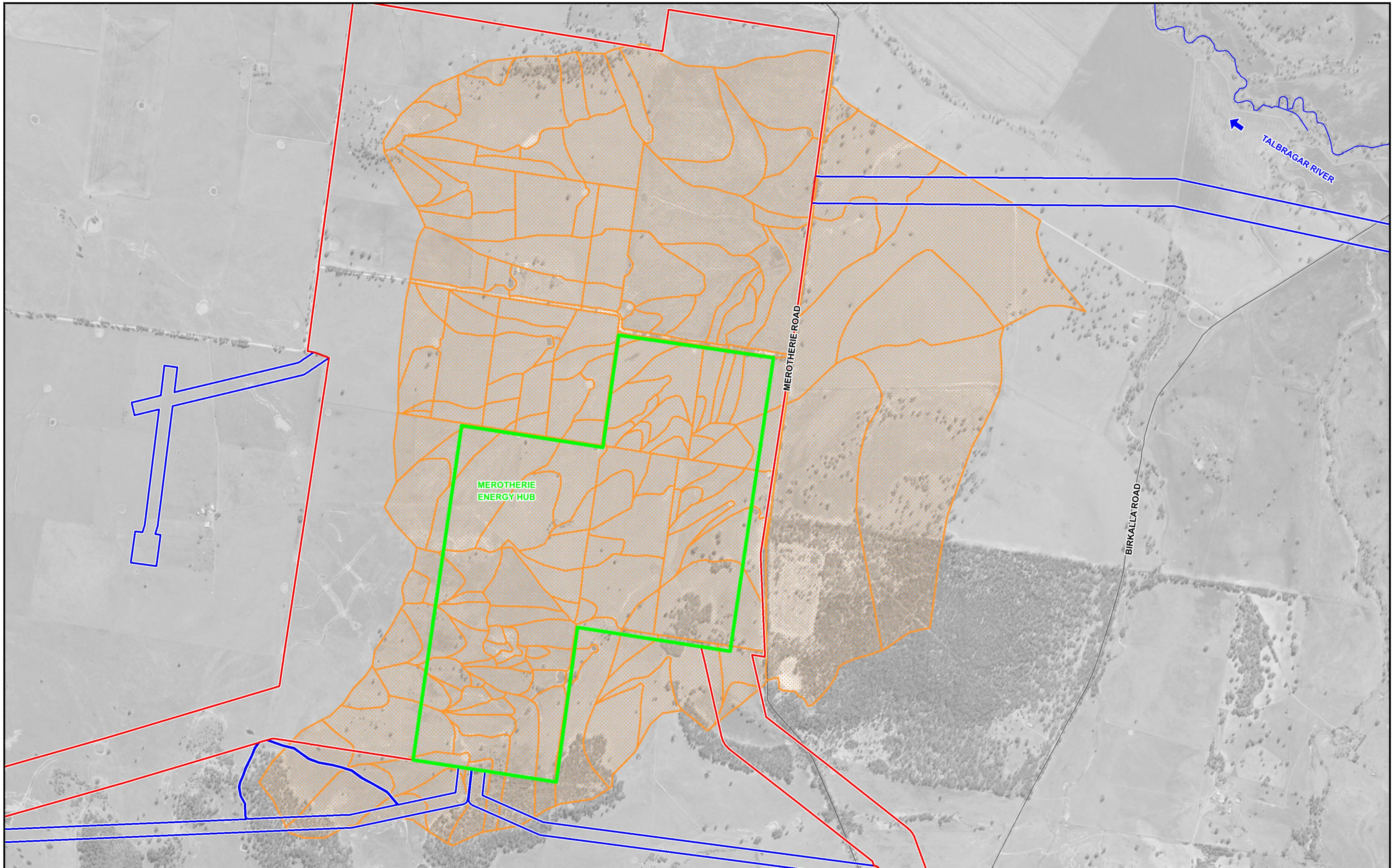
Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure A.2

NEW WOLLAR SWITCHING STATION DRAINS SUB-CATCHMENT LAYOUT



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- RAFTS Sub-Catchment Extent

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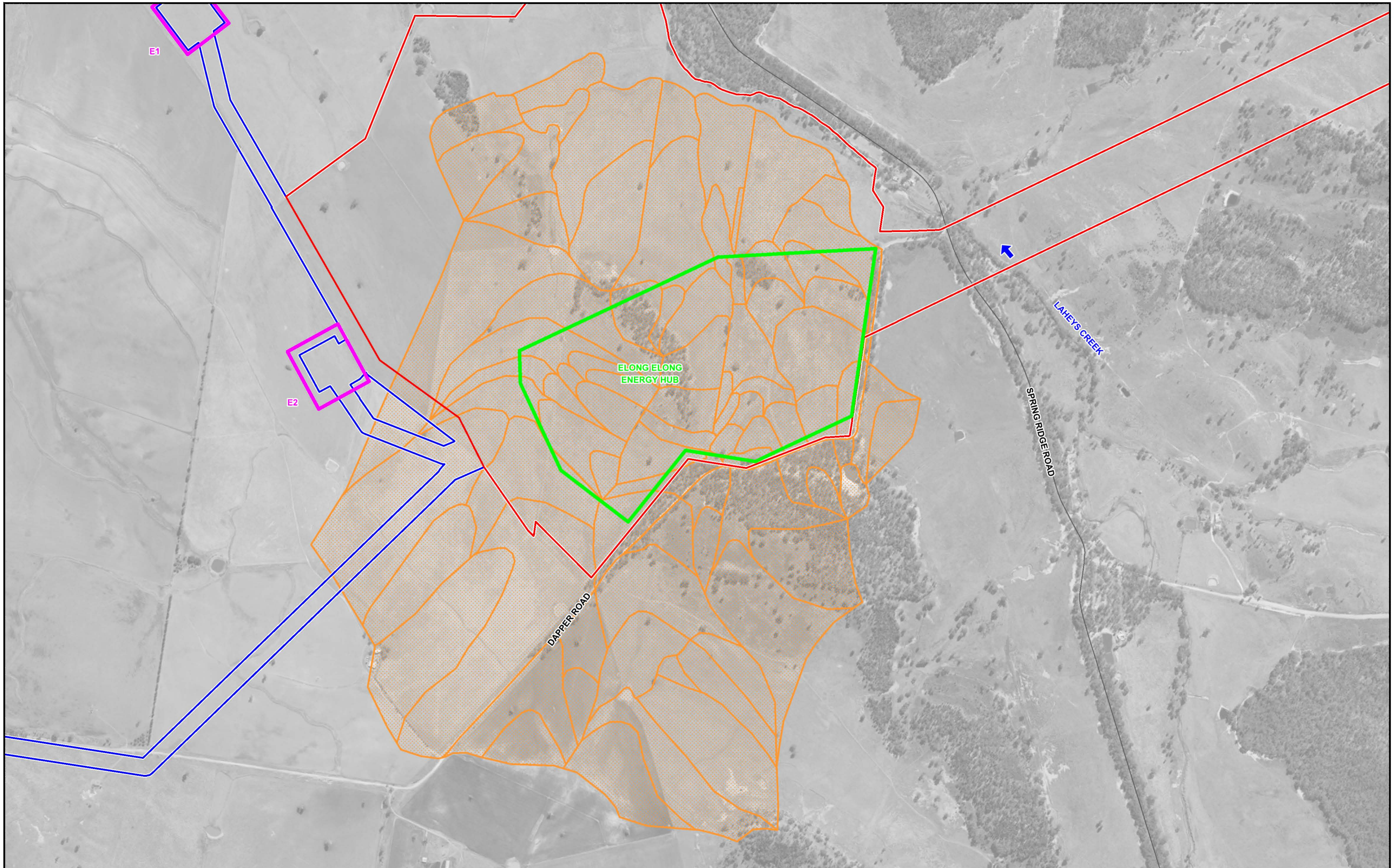
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.3

MEROTHERIE ENERGY HUB DRAINS SUB-CATCHMENT LAYOUT



LEGEND

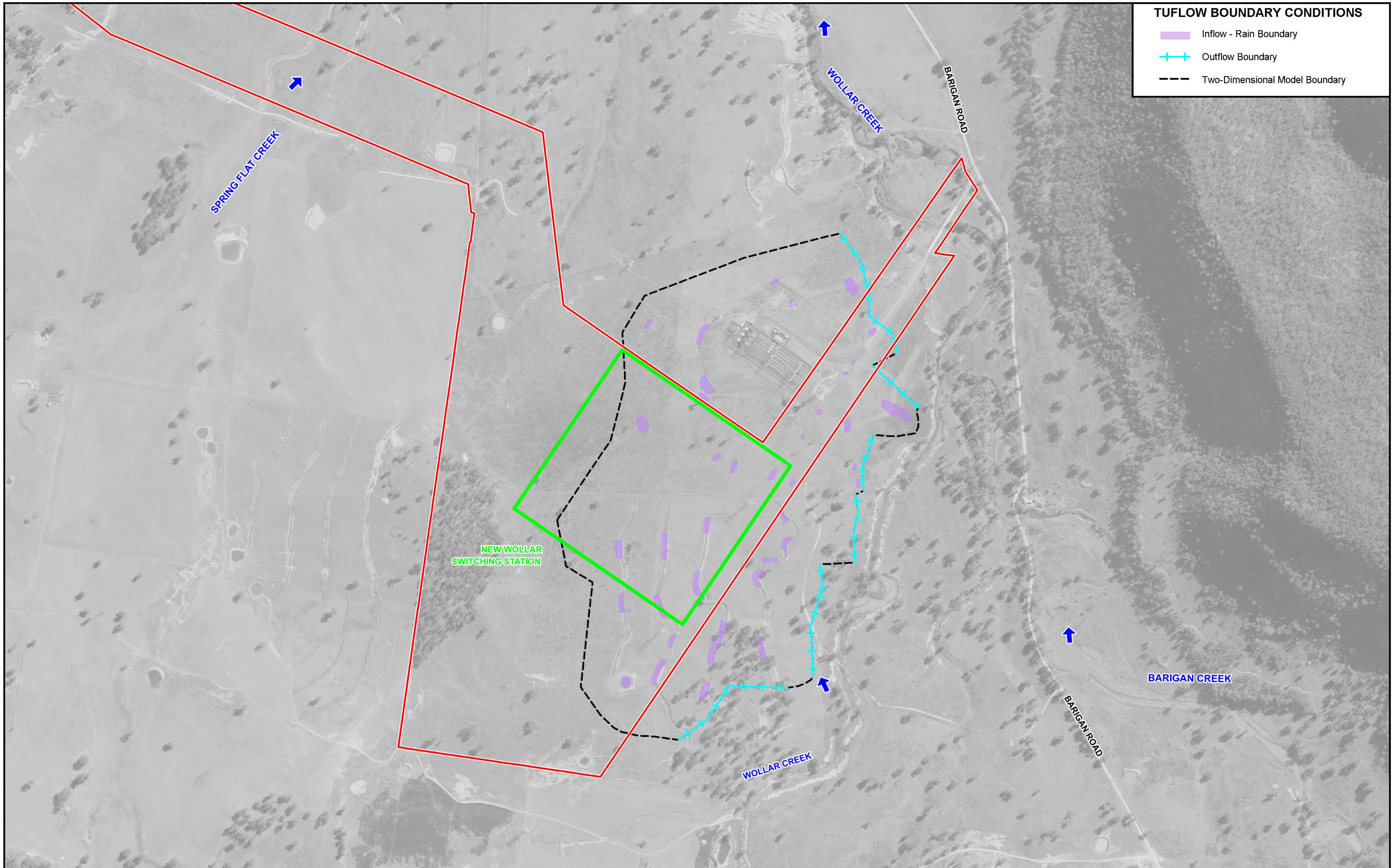
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- RAFTS Sub-Catchment Extent

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.4

ELONG ELONG ENERGY HUB DRAINS SUB-CATCHMENT LAYOUT



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

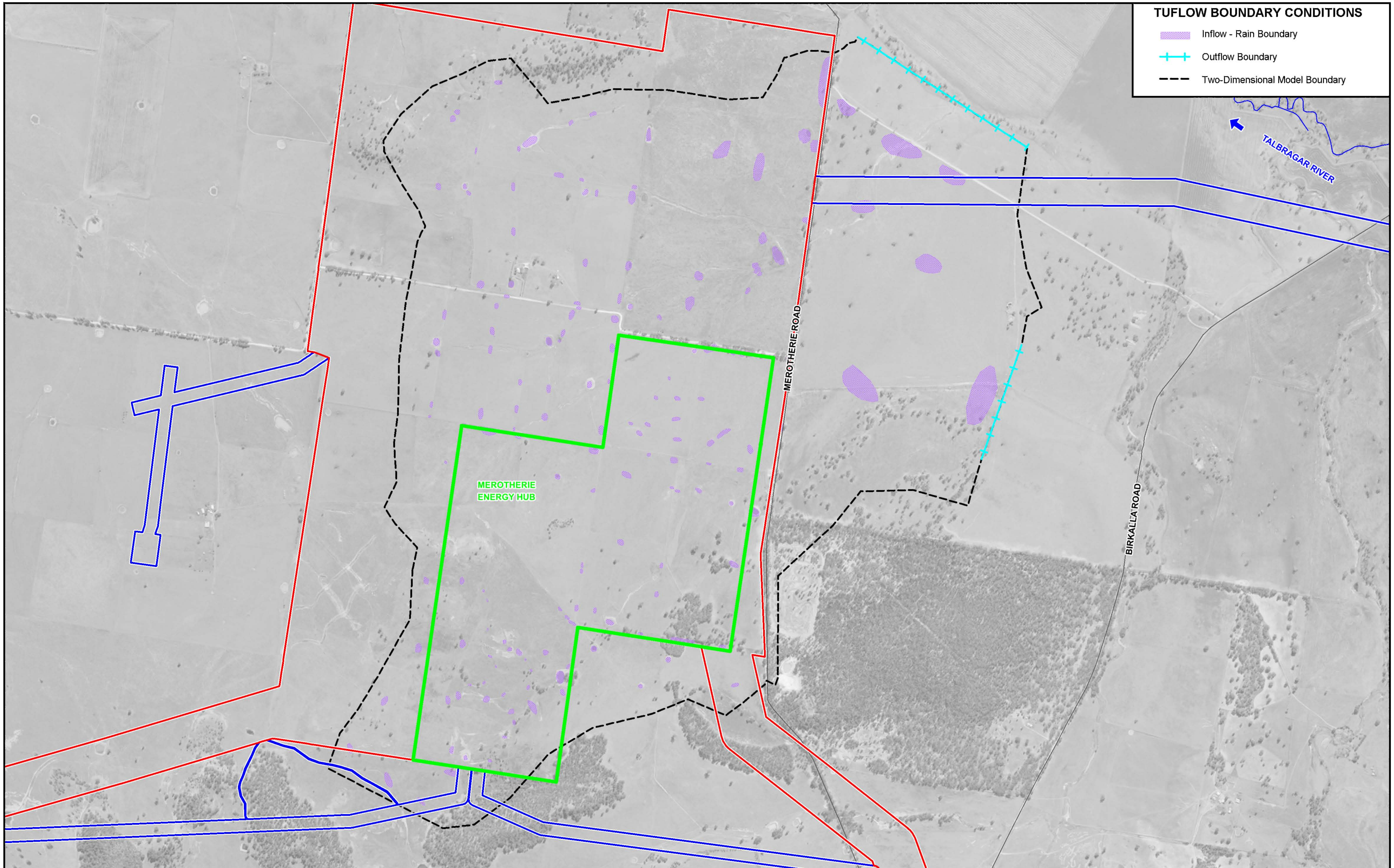
Roads

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.5

NEW WOLLAR SWITCHING STATION TUFLOW MODEL LAYOUT



N

160 0 160 320 480 m

Scale: 1:16,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Roads

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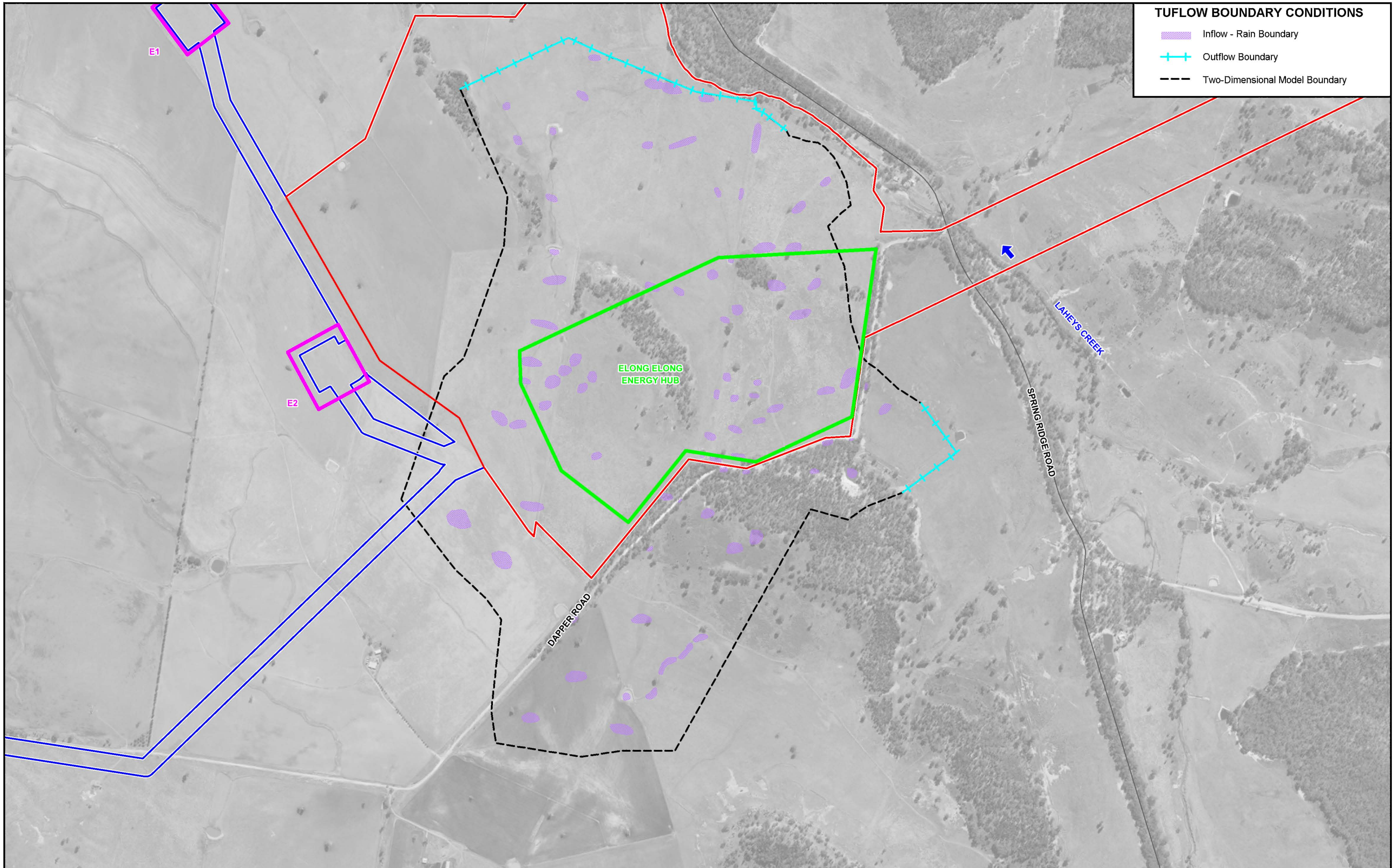
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.6

MEROTHERIE ENERGY HUB TUFLOW MODEL LAYOUT



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads

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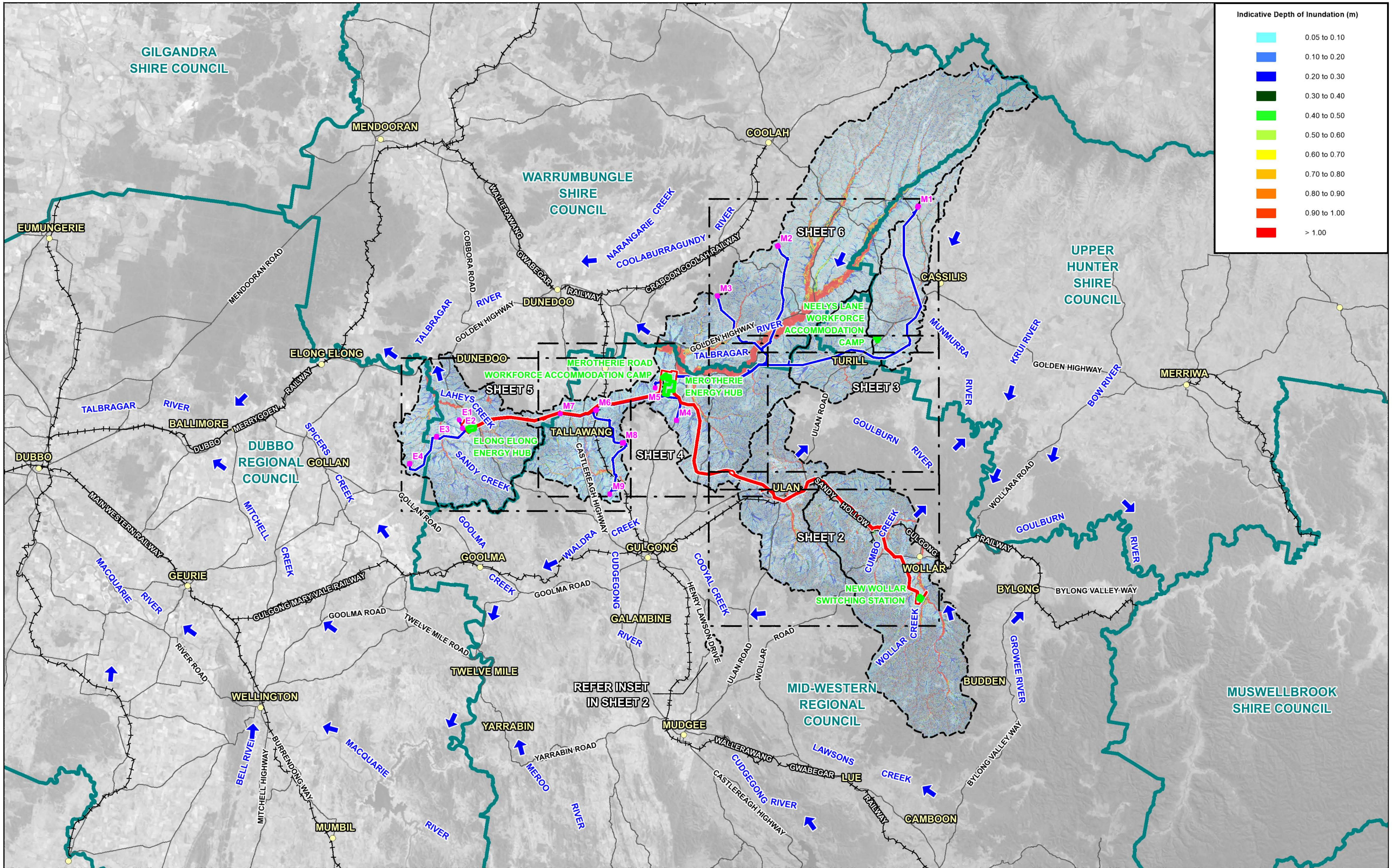
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure A.7

ELONG ELONG ENERGY HUB TUFLOW MODEL LAYOUT

ANNEXURE B

FIGURES SHOWING THE INDICATIVE EXTENT AND DEPTH OF INUNDATION ACROSS THE PROJECT DURING A 0.5% AND 0.2% AEP EVENT



5000 0 5000 10000 15000 m

Scale: 1:500,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Local Government Area (LGA) Boundary
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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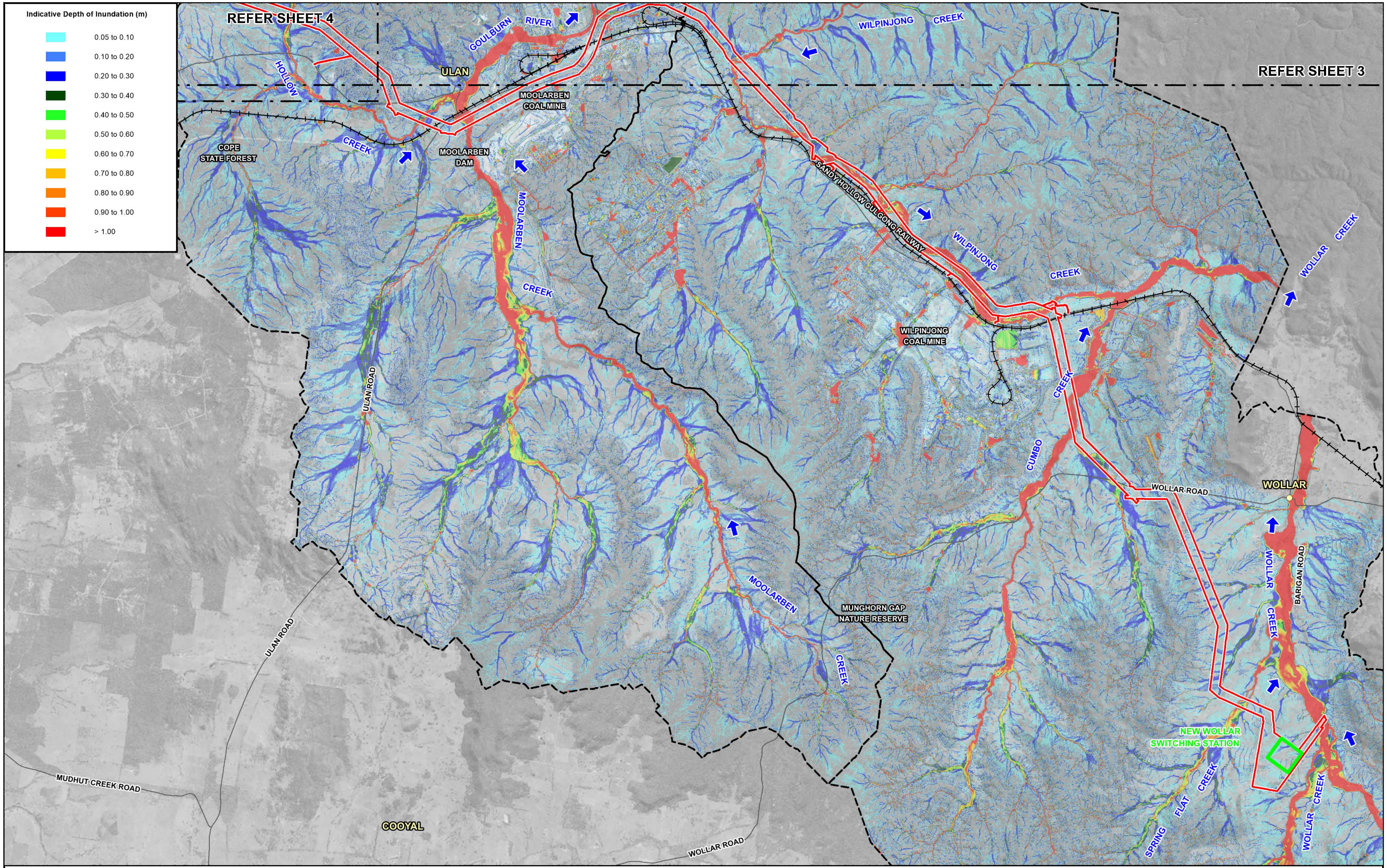
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.1
(Sheet 1 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.5% AEP



PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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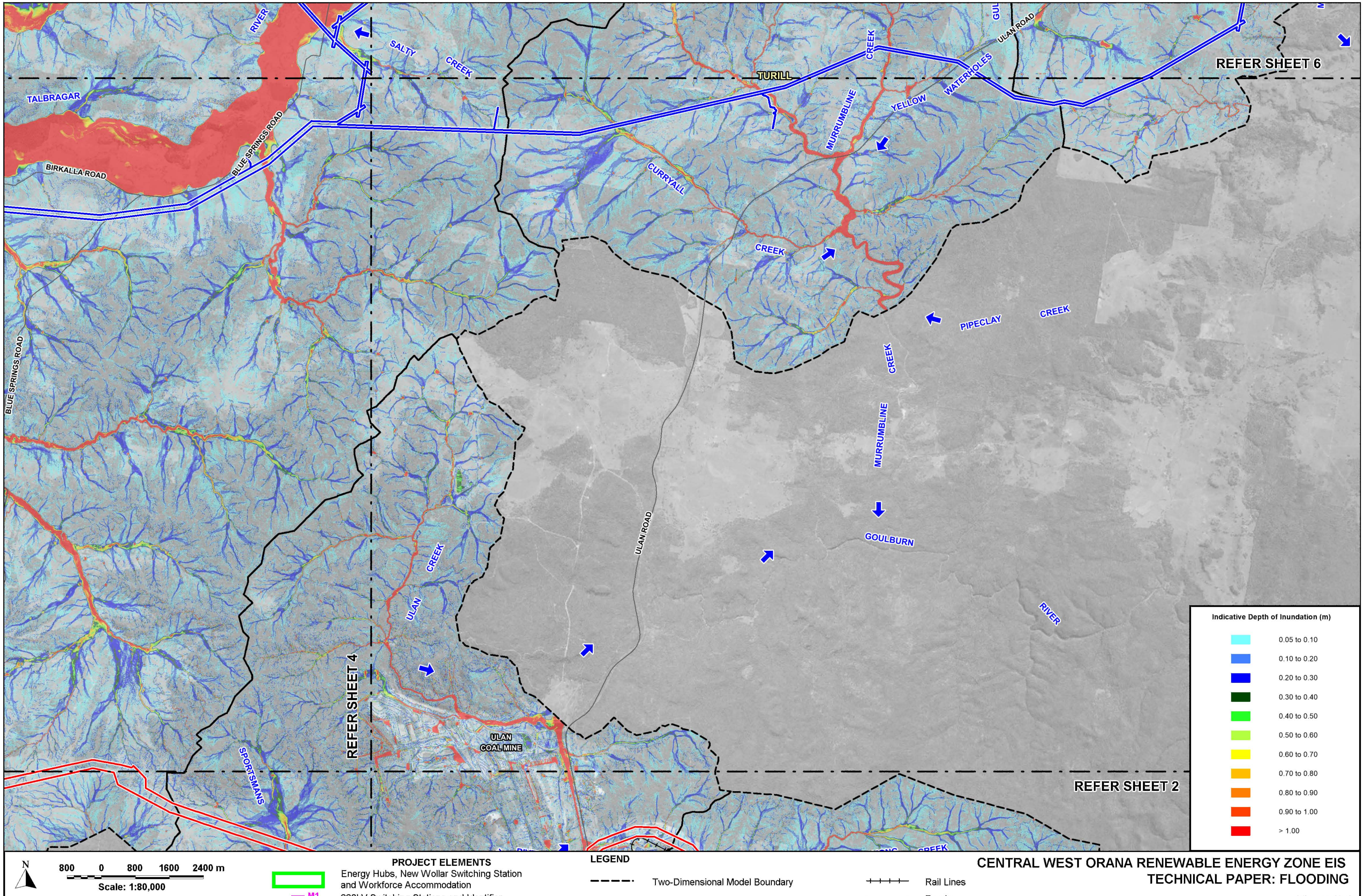
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.1
(Sheet 2 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.5% AEP



PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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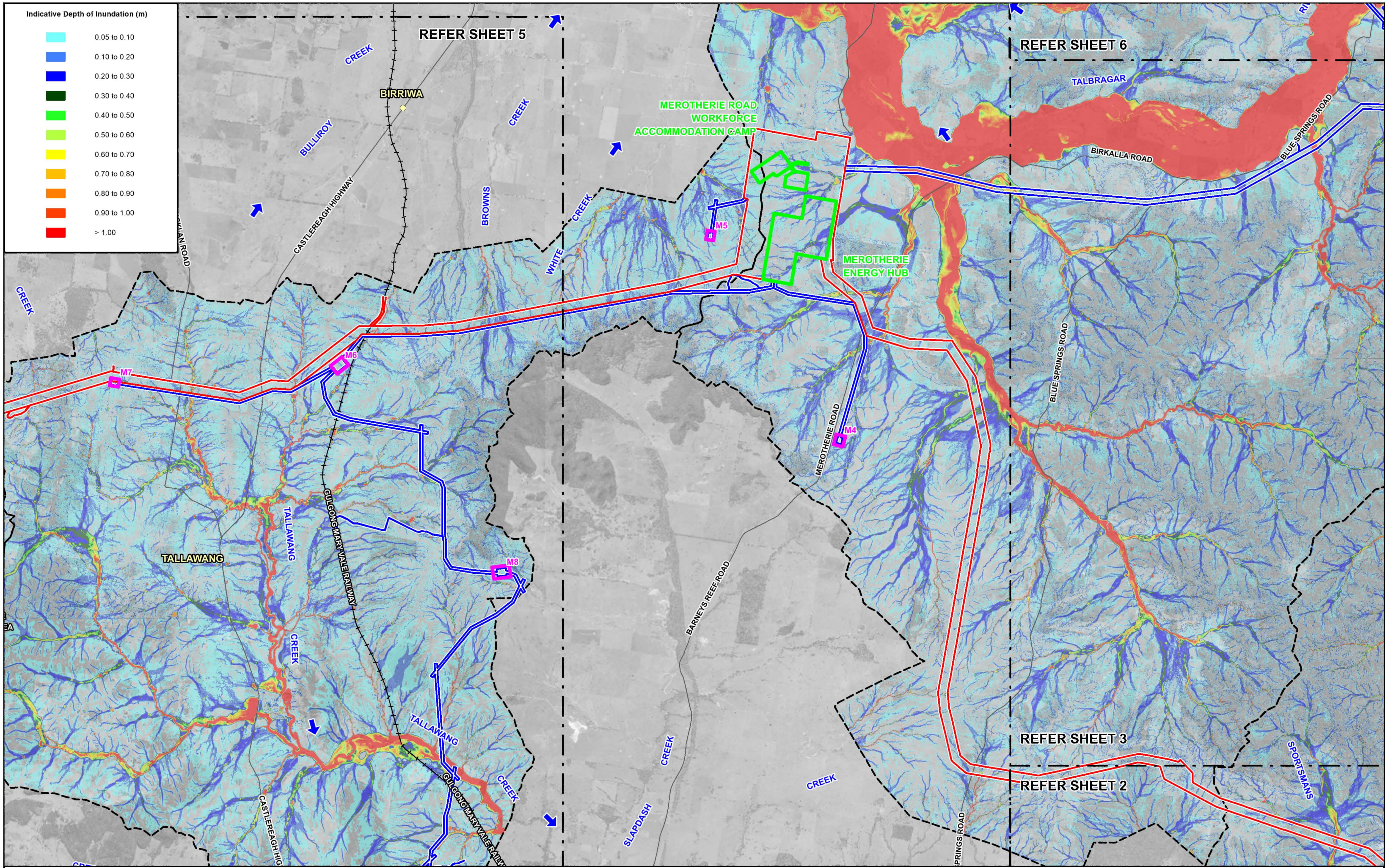
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.1
(Sheet 3 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.5% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

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PROJECT ELEMENTS

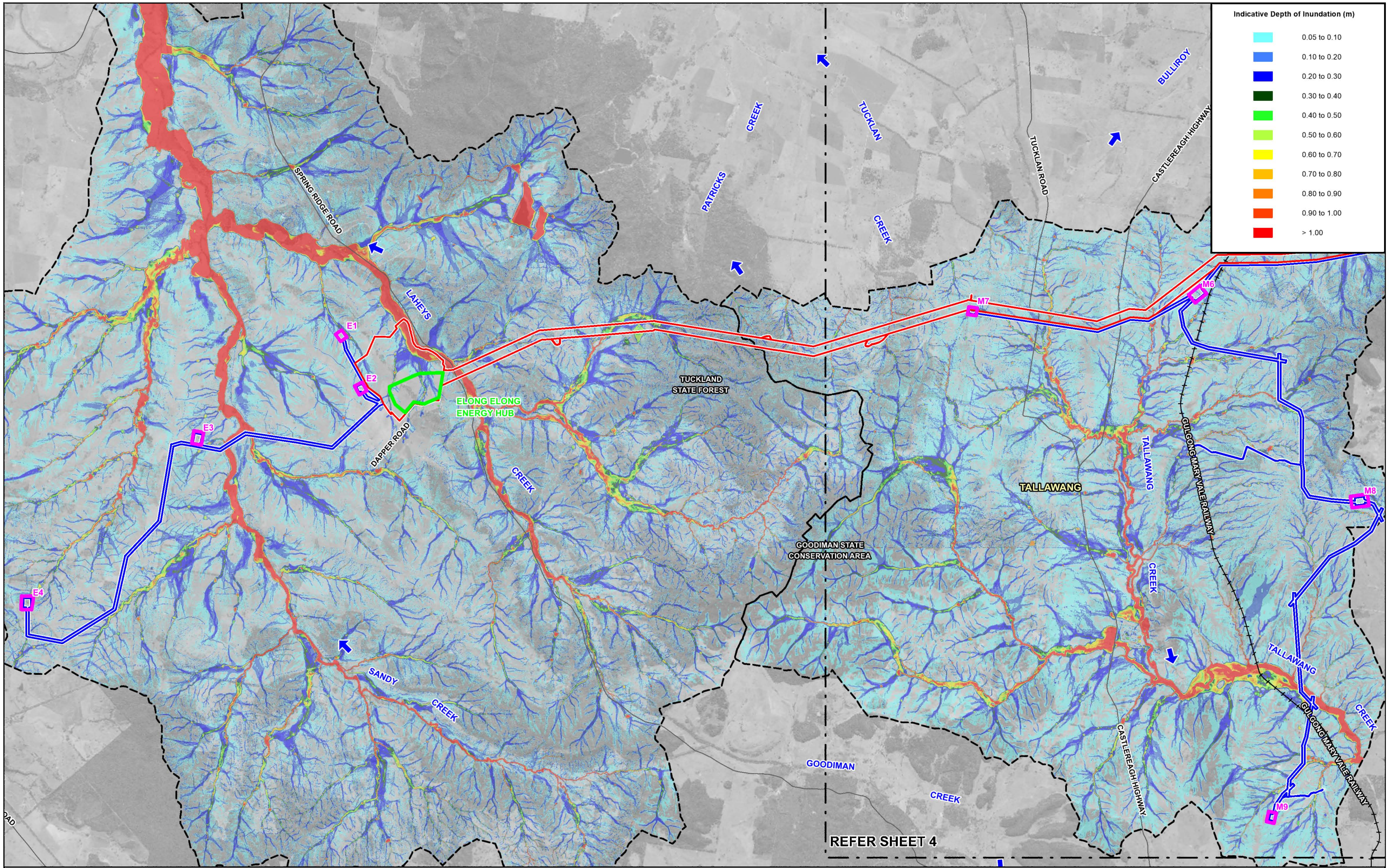
- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.1
(Sheet 4 of 6)
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.5% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

PROJECT ELEMENTS

Energy Hubs, New Wollar Switching Station and Workforce Accommodation

M1 330kV Switching Stations and Identifier

500kV Transmission Line Corridor

330kV Transmission Line Corridor

LEGEND

Two-Dimensional Model Boundary

Rail Lines

Roads

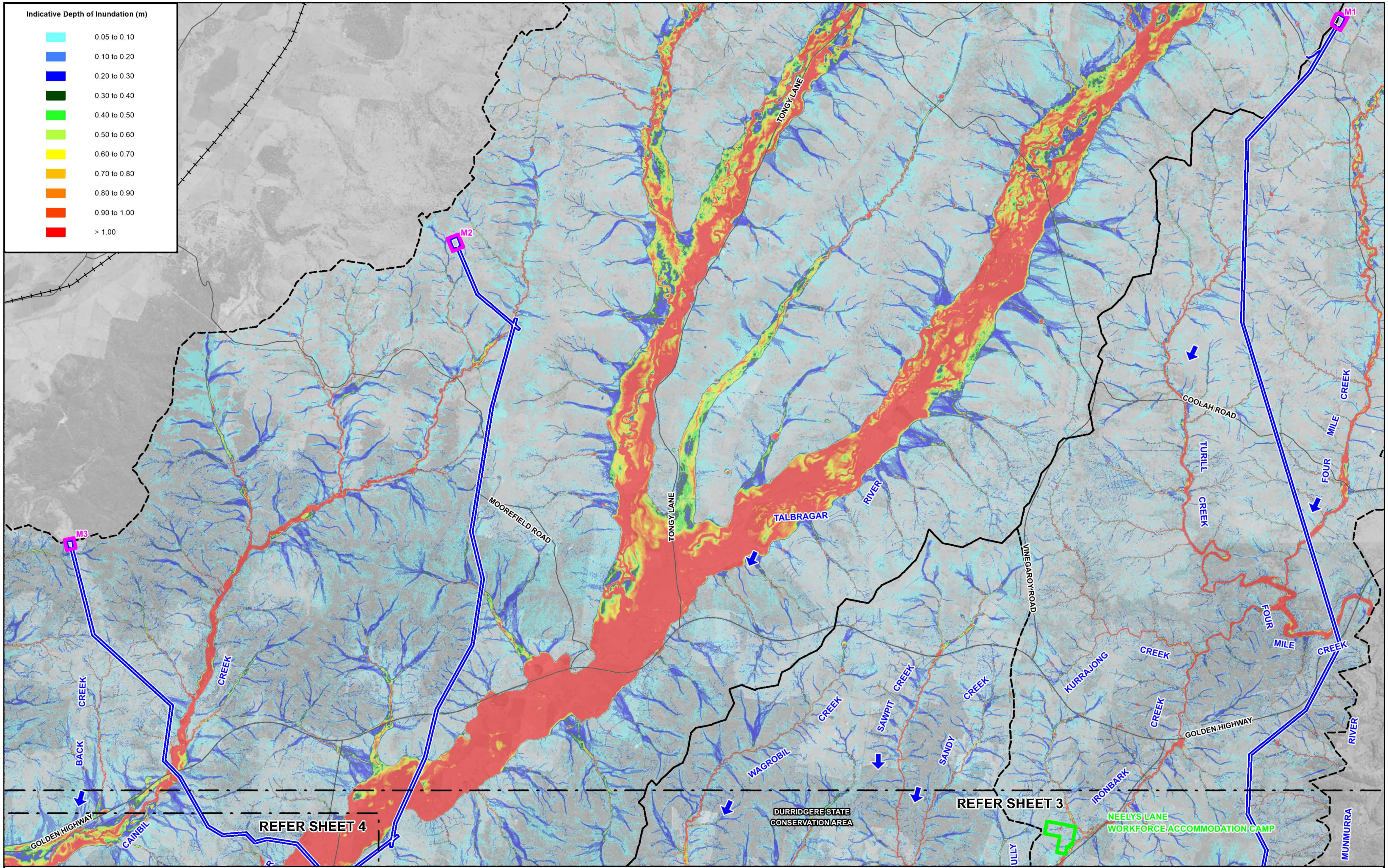
Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure B.1
(Sheet 5 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.5% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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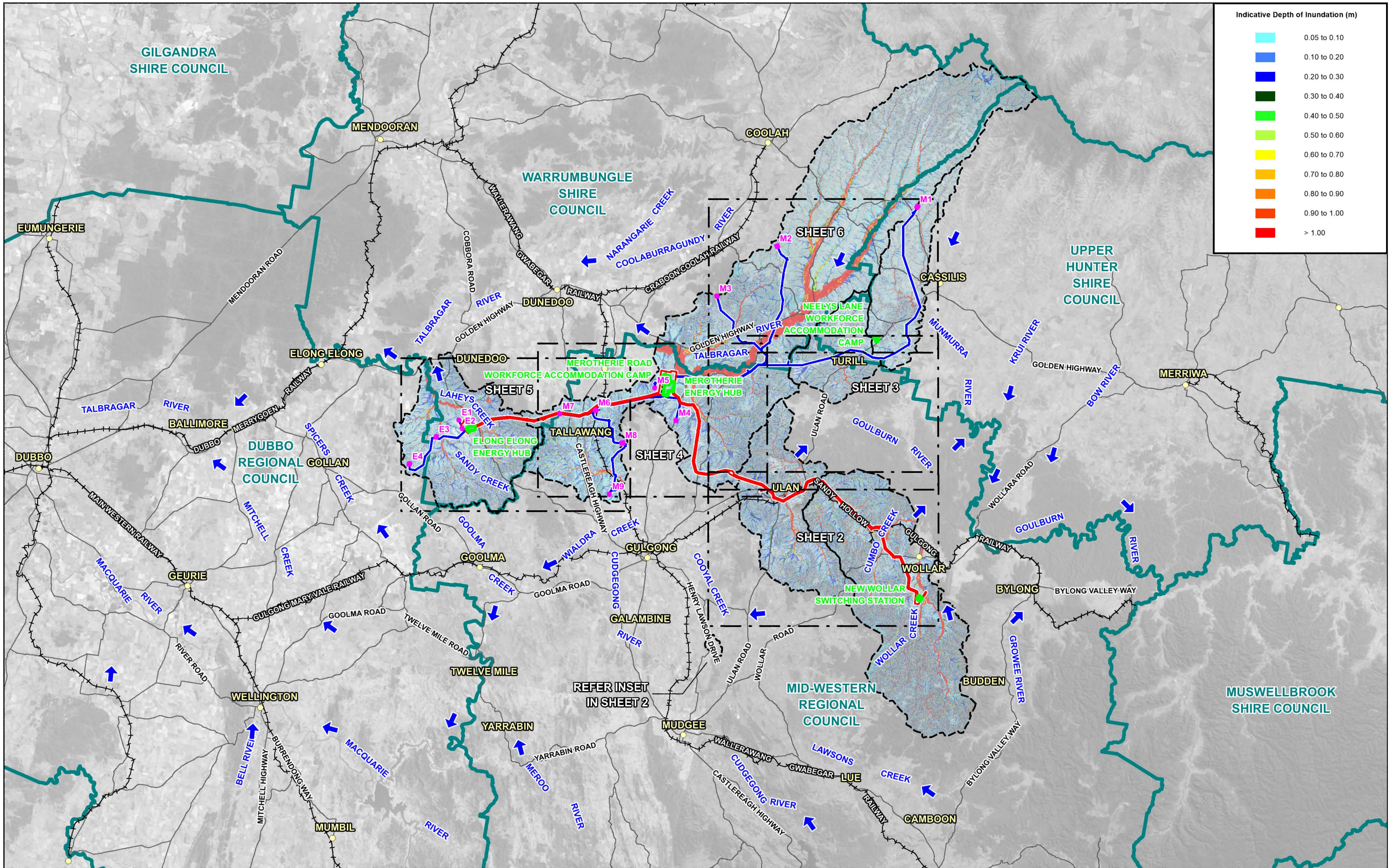
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.1
(Sheet 6 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.5% AEP



N

5000 0 5000 10000 15000 m

Scale: 1:500,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Local Government Area (LGA) Boundary
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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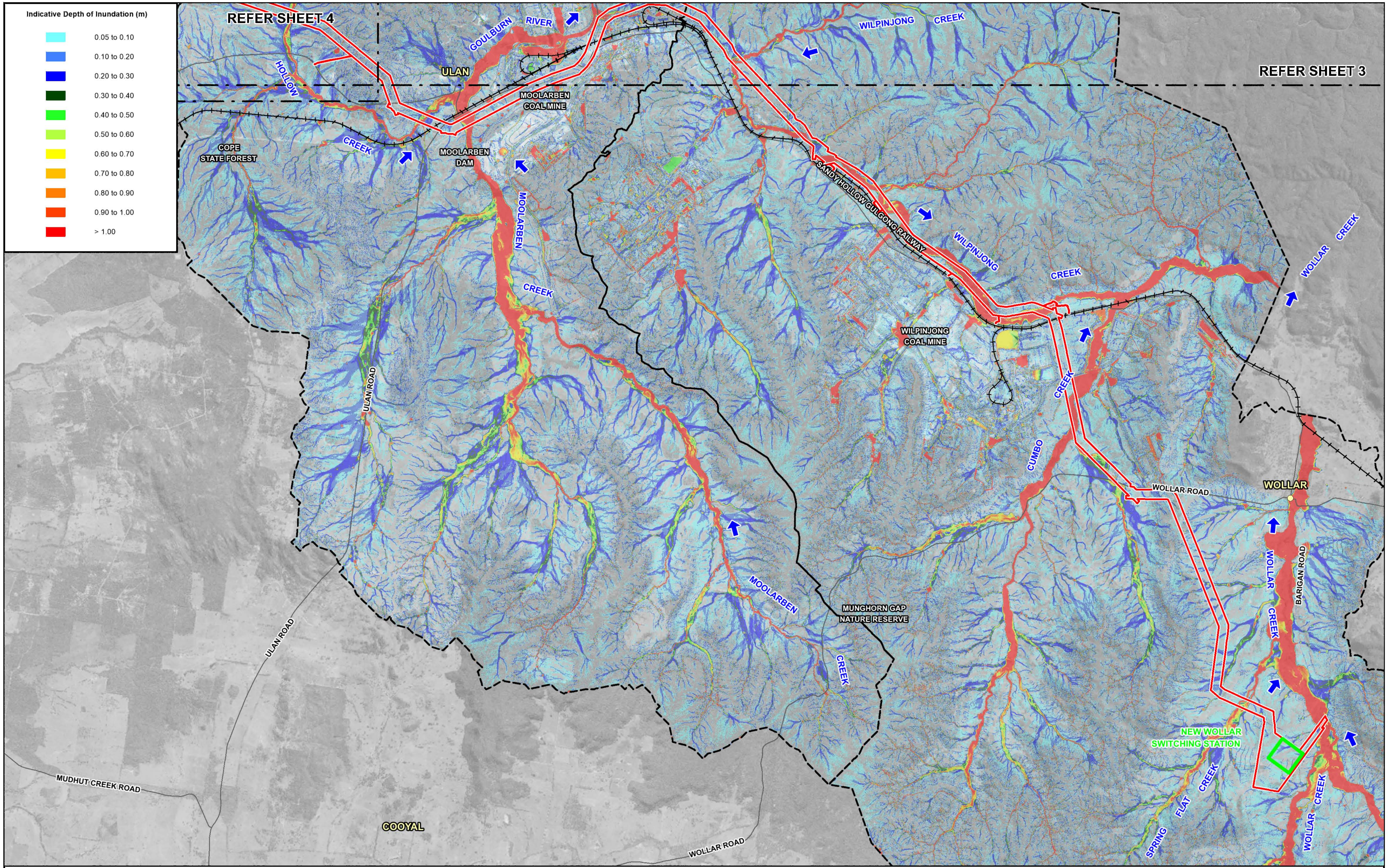
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.2
(Sheet 1 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.2% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

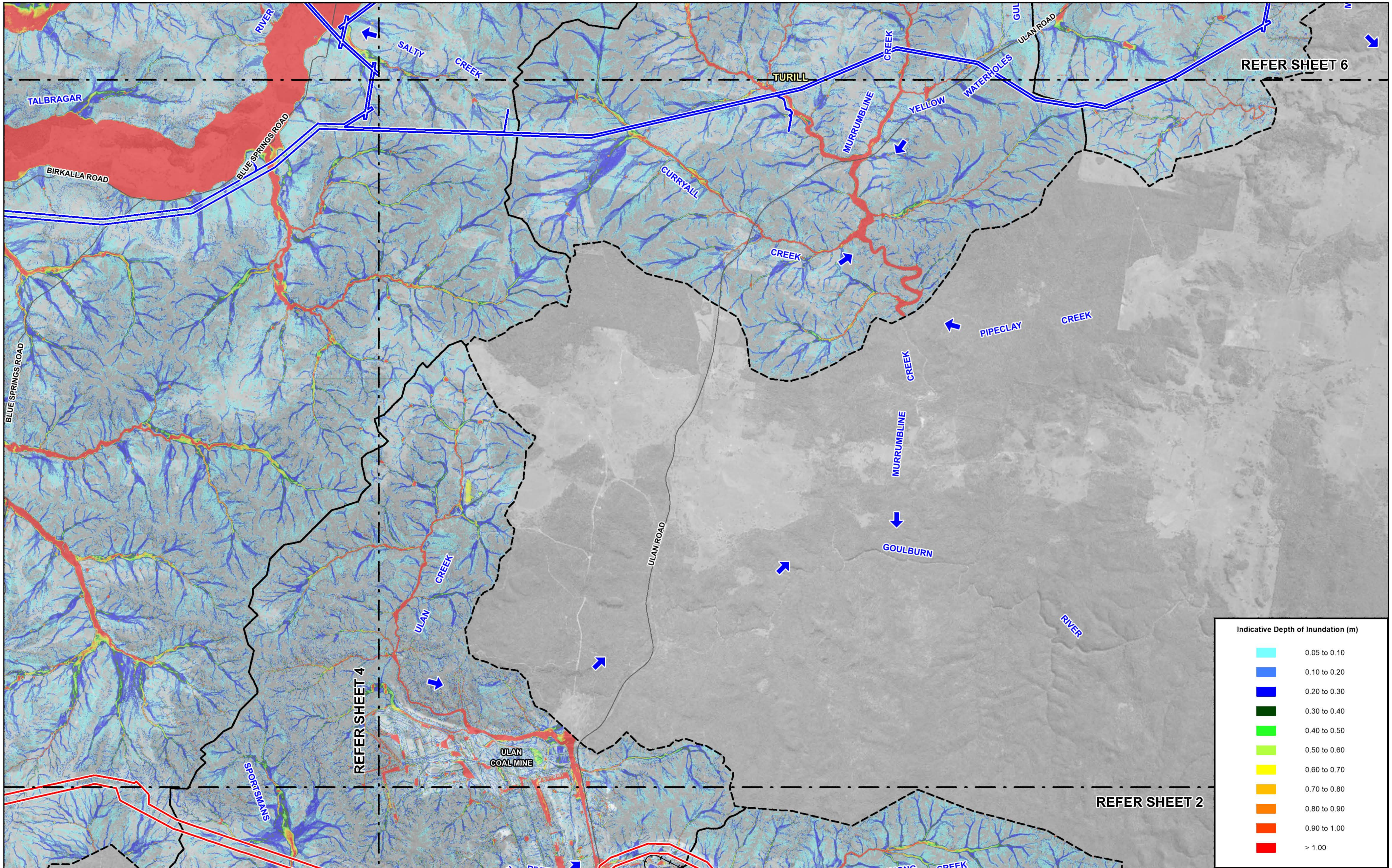
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.2
(Sheet 2 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.2% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

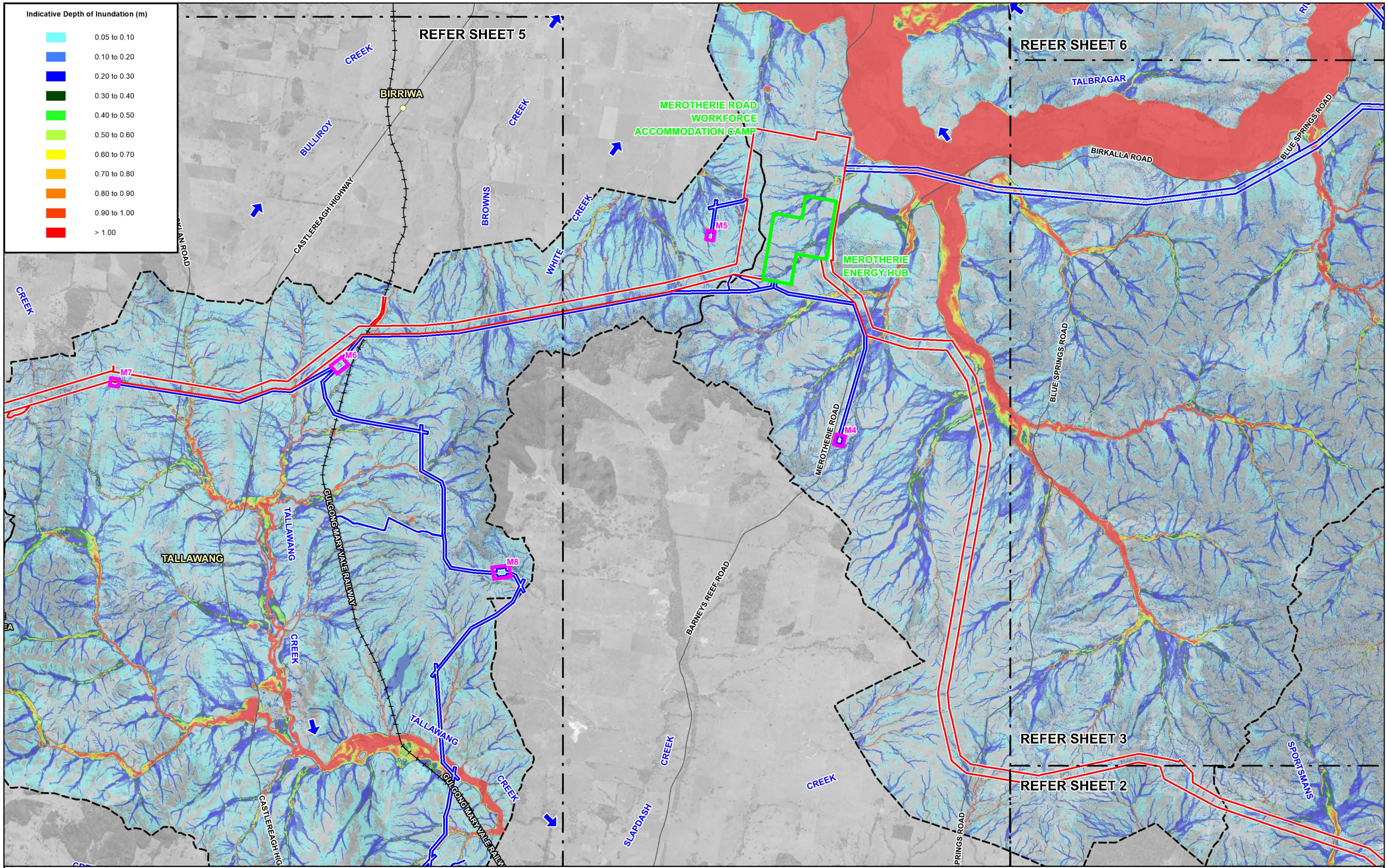
LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.2
(Sheet 3 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.2% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

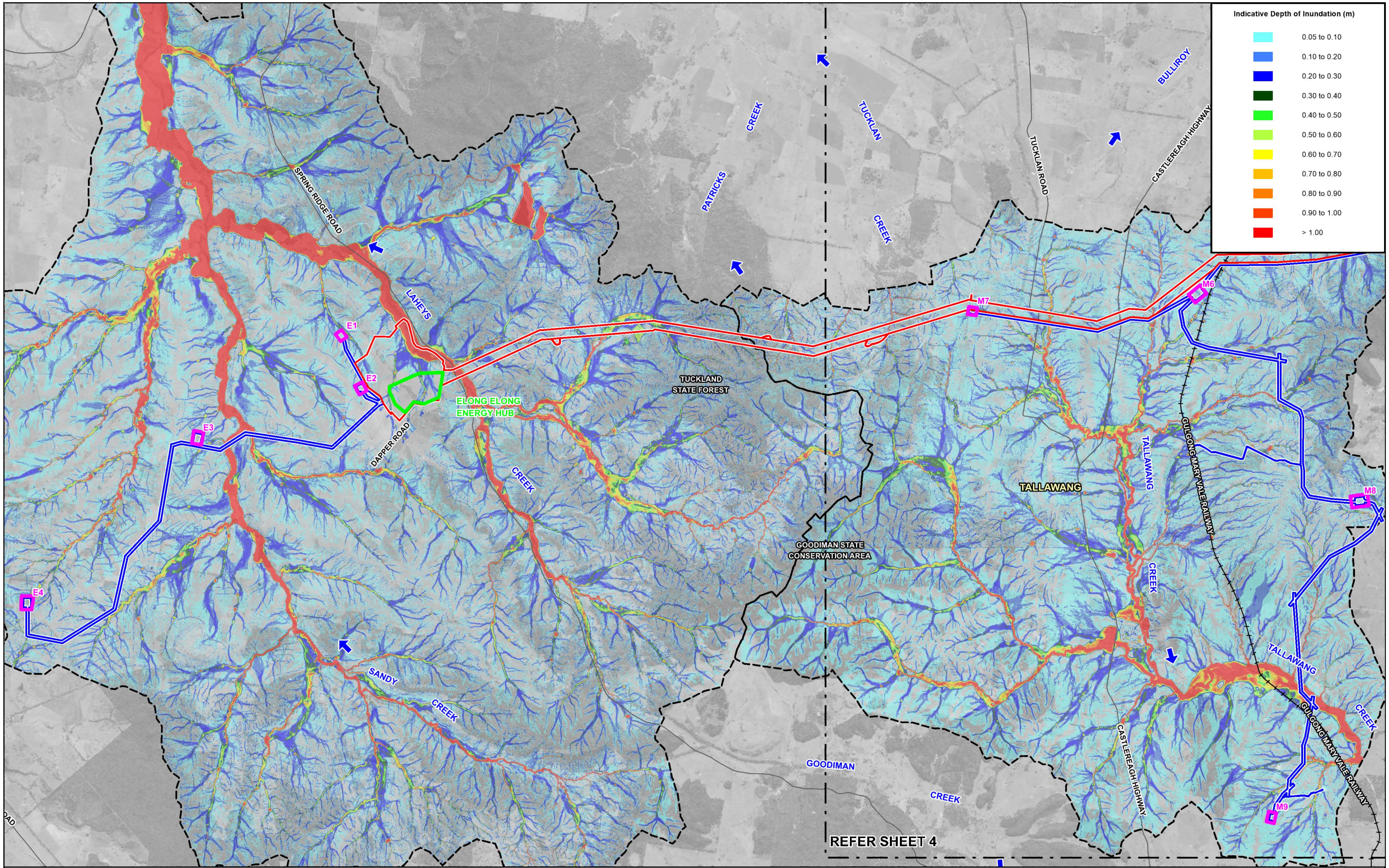
- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.2
(Sheet 4 of 6)
FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.2% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

- Two-Dimensional Model Boundary
- Rail Lines
- Roads

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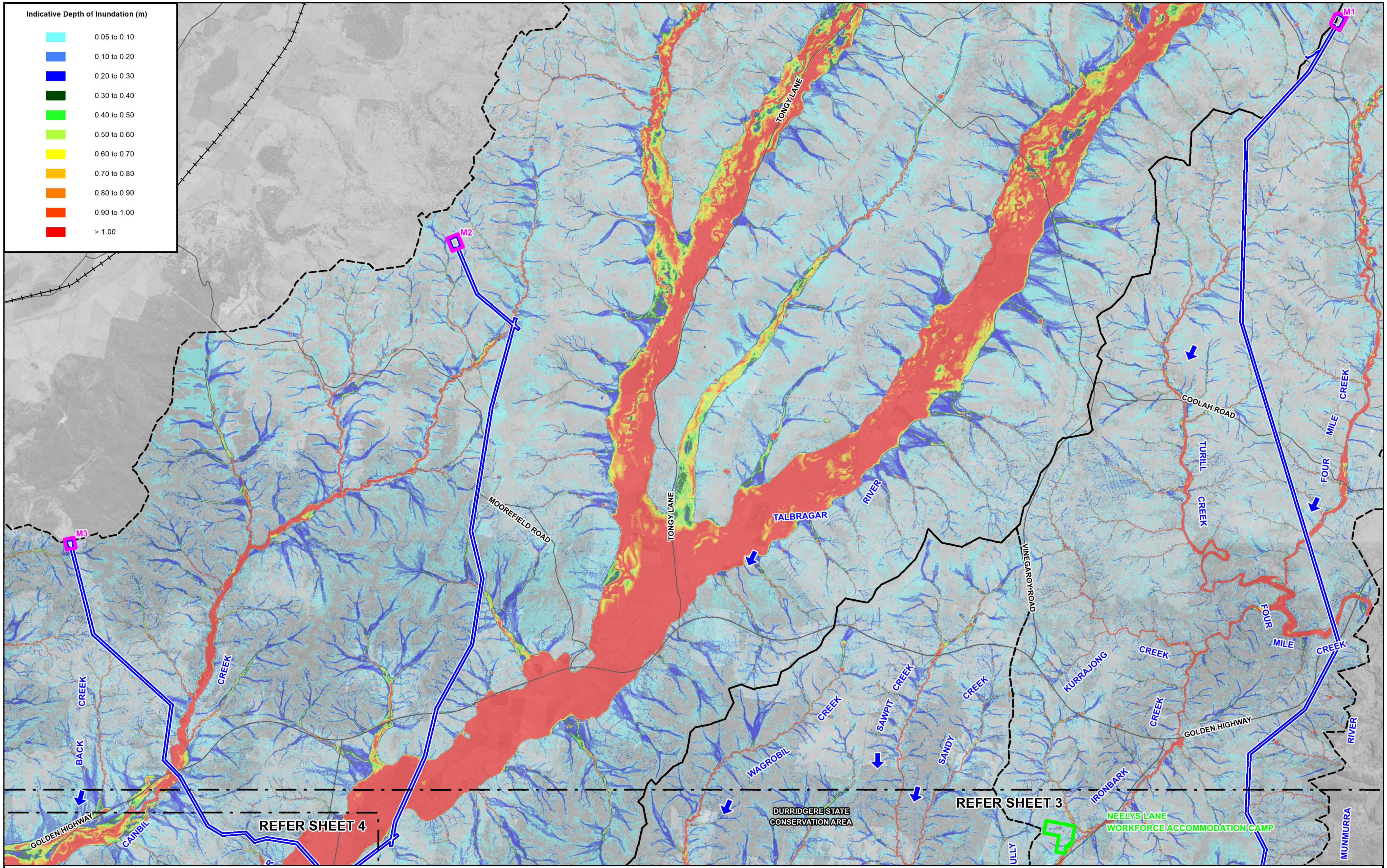
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.2
(Sheet 5 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.2% AEP



N

800 0 800 1600 2400 m

Scale: 1:80,000

Lyall & Associates

PROJECT ELEMENTS

- Energy Hubs, New Wollar Switching Station and Workforce Accommodation
- M1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor

LEGEND

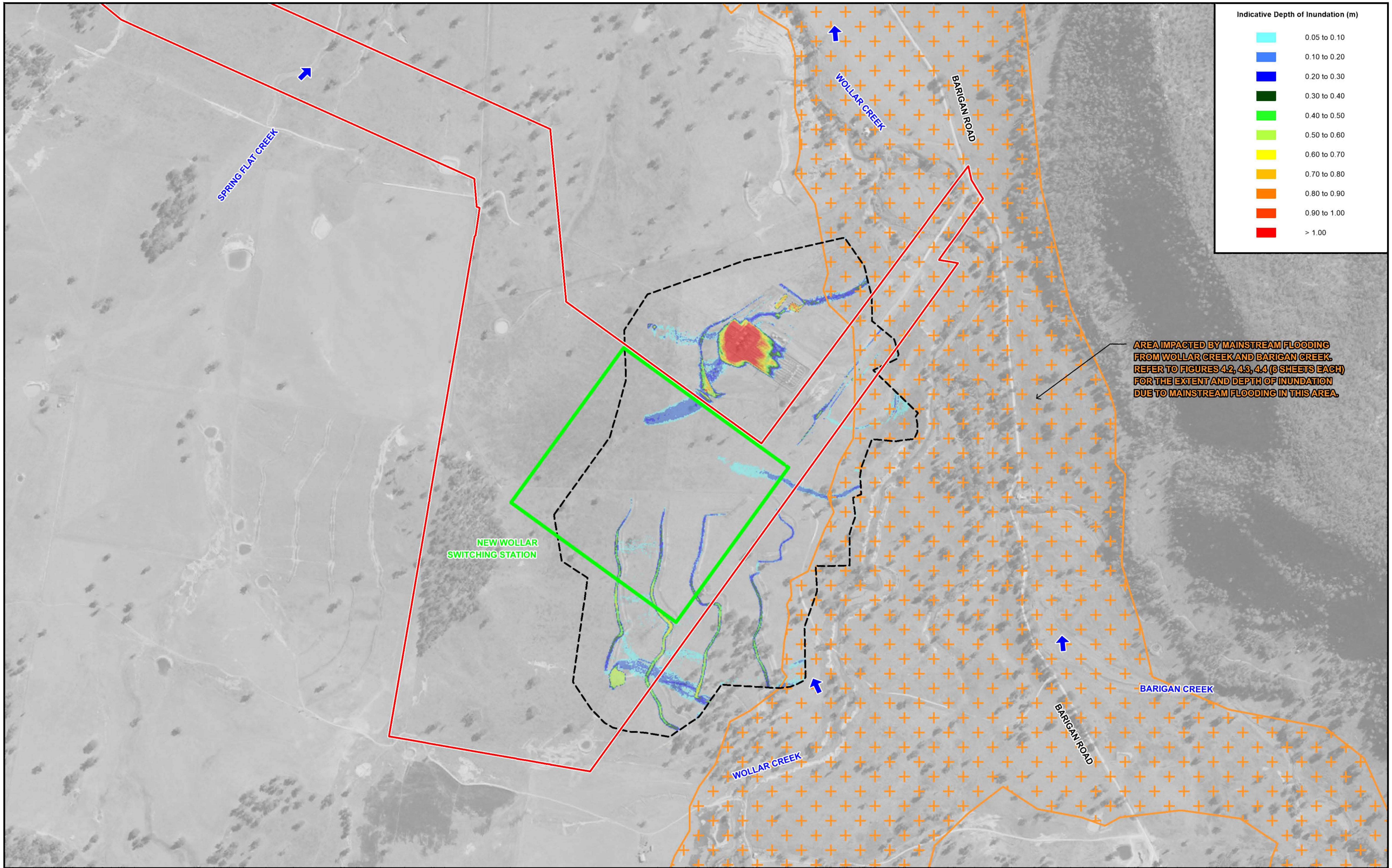
- Two-Dimensional Model Boundary
- Rail Lines
- Roads

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure B.2
(Sheet 6 of 6)

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS
0.2% AEP

ANNEXURE C
FIGURES SHOWING THE INDICATIVE EXTENT AND DEPTH OF INUNDATION IN THE VICINITY OF THE NEW WOLLAR SWITCHING STATION, MEROTHERIE ENERGY HUB AND ELONG ELONG ENERGY HUB DURING A 0.5% AND 0.2% AEP EVENT



LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

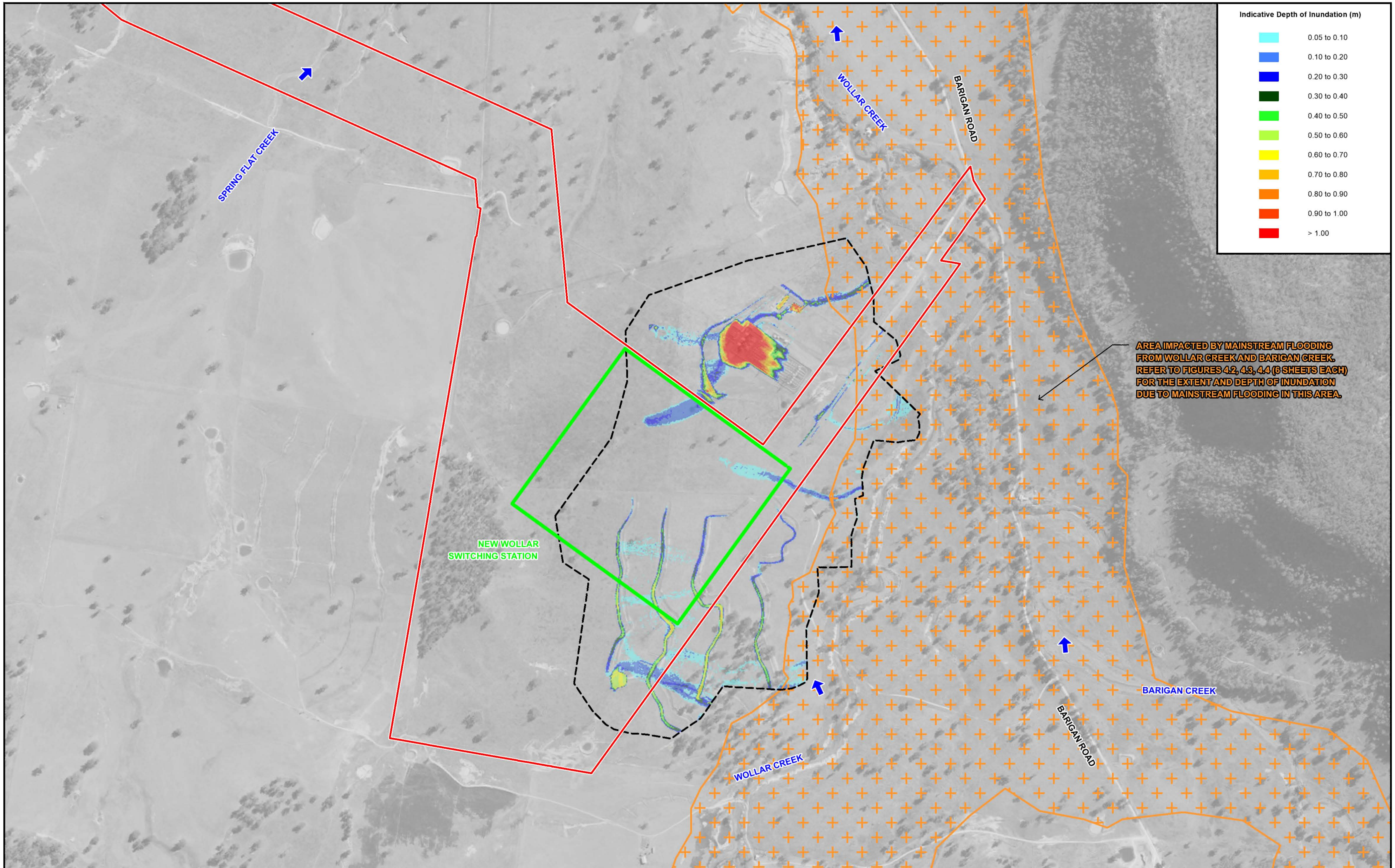
Two-Dimensional Model Boundary

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.1a

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
0.5% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

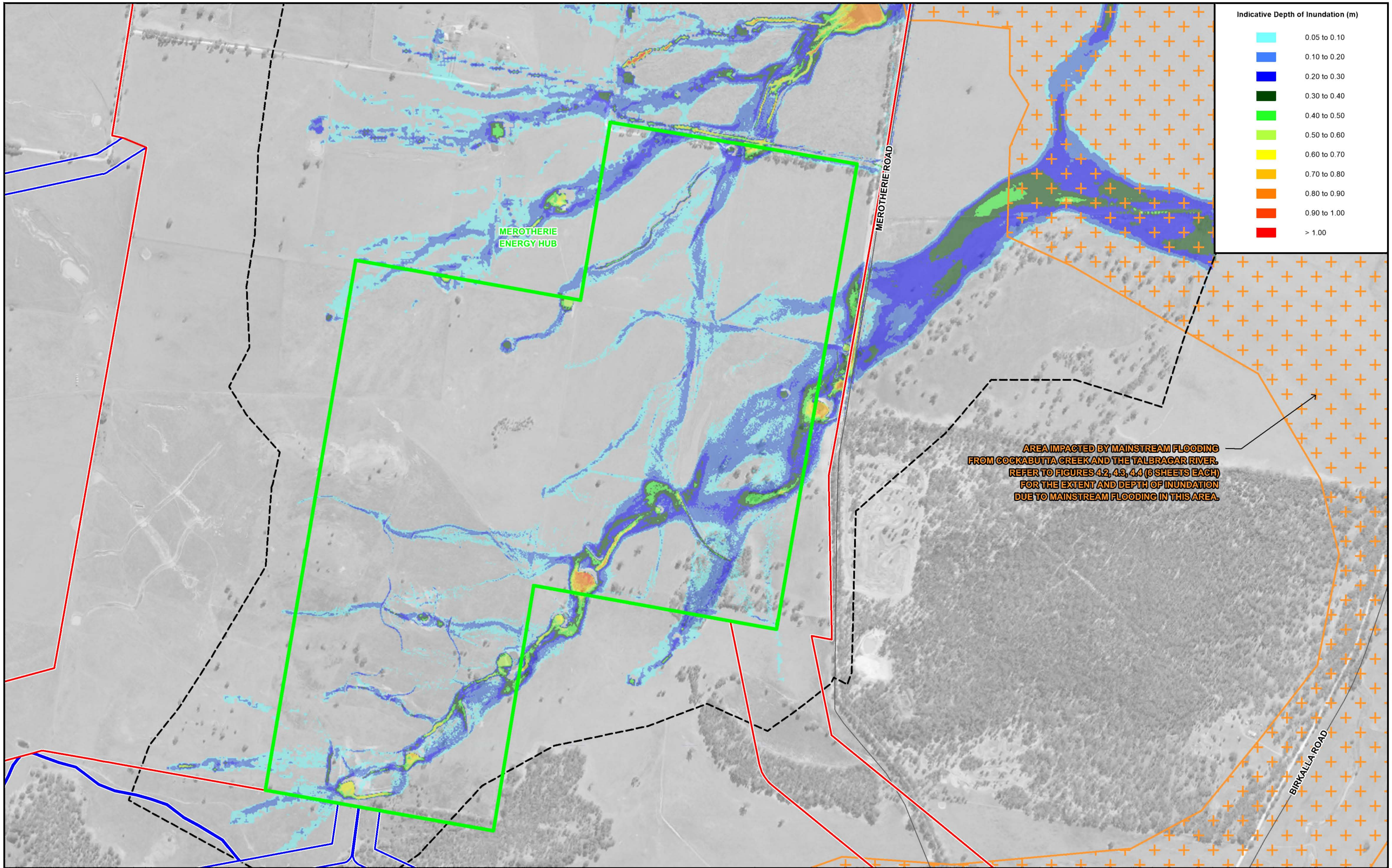
Two-Dimensional Model Boundary

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.1b

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
0.2% AEP



LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

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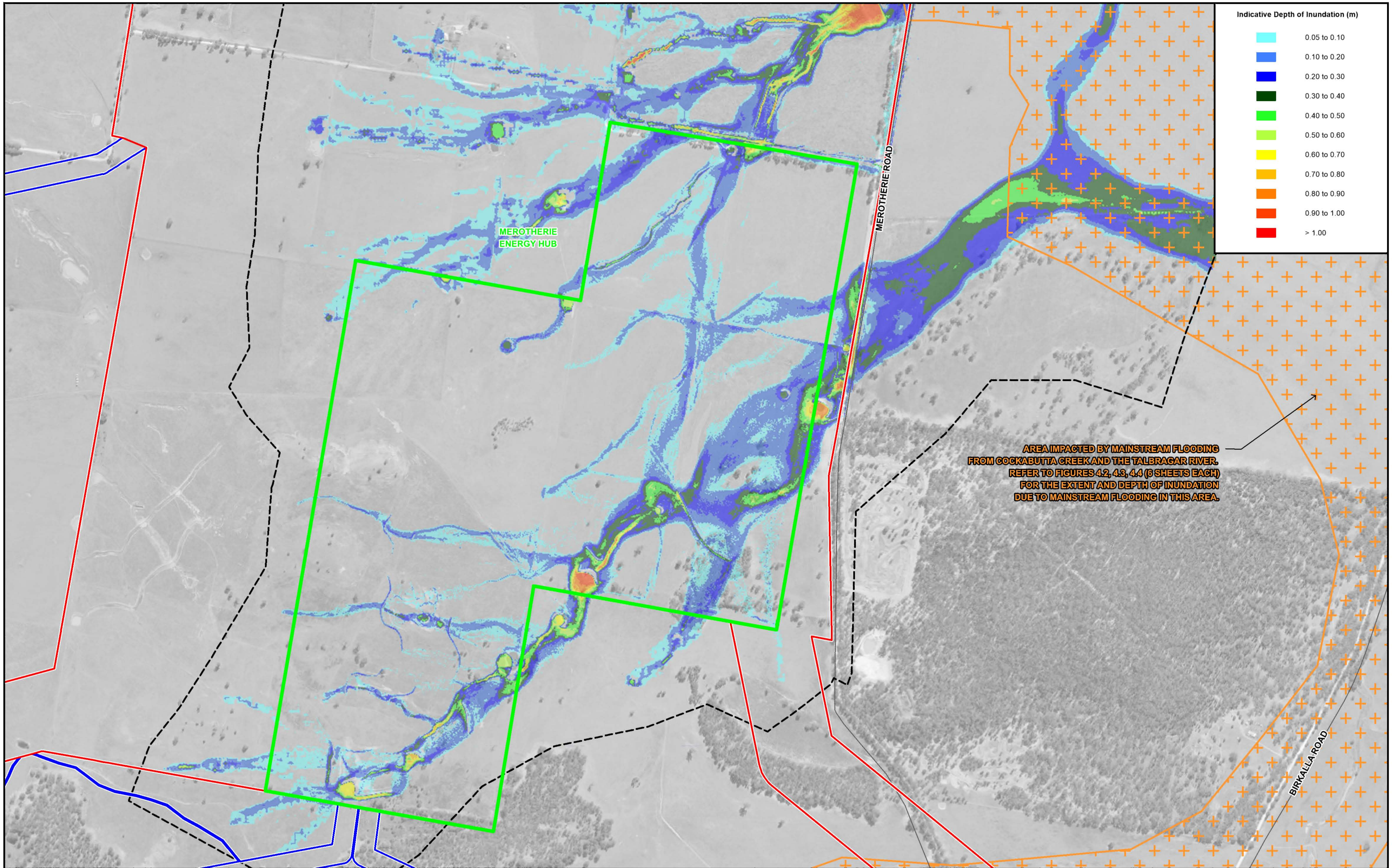
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.2a

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
0.5% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

Lyall & Associates

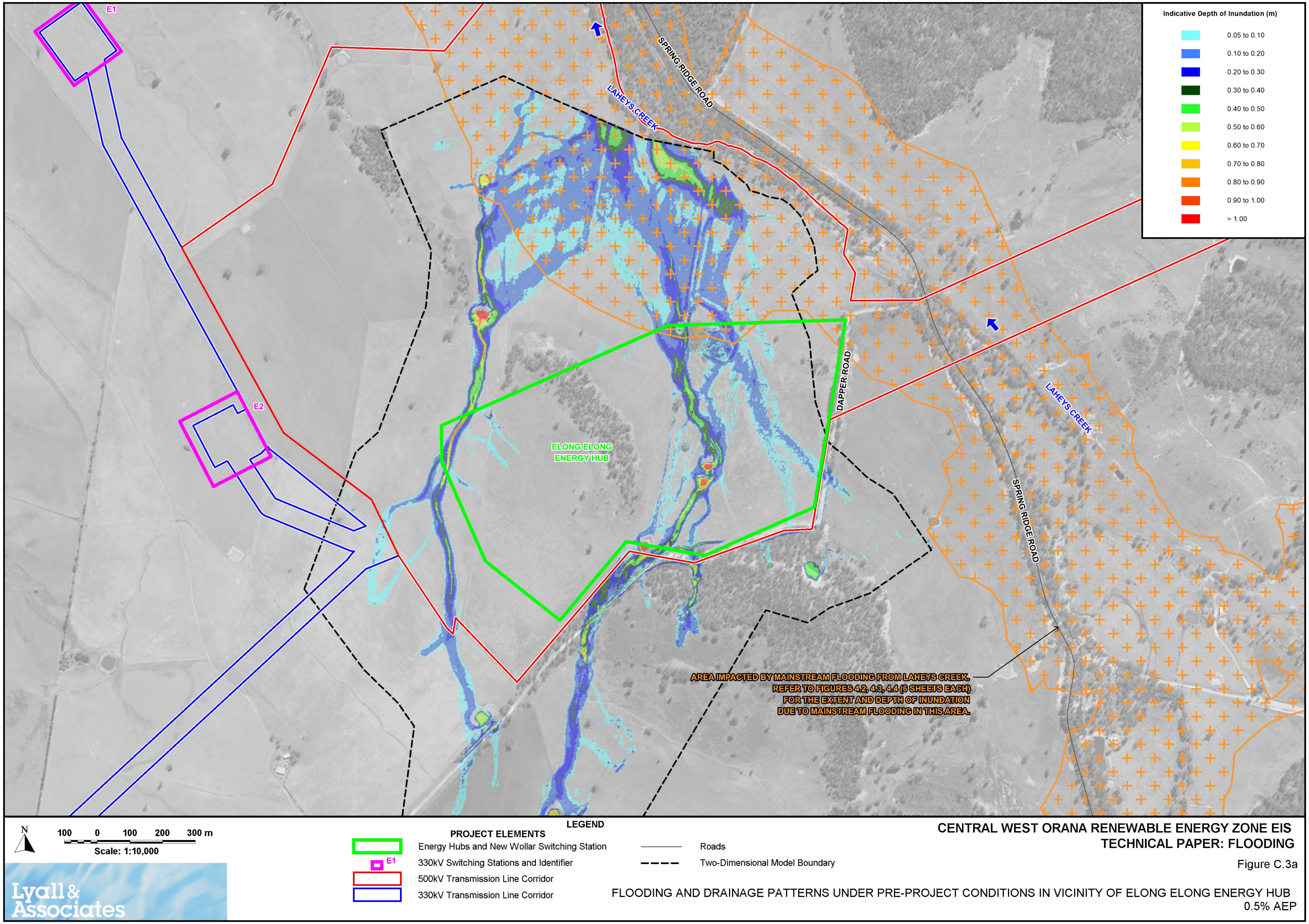
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure C.2b

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB

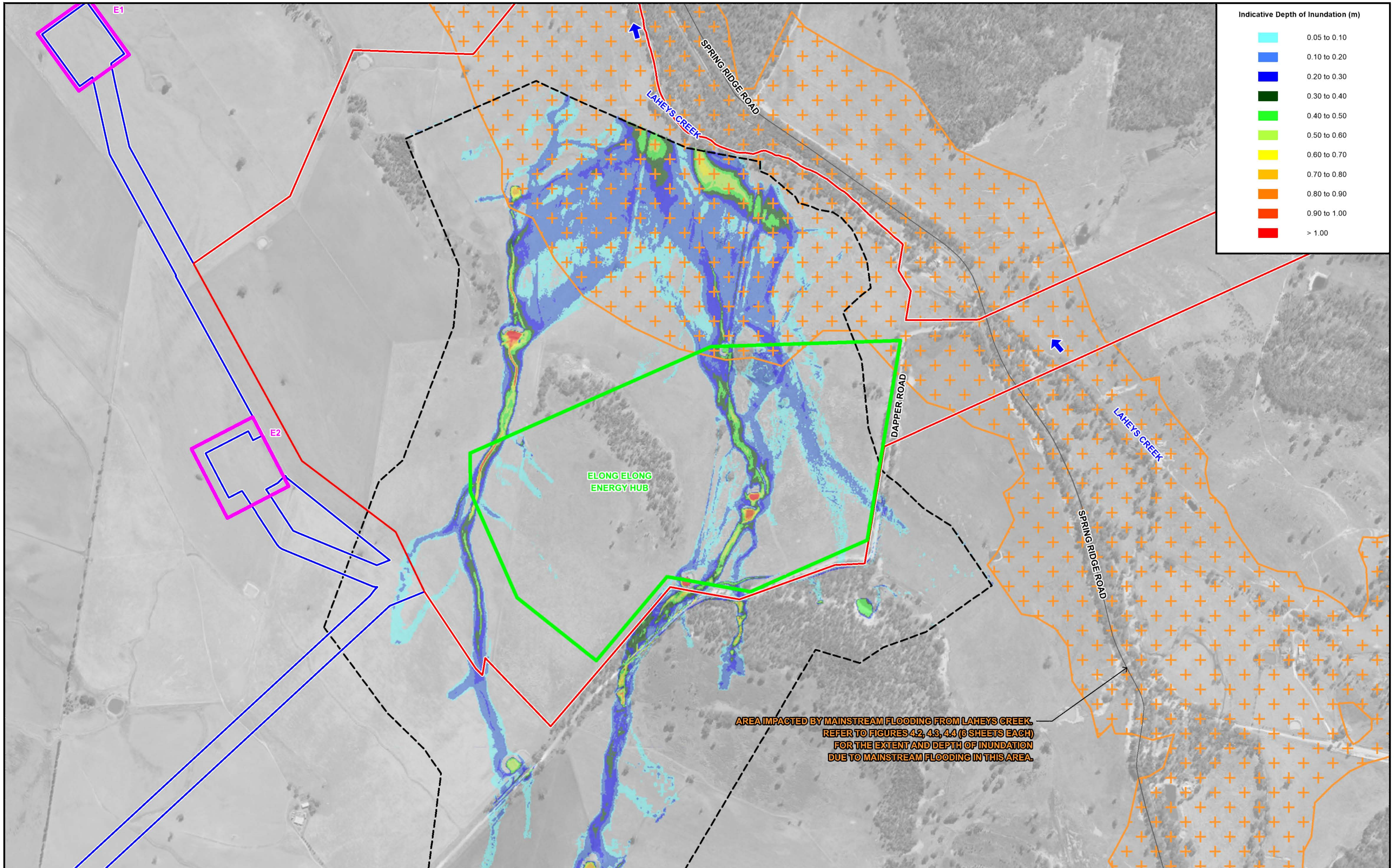
0.2% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.3a

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
0.5% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

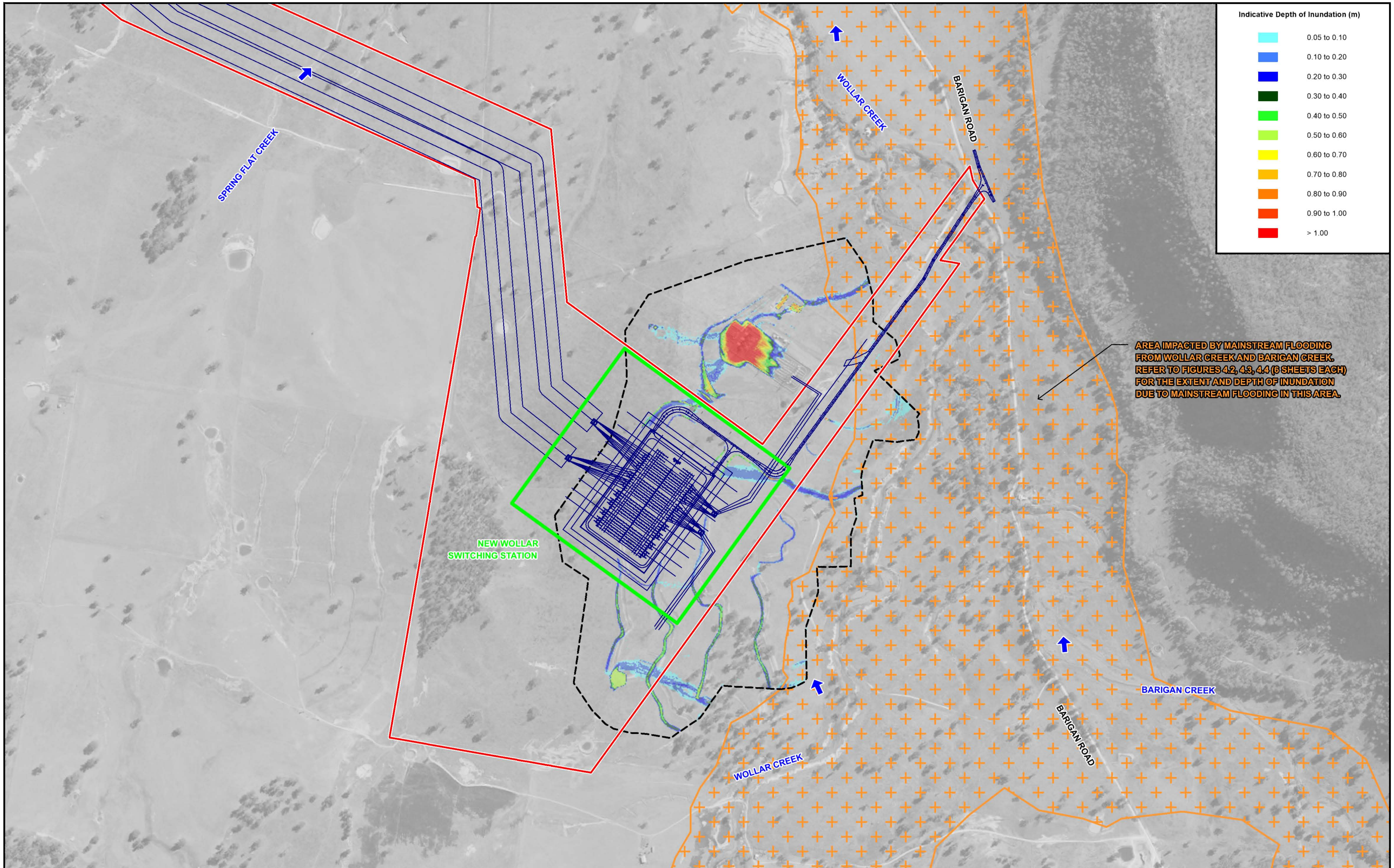
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure C.3b

FLOODING AND DRAINAGE PATTERNS UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB

0.2% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Green box	Energy Hubs and New Wollar Switching Station	Thin line	Roads
Red box	500kV Transmission Line Corridor	Dashed line	Two-Dimensional Model Boundary
Blue line	Operational Infrastructure		

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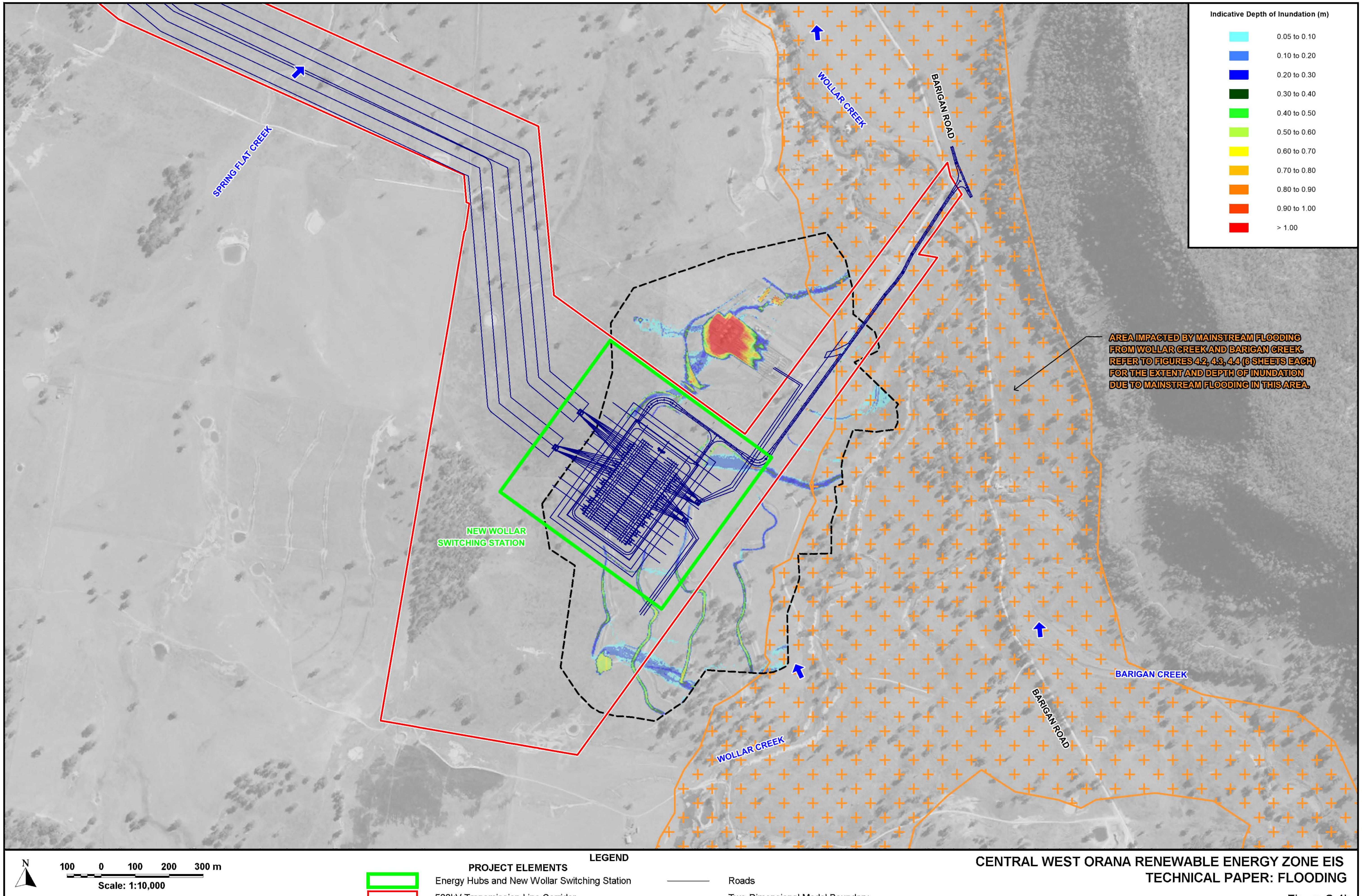
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.4a

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
0.5% AEP



LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station	Roads
500kV Transmission Line Corridor	Two-Dimensional Model Boundary
Operational Infrastructure	

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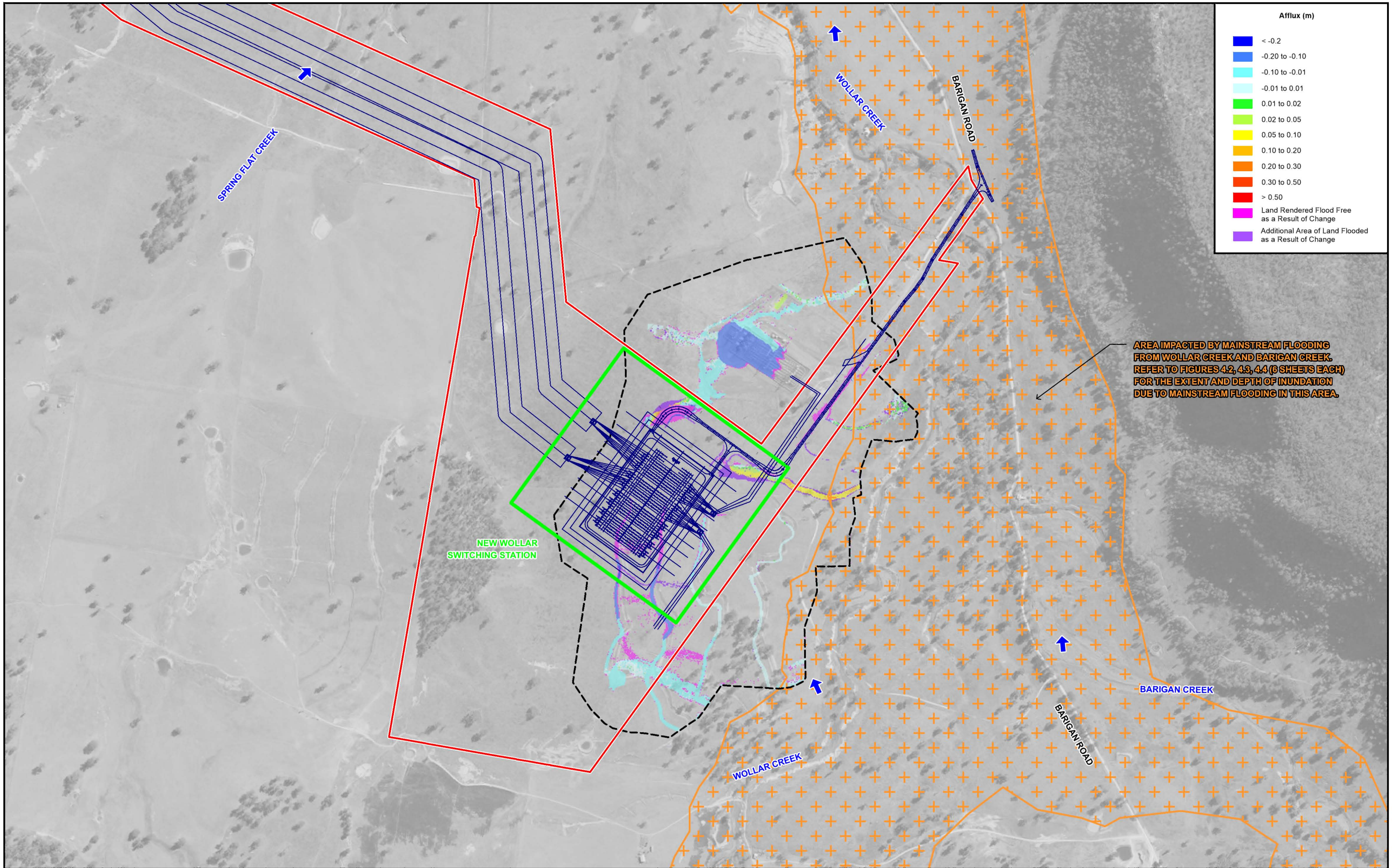
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.4b

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
0.2% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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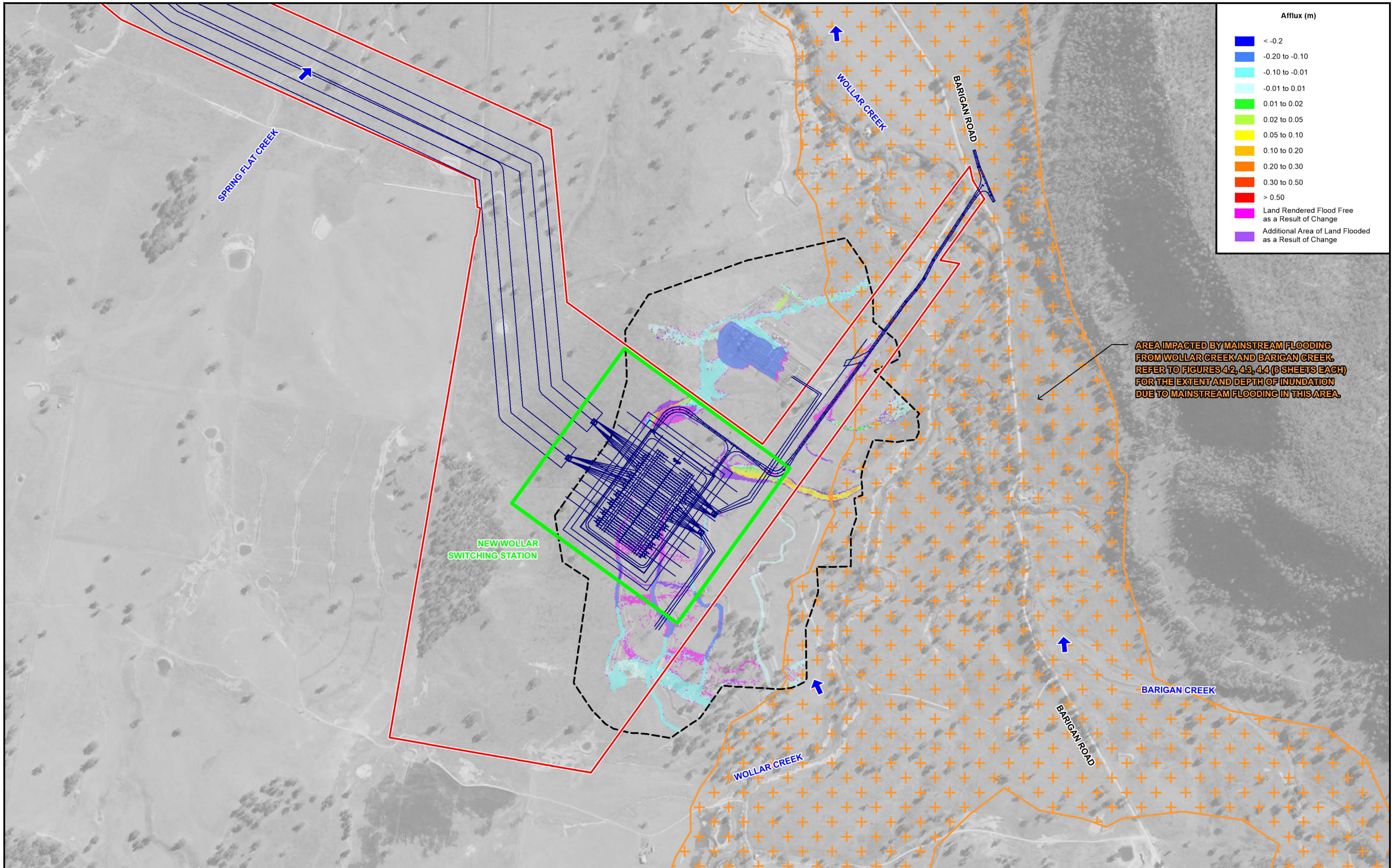
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.5a

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF NEW WOLLAR SWITCHING STATION
0.5% AEP



LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Operational Infrastructure

Roads

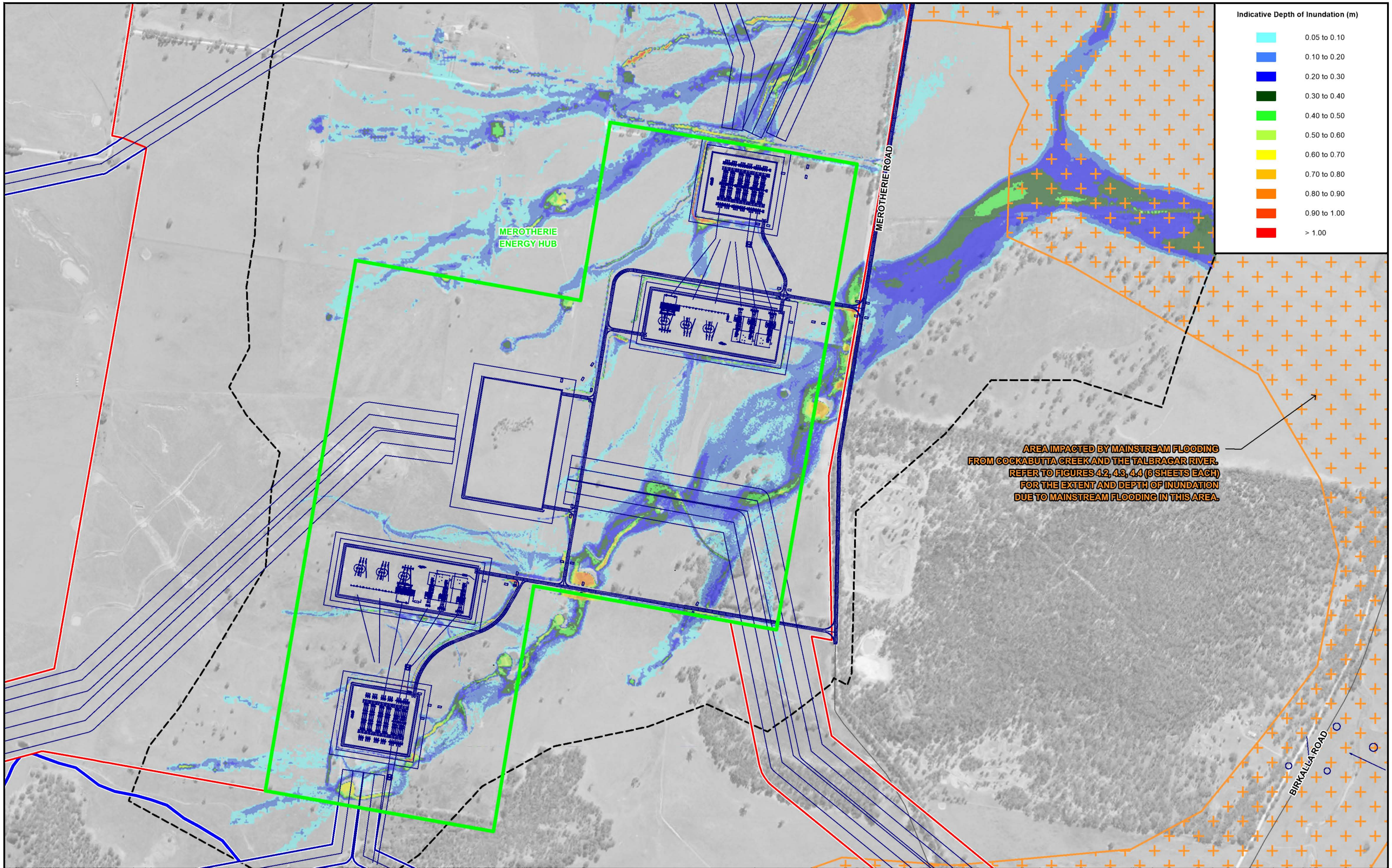
Two-Dimensional Model Boundary

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.5b

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF NEW WOLLAR SWITCHING STATION
0.2% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.6a

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
0.5% AEP

N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

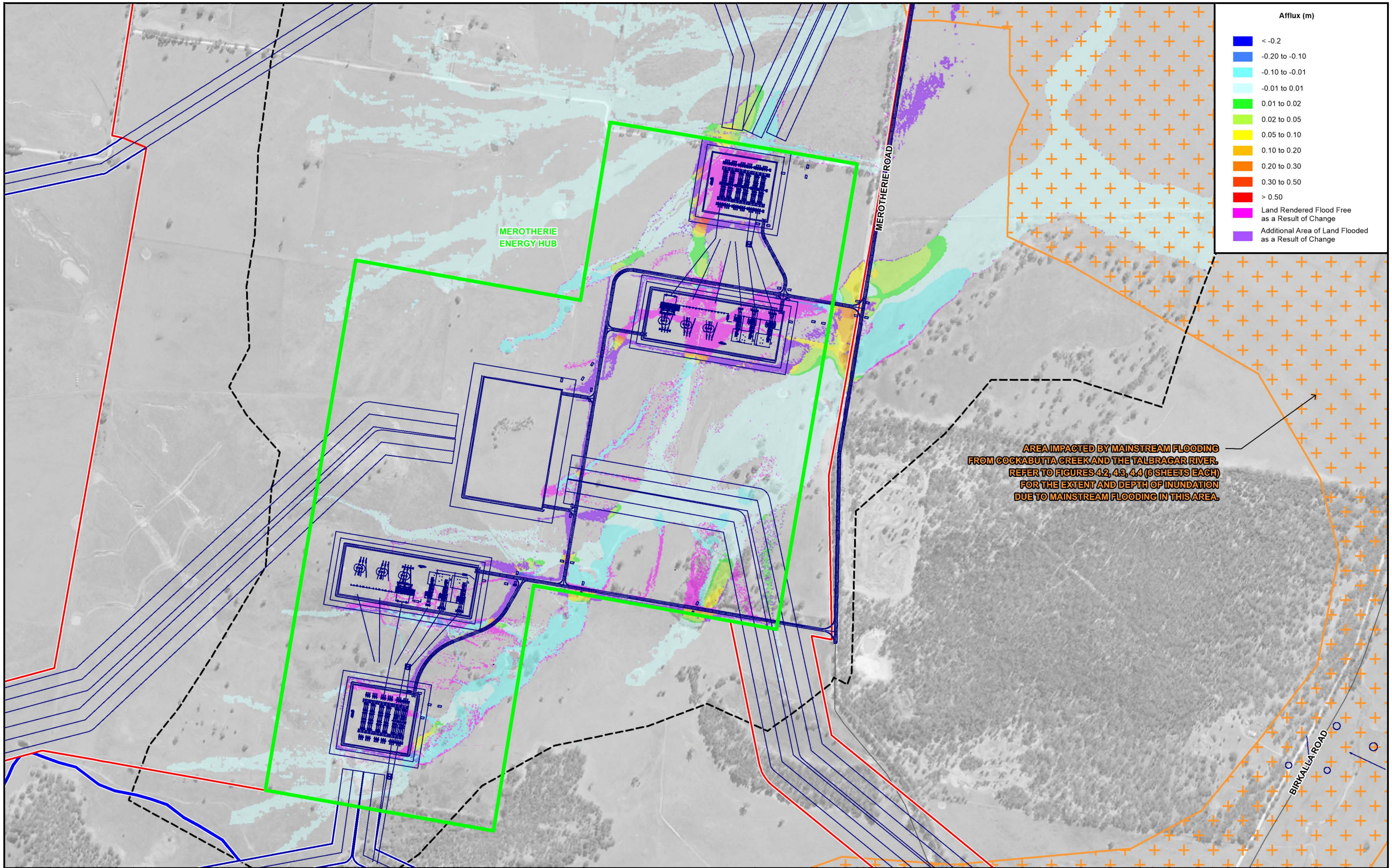
PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.6b

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
0.2% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

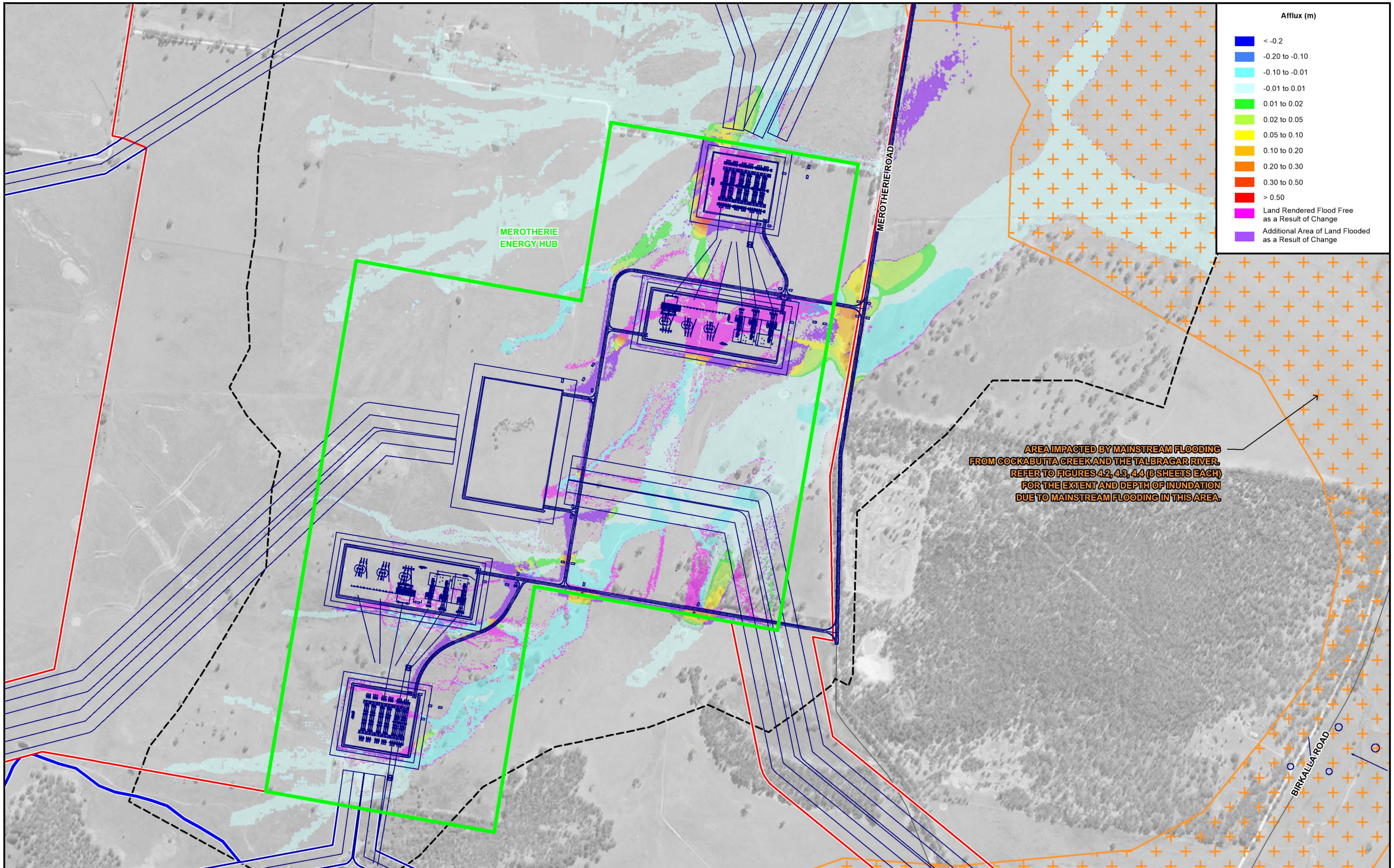
- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.7a

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF MEROTHERIE ENERGY HUB
0.5% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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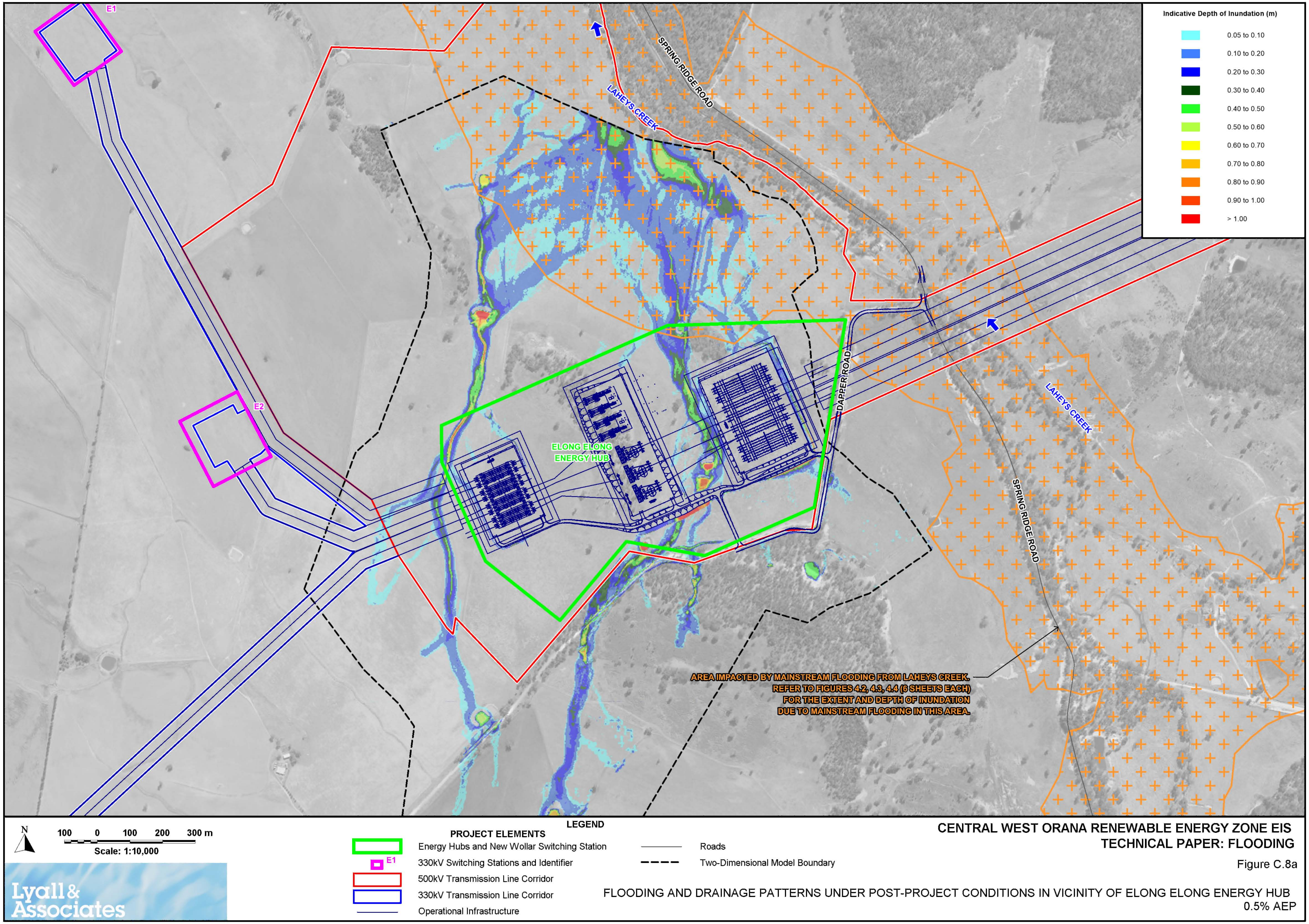
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.7b

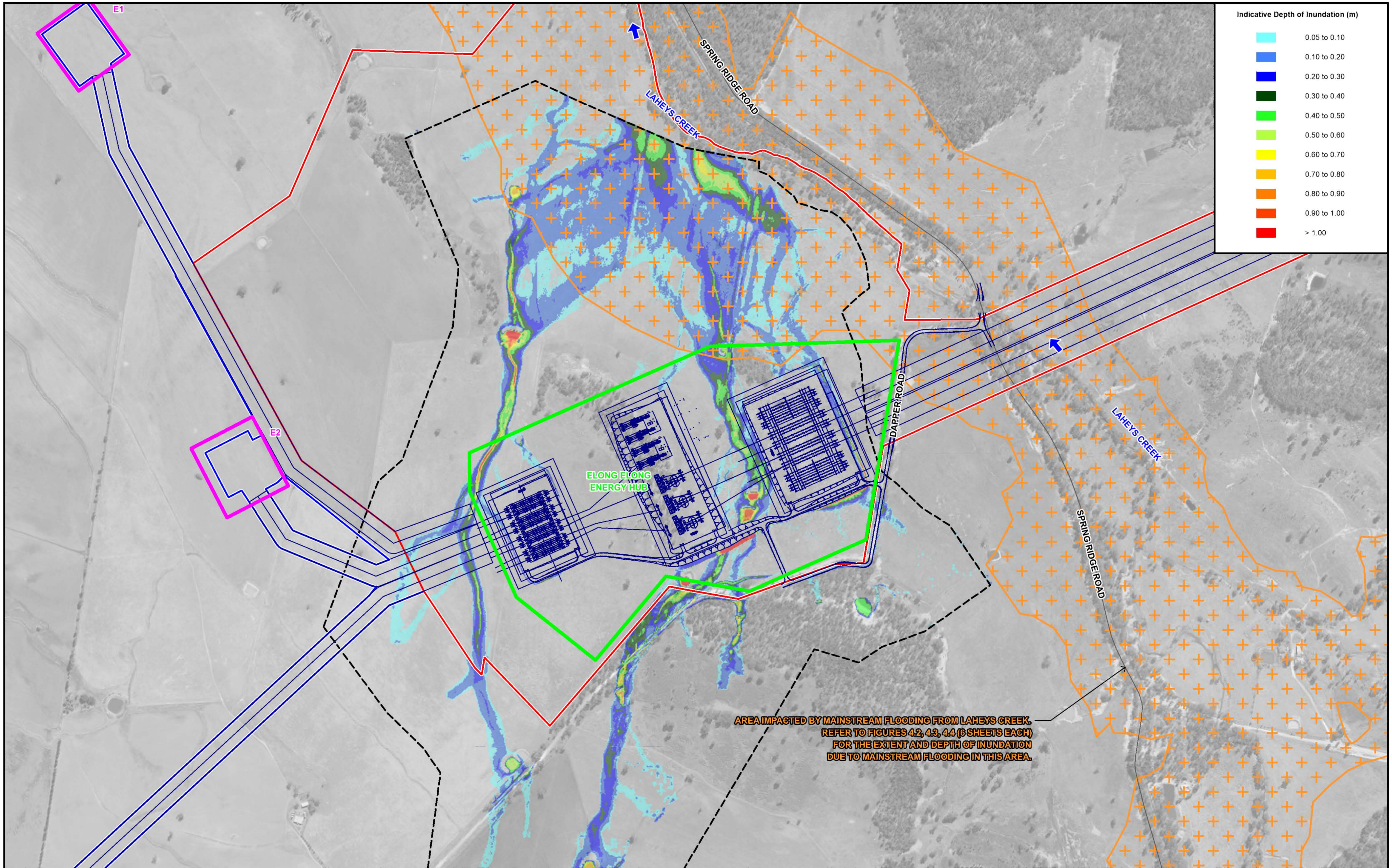
IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF MEROTHERIE ENERGY HUB
0.2% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.8a

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
0.5% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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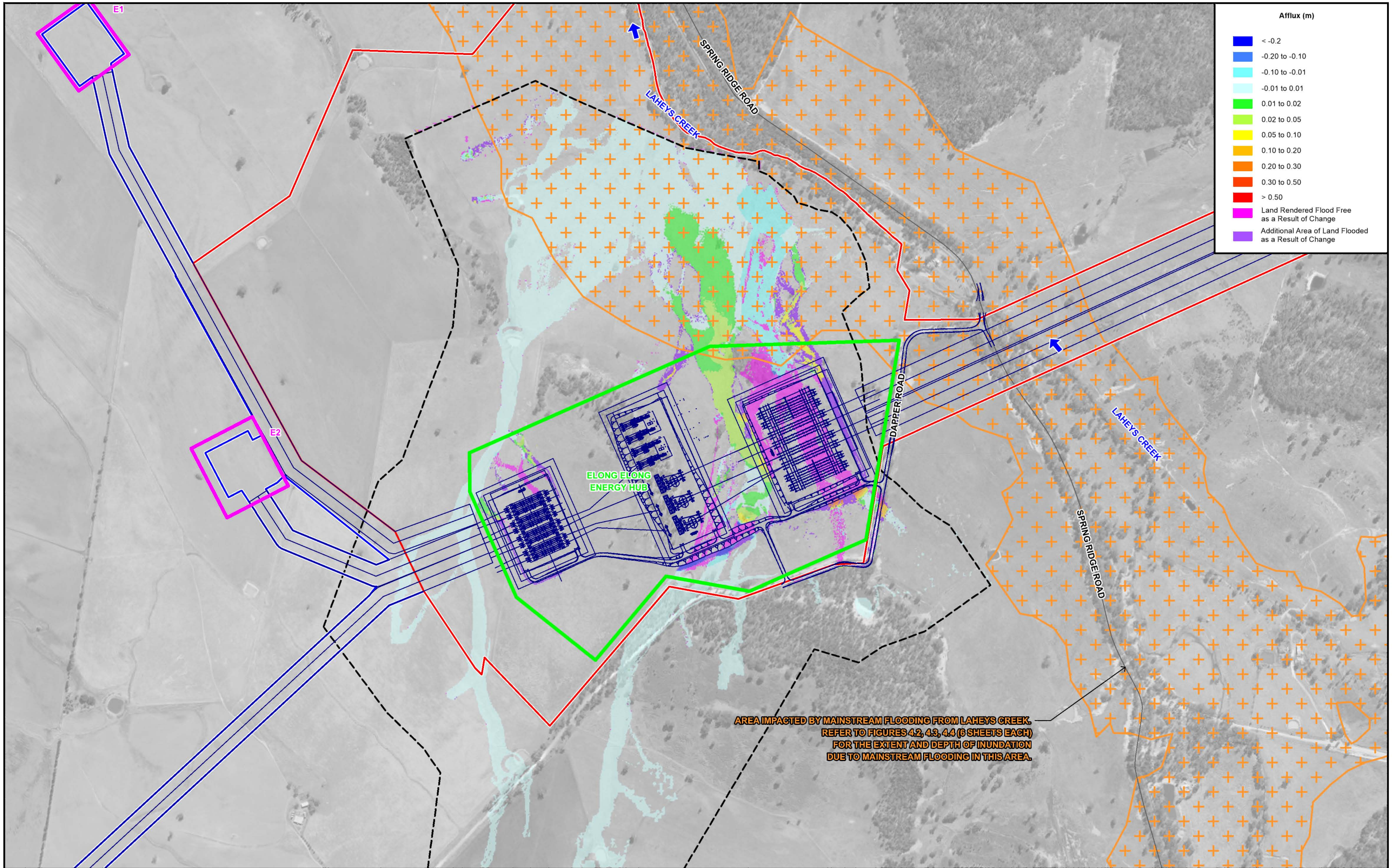
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.8b

FLOODING AND DRAINAGE PATTERNS UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
0.2% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station
E1 330kV Switching Stations and Identifier
500kV Transmission Line Corridor
330kV Transmission Line Corridor
Operational Infrastructure
Roads
Two-Dimensional Model Boundary

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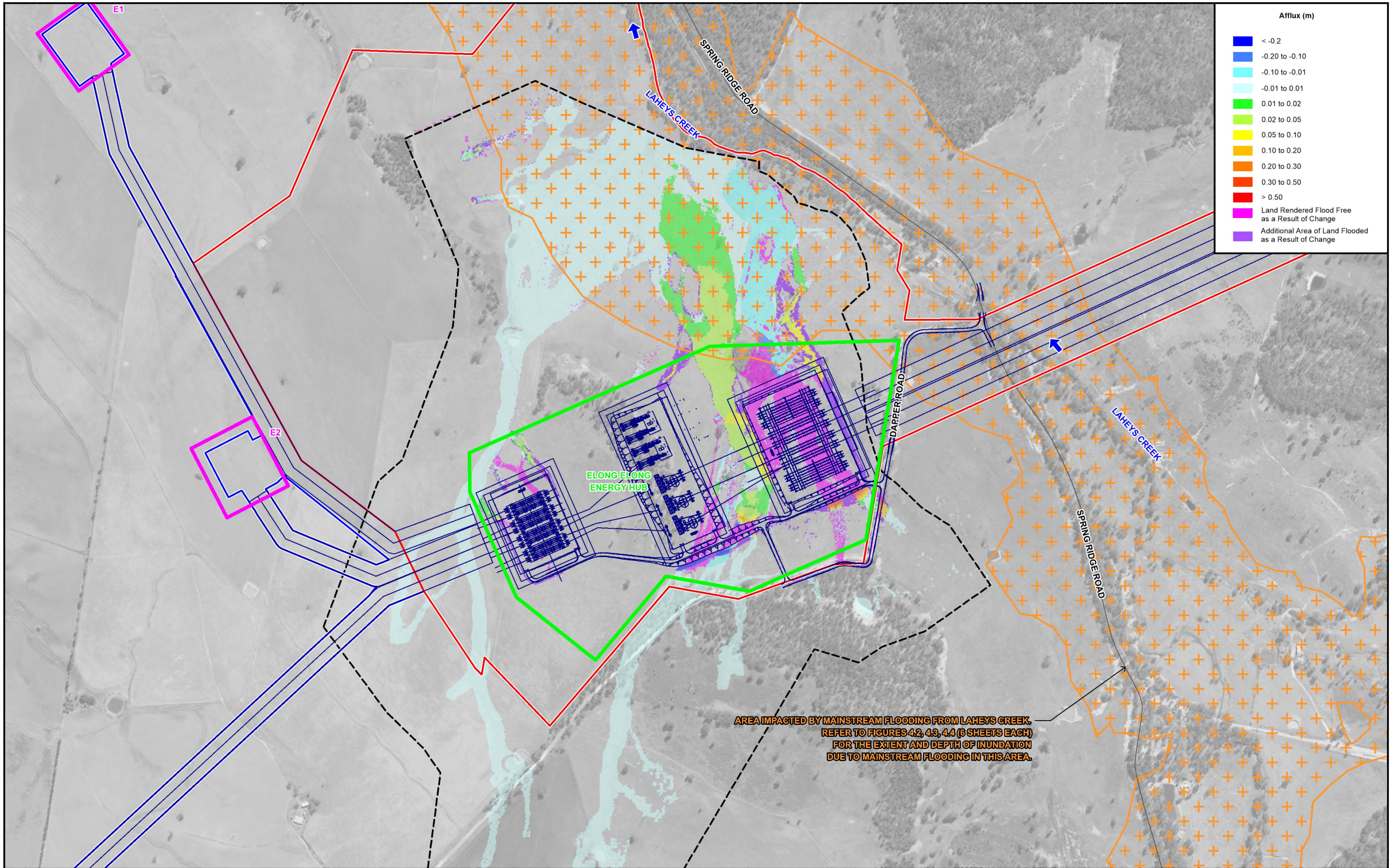
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.9a

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF ELONG ELONG ENERGY HUB
0.5% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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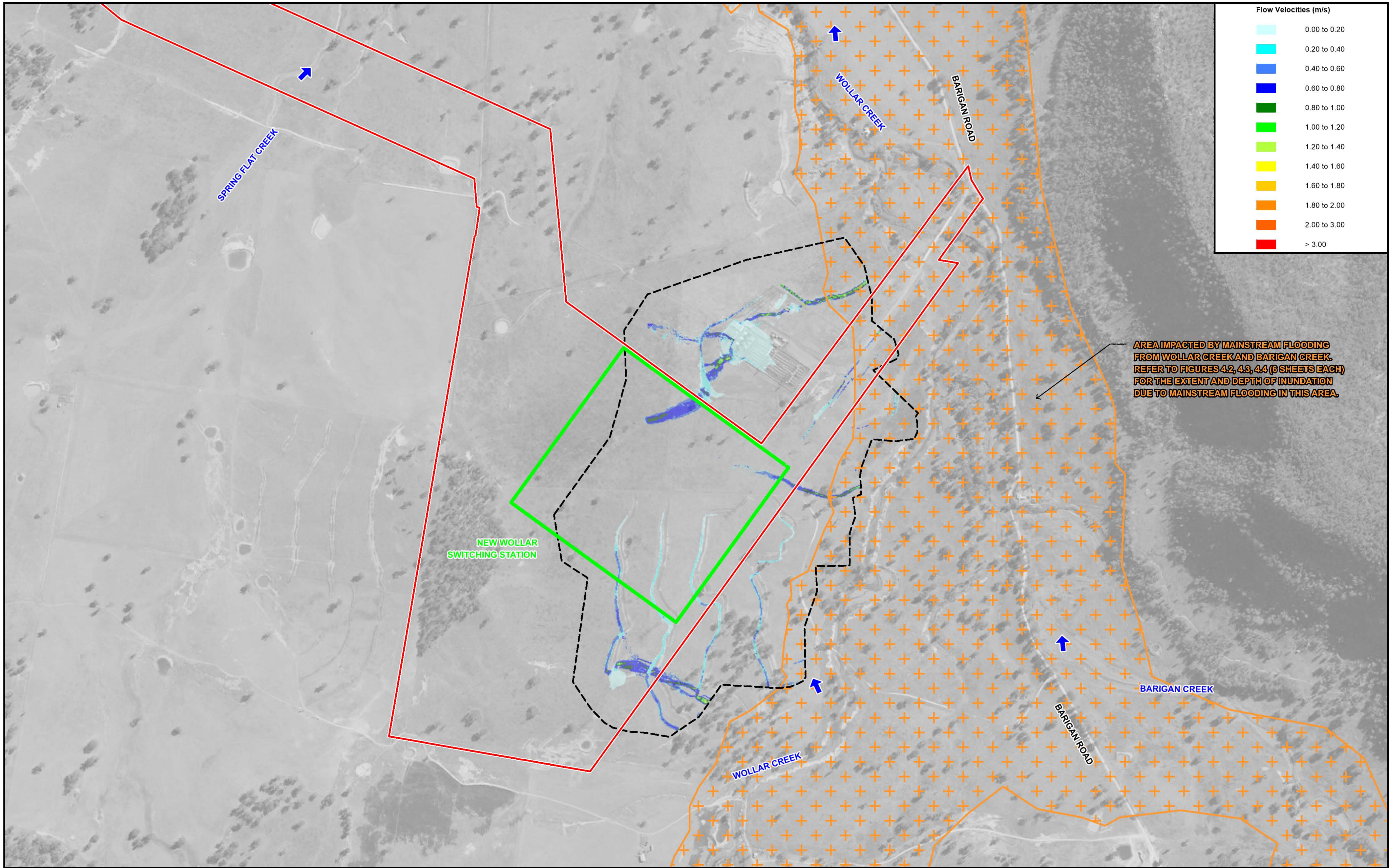
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure C.9b

IMPACT OF PROJECT ON FLOODING AND DRAINAGE PATTERNS IN VICINITY OF ELONG ELONG ENERGY HUB
0.2% AEP

ANNEXURE D

FIGURES SHOWING MAXIMUM FLOW VELOCITIES AND DURATIONS OF INUNDATION IN THE VICINITY OF THE NEW WOLLAR SWITCHING STATION, MEROTHERIE ENERGY HUB AND ELONG ELONG ENERGY HUB DURING A 10% AND 1% AEP EVENT



LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

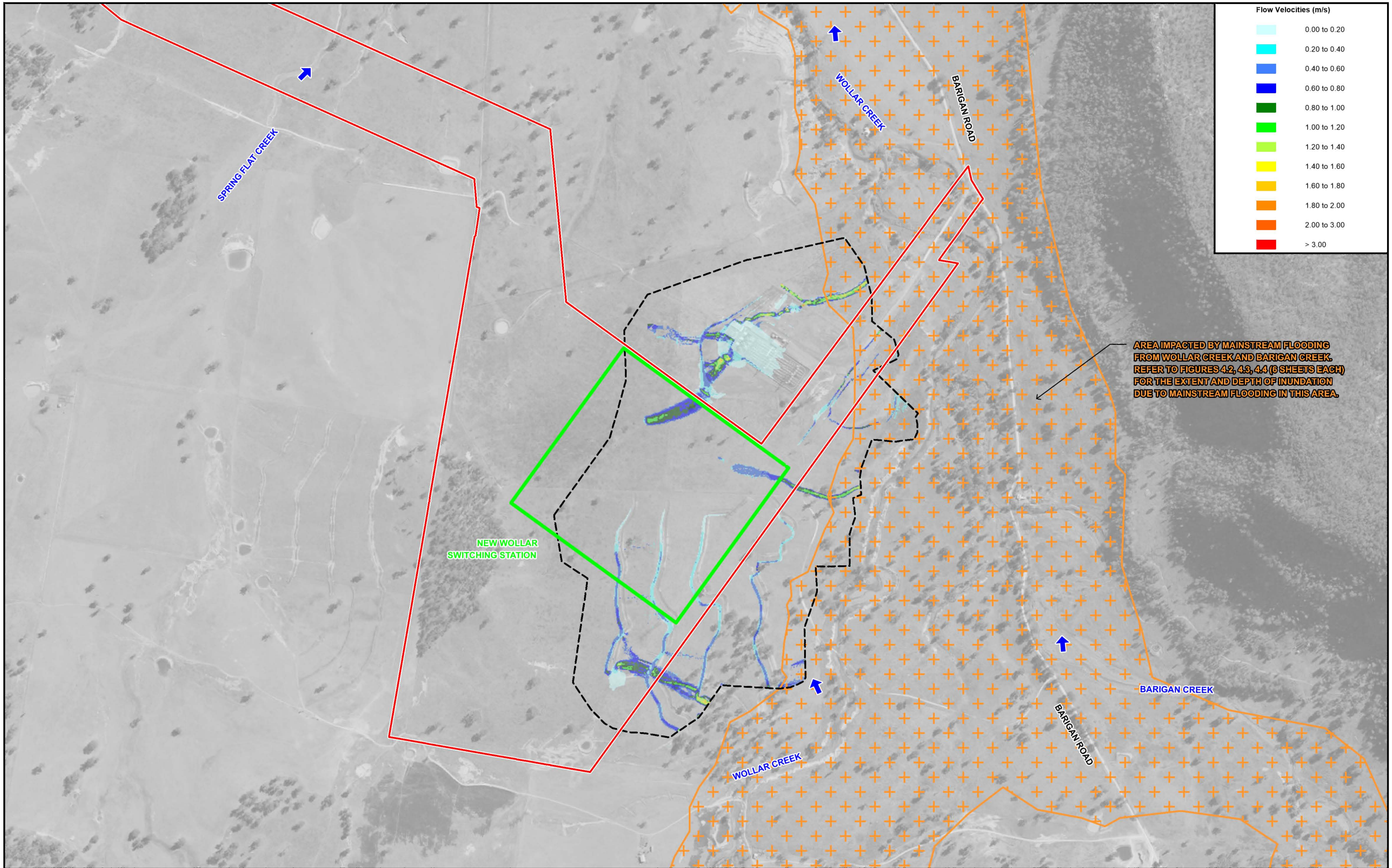
Two-Dimensional Model Boundary

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.1a

MAXIMUM FLOW VELOCITIES UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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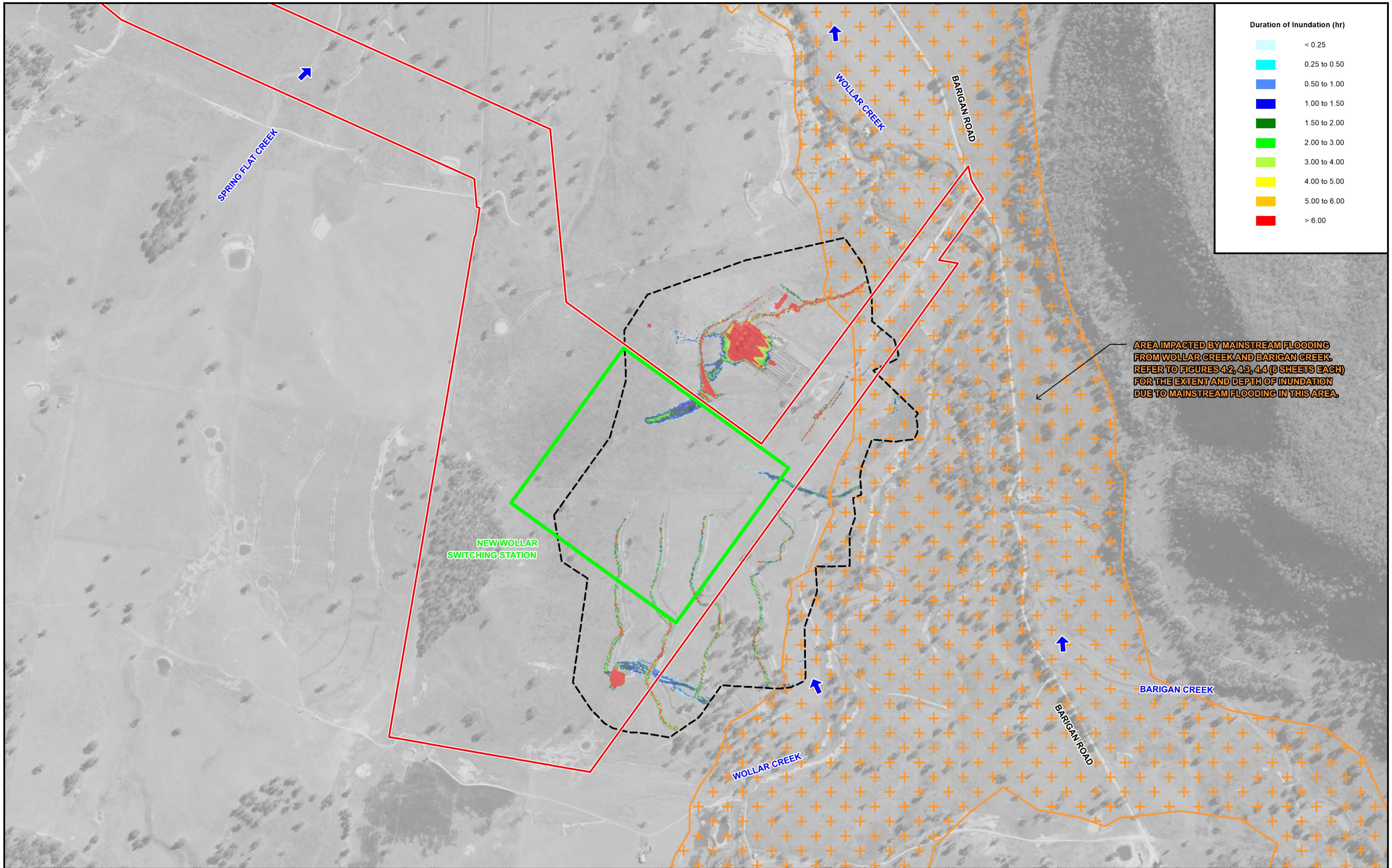
Figure D.1b

MAXIMUM FLOW VELOCITIES UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

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CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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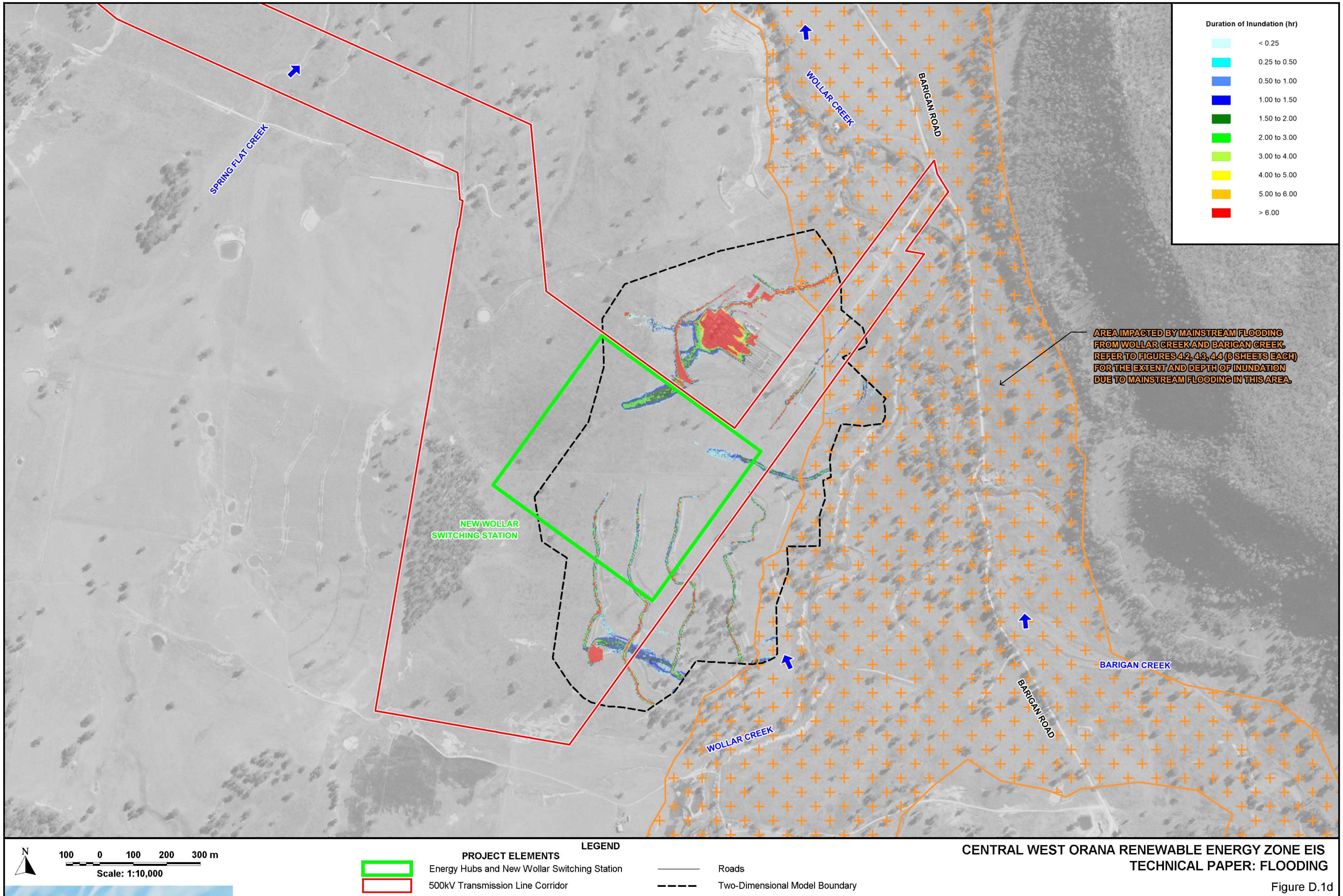
Figure D.1c

DURATION OF INUNDATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



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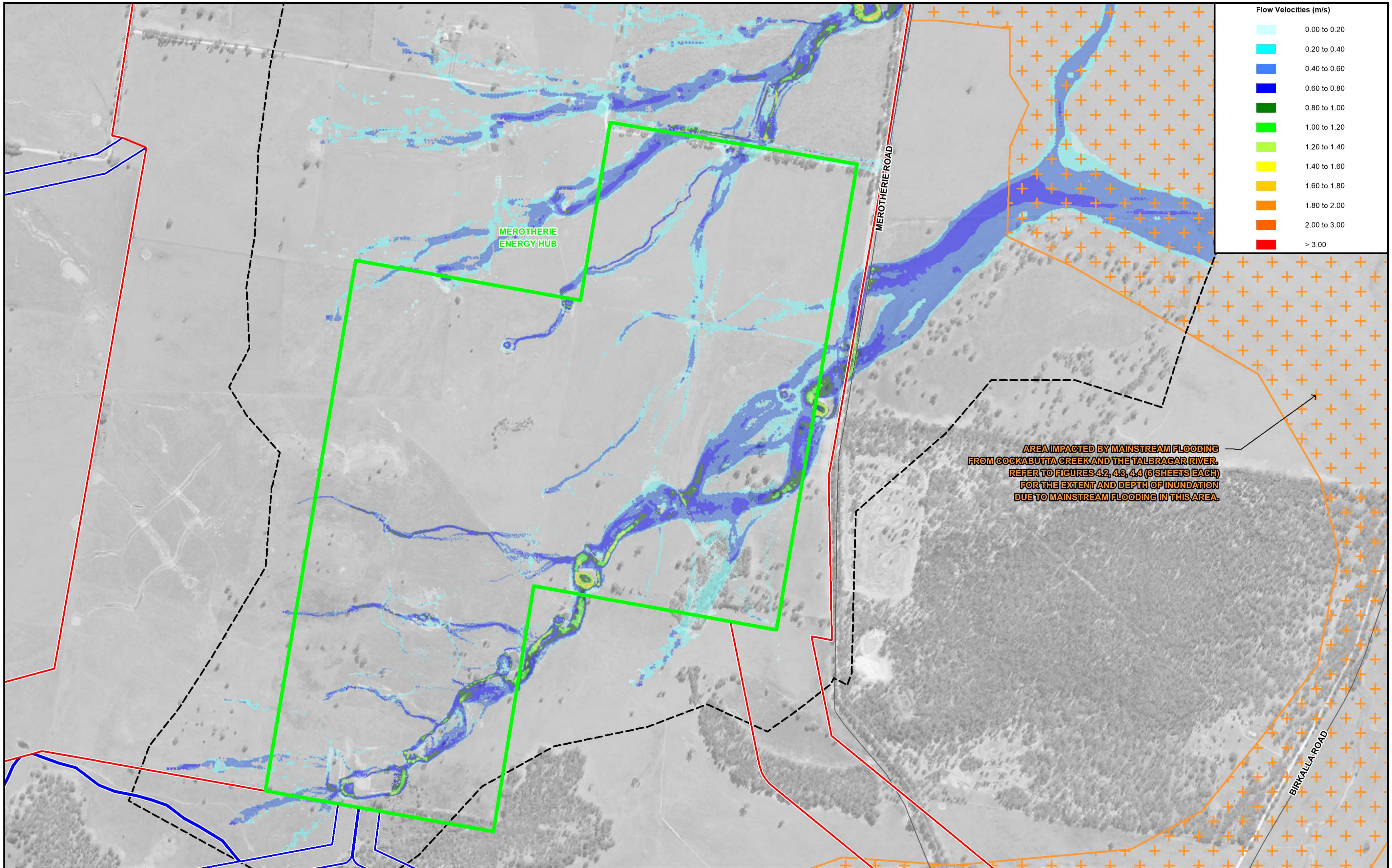
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.1d

DURATION OF INUNDATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS
Energy Hubs and New Wollar Switching Station
500kV Transmission Line Corridor
330kV Transmission Line Corridor
Roads
Two-Dimensional Model Boundary

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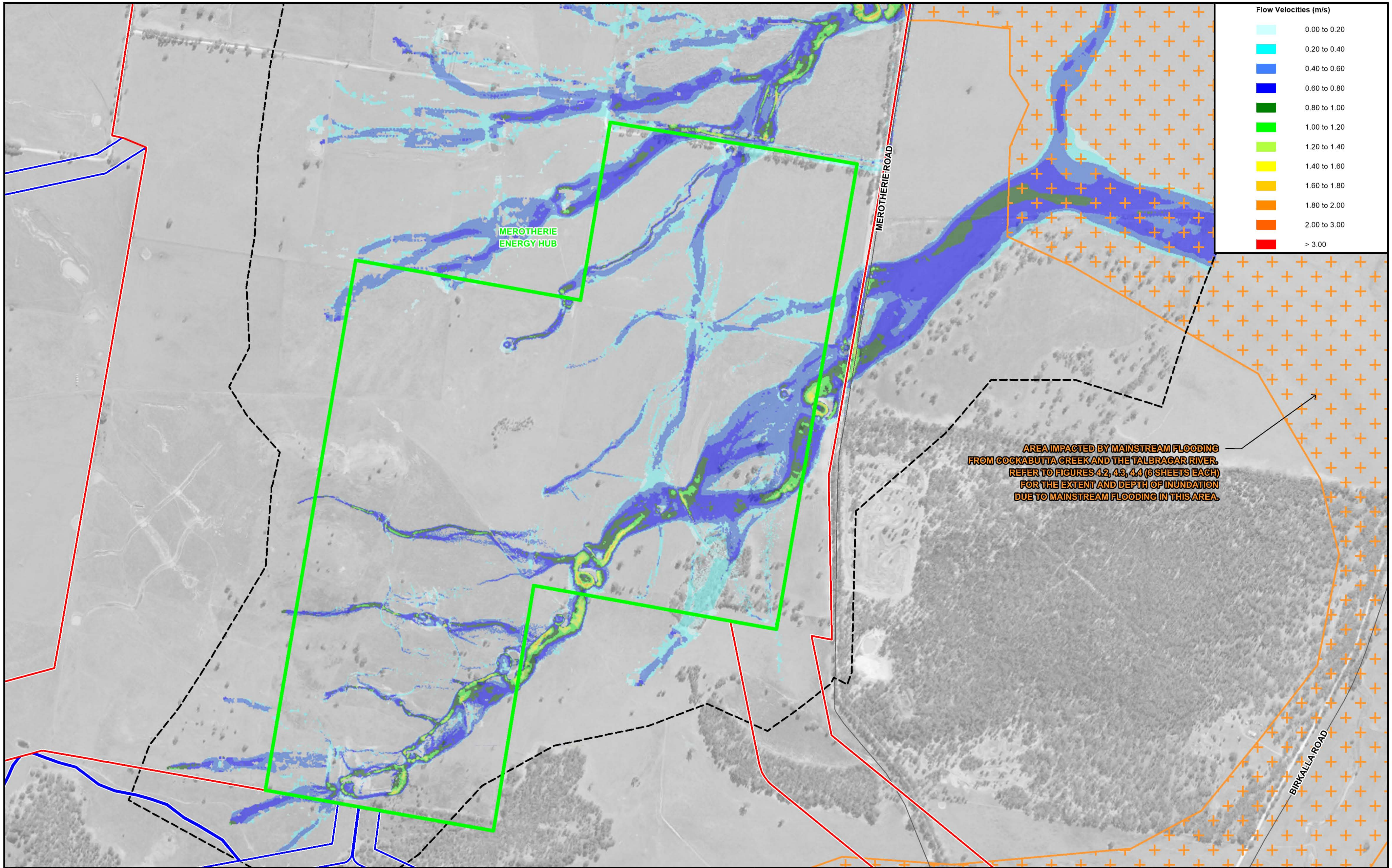
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.2a

MAXIMUM FLOW VELOCITIES UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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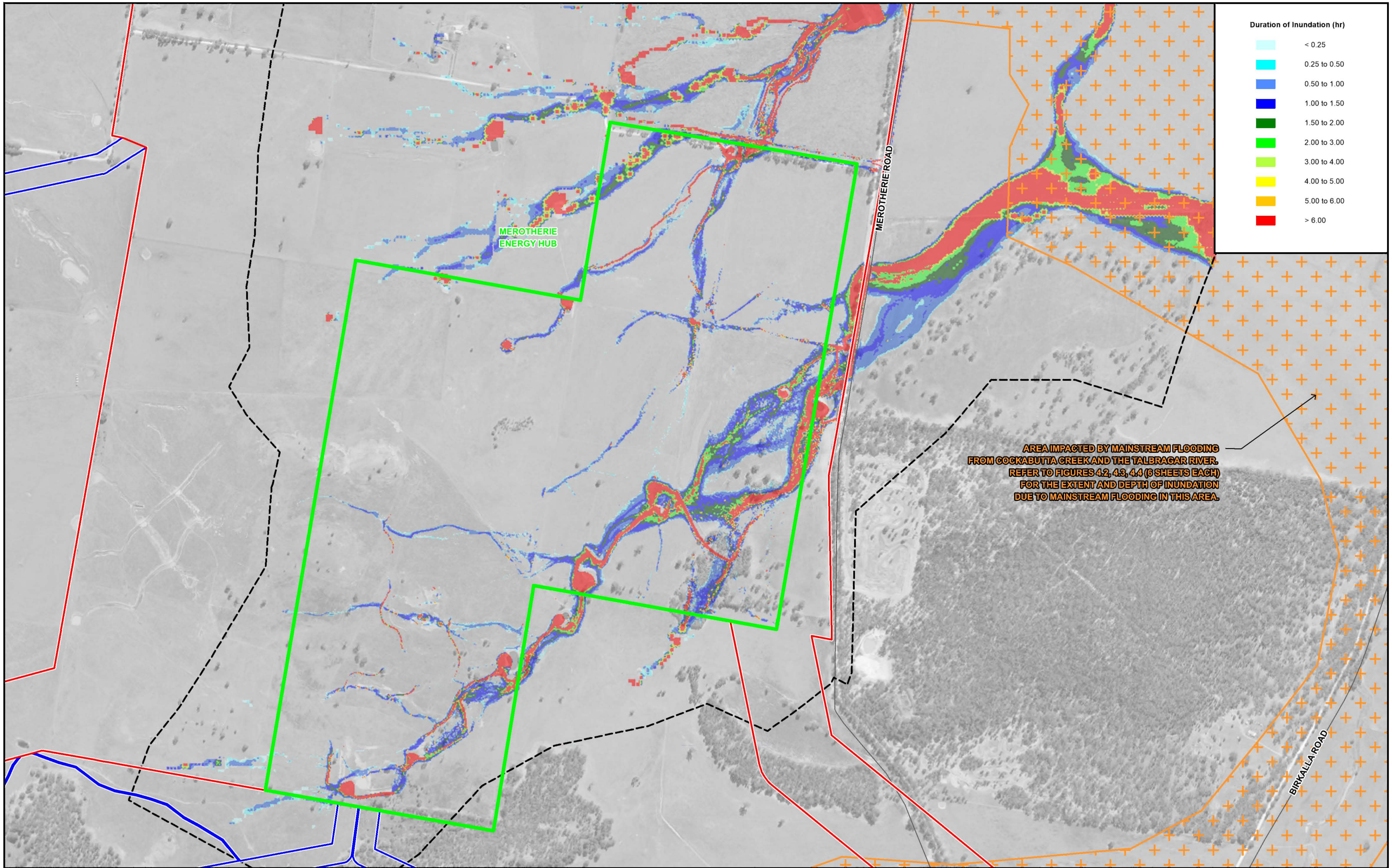
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.2b

MAXIMUM FLOW VELOCITIES UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS
- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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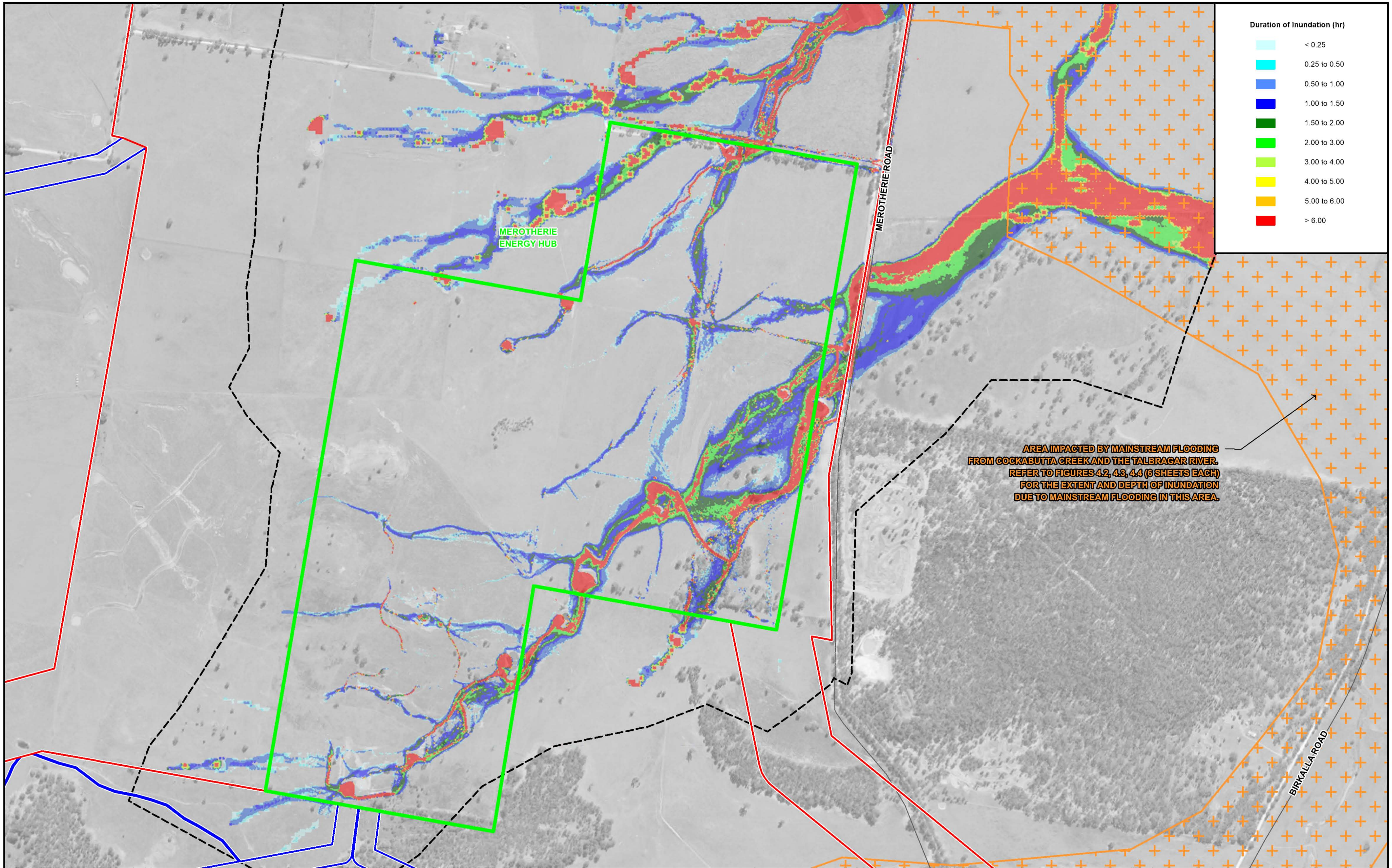
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.2c

DURATION OF INUNDATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

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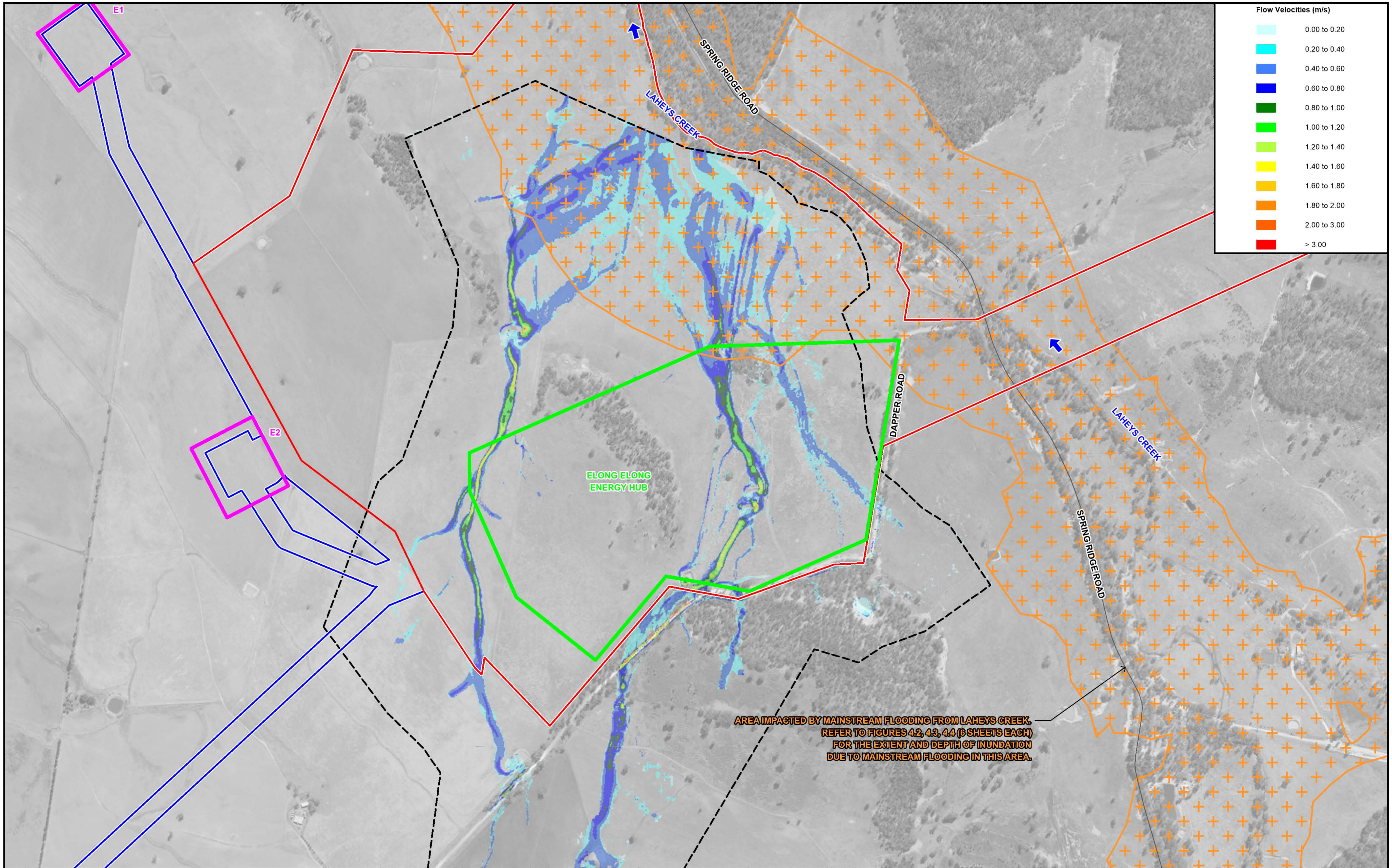
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS

TECHNICAL PAPER: FLOODING

Figure D.2d

DURATION OF INUNDATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB

1% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS
- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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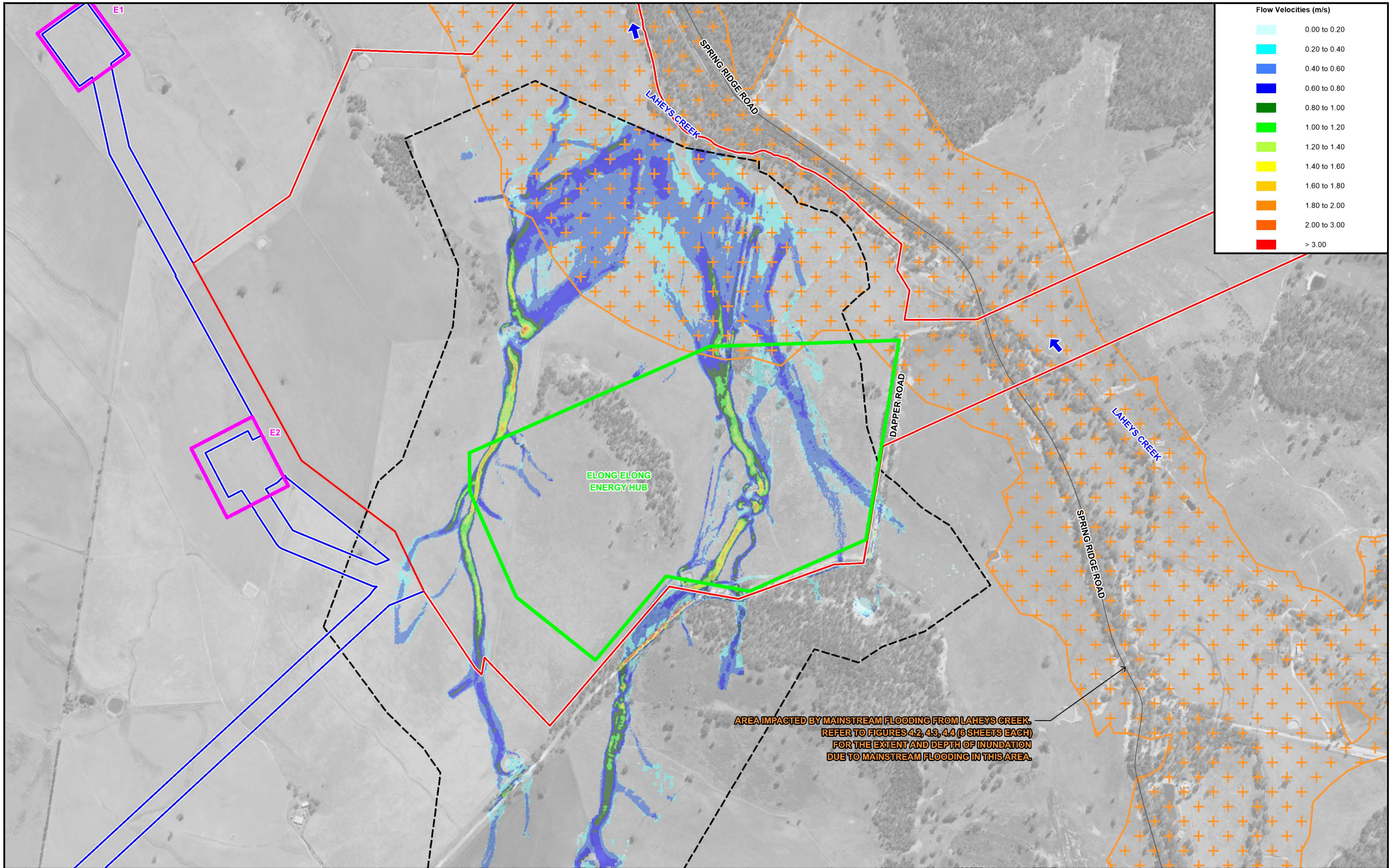
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.3a

MAXIMUM FLOW VELOCITIES UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

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CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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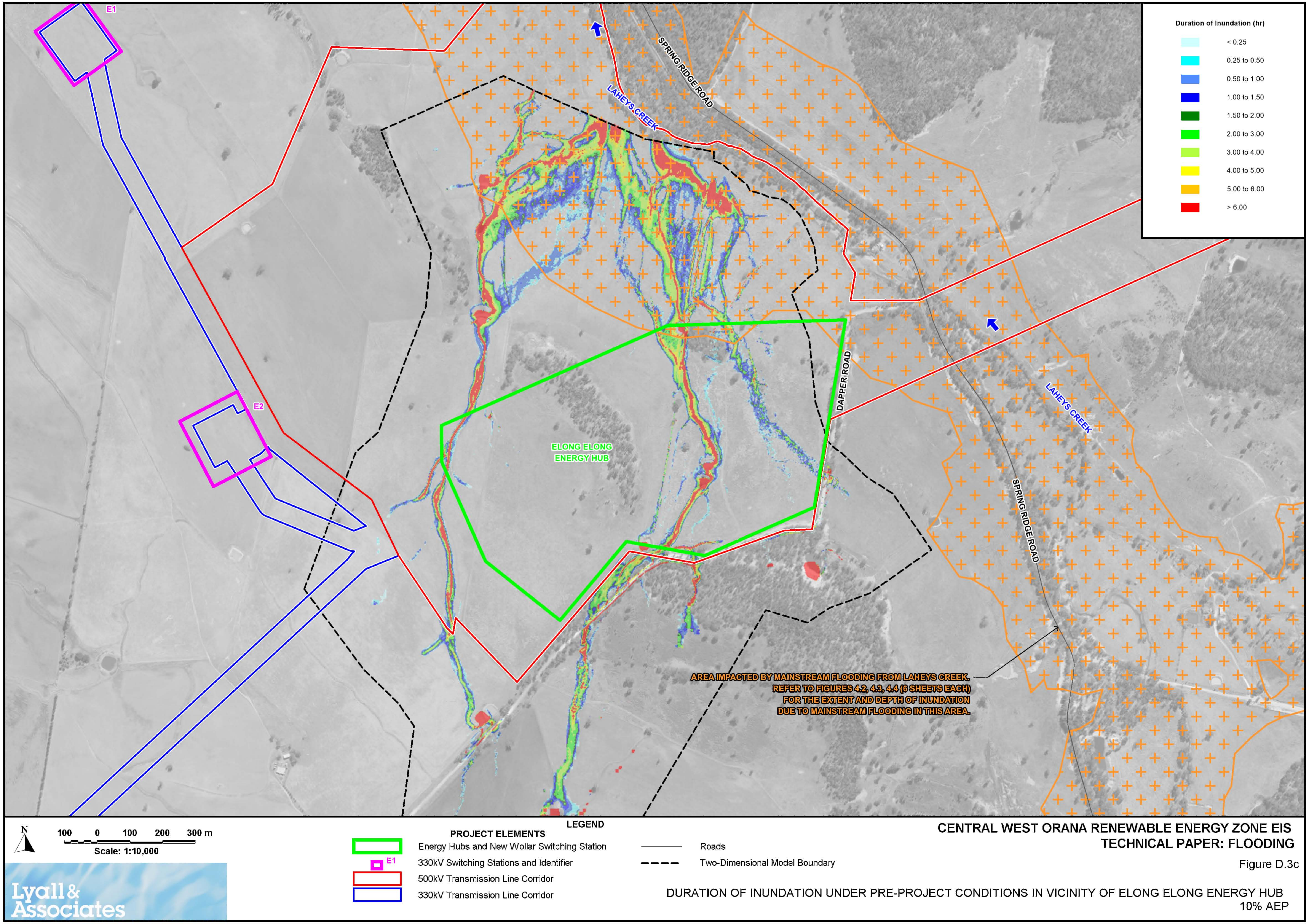
Figure D.3b

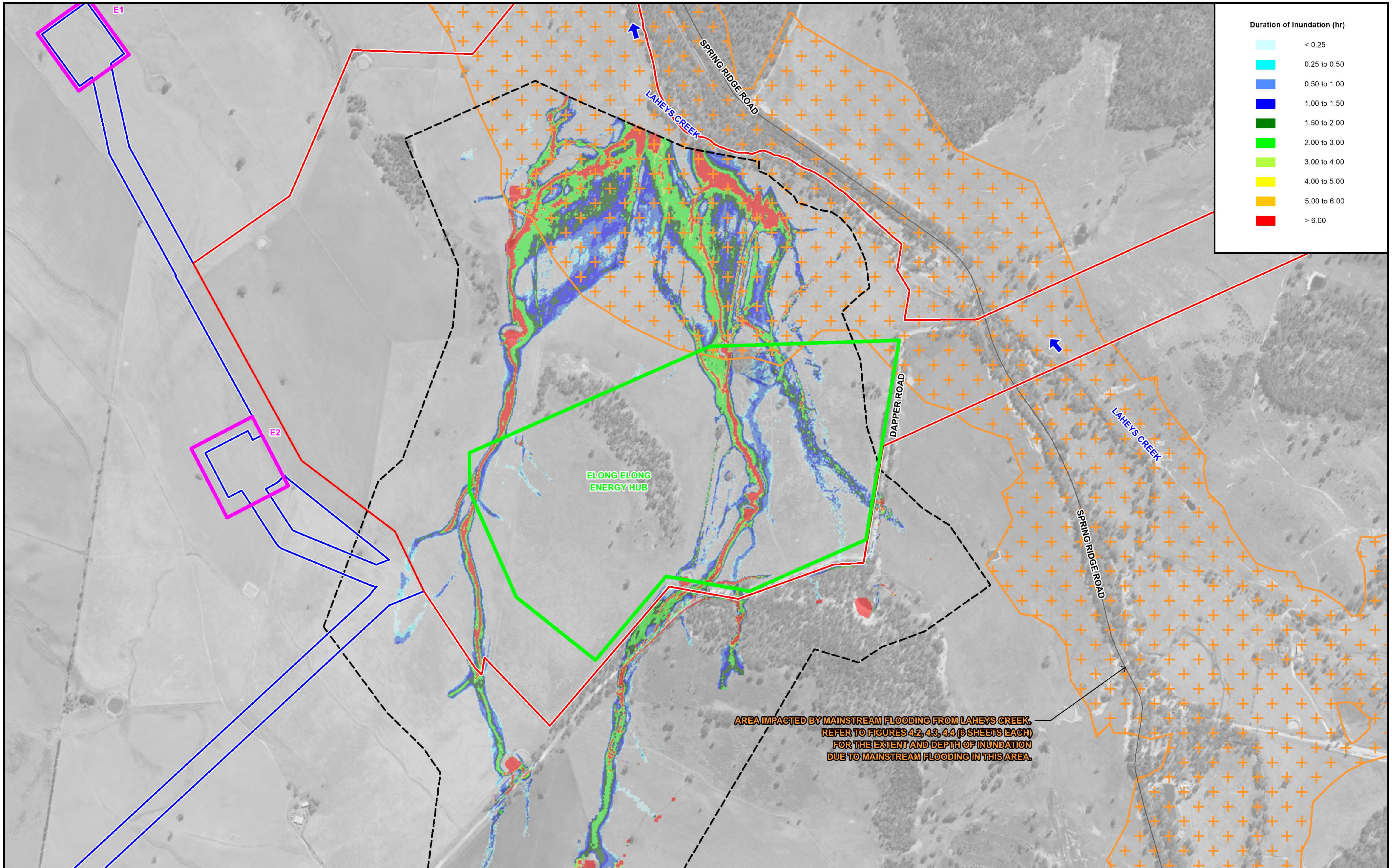
MAXIMUM FLOW VELOCITIES UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.3c

DURATION OF INUNDATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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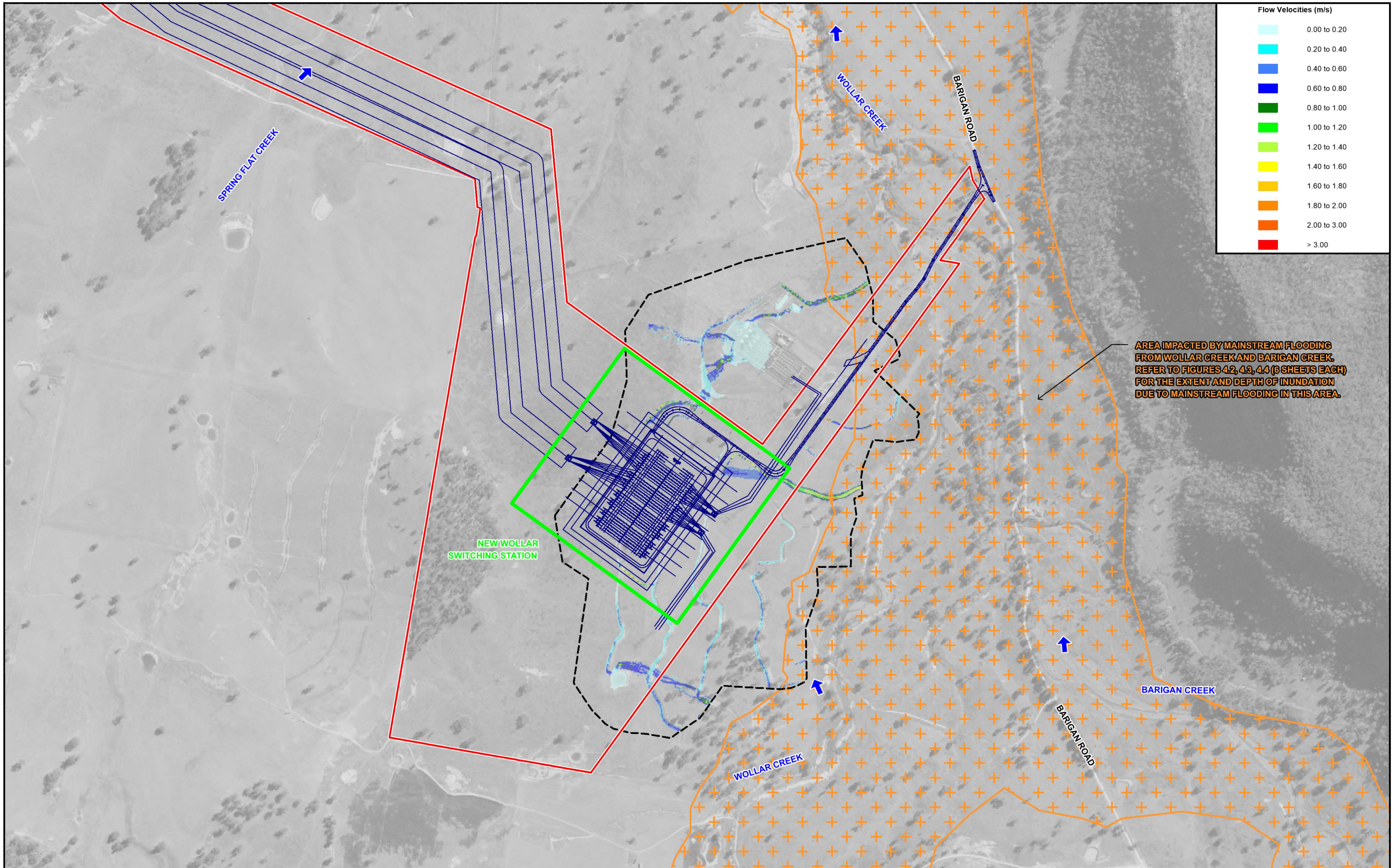
Figure D.3d

DURATION OF INUNDATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Operational Infrastructure

Roads

Two-Dimensional Model Boundary

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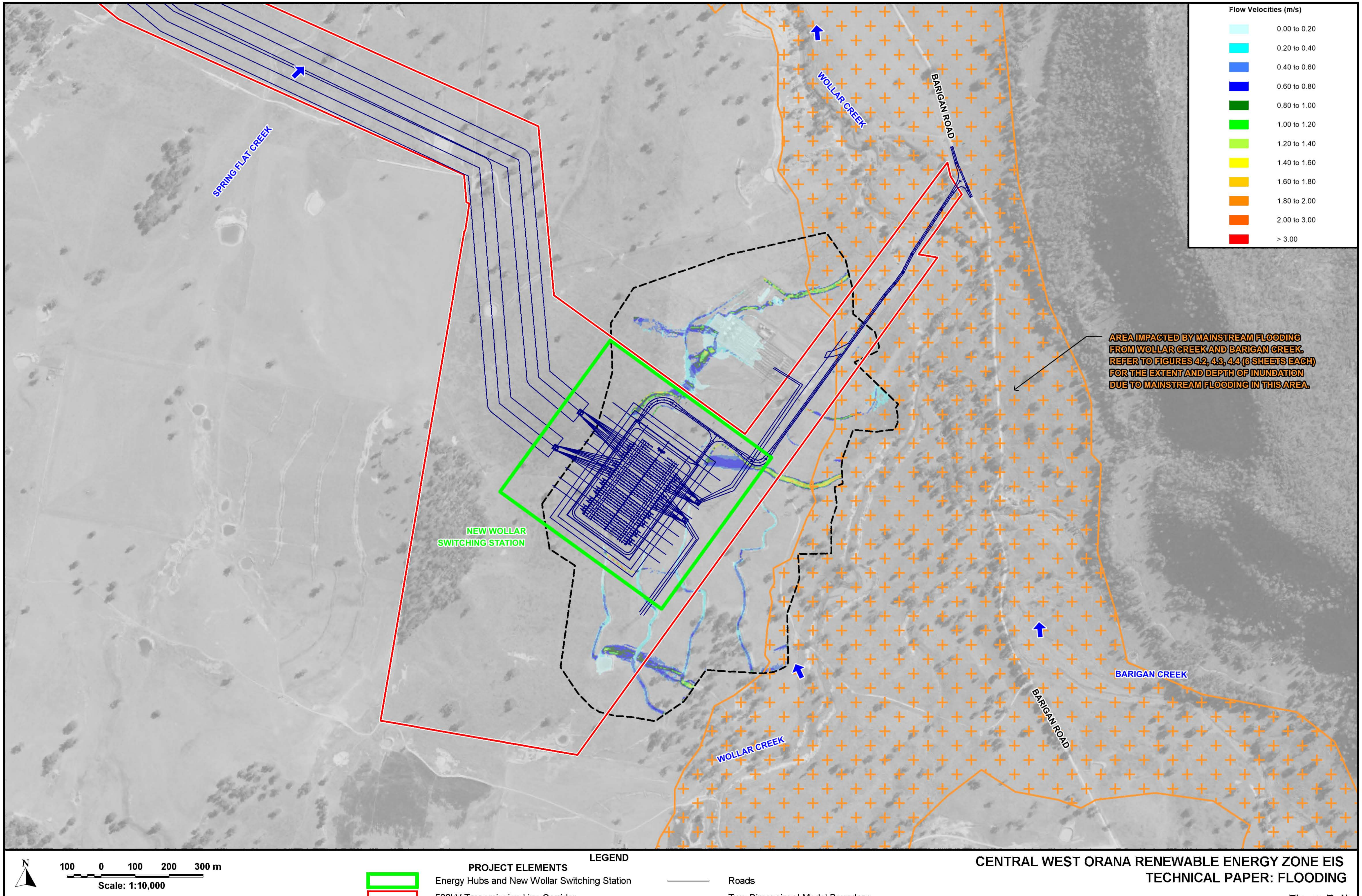
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.4a

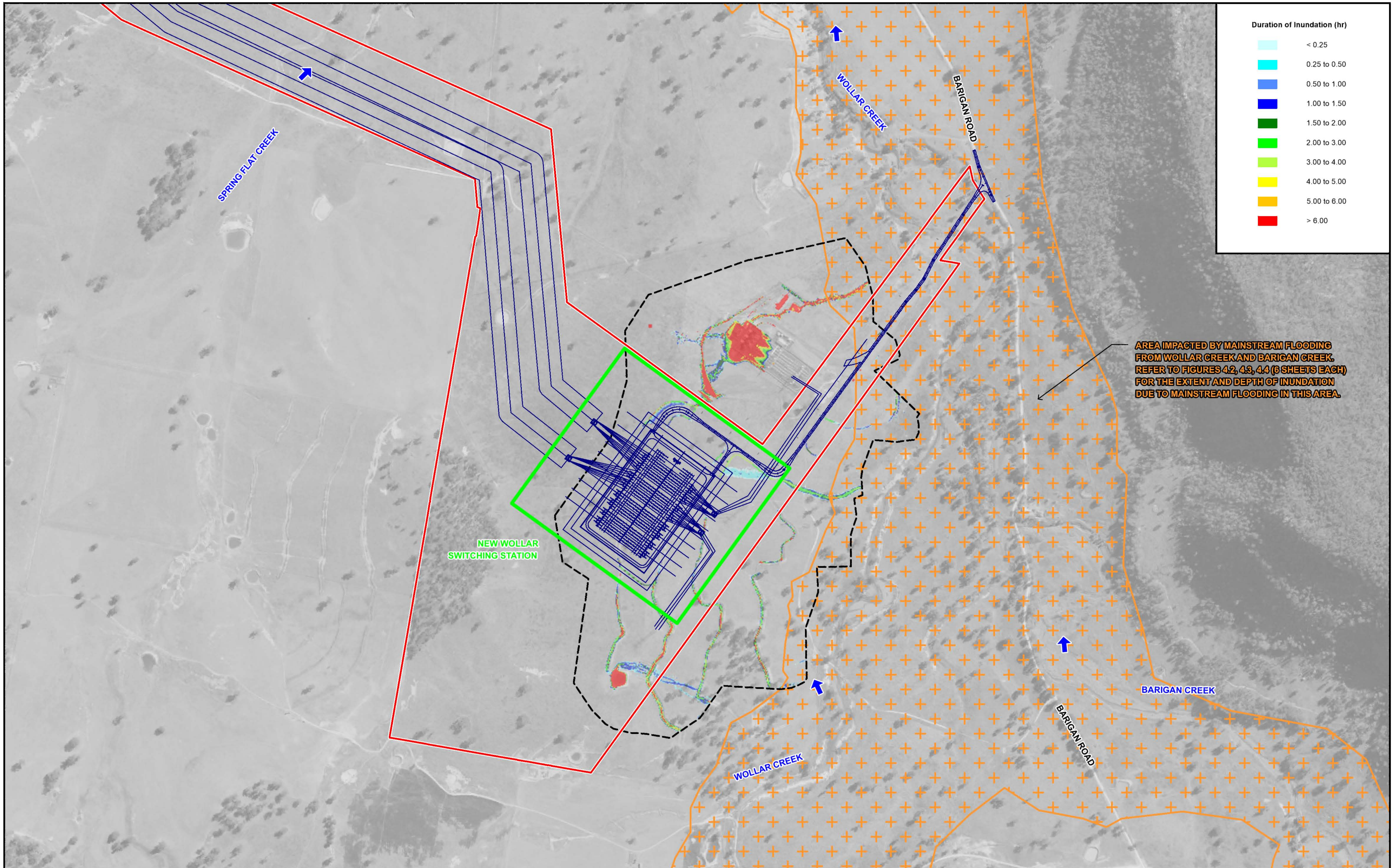
MAXIMUM FLOW VELOCITIES UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.4b

MAXIMUM FLOW VELOCITIES UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Operational Infrastructure

Roads

Two-Dimensional Model Boundary

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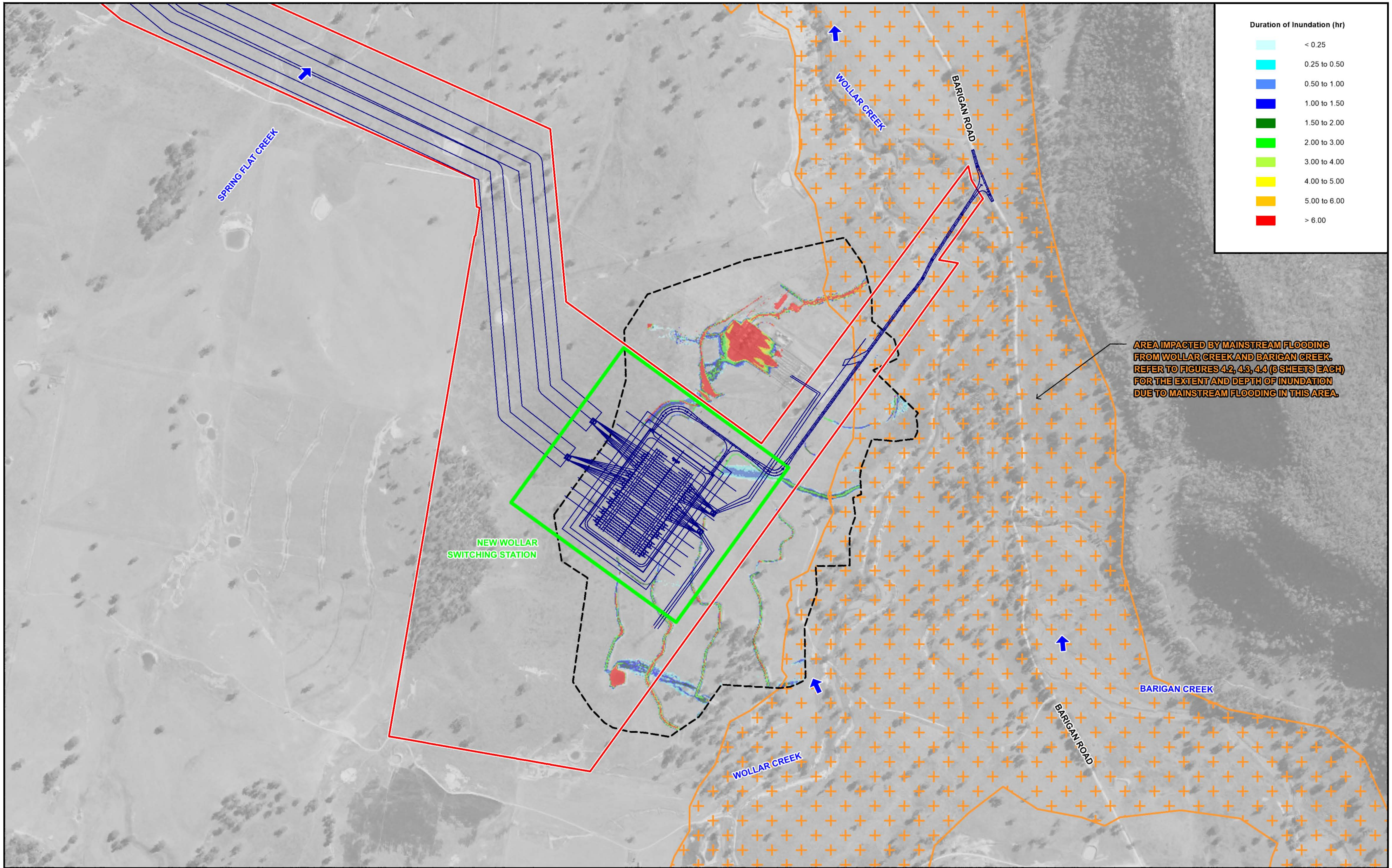
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.4c

DURATION OF INUNDATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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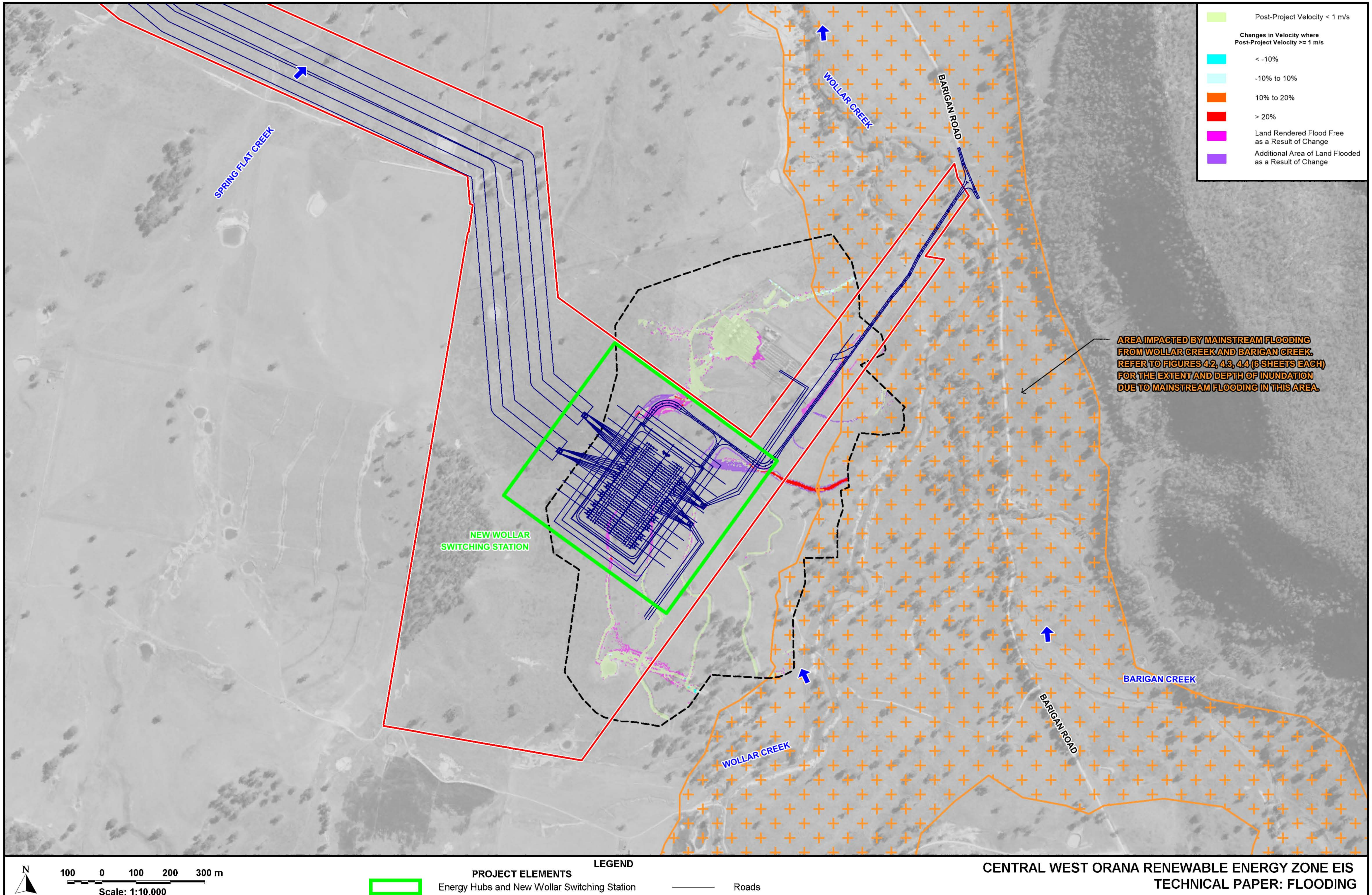
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.4d

DURATION OF INUNDATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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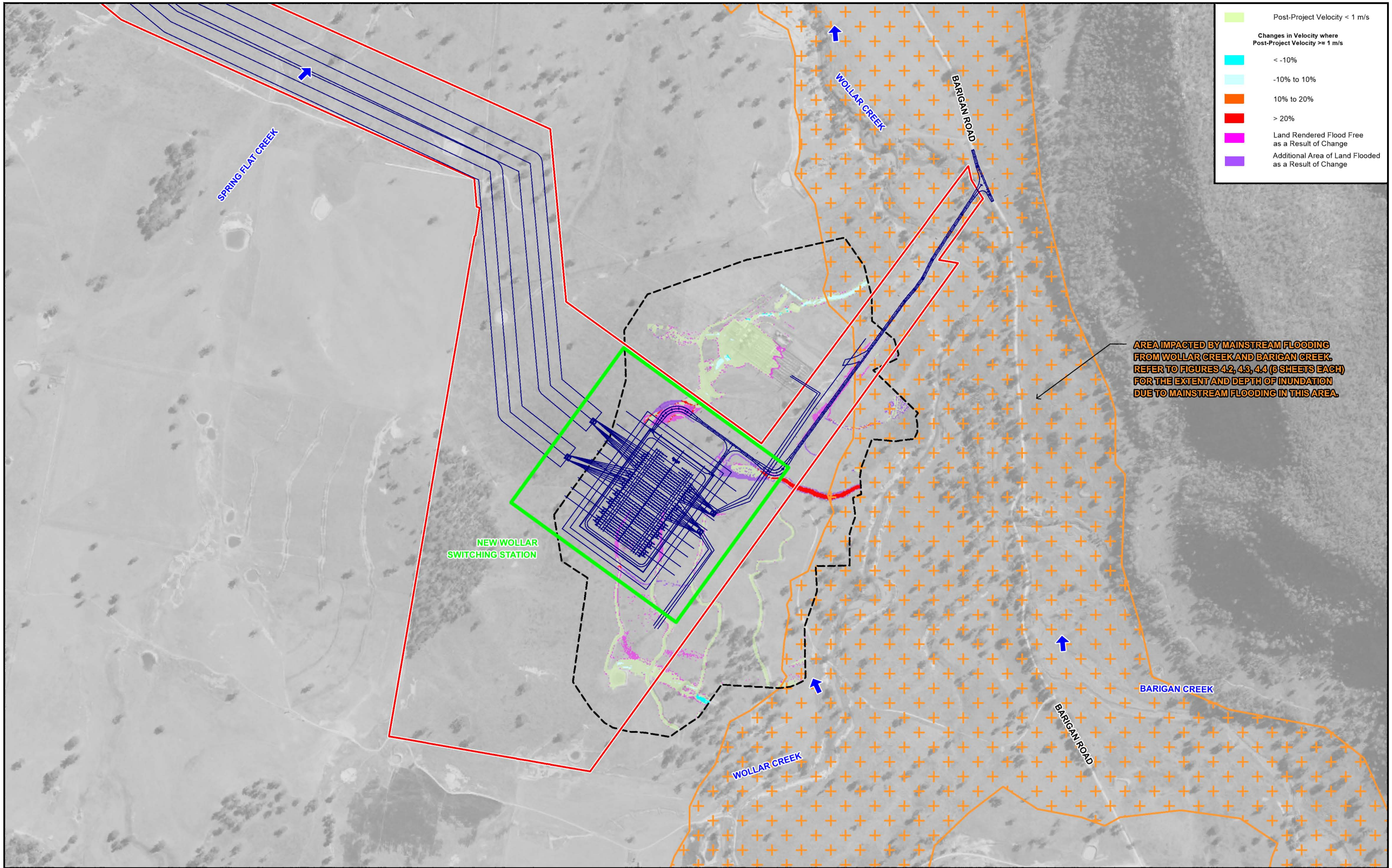
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.5a

IMPACT OF PROJECT ON MAXIMUM FLOW VELOCITIES IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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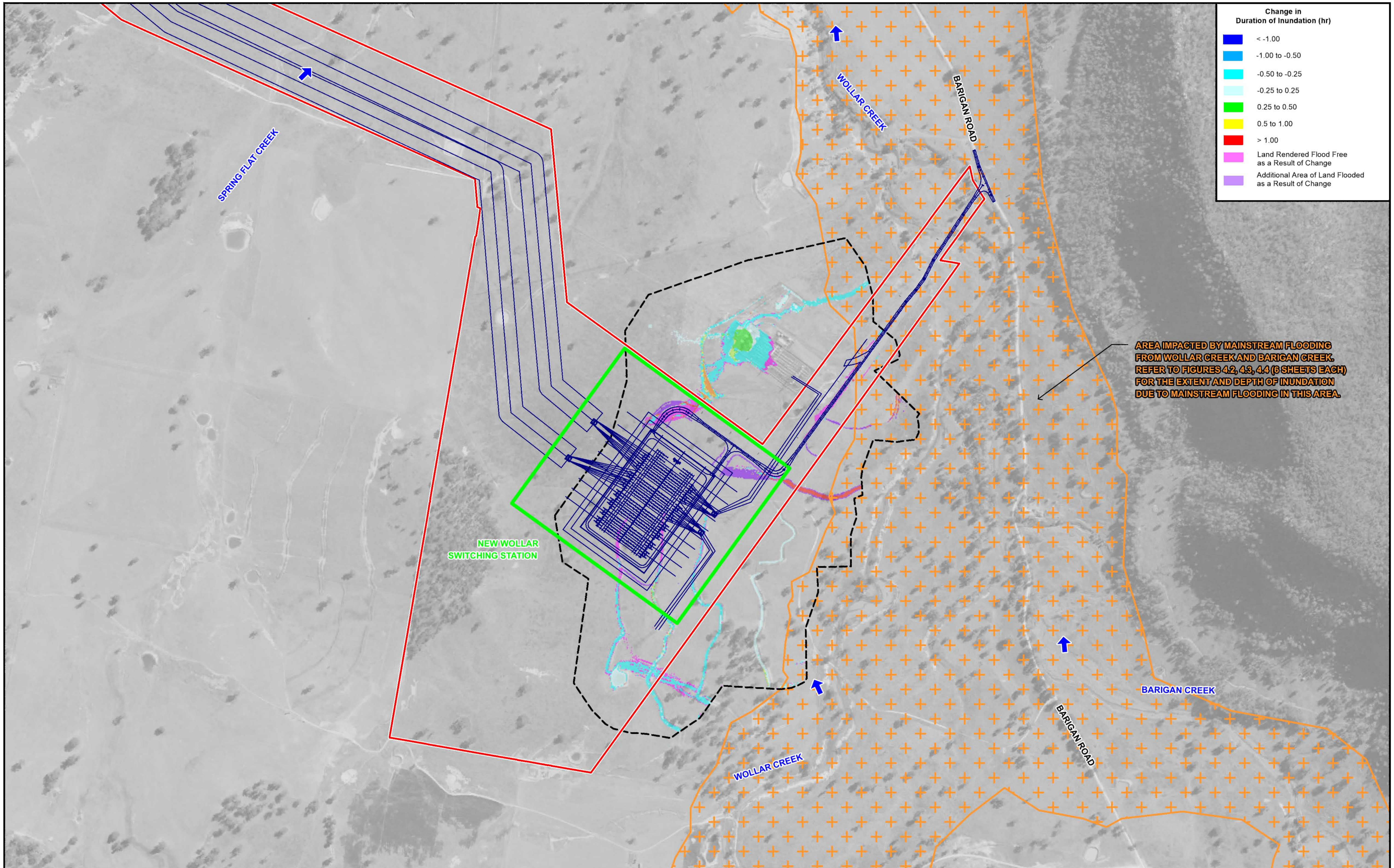
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.5b

IMPACT OF PROJECT ON MAXIMUM FLOW VELOCITIES IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

Operational Infrastructure

Roads

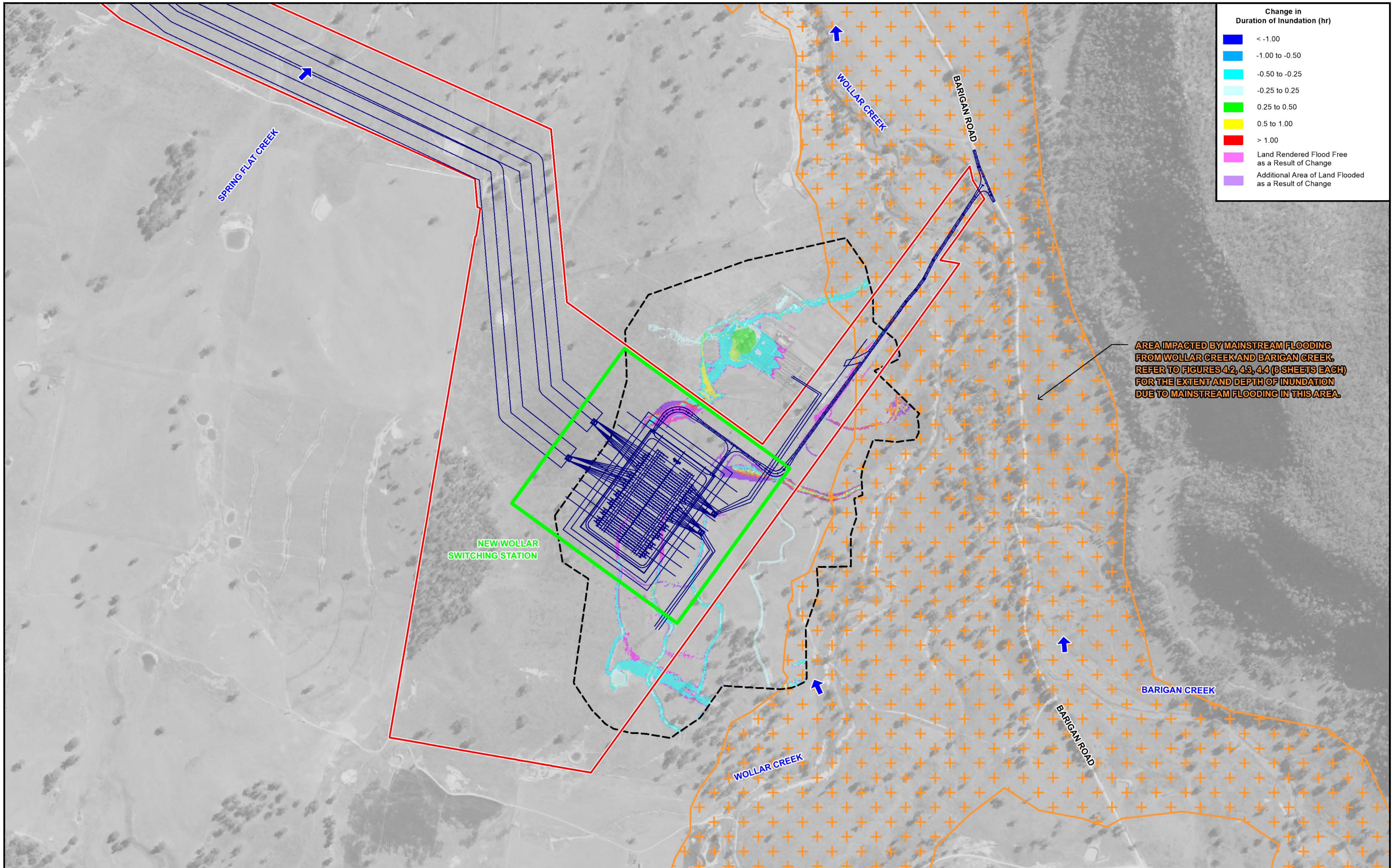
Two-Dimensional Model Boundary

Lyall & Associates

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.5c

IMPACT OF PROJECT ON DURATION OF INUNDATION IN VICINITY OF NEW WOLLAR SWITCHING STATION
10% AEP



N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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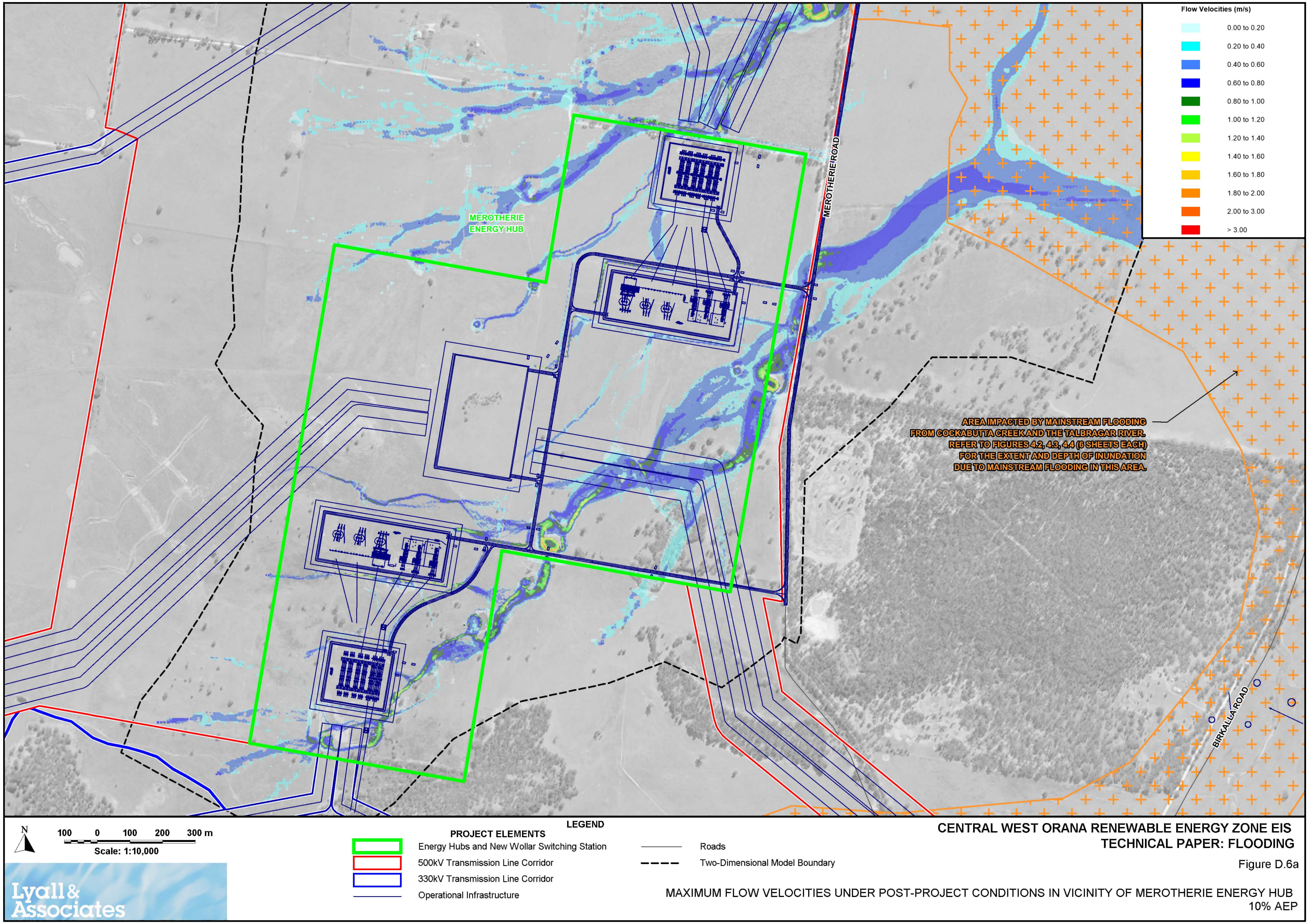
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.5d

IMPACT OF PROJECT ON DURATION OF INUNDATION IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.6a

MAXIMUM FLOW VELOCITIES UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP

N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS
- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.6b

MAXIMUM FLOW VELOCITIES UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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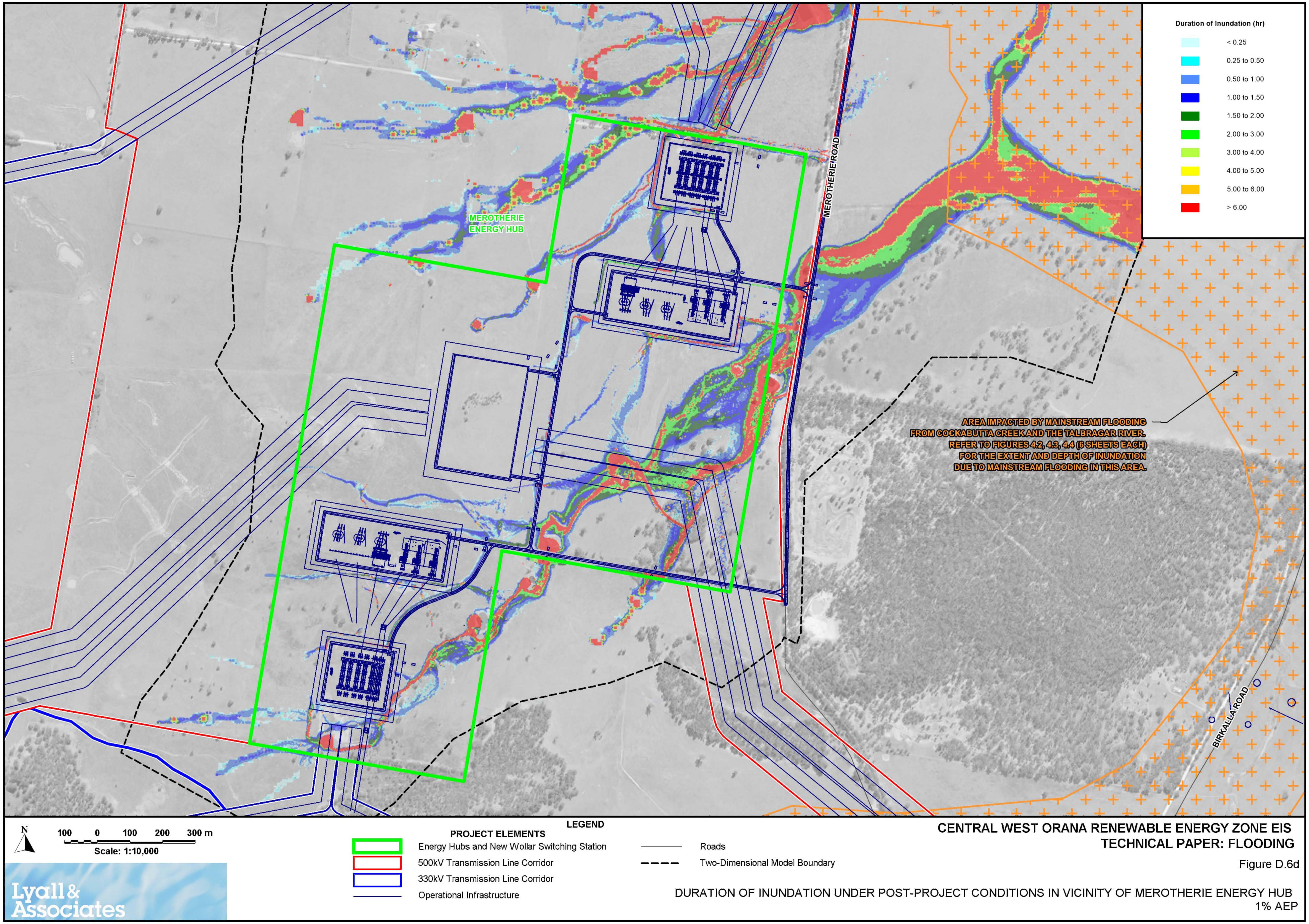
CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.6c

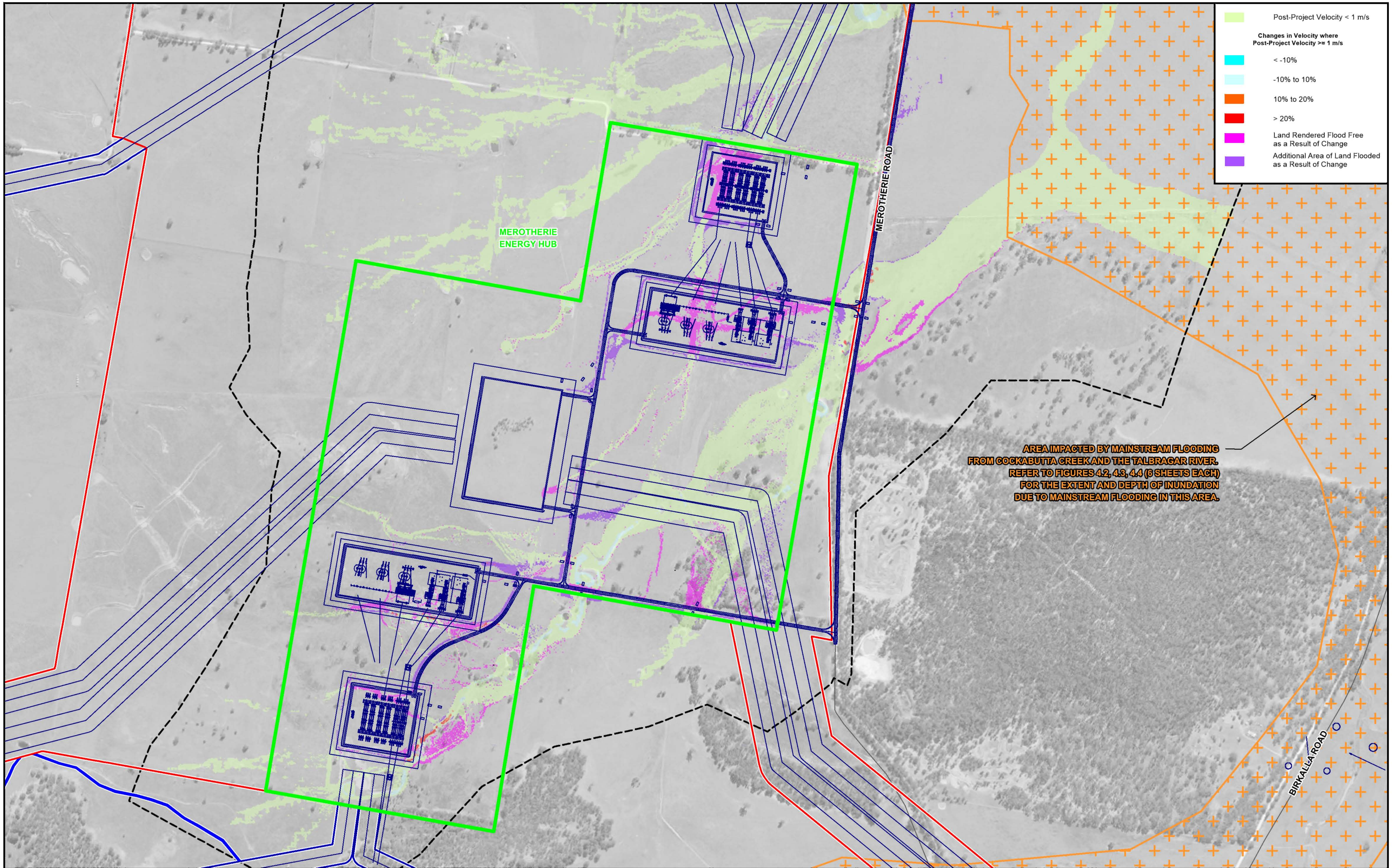
DURATION OF INUNDATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
TECHNICAL PAPER: FLOODING

Figure D.6d

DURATION OF INUNDATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP



N
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Scale: 1:10,000

LEGEND

PROJECT ELEMENTS
- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

Lyall & Associates

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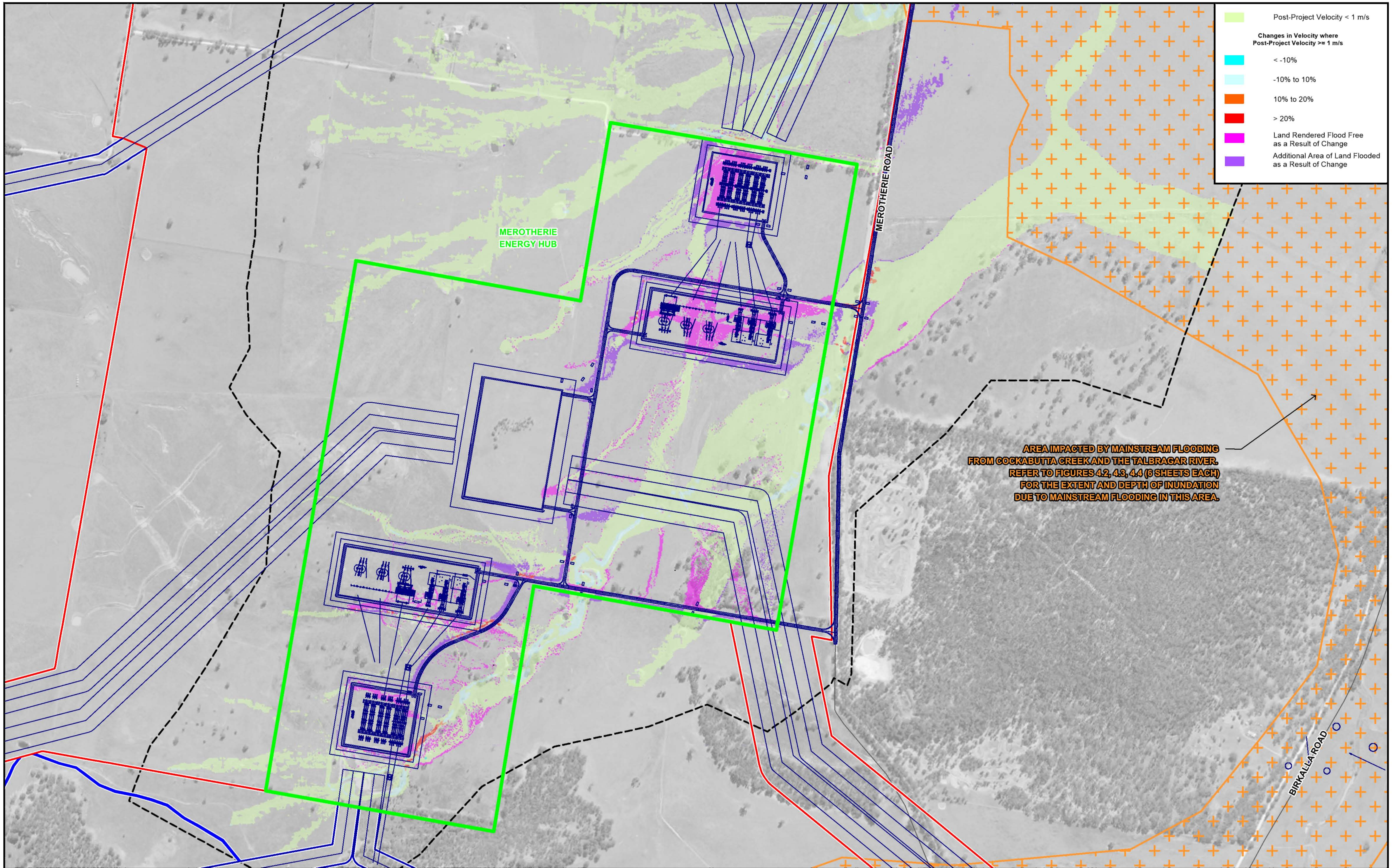
Figure D.7a

IMPACT OF PROJECT ON MAXIMUM FLOW VELOCITIES IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



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Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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Figure D.7b

IMPACT OF PROJECT ON MAXIMUM FLOW VELOCITIES IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP

N
100 0 100 200 300 m
Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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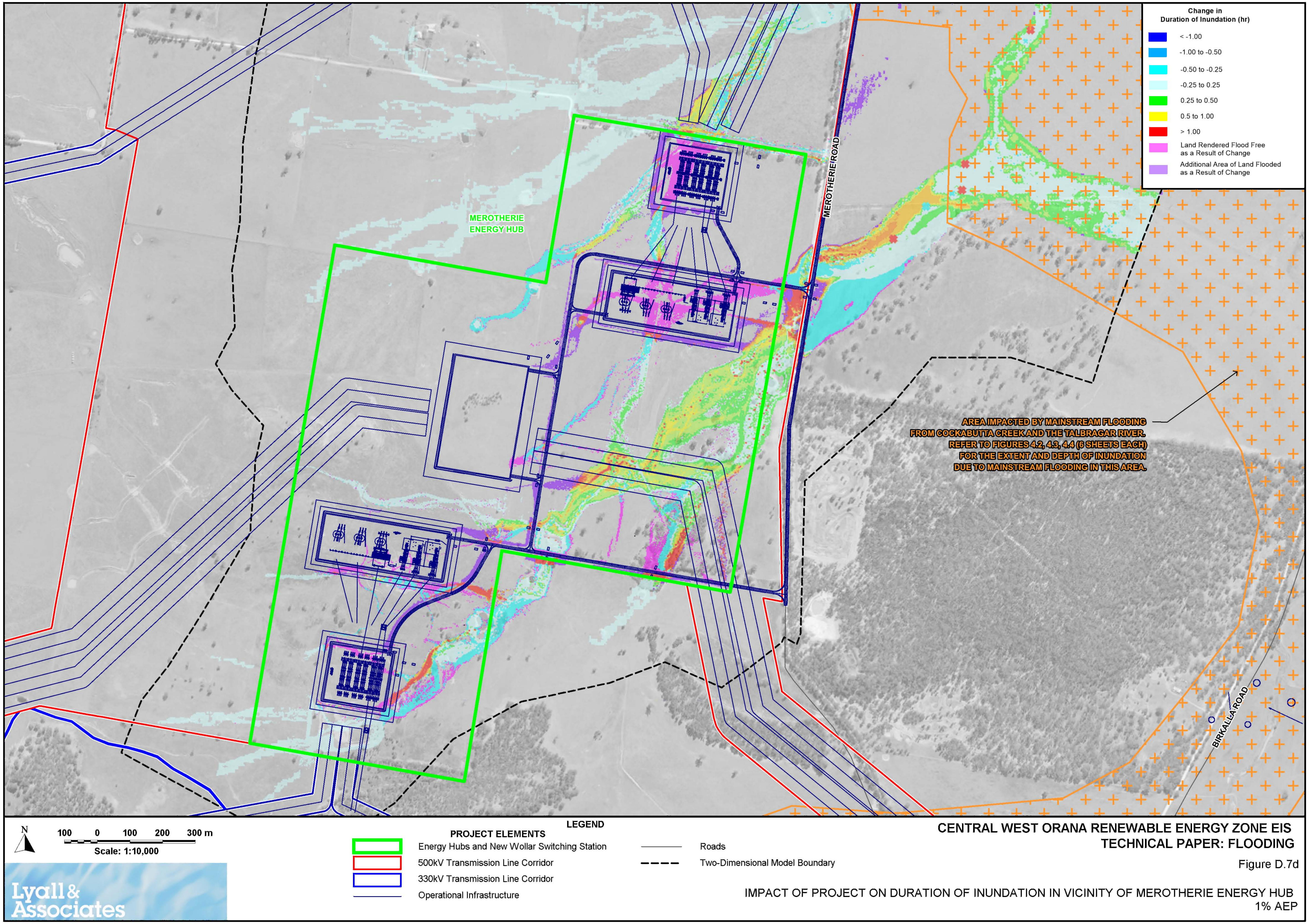
Figure D.7c

IMPACT OF PROJECT ON DURATION OF INUNDATION IN VICINITY OF MEROTHERIE ENERGY HUB
10% AEP



CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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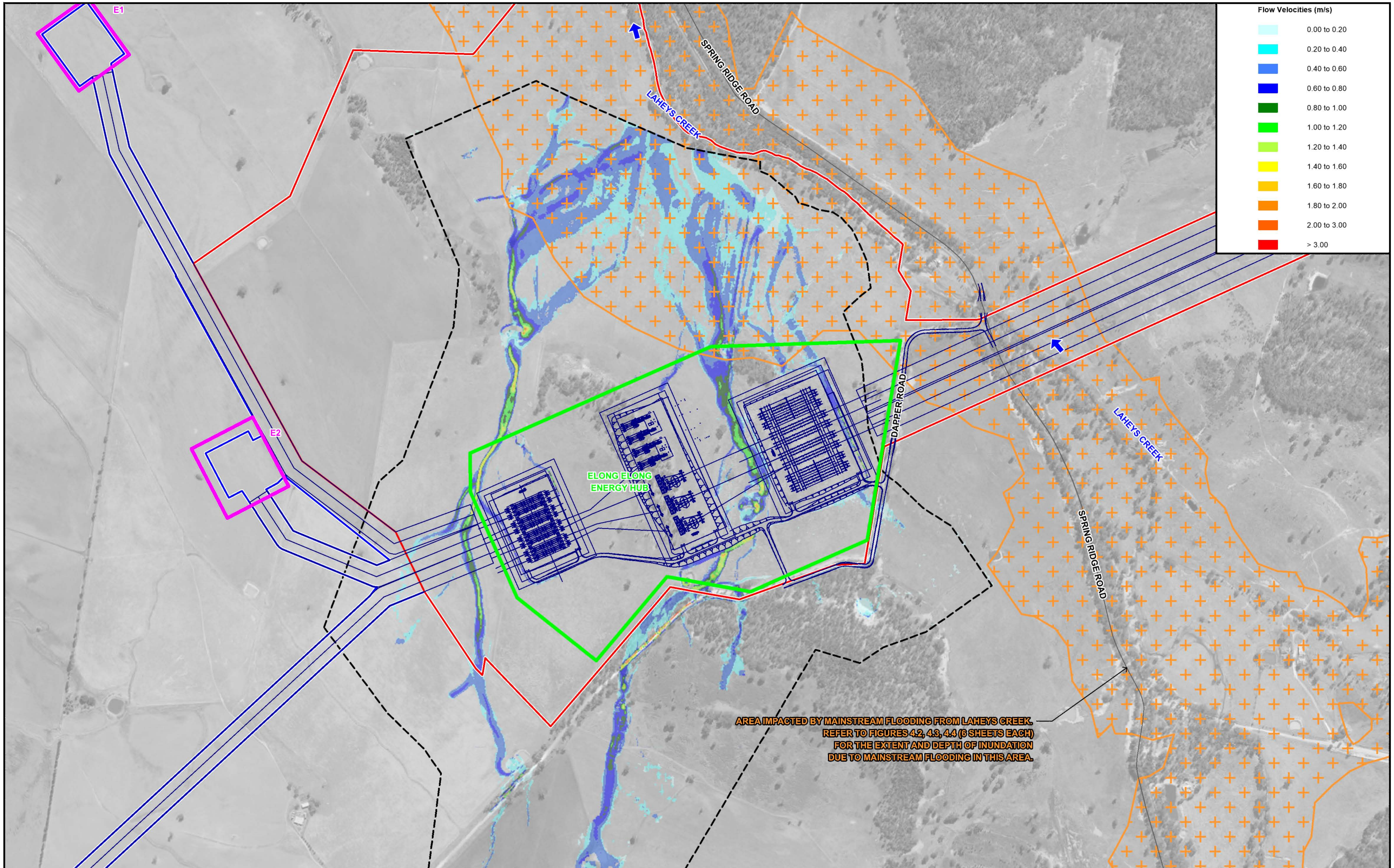
Figure D.7d

IMPACT OF PROJECT ON DURATION OF INUNDATION IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

E1 330kV Switching Stations and Identifier

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Operational Infrastructure

Roads

Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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Figure D.8a

MAXIMUM FLOW VELOCITIES UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP

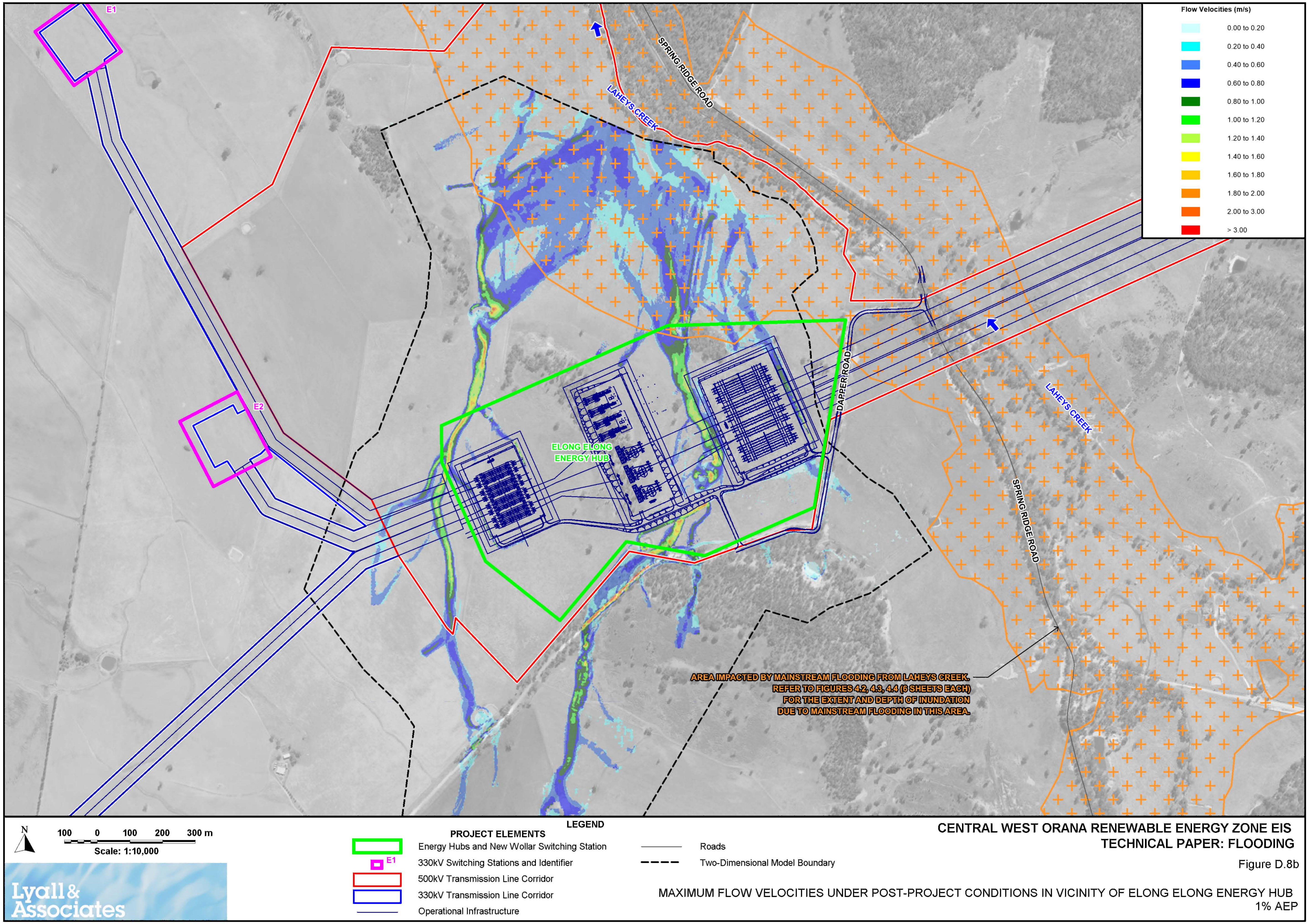

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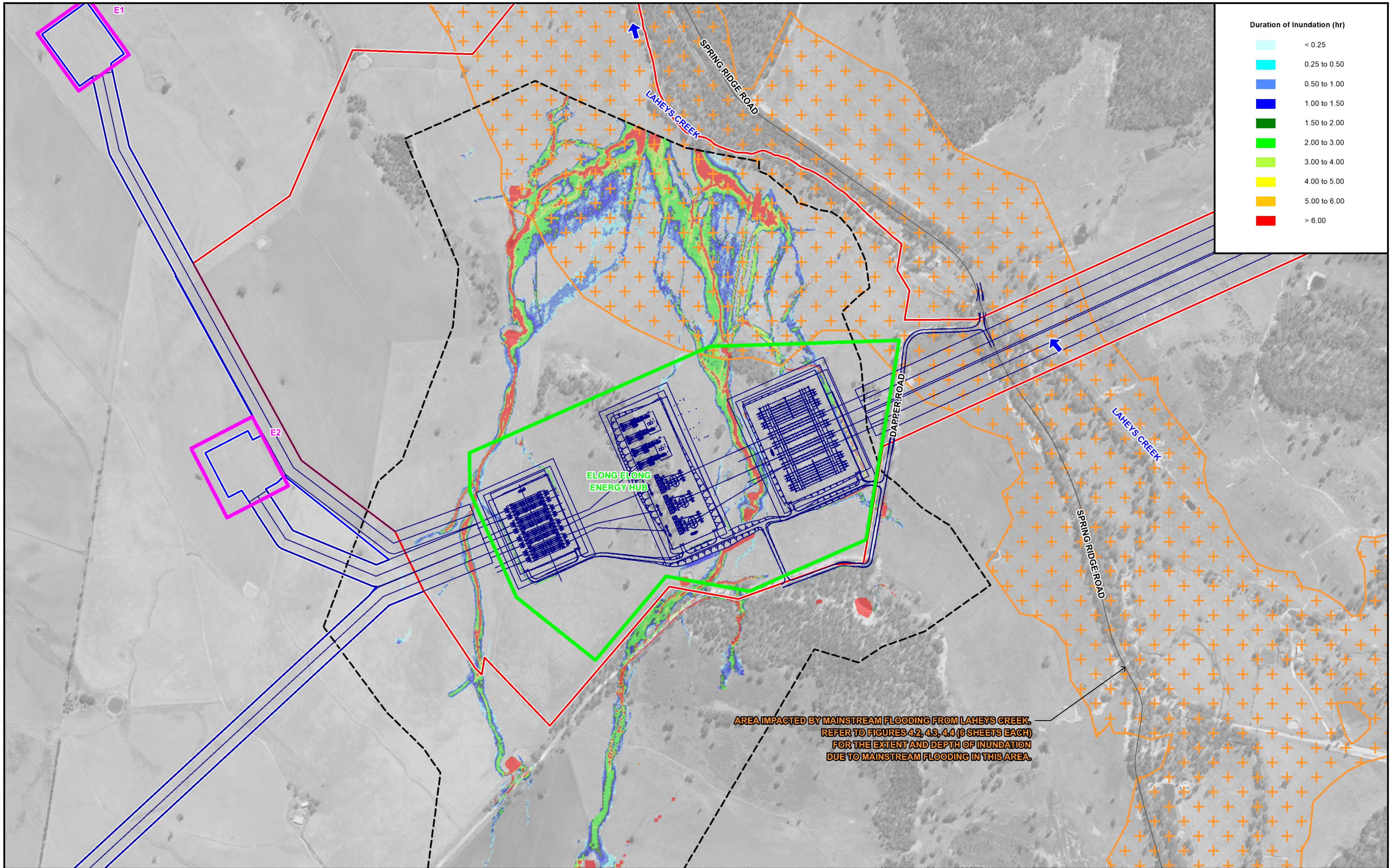
Figure D.8b

MAXIMUM FLOW VELOCITIES UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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Figure D.8c

DURATION OF INUNDATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP

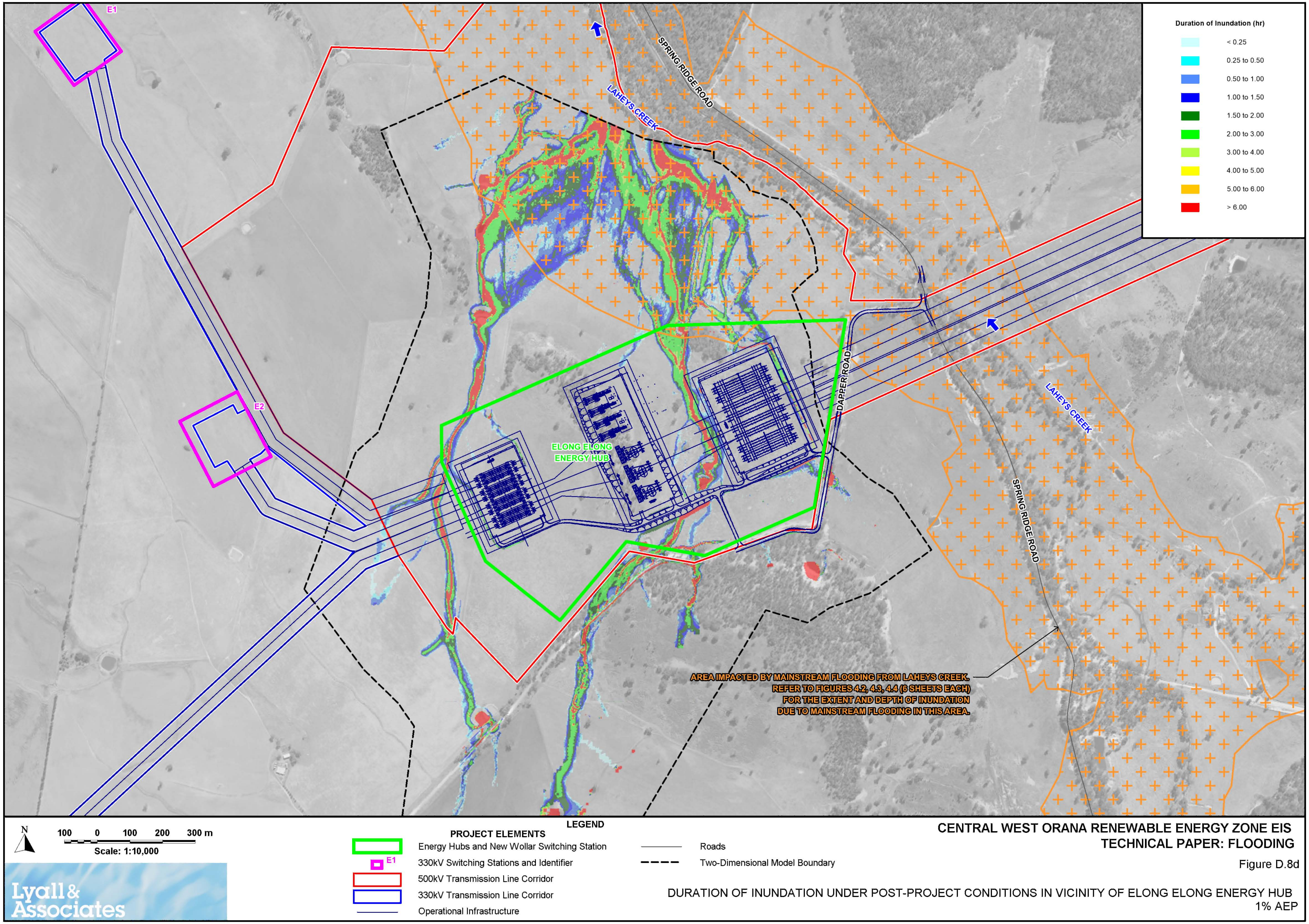

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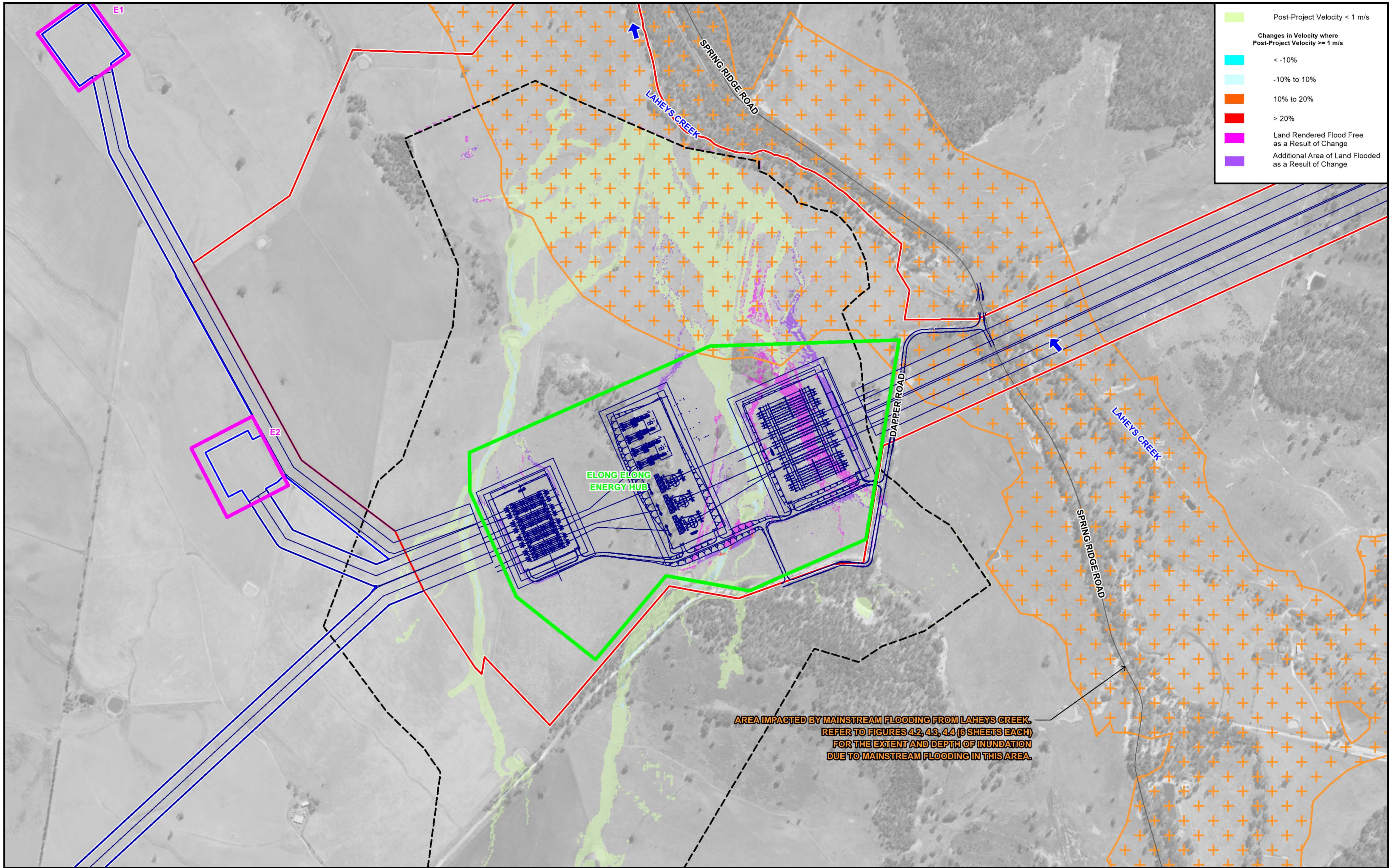
Figure D.8d

DURATION OF INUNDATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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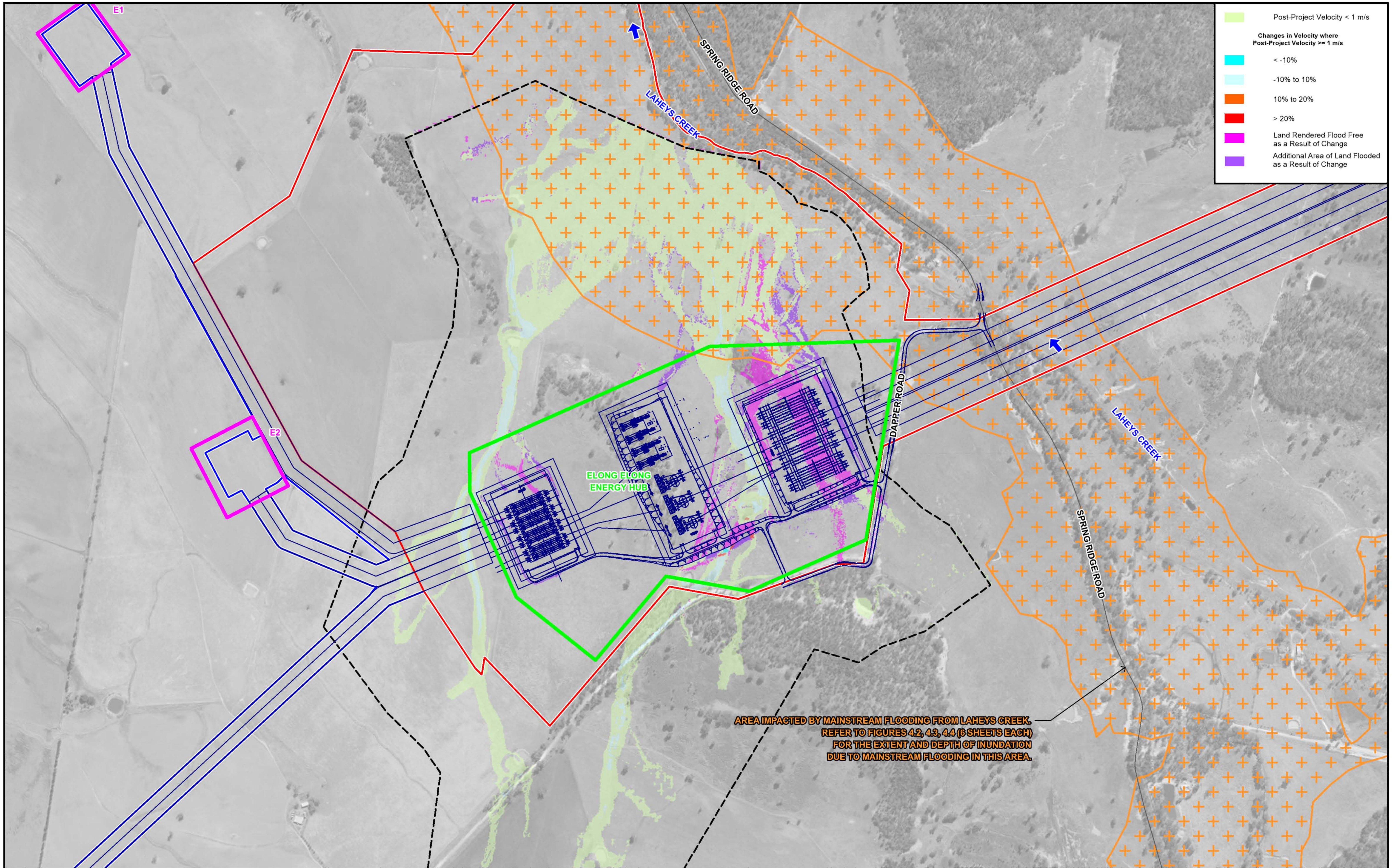
Figure D.9a

IMPACT OF PROJECT ON MAXIMUM FLOW VELOCITIES IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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Figure D.9b

IMPACT OF PROJECT ON MAXIMUM FLOW VELOCITIES IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP

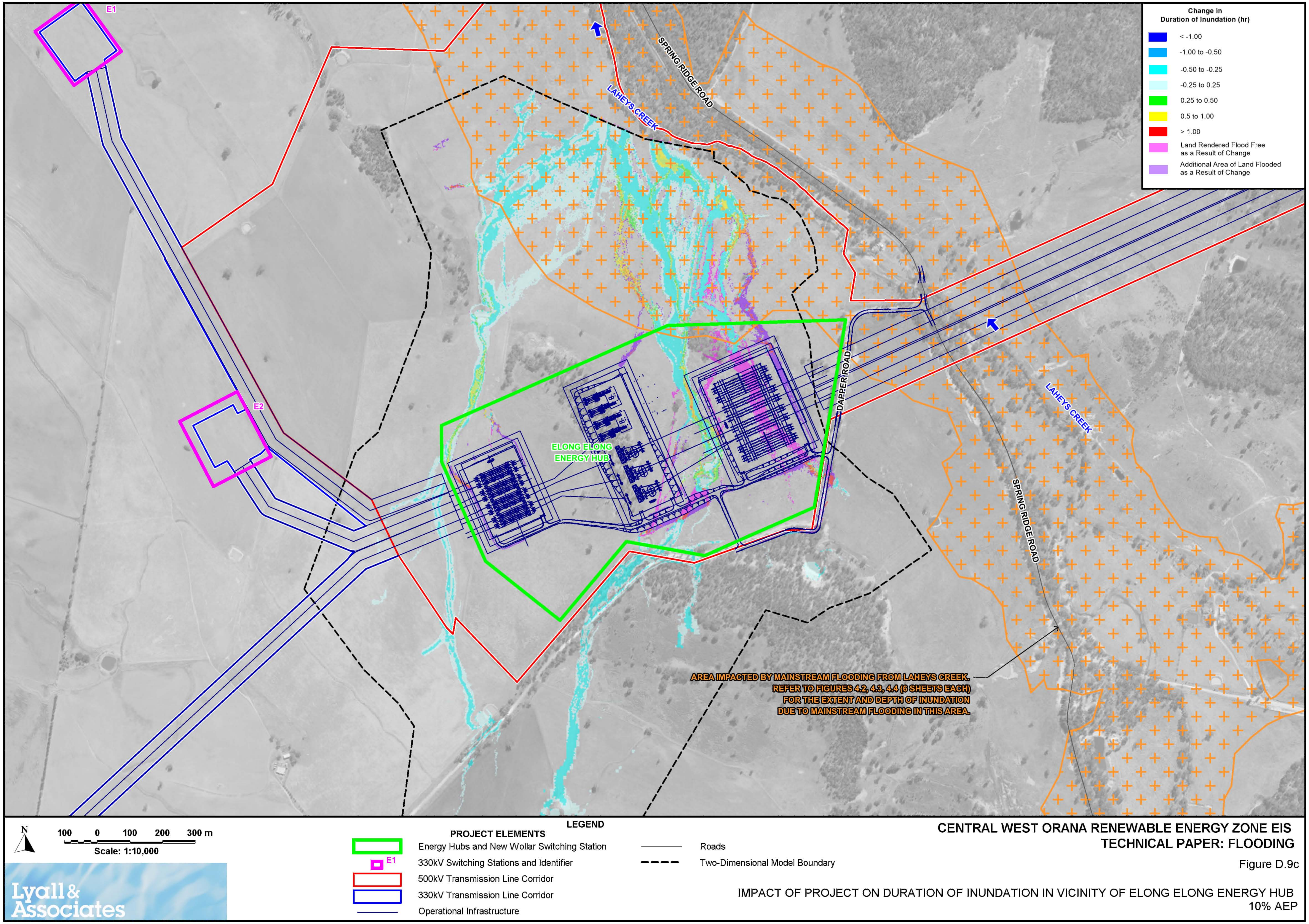

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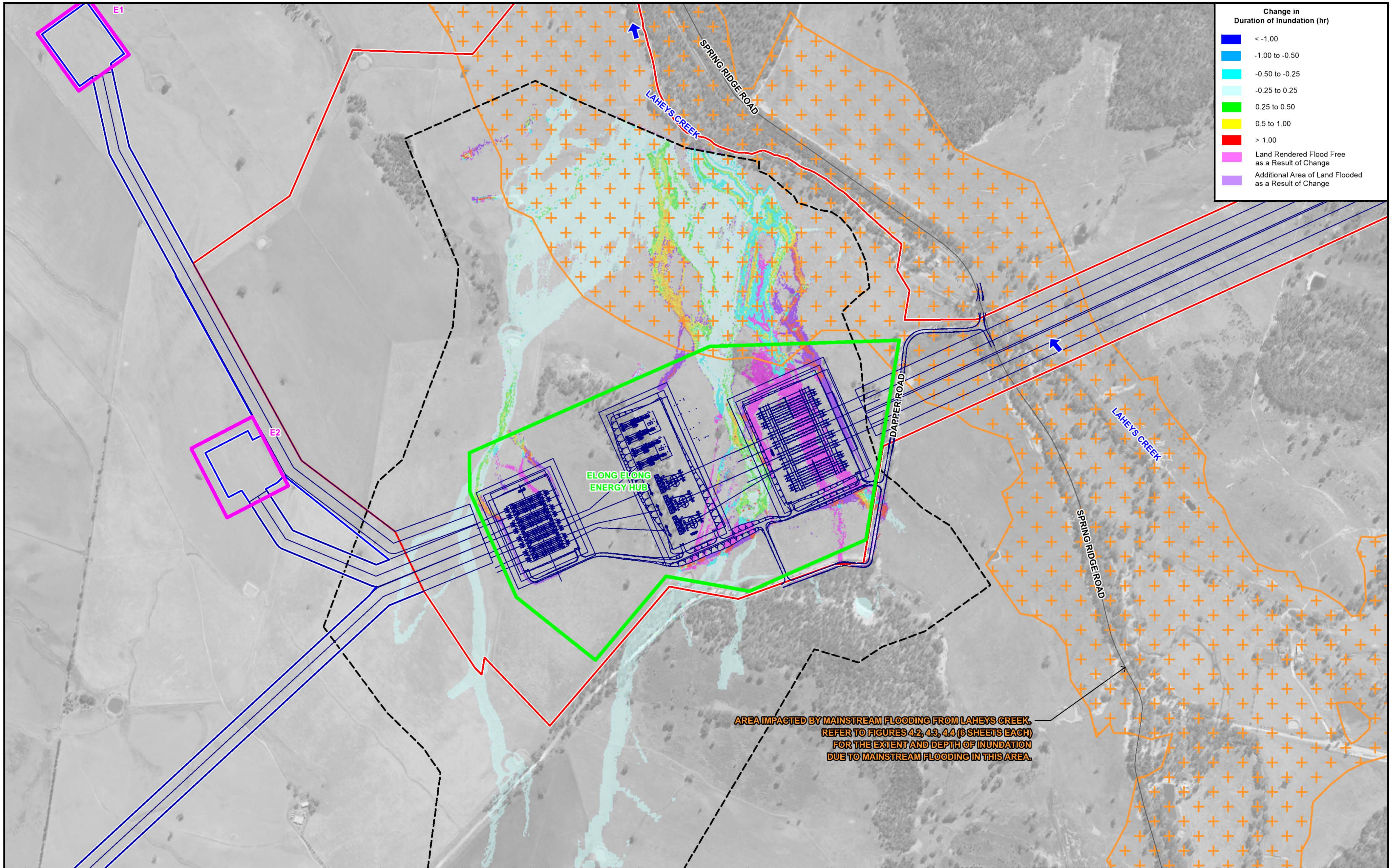
Figure D.9c

IMPACT OF PROJECT ON DURATION OF INUNDATION IN VICINITY OF ELONG ELONG ENERGY HUB
10% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

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LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

CENTRAL WEST ORANA RENEWABLE ENERGY ZONE EIS
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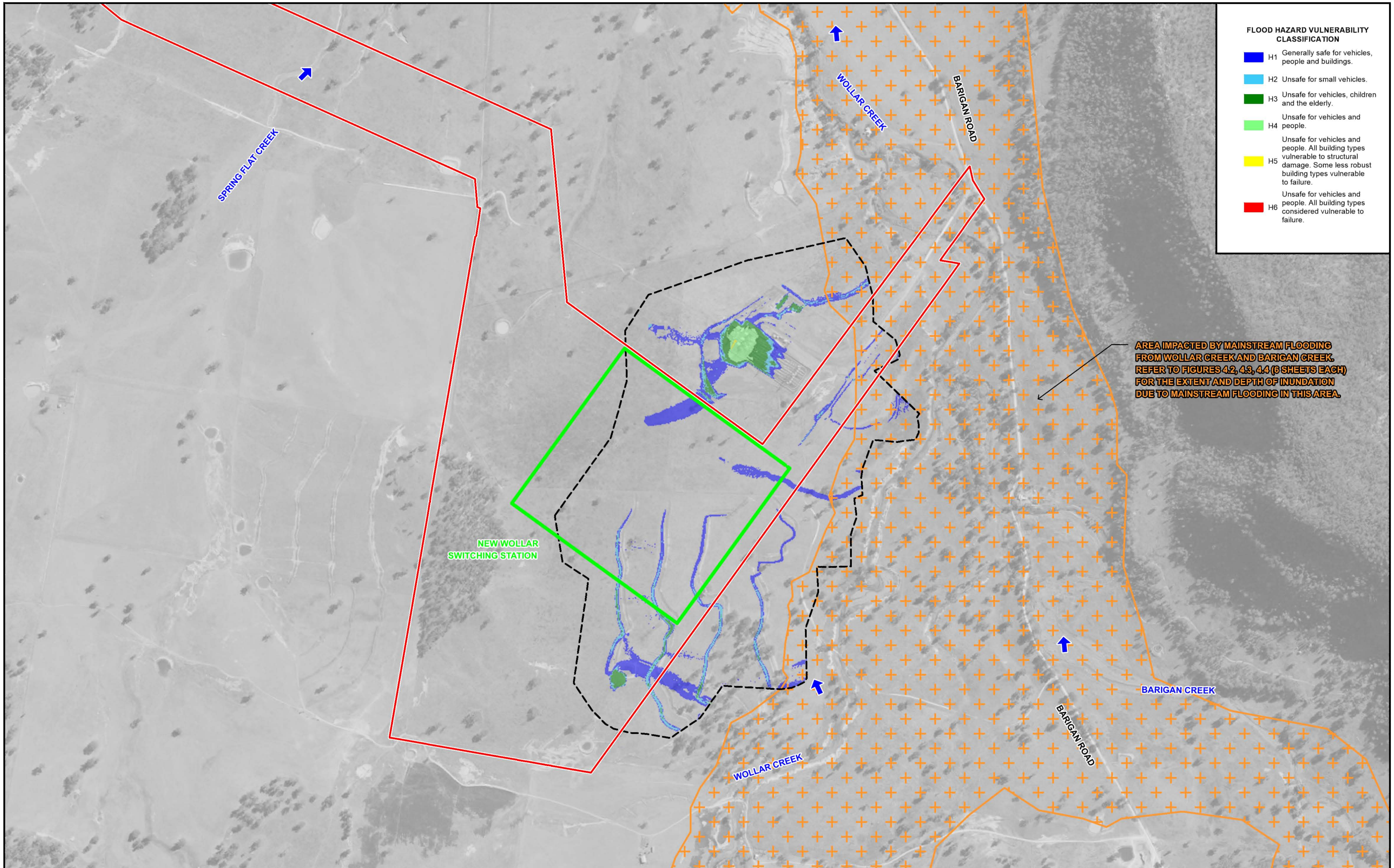
Figure D.9d

IMPACT OF PROJECT ON DURATION OF INUNDATION IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP

ANNEXURE E

FIGURES SHOWING THE HAZARD VULNERABILITY CLASSIFICATION IN THE VICINITY OF THE NEW WOLLAR SWITCHING STATION, MEROTHERIE ENERGY HUB AND ELONG ELONG ENERGY HUB DURING A 1% AEP EVENT



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

(green outline)	Energy Hubs and New Wollar Switching Station	(thin line)	Roads
(red outline)	500kV Transmission Line Corridor	(dashed line)	Two-Dimensional Model Boundary

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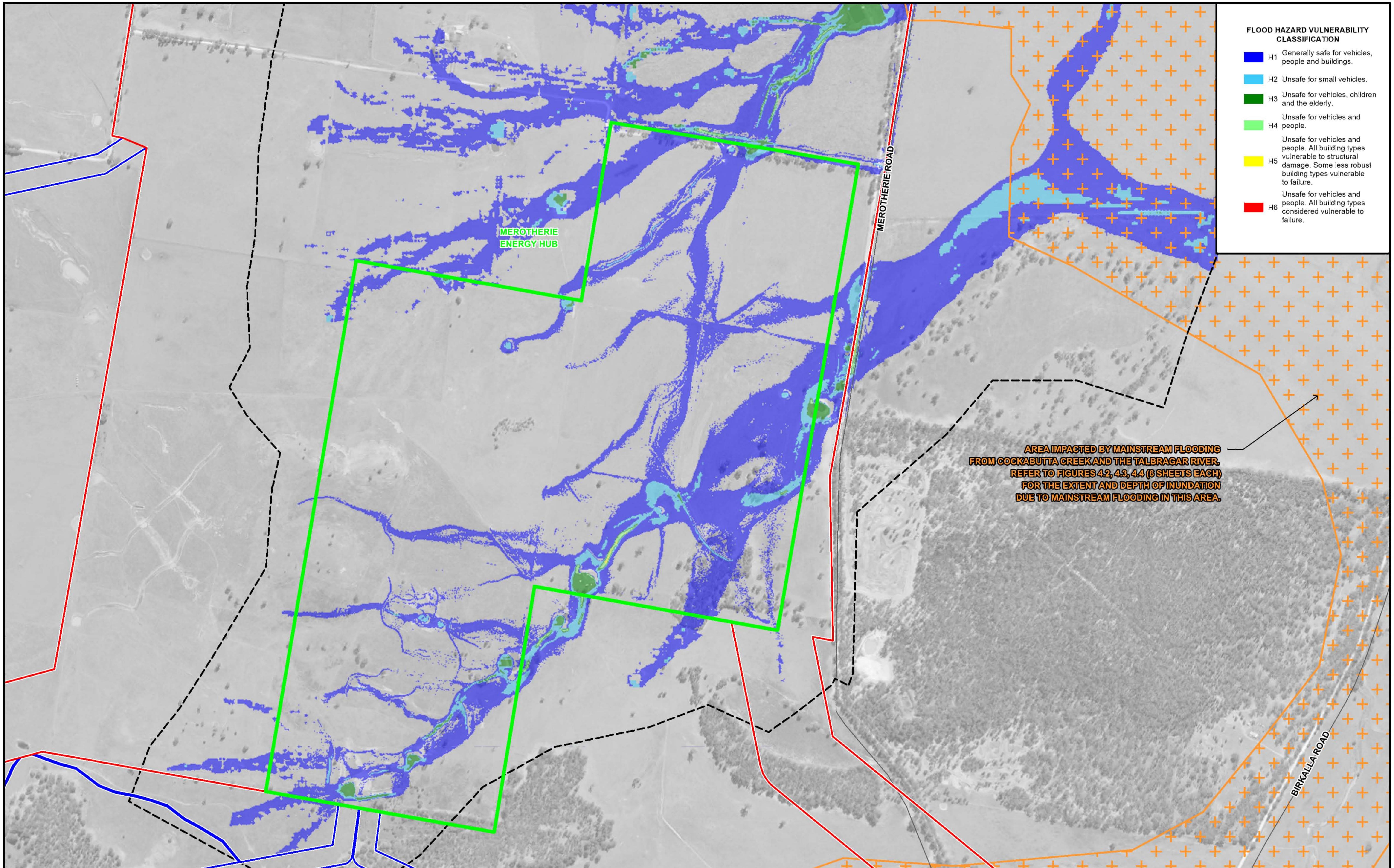
Figure E.1

HAZARD VULNERABILITY CLASSIFICATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP



N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

PROJECT ELEMENTS

Energy Hubs and New Wollar Switching Station

500kV Transmission Line Corridor

330kV Transmission Line Corridor

Roads

Two-Dimensional Model Boundary

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Figure E.2

HAZARD VULNERABILITY CLASSIFICATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP

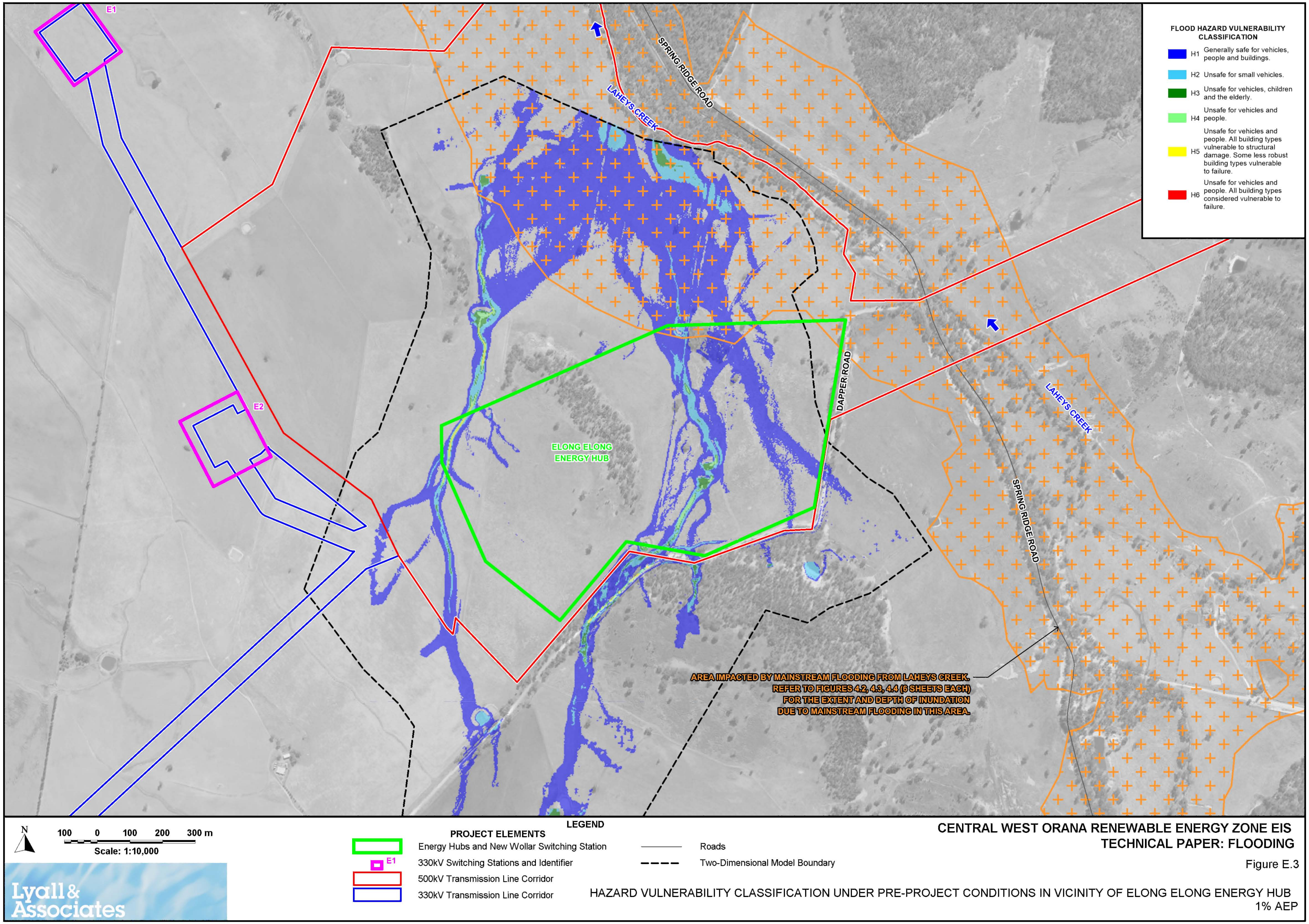

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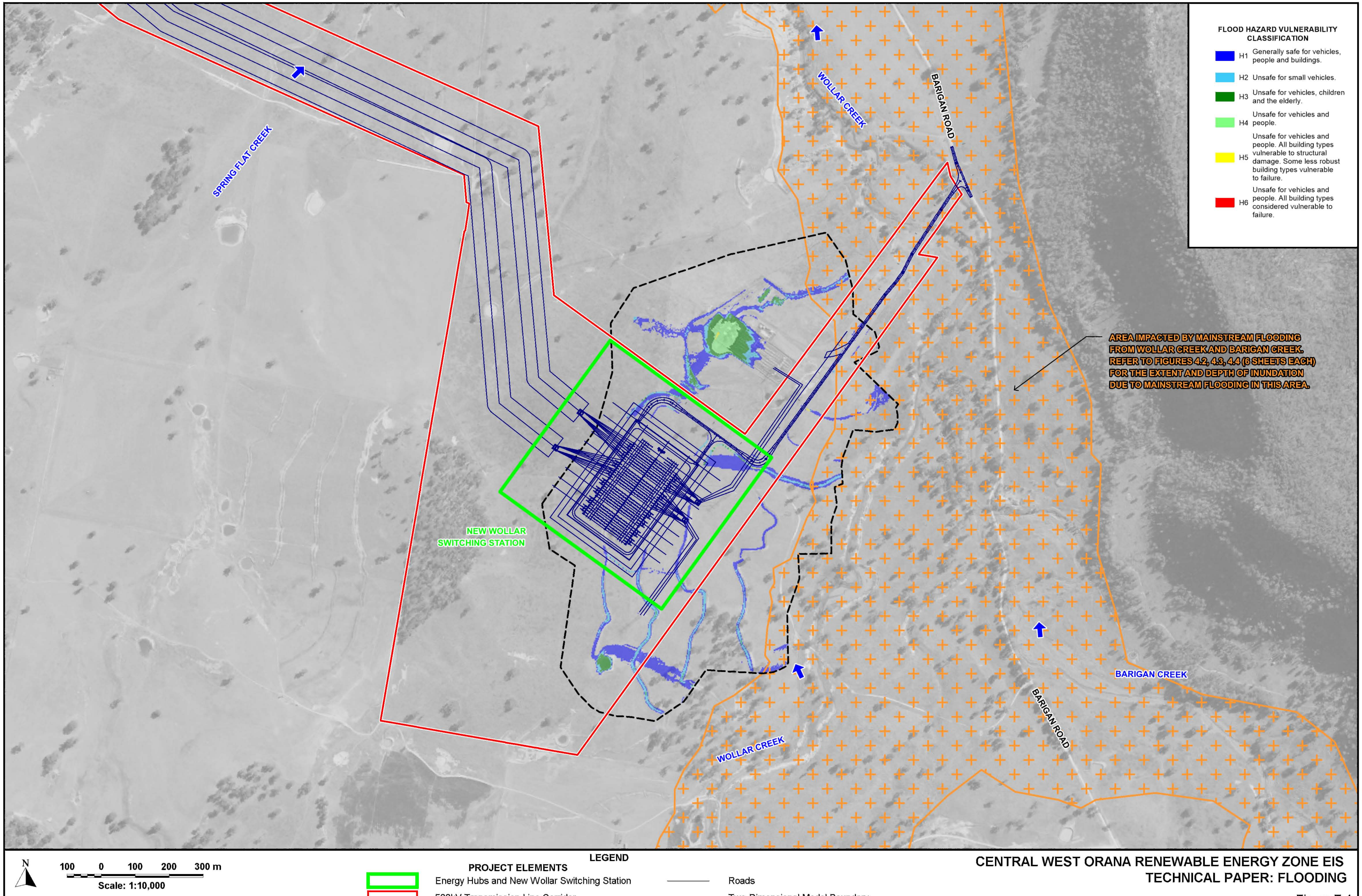
Figure E.3

HAZARD VULNERABILITY CLASSIFICATION UNDER PRE-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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Figure E.4

HAZARD VULNERABILITY CLASSIFICATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF NEW WOLLAR SWITCHING STATION
1% AEP

LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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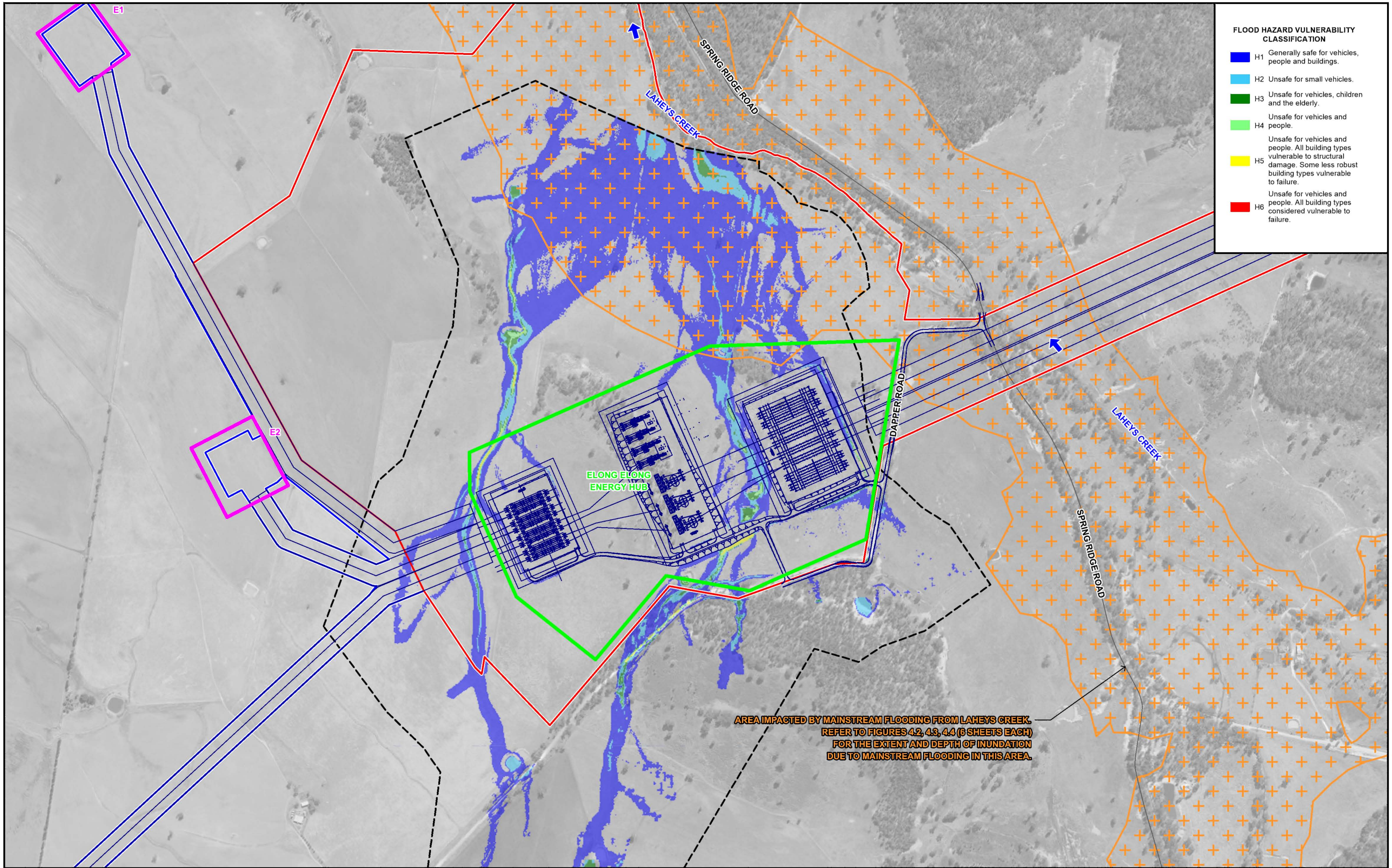
Figure E.5

HAZARD VULNERABILITY CLASSIFICATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF MEROTHERIE ENERGY HUB
1% AEP



LEGEND

PROJECT ELEMENTS

- Energy Hubs and New Wollar Switching Station
- E1 330kV Switching Stations and Identifier
- 500kV Transmission Line Corridor
- 330kV Transmission Line Corridor
- Operational Infrastructure
- Roads
- Two-Dimensional Model Boundary

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Figure E.6

HAZARD VULNERABILITY CLASSIFICATION UNDER POST-PROJECT CONDITIONS IN VICINITY OF ELONG ELONG ENERGY HUB
1% AEP