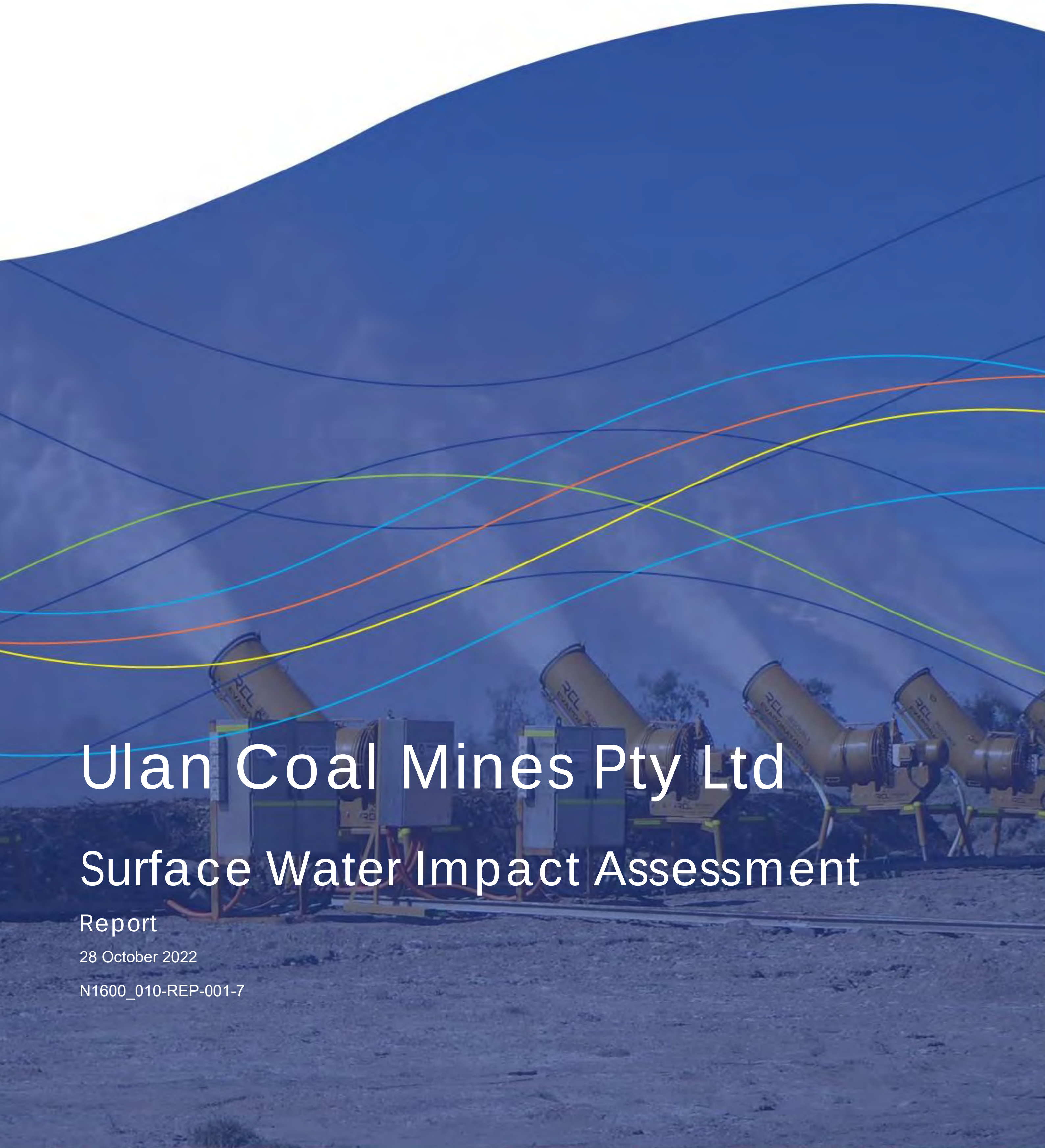
APPENDIX
9

Surface Water Impact Assessment



Ulan Coal Mines Pty Ltd

Surface Water Impact Assessment

Report

28 October 2022

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	4/06/2021	Ulan Modification SWIA	Susan Shield	Adam Wyatt	Susan Shield	Adam Wyatt
1	14/07/2021	Client Issue	Susan Shield	Adam Wyatt	Susan Shield	Adam Wyatt
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Signatures						

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1 INTRODUCTION

The Ulan Coal Complex (UCC) is located about 38 km north of Mudgee and about 19 km north-east of Gulgong in New South Wales, within the Mid-Western Regional Council Local Government Area (LGA). Ulan Coal Mines Pty Limited (UCMPL) was granted Project Approval (PA) 08_0184 under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 15 November 2010 for the Ulan Coal – Continued Operations Project (UCCO Project). Approved operations at the UCC consist of underground mining in the Ulan Underground and Ulan West areas as well as open cut mining, and associated coal handling, processing, and transport through to 30 August 2033. The open cut operations are currently in care and maintenance.

The UCC is located within the headwaters of both the Goulburn River system and the Talbragar River system (refer to Section 3). The catchments for these river systems are separated by the Great Dividing Range, with the Goulburn River system draining east into the Hunter River catchment and eventually into the Pacific Ocean, and the Talbragar River system draining west to the Macquarie River catchment and eventually into the Murray-Darling River System. All the tributaries in the approved mining areas draining to the Goulburn River and Talbragar River are ephemeral by nature. The additional underground mining area lies within the Mona Creek and Cockabutta Creek catchments which are sub-catchment areas within the Talbragar River catchment.

1.1 PROPOSED MODIFICATION

UCMPL is proposing a modification to PA 08_0184 pursuant to section 4.55(2) of the EP&A Act to maximise resource recovery from the existing underground mining operations within existing mining lease and exploration lease areas (refer to Figure 1.1). In addition to proposing to mine additional resources within existing mining lease areas, UCMPL has determined that there is a valuable mineable resource within Exploration Lease (EL) 7542 and is proposing to access this coal resource by extending the currently approved longwall panels. The Proposed Modification will extend the life of the existing operations by two years until 2035 and allow for an additional 25 Mt of product coal to be extracted.

The Proposed Modification comprises:

- Extension of Ulan Underground longwall (LW) panels LW W9 to LW W11 to the west.
- Widening of Ulan Underground LW W11 by approximately 30 m.
- Extension of Ulan West LW 9 to LW 12 to the north.

UCMPL is also proposing some minor changes to surface infrastructure to support underground mining activities including provision of:

- 3 ventilation shafts and associated infrastructure corridors.
- 5 dewatering bores and associated infrastructure corridors.
- An alternate access track.
- An infrastructure corridor and service borehole to the southwest of Ulan West.

There is an area within the Proposed Modification which may be accessed by either Ulan West Underground or Ulan Underground depending on timing of operations and mining conditions. The area referred to as the ‘Flexibility Area’ is shown on Figure 1.1. The coal in the Flexibility Area may be accessed by either a northern extension of Ulan West Underground LW9 or a western extension of Ulan Underground LWW9, 10 and 11. Both options have been considered in this assessment, being:

- Option 1 - referred to as the ‘Base case’ which mines the Flexibility Area via Longwall 9 at Ulan West
- Option 2 - accesses the Flexibility Area through extensions to Longwalls W9-W11 within the Ulan Underground.

1.1.1 Predicted Subsidence

Strata Control Technologies (SCT) assessed the potential subsidence impacts associated with the Proposed Modification.

SCT has indicated that estimates of conventional subsidence effects for the approved mining and extension areas are consistent with the range of values previously forecast at similar overburden depths in the original UCCO Project Environmental Assessment (EA) and subsequent updates due to modifications and subsidence management or extraction plan assessments for the UCC. The maximum predicted subsidence impacts within the Proposed Modification area are:

- Vertical subsidence from about 1.7 m (in deeper areas up to 250 metres depth of cover) to 2.1 metres (in the shallower areas of 130 m depth of cover).
- Tilts from about 40 to 85 mm/m.
- Compression strains from about 20 to 35 mm/m.
- Tensile strains from about 15 to 25 mm/m.
- Tension surface cracking, generally less than about 50 mm wide in deeper areas and up to 100 mm wide in shallower areas.

The subsidence assessment also indicates that disturbance of the overburden strata and full depressurisation of groundwater are expected through the full section between the mining horizon and the surface, consistent with previous monitoring indicating that full depressurisation may take several years to occur.

1.2 POTENTIAL SURFACE WATER IMPACTS AND MITIGATION MEASURES

The key interactions of the Proposed Modification in relation to surface water systems are outlined in Table 1.1.

Figure 1.1 show the key aspects of the Proposed Modification and the surface water context.

Table 1.1: Key Surface Water Interactions of the Proposed Modification

Aspect	Consideration
Changes to vertical subsidence resulting from the modification to the mine plans	Vertical subsidence has the potential to alter the longitudinal gradients of watercourses, especially at the upstream side of longwall panels, where increased gradients have the potential to cause localised increases to erosion and scouring, and the downstream side of longwalls panels, where decreased gradients have the potential to cause increased localised accumulation of sediment and localised ponding
Surface cracking resulting from the modification to the mine plans	Such cracking has the potential to intercept surface water flows, which then report to the groundwater system. The extent of cracking and losses to surface water flows was assessed by the Groundwater Impact Assessment (GIA) and concluded that vertical flows from surface waters are not increased with the Proposed Modification.
Changes to surface infrastructure	Potential for generation of erosion and associated sediment deposition if disturbance during construction is not managed appropriately.
Changes to the UCC water balance associated with changes to the mine plans	Assessed elsewhere – refer to the Ulan Coal Modification 6 Modification Report.

1.3 STRUCTURE OF THIS REPORT

The key components of the Surface Water Impact Assessment report for the Proposed Modification are included in the following sections:

- Regulatory context; Section 2.
- Surface water context, including existing watercourses, catchment context, flow regimes, flood mapping, water quality and water users; Section 3, Appendix A, Appendix B.
- Potential impacts, including consideration of climate change, cumulative impacts and proposed mitigation measures; Sections 4 and 5, Appendix C.
- Mitigation, Monitoring and Management Measures; Section 6.

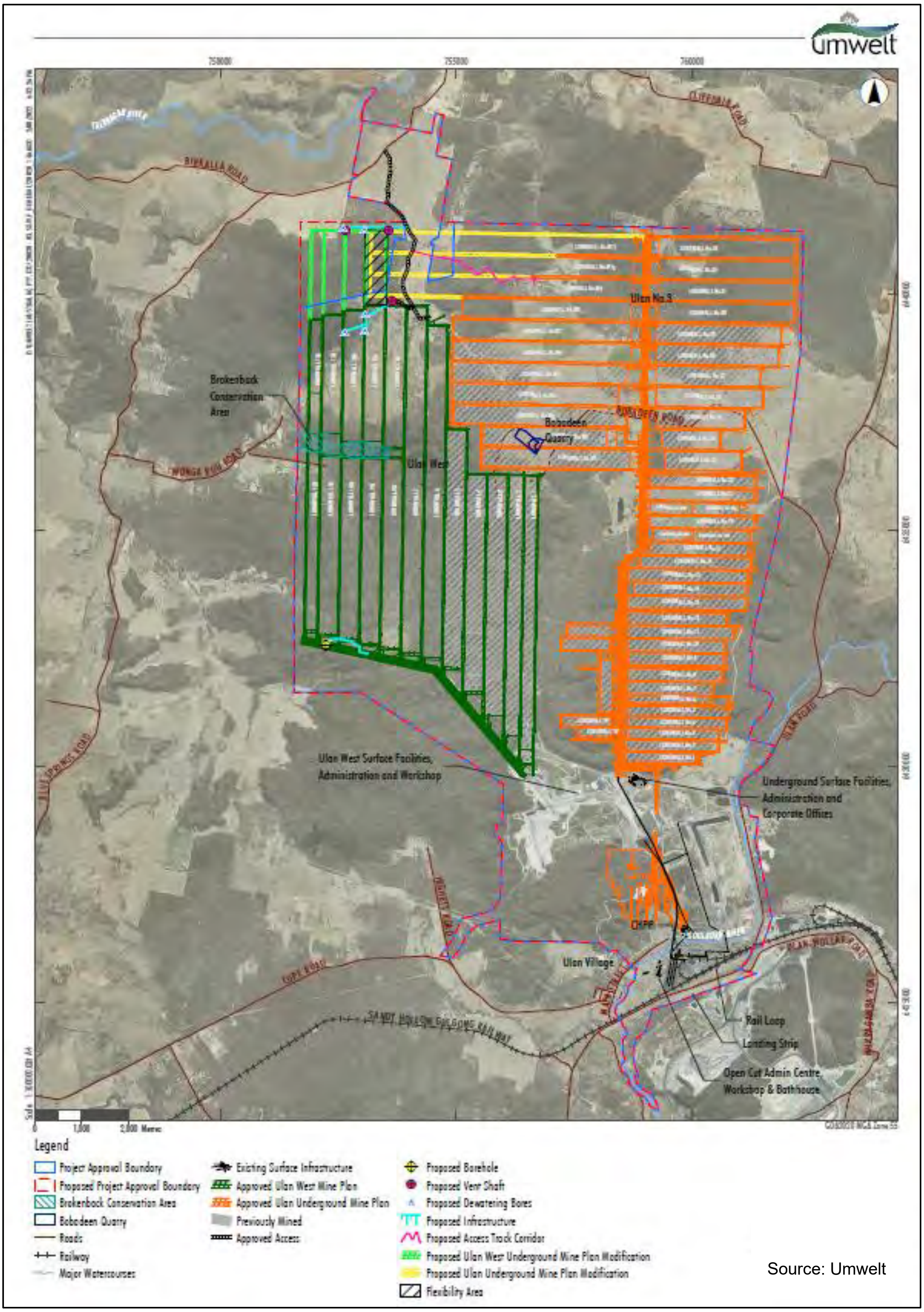


Figure 1.1: Proposed Modification

2 FRAMEWORK

The Proposed Modification has been assessed against the relevant requirements of the following water planning policies, plans and legislation:

- *Water Management Act 2000* (WM Act).
- *Protection of Environment Operations Act 1997* (POEO Act).
- Water Reporting Requirements for Mines (NSW Office of Water (NOW), 2009).
- Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region (Department of Water and Energy (DWE), undated).
- River Hydrology and Energy Relationships – Design Notes for the Mining Industry (DWE, 2007).
- Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments - Impacts on Water Resources (DoE, 2013).

2.1 COMMONWEALTH LEGISLATION

The Proposed Modification was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to the former Commonwealth Department of Agriculture, Water and the Environment (DAWE).

On 12 September 2022, a delegate of the Federal Minister for the Department of Climate Change, Energy, the Environment and Water (DCCEEW) determined the Proposed Modification, as referred under the EPBC Act, was a controlled action (EPBC 2022/09292) requiring assessment and approval under the EPBC Act due to controlling provisions related to listed threatened species and communities, and impacts to a water resource. The Proposed Modification will be assessed under the Bilateral Agreement made under section 45 of the EPBC Act between the Commonwealth of Australia and NSW. DCCEEW provided supplementary assessment requirements that DCCEEW require to be assessed for water resources.

A summary of the potential surface water impacts against the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (DoE, 2013) undertaken to support the referral is included in Section 5. Further to this a summary of where the DCCEEW supplementary assessment requirements are considered in this assessment is included in Section 5.

2.2 RELEVANT NSW LEGISLATION

The Approved Operations and Proposed Modification exist within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. This includes licensing of allowable water take with consideration of environmental flow requirements of watercourses and the needs of other water users; control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges; and guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with Environment Protection Licence (EPL) requirements. Further details of the NSW surface water regulatory framework and how it will continue to be applied to UCC including to the Proposed Modification is provided below.

There are two key Acts that provide the regulatory framework for water management in NSW. These acts are the WM Act and the *Water Act 1912*. The key provisions of these acts relevant to the Proposed Modification are outlined in Section 2.4.

At a State level, there is one other key water management regulation relevant to mining operations; the POEO Act. The POEO Act is the key piece of environmental protection legislation administered by the NSW Environment Protection Authority (EPA). The key components of the POEO Act relevant to surface waters are outlined in Section 2.5.

2.3 NSW REGULATORY REQUIREMENTS – WATER USE/TAKE

The objective of the WM Act is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development. The WM Act defines water access and water sharing strategies within NSW. The WM Act supersedes the provisions of the *Water Act 1912* regarding water take when a Water Sharing Plan (WSP) is in place and in regard to works adjacent to or within watercourses.

As part of the WM Act, WSPs have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSP's specify maximum water extractions and allocations. By complying with the requirements of the WSP's, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems.

The additional underground mining area is located within the areas covered by:

- The *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012* (Macquarie Bogan Unregulated and Alluvial Water Sources WSP) - applies to watercourses and alluvial groundwater.
- The *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020* (NSW Murray Darling Basin Porous Rock Groundwater Sources WSP) - applies to coal measure aquifers, sandstone aquifers, etc.

In addition, the following WSPs apply to the wider approved mining area:

- The *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*.
- The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*.

2.4 LICENSING

All water extraction in NSW, apart from some exemptions for government authorities and basic landholder rights extractions, must be authorised by a water licence. Harvestable rights, which are a Basic Landholder Right under the WM Act, allow a landholder to capture and use up to 10 per cent of the average regional runoff from minor watercourses within a landholding. Basic landholder rights are exempt from licensing requirements.

Each water licence, referred to under the WSP system as a Water Access Licence (WAL), specifies a share component. The share components of specific purpose licences such as local water utility, major utility and domestic and stock are expressed as a number in megalitres per year. The share components of high security, general security and supplementary WALs are expressed as a number of unit shares for the water source. The value of each unit share is subject to Available Water Determinations (AWDs) as specified by WaterNSW. Details of the licences currently held by UCMPL are included in Table 2.1.

A Groundwater Impact Assessment (GIA) and a Water Balance Assessment have been prepared for the Proposed Modification and are reported separately (refer to the Modification Report). These studies consider the potential impacts on the WALs listed below.

Table 2.1: Water Access Licences

Number	Allocation	WSP	Water Source	Extraction
WAL41492	7060*	North Coast Fractured and Porous Rock Groundwater Sources 2016	Oxley Basin Coast Groundwater Source	Direct Extraction
WAL37192	704	NSW MDB Porous Rock Groundwater Sources 2011	Sydney Basin of the Murray Darling Basin Groundwater Source	Direct Extraction
WAL41906	2215			
WAL42900	4031			
WAL41817	50	Macquarie Bogan Unregulated Water Sources 2012	Upper Talbragar River Water Source	Passive take – Baseflow loss offset

Number	Allocation	WSP	Water Source	Extraction
WAL34921	30	Macquarie - Castlereagh Groundwater Sources Order 2020 - Talbragar Alluvial Groundwater Source	Talbragar Alluvial Groundwater Source	Passive take – Baseflow loss
WAL19047	600	Hunter Unregulated and Alluvial Water Sources 2009	Upper Goulburn River water source	Riparian rights, water harvesting and passive take offset for baseflow losses

Note *the licence for the North Coast Fractured and Porous Rock of 7060 units is currently assigned to another water source due to a clerical error and is in the process of being corrected.

2.5 ENVIRONMENT PROTECTION LICENCE

Activities that may lead to pollution of waters in NSW are regulated by the EPA under the POEO Act. Where discharge of waters is permitted it is controlled by licence conditions such that discharges do not result in significant impacts on water resources.

Under Section 120 of the POEO Act, it is an offence to pollute waters or cause harm unless licensed to do so. Pollution in NSW is regulated by the POEO Act with discharges from mine water management systems requiring licensing by an EPL if the discharge would otherwise constitute a pollution of waters (Section 120 of the POEO Act).

The licenced discharge points included in EPL 394 are summarised in Table 2.2.

Table 2.2: EPL Licenced Discharge Points

EPL Point	Location Name	Limits	Units	50th Percentile	100th Percentile
1	USO Effluent Storage Dam (Discharges to Land)	Electrical Conductivity	µS/cm	-	810
		pH	pH	-	6.5 to 8.5
		Flow	kL/day	-	85
2	Millers Dam	Electrical Conductivity	µS/cm	-	900
		Iron	mg/L	-	5
		Oil and Grease	mg/L	-	10
		pH	pH	-	6.5 to 8.5
		Total Suspended Solids (TSS)	mg/L	-	50
		Zinc	Mg/L	-	5
		Flow	kL/day	-	600
3	Outlet from Rowans Dam to Ulan Creek	Electrical Conductivity	µS/cm	800	900
		Iron	mg/L	-	5
		Oil and Grease	mg/L	-	10
		pH	pH	-	6.5 to 8.5

EPL Point	Location Name	Limits	Units	50th Percentile	100th Percentile
		Total Suspended Solids (TSS)	mg/L	-	50
		Zinc	mg/L	-	5
		Flow	kL/day	-	10,000
4	Drainage Outlet from Truck fill Dam to unnamed watercourse	Electrical Conductivity	µS/cm	-	900
		Iron	mg/L	-	5
		Oil and Grease	mg/L	-	10
		pH	pH	-	6.5 to 8.5
		Total Suspended Solids (TSS)	mg/L	-	50
		Zinc	mg/L	-	5
		Flow	kL/day	-	2,000
6	Discharge to Ulan Creek from Bobadeen WTF	Electrical Conductivity	µS/cm	800	900
		pH	pH	-	6.5 to 8.5
		Total Suspended Solids (TSS)	mg/L	-	50
		Flow	kL/day	-	15,000
19	Discharge to Ulan Creek from NWSD WTF	Electrical Conductivity	µS/cm	800	900
		pH	pH	-	6.5 to 8.5
		Total Suspended Solids (TSS)	mg/L	-	50
		Flow	kL/day	-	30,000

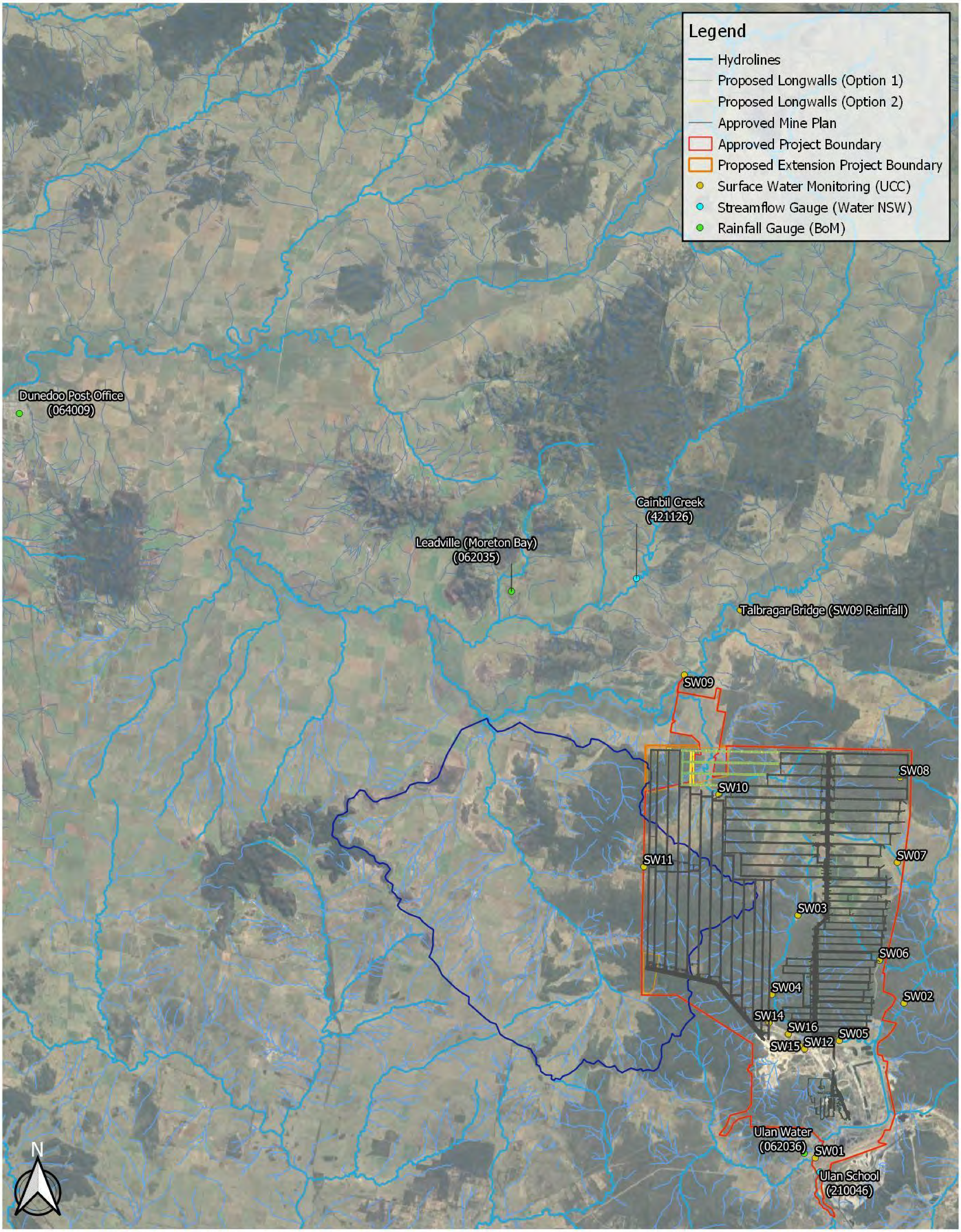
A Water Balance Assessment has been prepared for the Proposed Modification and is reported separately (refer to the Modification Report).

3 SURFACE WATER CONTEXT

The UCC is located within the headwaters of both the Goulburn River system and the Talbragar River system (refer to Figure 3.1). The catchments for these river systems are separated by the Great Dividing Range, with the Goulburn River system draining east into the Hunter River catchment, and the Talbragar River system draining west to the Macquarie River catchment and eventually into the Murray-Darling River System. All the tributaries in the approved mining areas draining to the Goulburn River and Talbragar River are ephemeral by nature.

The additional underground mining area lies within the Mona Creek catchment. Mona Creek is part of the Talbragar River system. The bed and banks of Mona Creek are in generally good condition with some isolated areas of erosion, despite including soils typically associated with high erosion hazard.

The followings sections describe the nature of these catchment areas and associated watercourses, existing water quality and licensing provisions, as well as downstream water users.



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Scale in metres (1:130,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Ulan Mod5 Flood Impact Assessment

Figure 3.1: Project Context

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Revision: 0
Drawn: GC
Checked: SS
Date: 11 /10 /2022

3.1 CLIMATE

The regional climate is warm and temperate, characterised by hot and humid summers, and cold to mild winters. The average annual rainfall is 670 mm and falls fairly evenly year-round with a slight peak in summer months (refer to Figure 3.2).

There are four Bureau of Meteorology (BoM) operated long term rainfall gauges within 35 km of the site (refer to Figure 3.1). The Ulan Water gauge (062036) is located adjacent to UCC and provides a long term rainfall record of over 100 years for the eastern catchments. UCMPL also operate one site rainfall gauge. The BoM stations are summarised in Table 3.1. Typical rainfall and evaporation rates for the site are presented in Figure 3.2 and Figure 3.3, respectively. Average daily pan evaporation data for each month of the year, presented in Figure 3.3, was sourced from the Wellington BOM gauge (refer to Figure 3.1).

For the purposes of the impact assessment, data from a SILO Data Drill (1889 to 2021) was used to represent the long-term rainfall and evaporation data set for the Proposed Modification. The SILO data drill is a derived data set from a combination of interpolated recorded data between weather stations and derived long-term average values. Due to poor distribution of evaporation monitoring stations near the Proposed Modification, the interpolated evaporation data at the location of the Proposed Modification may be inaccurate. Therefore, the long-term pan evaporation derived from the SILO data drill has been compared against the average daily recorded data from the Wellington Research Centre BoM station (061069) (nearest station available) to validate the SILO data, presented in Figure 3.3. The long-term average data from the SILO data drill matches well with the data recorded at the Wellington Research Centre BoM station for the period 1946 to 2005.

Table 3.1: Nearby Rainfall Gauging Stations

Source	Proximity to Site (km)	Data Range
Leadville (062035)	11.7	1955 – Present
Ulan Water (062036)	16.5	1906 - Present
Cassilis (Dalkeith) (062009)	30.8	1874 - Present
Dunedoo Post Office (064009)	32.3	1912 - Present
Wellington Research Centre BoM station (065035)	80.1	1946 - 2005

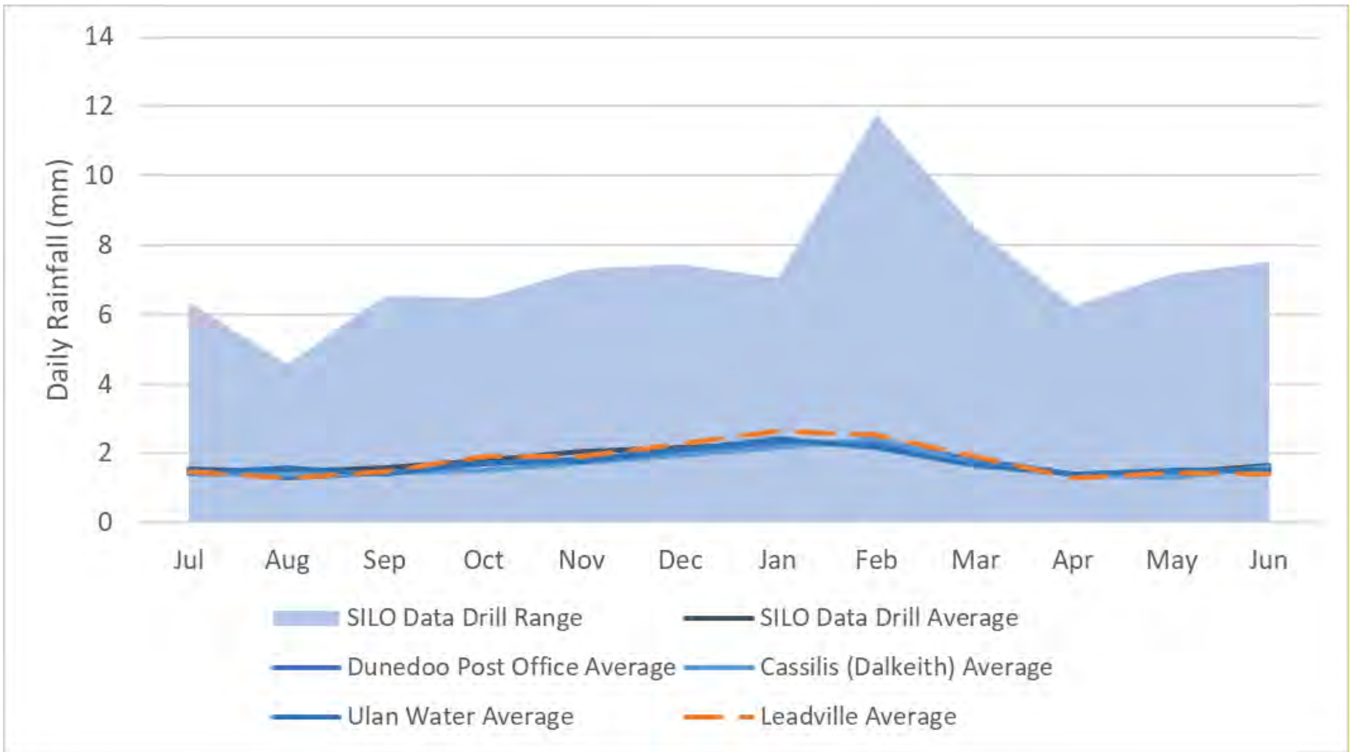

Figure 3.2: Daily Rainfall Comparison (Range and Mean)

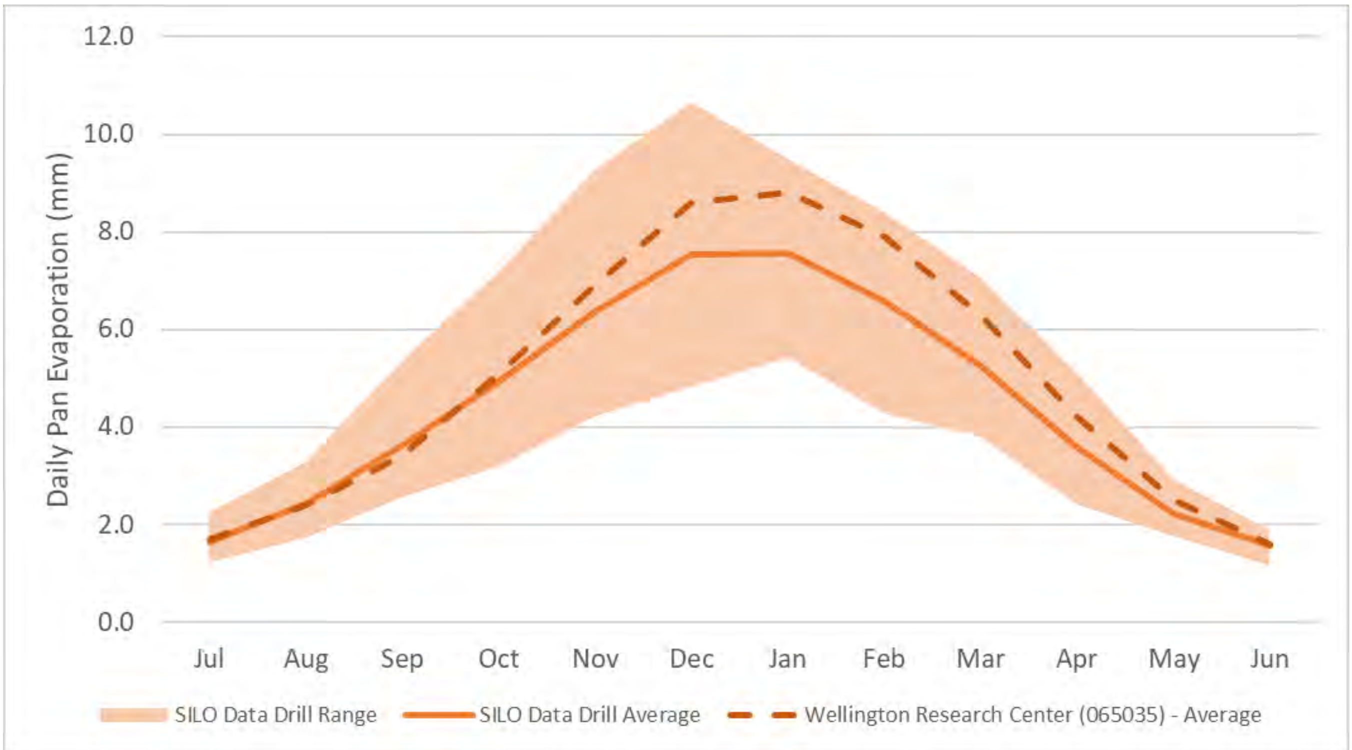

Figure 3.3: Average Daily Evaporation

3.2 TALBRAGAR RIVER

The Talbragar River flows in a south-westerly direction to the north of the Approved and Proposed Project Area. The Approved Project Area extends to the north of the underground mining area, by approximately 750 metres, to encompass the approved (but not constructed) Talbragar River discharge structure and associated pipeline. The Talbragar River is a Category 3 stream (i.e. greater than 4th order) as defined by Strahler stream order system, and a tributary of the Macquarie River which forms part of the Murray-Darling River System.

Both water quality and flows are monitored in the Talbragar River by WaterNSW at Elong Elong, approximately 100 km downstream of the Project Area. WaterNSW also monitors flows in the Talbragar River at Dunedoo, approximately 50 km downstream of the Project Area. UCMPL also undertake water quality and flow monitoring in the Talbragar River near the location of the approved (but not constructed) discharge location (refer to Figure 3.1). Water quality monitoring has been undertaken at this location since November 2011. Flow monitoring has been undertaken by visual observation since 2011, with a flow gauge installed in 2015. The flow data has a limited data set due to the intermittent flows in the river and a data record of only 6 years.

3.2.1 Mona Creek

Mona Creek is a fourth order watercourse and flows in a north-westerly direction to the Talbragar River (refer to Figure 3.1).

Mona Creek is an ephemeral creek and there is one farm dam located in the north of the additional underground mining area associated with the Proposed Modification. The soil landscape within the upper reaches of Mona Creek is the Turill soil landscape, with soils of low fertility, well drained but highly susceptible to erosion. The additional underground mining area associated with the Proposed Modification also intersects the Ulan soil landscape. Soils in the Ulan soil landscape typically have low fertility, are imperfectly drained and have moderate to high susceptibility to erosion (Yoo *et al*, 2001). The catchment includes areas of open grassland (primarily along the creekline) and forest/woodland along the ridgelines and upper slopes.

The bed and banks of Mona Creek generally consist of sandy material, while the upper reaches are typically sandy clay (refer to Figures 3.4 to 3.6). The channel section of Mona Creek is typically shallow in the upper reaches ranging up to two metres deep with bank slopes ranging between gentle gradual slopes to 1:3 (vertical: horizontal). The bed width of the creek ranges from approximately one metre to up to fifty metres. Mona Creek is in generally good condition with some isolated areas of erosion within the bed and banks of the channels, some triggered by wombat burrows, with some areas of bank erosion within the fourth order section that were observed during the site inspection. The creek bed grade ranges typically between 1% to 2%.

UCMPL monitors water quality and flows in Mona Creek at one location (refer to Figure 3.1). Water quality monitoring has been undertaken at this location since February 2012. Flow monitoring has been undertaken since 2015 and currently has a limited data set due to the ephemeral natural of the watercourse combined with a monitoring period of only 6 years and the sandy bed conditions.

Figure 3.4: Mona Creek Looking Downstream (4th order reach)

Figure 3.5: Mona Creek Looking Downstream (4th order reach)

Figure 3.6: Mona Creek Looking Upstream (1st order reach)

3.3 FLOW REGIMES

Mining operations have the potential to impact on flow regimes in watercourses by impacts on surface water runoff and baseflow contributions. Streamflow sequencing analysis was undertaken for the Talbragar River and Mona Creek to quantify the typical volumes and flow sequencing patterns for each system.

3.3.1 Historical Flow Gauging Data

Flow gauging data is collected in NSW by WaterNSW, while UCMPL also undertake monitoring in both the Goulburn and Talbragar River systems (refer to Figure 3.1 and the UCC Surface Water Monitoring Program (UCC, 2019)). There is limited flow gauging data for ephemeral creek systems by WaterNSW with flow gauging on these systems typically discontinued many years ago. The available flow gauging data used for the Proposed Modification is listed in Table 3.2.

Table 3.2: Available Flow Gauge Data

Gauge	Owner	Watercourse	Monitoring Period	Catchment Area (ha)	Volumetric Runoff Coefficient[1]
Cainbil Creek (421126)	WaterNSW	Cainbil Creek	1982 to 1999	8,100	2.2%
SW10[2]	UCMPL	Mona Creek	2015 to Present	2,140	1%
SW09[2]	UCMPL	Talbragar River	2015 to Present	66,360	7.4%
Dunedoo (421904)	WaterNSW	Talbragar River	2017 to Present	200,260	12.3%
Elong Elong (421042)	WaterNSW	Talbragar River	1970 to Present	305,000	2.9%

1. Volumetric Runoff Coefficient (VRC) calculated as (volume of flow) / (volume of rainfall) over the period of record
2. Flow gauge operated by UCMPL. Current data set is limited.

The Elong Elong WaterNSW gauge on the Talbragar River contains 51 years of streamflow data. Due to the long unbroken record and the quality of the readings, the Elong Elong gauge data has been used previously for the streamflow assessments on the Talbragar River.

The Dunedoo WaterNSW gauge and the SW09 UCML gauge on the Talbragar River have limited data sets but analysis has indicated that the gauges provide data suitable to be used for hydrological models to determine potential streamflow impacts in the Talbragar River.

The SW10 and SW11 gauges only contain monitoring data from 2015 and is limited due to the ephemeral nature of these watercourses, as well as the monitoring period of only 6 years and, as such they do not provide an adequate data series from which a streamflow sequencing model could be calibrated.

The Cainbil Creek WaterNSW gauge (421126) contains 17 years' worth of records and is in the Talbragar River catchment to the north of the Mona Creek catchment. The catchment area to the Cainbil Creek gauge is 8,100 ha, by way of comparison, the Mona Creek Catchment area is 4,876 ha. Given the quality of the record, the proximity to the Project Area and the size of the catchment, the gauge was considered suitable to be used for a hydrologic model to determine potential streamflow sequences in the Mona Creek catchment.

3.3.2 Australian Water Balance Model Catchment Model

Three Australian Water Balance Model (AWBM) were developed to model the flow sequencing in: Talbragar River at SW09, Talbragar River at Dunedoo; and Mona Creek.

AWBM relates daily rainfall and evapotranspiration to runoff using five functional stores; three surface stores to simulate partial areas of runoff, a base flow store and a surface runoff routing store, as follows:

- C1 to C3 = surface storage capacities.
- A1 to A3 = partial areas represented by surface storages.
- BFI = baseflow index.
- K = daily baseflow recession constant.
- Ks = daily surface flow recession constant.
- Kb = daily baseflow recession constant.

The calibration fits for the three models are presented in Figures 3.7, 3.8 and 3.9 with the calibration parameters provided in Table 3.3.

The hydrological model was calibrated to the historical WaterNSW flow gauging data available for Cainbil Creek due to the completeness of the data. It should be noted there is minimal low flow data for the historical gauging data at Cainbil Creek and at Dunedoo on the Talbragar River.

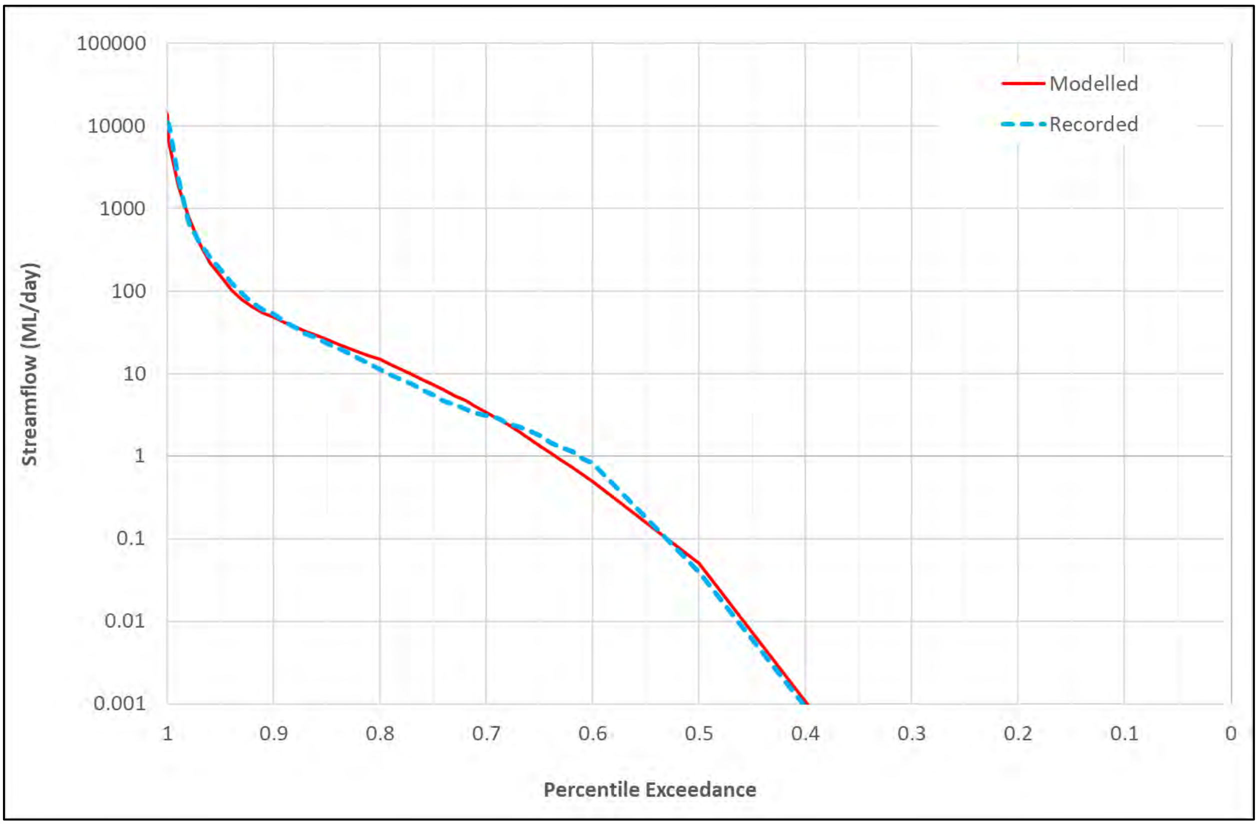

Figure 3.7: Calibration – AWBM Catchment Model – Flow Duration Curve – Talbragar River at SW09

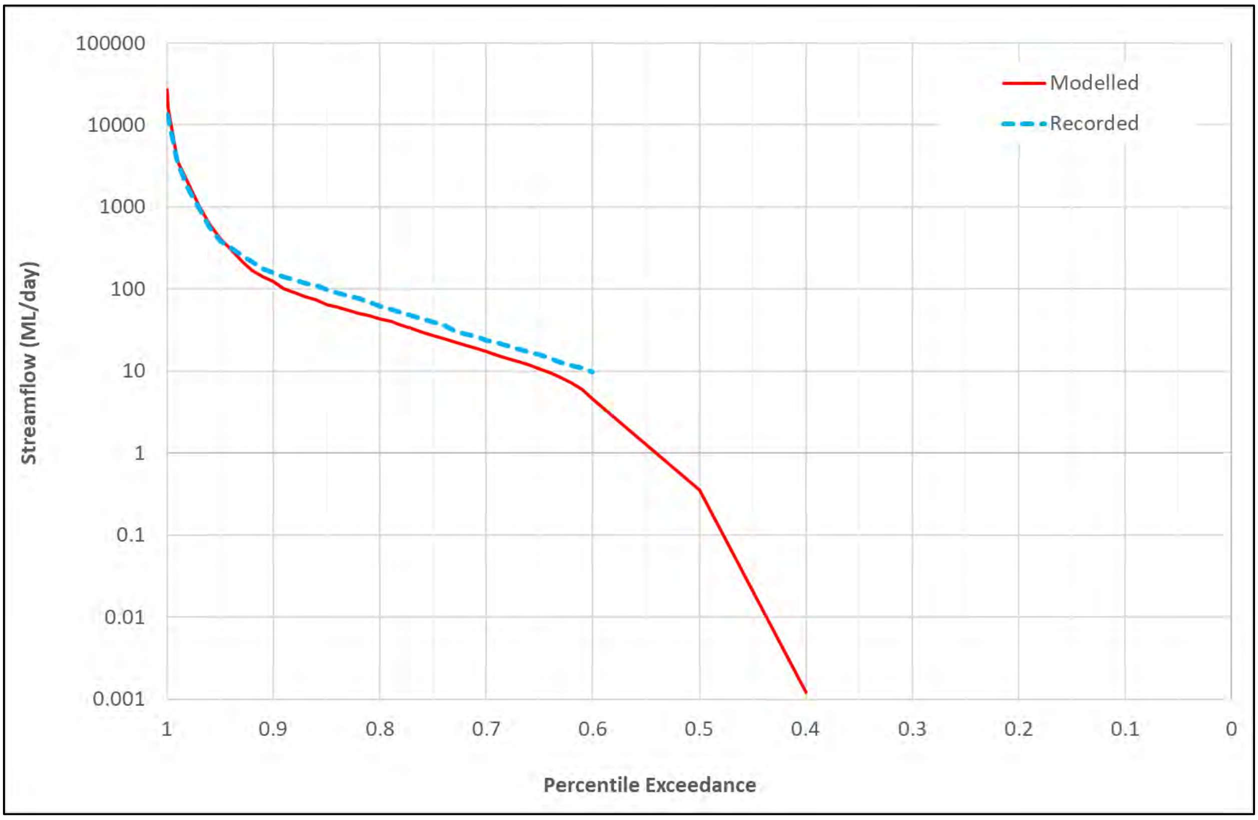

Figure 3.8: Calibration – AWBM Catchment Model – Flow Duration Curve – Talbragar River at Dunedoo

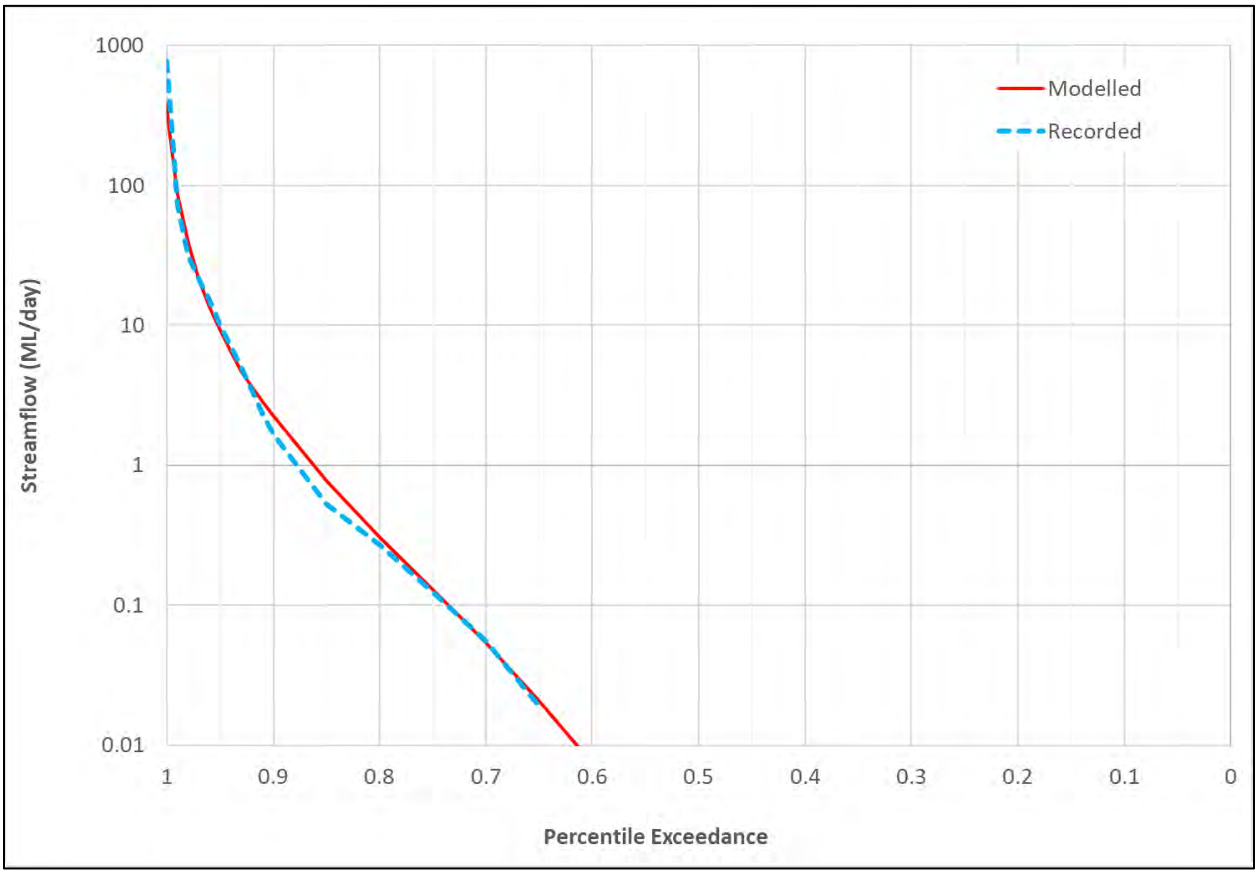

Figure 3.9: Calibration – AWBM Catchment Model – Flow Duration Curve – Mona Creek

Table 3.3: AWBM Parameters

Parameter	C1	C2	C3	A1	A2	A3	BFI	KS	KB
Talbragar at SW09	40	150	350	0.55	0.25	0.20	0.15	0.955	0.35
Talbragar at Dunedoo	45	150	350	0.30	0.35	0.35	0.15	0.955	0.4
Mona Creek	80	150	70	0.20	0.60	0.02	0.25	0.85	0.96

The modelled data shows good fits to the recorded data for flood and events (i.e. greater than 95th percentile exceedance) and for baseflow events (i.e. less than 80th percentile exceedance) (where the data is available).

3.3.3 Model Results

The calibrated AWBM models were used to simulate the long term streamflow conditions in the model simulation. The long term flow sequencing modelling was undertaken using SILO climate data (refer to Section 3.1).

The baseline hydrological modelling results for the three models are presented in Figures 3.10, 3.11 and 3.12.

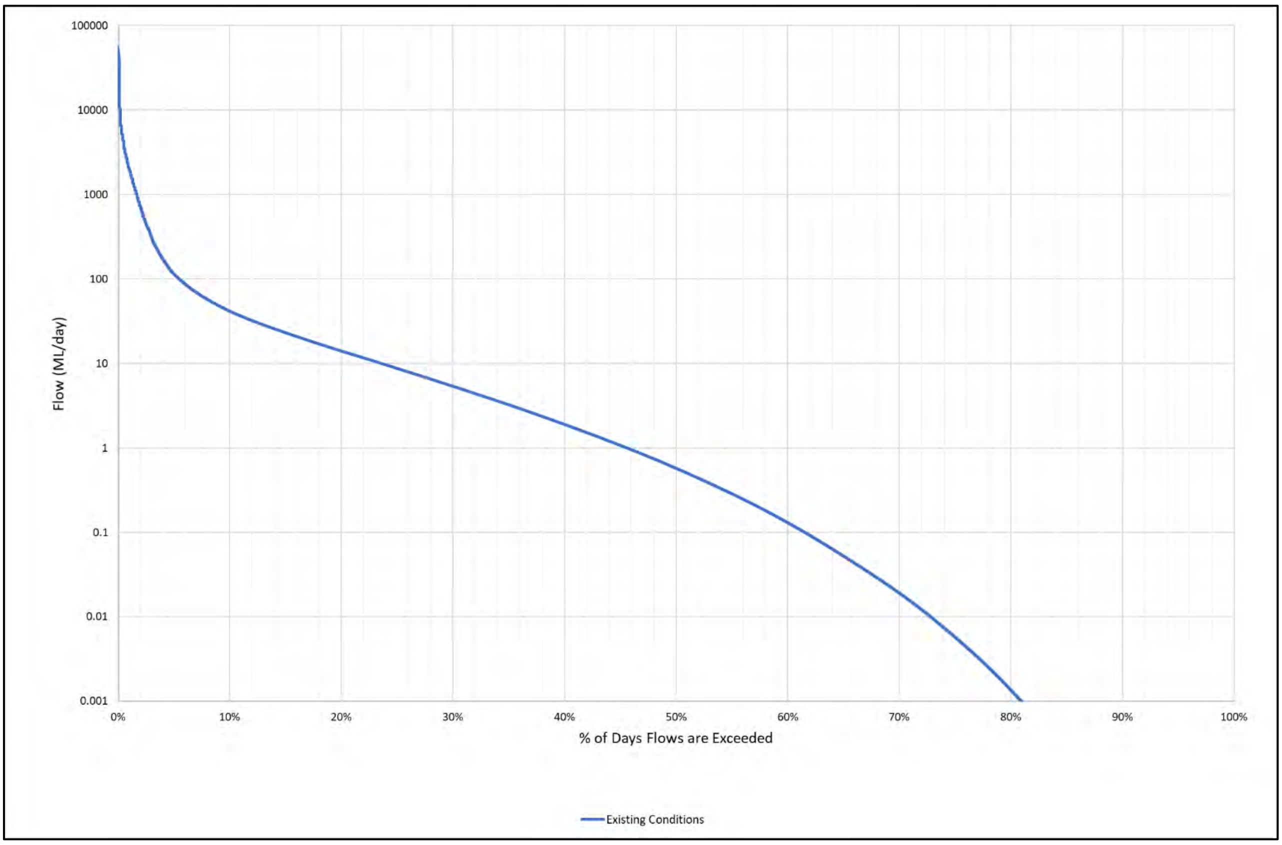

Figure 3.10: Flow Duration Modelled Results – Talbragar River at SW09

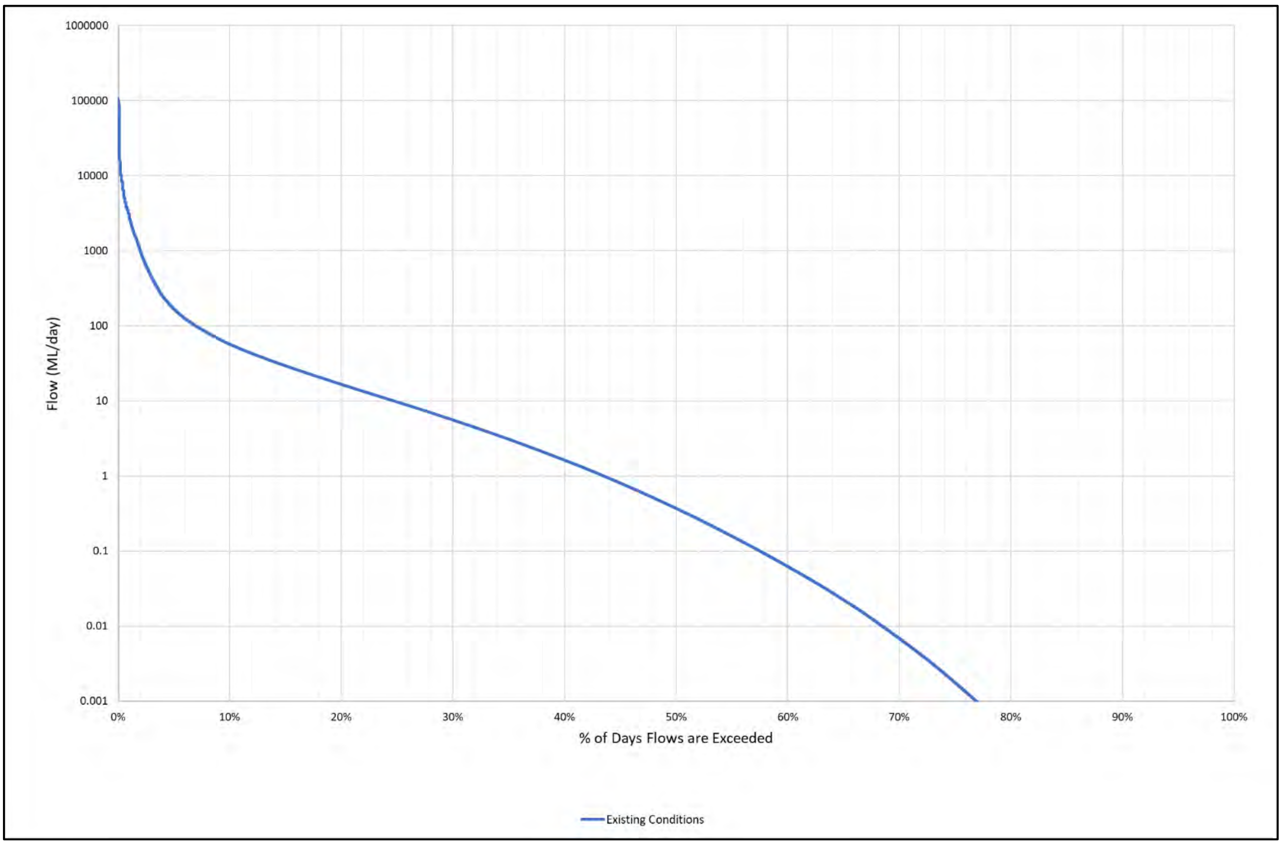

Figure 3.11: Flow Duration Modelled Results – Talbragar River at Dunedoo

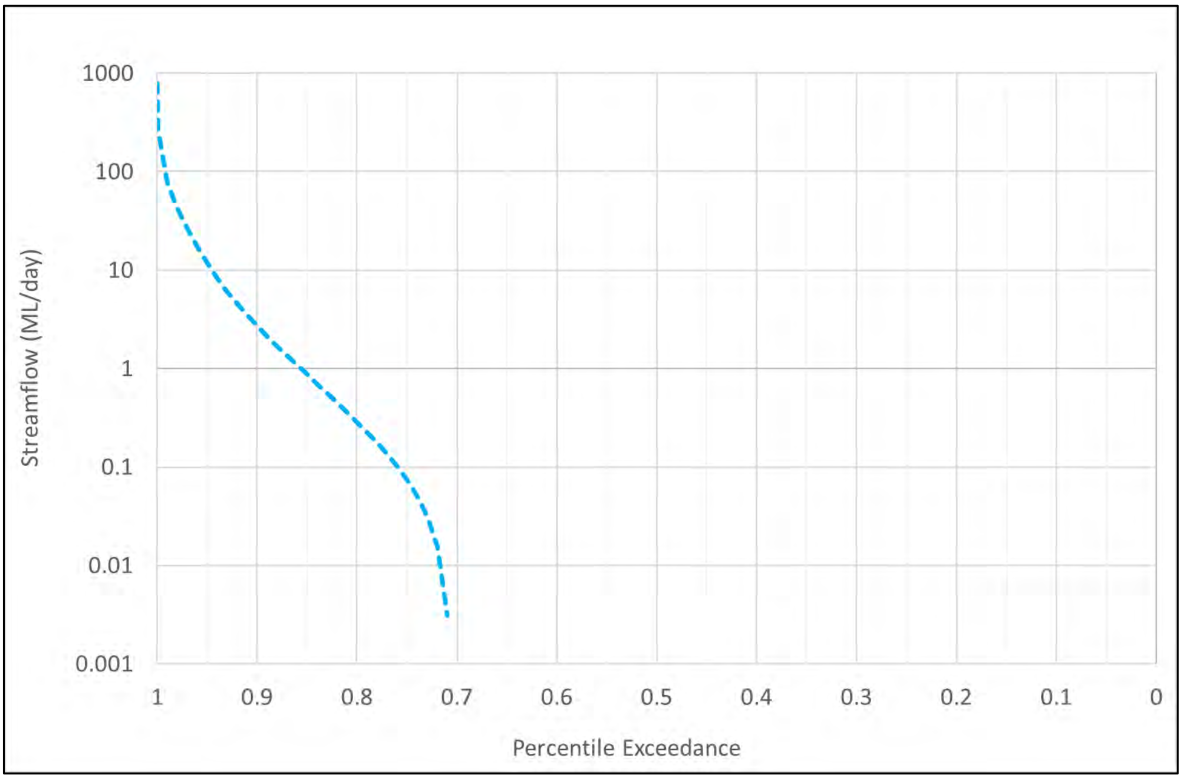

Figure 3.12: Flow Duration Modelled Results – Mona Creek

3.3.4 Average Annual Flow Conditions

The modelled average annual dry days (defined as flows less than 0.1 ML/day (approximately 1 L/s) and flow volumes are summarised in Table 3.4.

Table 3.4: Average Annual Flow Conditions

Watercourse	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)
Talbragar River at SW09	134	28,485
Talbragar River at Dunedoo	161	43,115
Mona Creek	276	1,179

3.3.5 Flooding

Detailed flood modelling was undertaken to estimate the flood conditions within Mona Creek for the approved mine plan (and subsidence impacts), as well as estimate the potential changes to the flooding in response to the Proposed Modification (refer to Section 4.2.1). The flood modelling approach is described in detail in Appendix A, and key results are discussed in Section 4.3. It should be noted, as described in Section 3.2.1, Mona Creek along the creekline consists typically of grassland. Further to this, there are no structures in the floodplain.

A detailed description of the flood modelling methods, assumptions, and input data is included in Appendix A and a full suite of thematic mapping, showing maximum modelled flood depths, extents and velocities for the existing conditions are also included in Appendix A.

Hydrologic modelling for this study was undertaken using the XP-RAFTS software package to estimate catchment runoff for the critical duration at 50% (approximately bank-full flows), 10%, 1% and 0.1% Annual Exceedance Probability (AEP) and Probable

Maximum Flood (PMF). Design storm parameters were sourced from Australian Rainfall and Runoff 2019 (ARR2019) Data Hub (data.arr-software.org).

A two-dimensional TUFLOW model was developed to model the hydraulic responses of the approved and proposed subsided landforms. The model includes the reaches and tributaries of Mona Creek and adjacent floodplain, extending from upstream of the predicted subsidence impacts to downstream of the confluence of Mona Creek and the Talbragar River (refer to Figure A.1).

Subsidence impacts do not extend to the Talbragar River floodplains, therefore the model extents encompass the Mona Creek catchment and a small area of the Talbragar River downstream of the confluence with Mona Creek.

The modelling indicates that for the approved operations, flooding is generally confined to the main channel and connected floodplain of Mona Creek, with a total floodplain width of about 350m within the vicinity of LW W9 to LW W11 (refer to Figure 3.13).

Figure 3.13: Maximum Modelling Flood Depths (1% AEP) – Existing (Approved) Conditions

3.4 WATER QUALITY

3.4.1 Background

Multiple reports from the former DPIE have rated water quality within the Talbragar River to be poor (DPIE 2018, DPIE, 2020). This is based on a low (31) Water Quality Index (WaQI) score, an integrated indicator of total nitrogen and phosphorus, pH, turbidity, and dissolved oxygen. DPIE has also stated that it is evident that the Talbragar River has very high nutrient (phosphorus and nitrogen) concentrations, and a naturally occurring high salinity (DPIE, 2020).

Samples of the Talbragar River at Elong Elong exceeded the ANZECC guideline recommendations for phosphorus 100% of the time, and turbidity 56% of the time (NSW Government 2010).

Previous reporting by DPIE also indicates:

- Turbidity in the Talbragar River is exacerbated by areas with high erosion risk and reaches where bank and riparian condition are poor (DPIE, 2020).
- Large sections of the Talbragar with less than 20% native woody riparian vegetation (DPIE, 2020).
- Nutrient concentrations are generally driven by runoff and erosion during rainfall events with higher concentrations at high flow. In addition, some of the higher nutrient concentrations at some sites occur during low or cease to flow periods. This suggests the sources of nutrients can be mixed. (DPIE, 2020).
- Historical data highlights that low rainfall in the headland regions attribute to flow in the river ceasing 20% of the time (DPIE, 2018).
- It must be determined if more appropriate targets need to be developed, or accept that the river is degraded, and the low WaQI score is an accurate reflection of the quality of the water (DPIE, 2020).
- The nutrient concentrations at this site are likely to exceed the Basin Plan targets most years (DPIE, 2020).

3.4.2 Monitoring Program

UCMPL monitors surface water quality in accordance with the Ulan Coal Surface Water Monitoring Program (*ULNCX-111515275-1642*) (2021) and the Surface Water and Groundwater Response Plan (*ULNCX-111515275-1644*) (2021).

The Surface Water Monitoring Program and Surface Water and Groundwater Response Plan require the following:

- Water quality monitoring of basic analytes (pH, EC, TSS, TDS, and Turbidity) is undertaken within the Talbragar River and Mona Creek in accordance with the following frequencies:
  - Monthly (when flowing).
  - Following a rainfall event of 30 mm or greater in 24 hours.
- Stream health monitoring (such as water temperature, conductivity, dissolved oxygen, turbidity, pH, alkalinity) is also undertaken in the Talbragar River, and Mona Creek annually in spring by a qualified ecologist.

3.4.3 Surface Water Trigger Values

Surface water trigger values at the UCC have been developed in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) (ANZECC Guidelines) (ANZG, 2018). The ANZECC Guidelines provide default trigger values and methods to determine site specific trigger values. The ANZECC guidelines indicate the preferred use of site-specific data to define trigger values. To define site-specific trigger values, at least 2 years of monthly sampling data is required.

Site specific trigger values have recently been developed for both the Talbragar River and Mona Creek based on the collection of sufficient monitoring data between February 2012 and April 2021. The updated Surface Water Monitoring Program is currently with Department of Planning and Environment for approval. Table 3.5 presents the currently approved interim trigger values (default ANZECC trigger values for lowland rivers in NSW) and the proposed site specific trigger values.

Table 3.5: Existing Surface Water Quality Trigger Values

Parameter	Default Talbragar River (SW09)	Site Specific Talbragar River (SW09)	Watercourses flowing to Talbragar River[1]	Site Specific Mona Creek (SW10)
pH	6.5 – 8.5	7.6 – 8.5	6.5 – 8.0	6.4-7.5
EC (µS/cm)	125 – 2,200	1004	30 – 350	177
TSS (mg/L)	50[2]	460	50[2]	123

[1] *Adopted Trigger Levels for Mona Creek*
[2] *Interim trigger value based on Volume 1 of Managing Urban Stormwater: Soils and Construction (Landcom, 2004)*

3.4.4 Existing Surface Water Quality

Water quality monitoring data for pH, EC and TSS are reported in the Annual Review for the UCC. Data presented in the Annual Reviews indicates that water quality in the Talbragar River and Mona Creek generally remain within historical trends and trigger levels and there is no statistically significant difference between pre and post mining.

Statistical analyses of the existing water quality monitoring data for pH, EC, TSS and TDS at monitoring locations along the Talbragar River (SW09) and Mona Creek (SW10) was undertaken. A summary of the analysis is presented in Table 3.6. Box and whisker plots for each monitoring location are presented in Appendix B. Appendix B also includes plots of recorded water quality parameters against the existing trigger values, identified in Table 3.6.

Table 3.6: Existing Water Quality within each Water Management System (Basic Analytes)

Monitoring Location	Statistic	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
SW09 (Talbragar River)	Number of Samples	81	82	80	80
	Minimum	6.2	43	2	117
	20th percentile	7.8	377	15	306
	Median	8.3	673	44	361
	80th percentile	8.5	837	179	489
	Maximum	9.3	2660	12700	968
	Average	8.2	634	409	397
SW10 (Mona Creek)	Number of Samples	36	35	33	35
	Minimum	6.1	30	2	64
	20th percentile	6.7	82	8	123
	Median	7.0	125	26	144
	80th percentile	7.4	214	92	200
	Maximum	8.1	955	700	674
	Average	7.0	163	78	166

The monitoring results indicate the following for the routine parameters of pH, EC, TSS and TDS (note: the typical ranges discussed below correspond to the 20th percentile and 80th percentile values):

- pH values typically range between 7.8 to 8.5 in the Talbragar River and 6.7 to 7.4 in Mona Creek.
- There are no visible temporal trends in the data available for pH within the Talbragar River and Mona Creek. Refer to Appendix B.
- EC typically ranges between 377 to 837 µS/cm in the Talbragar River and 82 to 214 µS/cm in Mona Creek.
- TSS typically ranges between 15 to 179 mg/L in the Talbragar River and 8 to 92 mg/L in Mona Creek. As such, recorded TSS values are often observed to exceed the existing surface water trigger level of 50 mg/L on several occasions however typically fall below this level. Refer to Appendix B.
- TDS records typically range between 306 to 489 mg/L in the Talbragar River and 123 to 200 mg/L in Mona Creek. Refer to Appendix B.

Water Quality Trends in the Talbragar River

Further analysis was undertaken on the EC and flow data for the Talbragar River to look for trends in water quality and flow.

Monitoring results over the period 2000 to 2007 at the Elong Elong gauge (WaterNSW database, 2021) indicate that EC has an average value of around 1500 µS/cm but falls significantly (for short periods of time) during intense rainfall events and can increase steadily to at least as high as 2000 µS/cm during prolonged dry periods (Figure 3.14) (AGE, 2022).

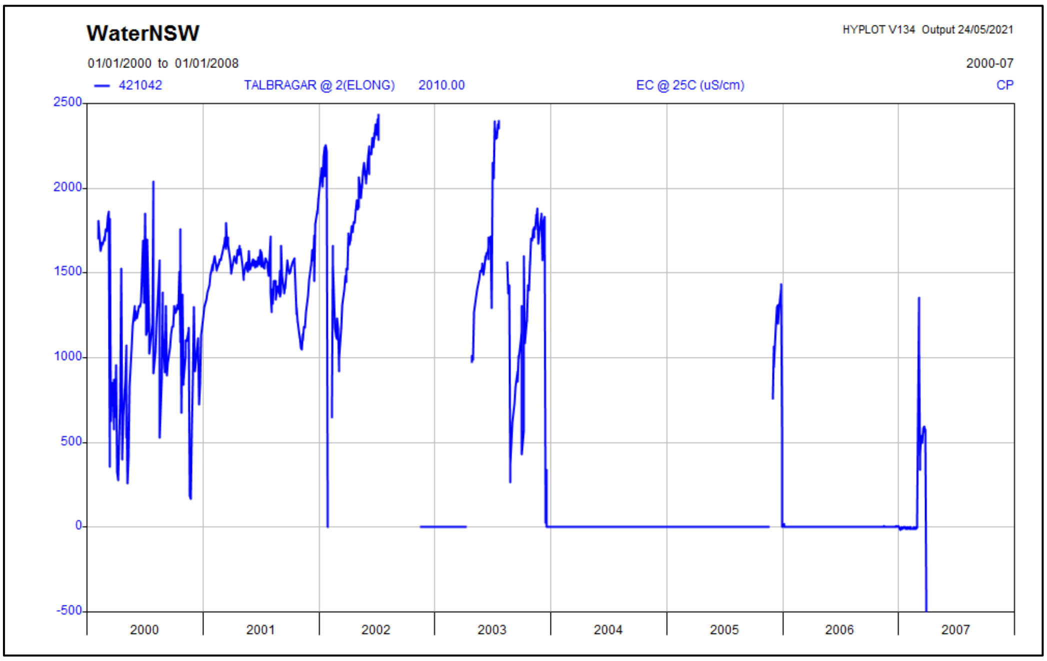

Figure 3.14: EC plot for river station 421042, Talbragar river at Elong Elong

EC data is available for the record shown above (refer to Figure 3.16) at the Elong Elong gauge (WaterNSW records) as well as daily EC data at SW09 (UCMPL) from October 2011 to November 2017 (with various data gaps) and monthly samples at SW09 from 2012 to 2022. For the periods of continuous daily records of EC at SW09 there is limited flow data for the Talbragar River at this location (refer to Table 3.2). The available EC data at SW09 and Elong Elong were compared to rainfall gauge data (at Dunedoo and Elong Elong respectively).

The outcomes of this analysis are presented in Figure 3.15 and Figure 3.16 indicates a trend the relationship between EC and rainfall data. That is periods of higher than average rainfall corresponding with periods of lower than average EC, and visa versa.

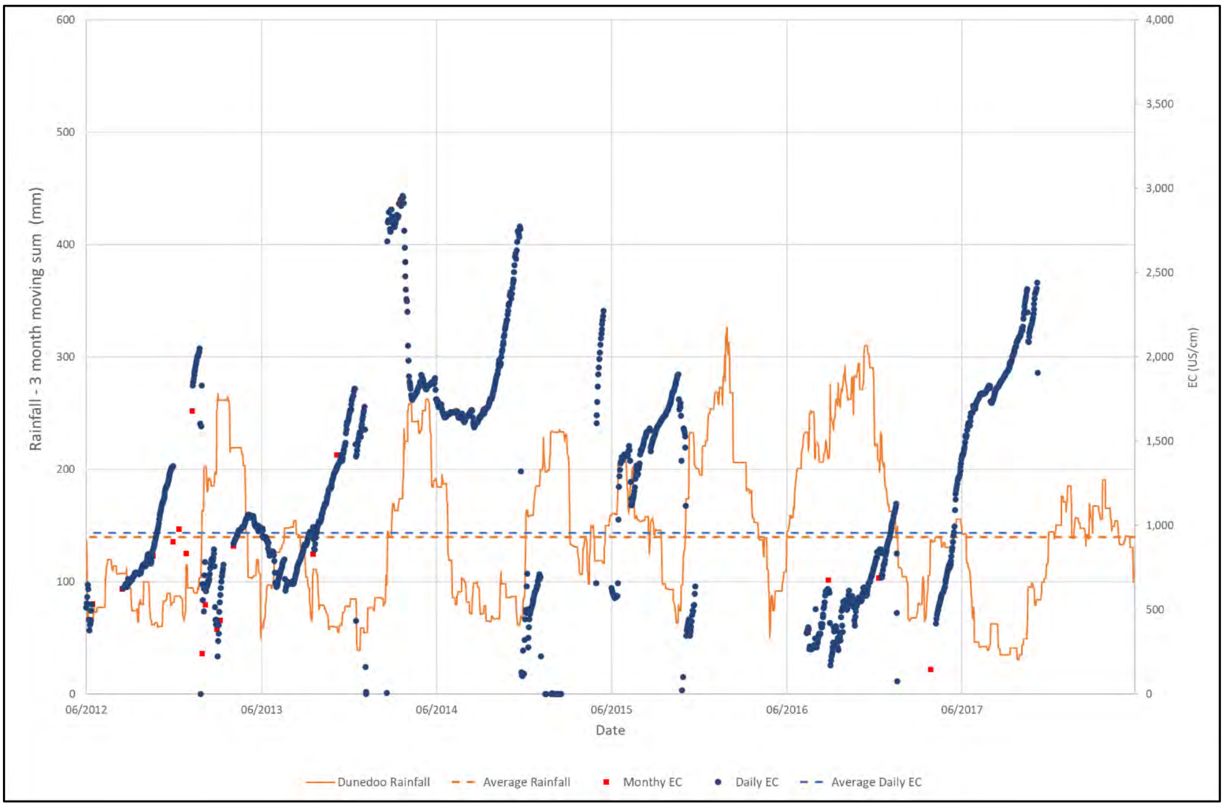

Figure 3.15: EC and Rainfall Analysis – SW09

Note: unfiltered data from UCMPL includes values of 0 µS/cm

Figure 3.16: EC and Rainfall Analysis – Elong Elong

Note: unfiltered data from WaterNSW includes values of 0 µS/cm

3.5 WATER USERS

The area of additional underground mining associated with the Proposed Modification is predominately located in areas owned by UCMPL but includes parts of private properties within the predicted subsidence zone.

As discussed in the Surface Water Assessment for the UCCO Project (Umwelt, 2009), the regions downstream of the UCC are primarily forested within the Goulburn River catchment but also include irrigated pasture/fodder crops within the Talbragar River catchment. Irrigation water along the Talbragar River is primarily sourced from the river, when flowing, and alluvial systems.

No private landholders have been identified using the surface waters of Mona Creek within or downstream of the area of additional underground mining associated with the Proposed Modification, except for stock access via basic landholder rights.

4 SURFACE WATER IMPACT ASSESSMENT

The SWIA assesses the potential impacts of the Proposed Modification on catchment areas, flow regimes, flooding, remnant ponding, water quality and water users (refer to Sections 4.1 to 4.9). Following receipt of the DCCEEW supplementary assessment requirements further consideration of potential climate change on streamflow and flood impacts was also included in the assessment (refer to Appendix C and Section 4.10).

4.1 CATCHMENT AREAS

A review of the catchment boundaries was undertaken using the predicted subsidence contours. No measurable changes to catchment boundaries were found as a result of predicted subsidence.

4.2 FLOW REGIMES

Flow regimes in the river and creek systems which are expected to be impacted by the Proposed Modification were modelled to assess the impact of any potential reduction in baseflows. The estimated baseflow loss provided by the Groundwater Impact Assessment (AGE, 2022) was applied to the calibrated models discussed in Section 3.3 to determine any impacts on baseflows to affected rivers and creeks. The baseflow losses were estimated to be the same for Option 1 (base case) and Option 2 (flexible) mine plans.

4.2.1 Talbragar River

Talbragar River at SW09

To assess the impacts of the Proposed Modification on streamflow in the Talbragar River at SW09, the predicted baseflow impacts (AGE, 2022) were subtracted from the modelled daily flows to create a predicted streamflow sequence. To assess the impact of the Proposed Modification, the data for existing mining in the catchment was used from the AGE predictions.

Table 4.3 shows the modelled scenarios and the impact on annual flow conditions as a result of the Proposed Modification.

Table 4.1: Talbragar River at SW09 Flow Duration Analysis

Scenario	Catchment Area (km^2)	Mining Induced Baseflow Losses (ML/d)	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)	Average duration of dry periods (days)
Existing	66,360	-	277	28,485	145
Approved Conditions	66,360	0.00804	280	28,480	147
Proposed Modification	66,360	0.00819	280	28,480	147

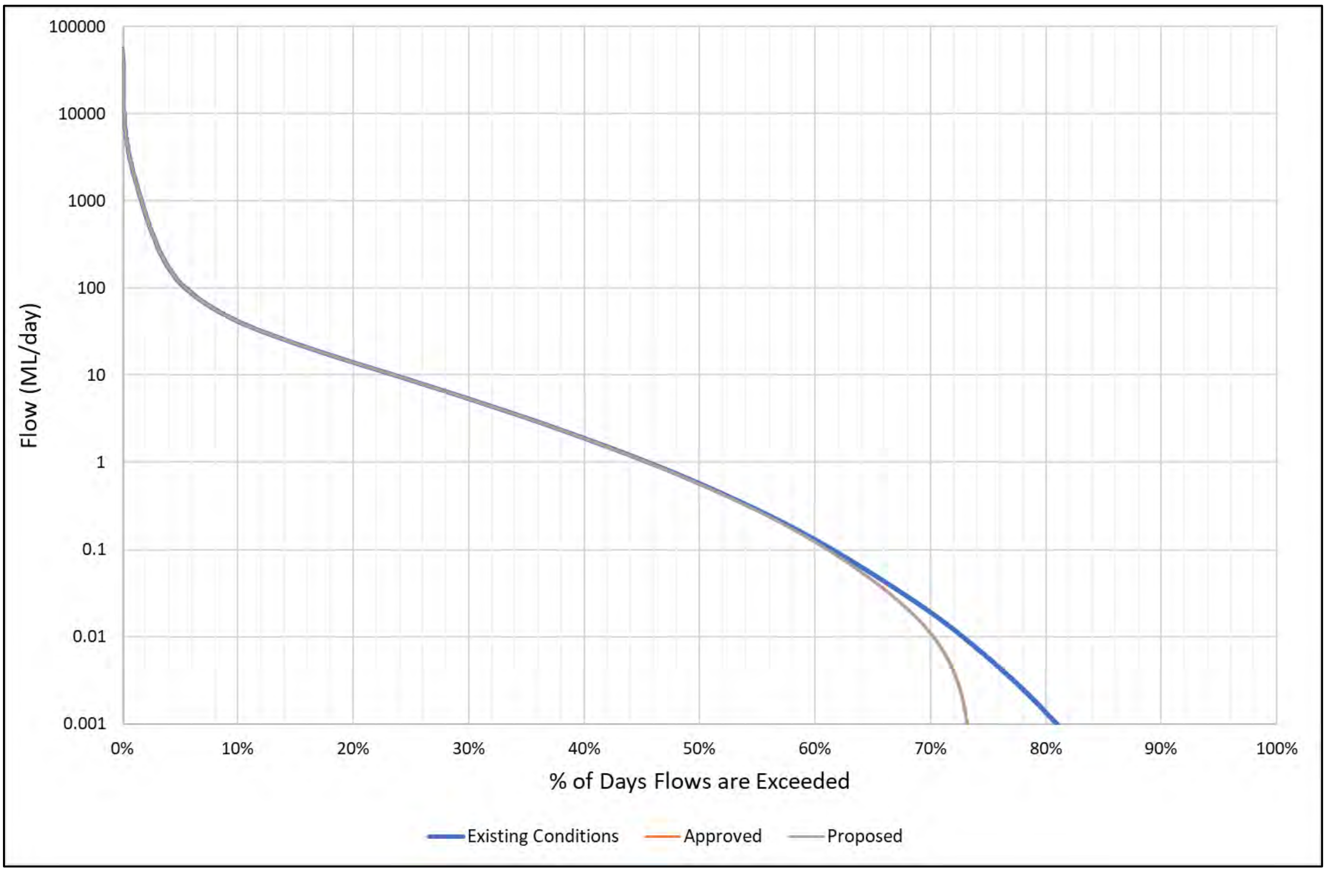

Figure 4.1: Talbragar River at SW09 Modelled Flow Duration

The model indicates no increase to the estimated frequency of no flow periods and no increase in average annual dry days (defined as flows less than 0.1 ML/day) in the Talbragar River as a result of the Proposed Modification relative to the currently approved mining operations. The modelling also indicates an existing approved impact on baseflows for the current approved mining operations.

Talbragar River at Dunedoo

To assess the impacts of the Proposed Modification on streamflow in the Talbragar River at Dunedoo, the predicted baseflow impacts (AGE, 2022) were subtracted from the modelled daily flows to create a predicted streamflow sequence. To assess the impact of the Proposed Modification, the data for existing mining in the catchment was used from the AGE predictions.

Table 4.2 shows the modelled scenarios and the impact on annual flow conditions as a result of the Proposed Modification.

Table 4.2: Talbragar River at Dunedoo Flow Duration Analysis

Scenario	Catchment Area (km^2)	Mining Induced Baseflow Losses (ML/d)	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)	Average duration of dry periods (days)
Existing	200,260	-	306	43,115	171
Approved Conditions	200,260	0.05375	323	43,100	171
Proposed Modification	200,260	0.05484	323	43,100	171

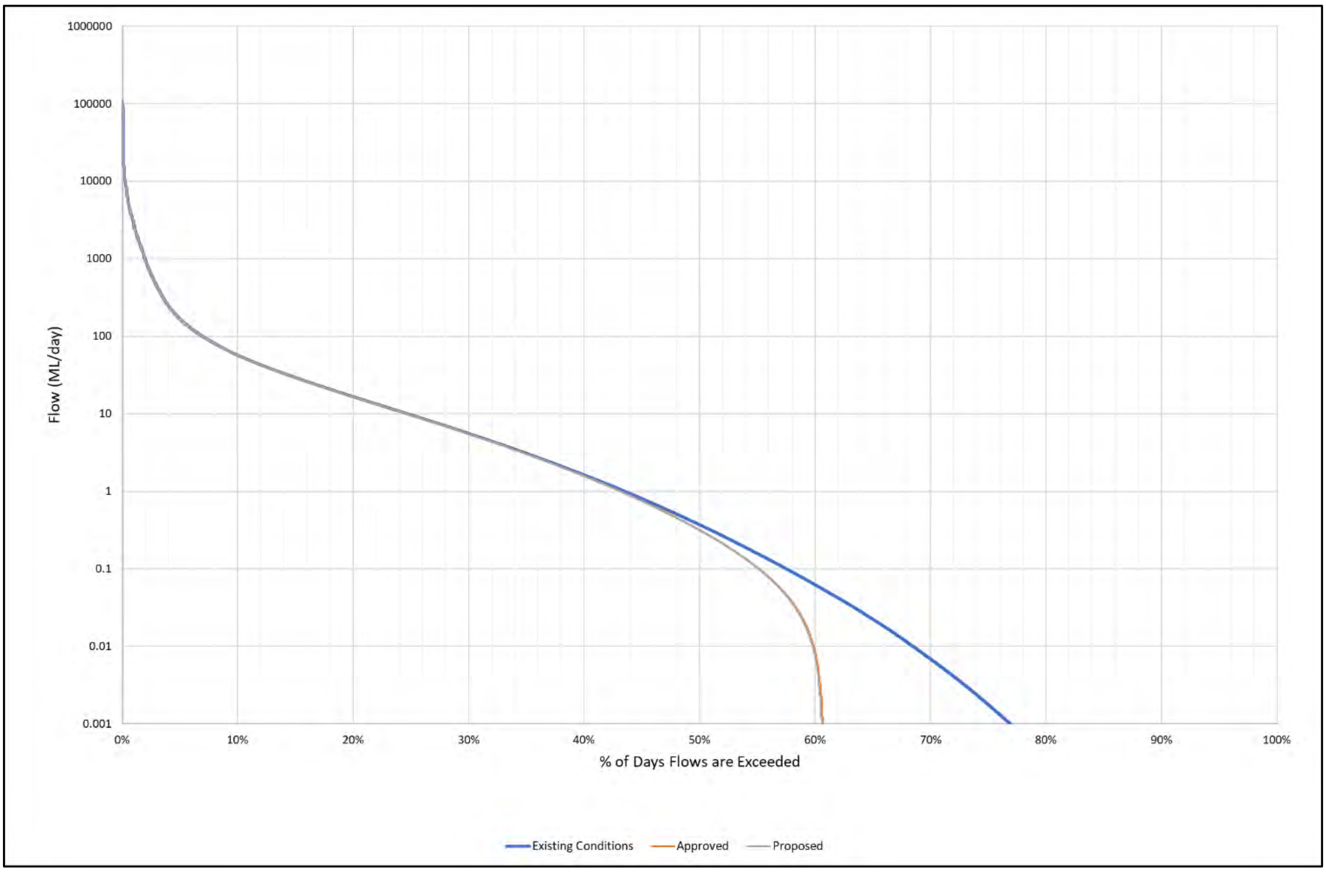

Figure 4.2: Talbragar River at Dunedoo Modelled Flow Duration

The model indicates no increase to the estimated frequency of no flow periods and no increase in average annual dry days (defined as flows less than 0.1 ML/day) in the Talbragar River as a result of the Proposed Modification relative to the currently approved mining operations. The modelling also indicates an existing approved impact on baseflows for the current approved mining operations.

Talbragar River at Elong Elong

To assess the impacts of the Proposed Modification on streamflow in the Talbragar River at Elong Elong, the predicted baseflow impacts (AGE, 2022) were subtracted from the observed daily flow to create a predicted streamflow over the historic period. To assess the impact of the Proposed Modification, only the records prior to 19 May 2014 for pre-mining (that is, the date which mining began in the Talbragar River catchment (i.e., west of the Great Dividing Range)) were used in the assessment.

Table 4.3 shows the modelled scenarios and the impact on annual flow conditions as a result of the Proposed Modification.

Table 4.3: Talbragar River at Elong Elong Flow Duration Analysis

Scenario	Catchment Area (km^2)	Mining Induced Baseflow Losses (ML/d)	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)
Pre-mining	305,000	-	116	80,930
Approved Conditions	305,000	0.05928	117	80,920
Proposed Modification	305,000	0.06037	117	80,920

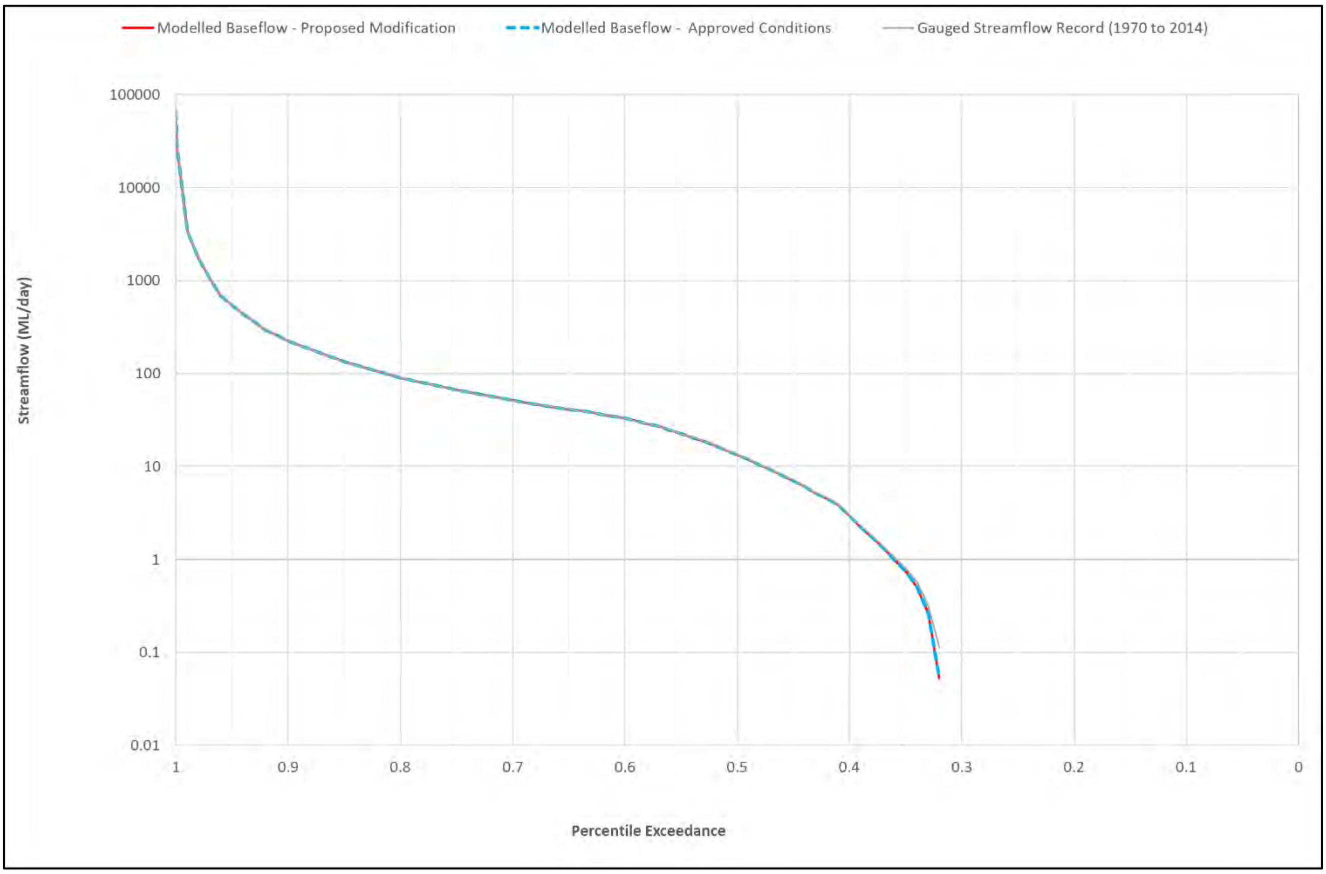

Figure 4.3: Talbragar River at Elong Elong Modelled Flow Duration

The model indicates negligible impact to the estimated frequency of no flow periods and no increase in average annual dry days (defined as flows less than 0.1 ML/day) in the Talbragar River as a result of the Proposed Modification relative to the currently approved mining operations.

4.2.2 Mona Creek

As a result of the predicted subsidence there are no changes to catchment areas in Mona Creek (refer to Section 4.1) or baseflow to the creek system (AGE, 2022). As such the Proposed Modification is not expected to have any impact on streamflow sequences in Mona Creek.

4.3 FLOODING

A flood impact assessment was undertaken using the TUFLOW model outlined in Section 3.4 and detailed in Appendix A. The two landform scenarios for the proposed modification were modelled: Option 1 (base case); and Option 2 (flexible). These were compared to the approved subsided landform when assessing impacts. All subsidence data was provided by SCT (2022).

Since the last approval, additional data on depth of cover and more complex algorithms for computing predicted subsidence bowls have been applied to the Ulan mine plan. As such there are as some minor changes to subsidence bowls outside of the areas of the proposed modification. These areas result in some areas with minor changes to the flood modelling outcomes. It should be noted that these ranges are within the range of the subsidence predictions and are considered to be of no consequence.

Impacts to flood depths, velocities and stream health were assessed for the 50%, 10%, 1%, 0.1% AEP events and the PMF. Appendix A contains the flood mapping for all modelled events. Generally, it was found that the modelled impacts to flood depths and velocities do not extend beyond the predicted vertical subsidence affectation area.

4.3.1 Flood Depth – Option 1

The modelling results for Option 1 of the proposed modification indicate that the impact of the predicted subsidence typically are:

- Pooling on the upstream side of each chain pillar due to the localised flattening of the floodplain.
- Decreases to flood depth downstream of each chain pillar side due to the localised steepening of the floodplain.

Model results from the proposed scenario show that, immediately downstream of the farm dam on Mona Creek, flood flows are concentrated into the channel due to changes in the level of a spill point into an old channel. This has the effect of removing a breakout path across the grassed floodplain area in all modelled events up to and including the 0.1% AEP event. This breakout path is across grassed areas and has been formed due to the construction of the farm dam. Refer to the 'was wet now dry' extents above the proposed longwall locations in Figure 4.4.

For the 1% AEP the approved landform modelling indicates localised flood depths of up to 3.4 m within the Mona Creek channel above the proposed longwall extensions under approved conditions. These depths are predicted to increase to approximately 4.3 m in localised areas with the Option 1 Proposed Modification. The predicted 1% AEP flood afflux (i.e. modelling increase in flood depth with the Proposed Modification) is shown in Figure 4.5.

A comparison of the modelled hydrographs for the approved and proposed Option 1 subsidence within the main channel of Mona Creek indicates that the duration of flooding is unlikely to substantially change as a result of the Proposed Modification. The modelling indicates that flood durations are estimated to decrease by about 5 minutes for the 1% AEP flood event.

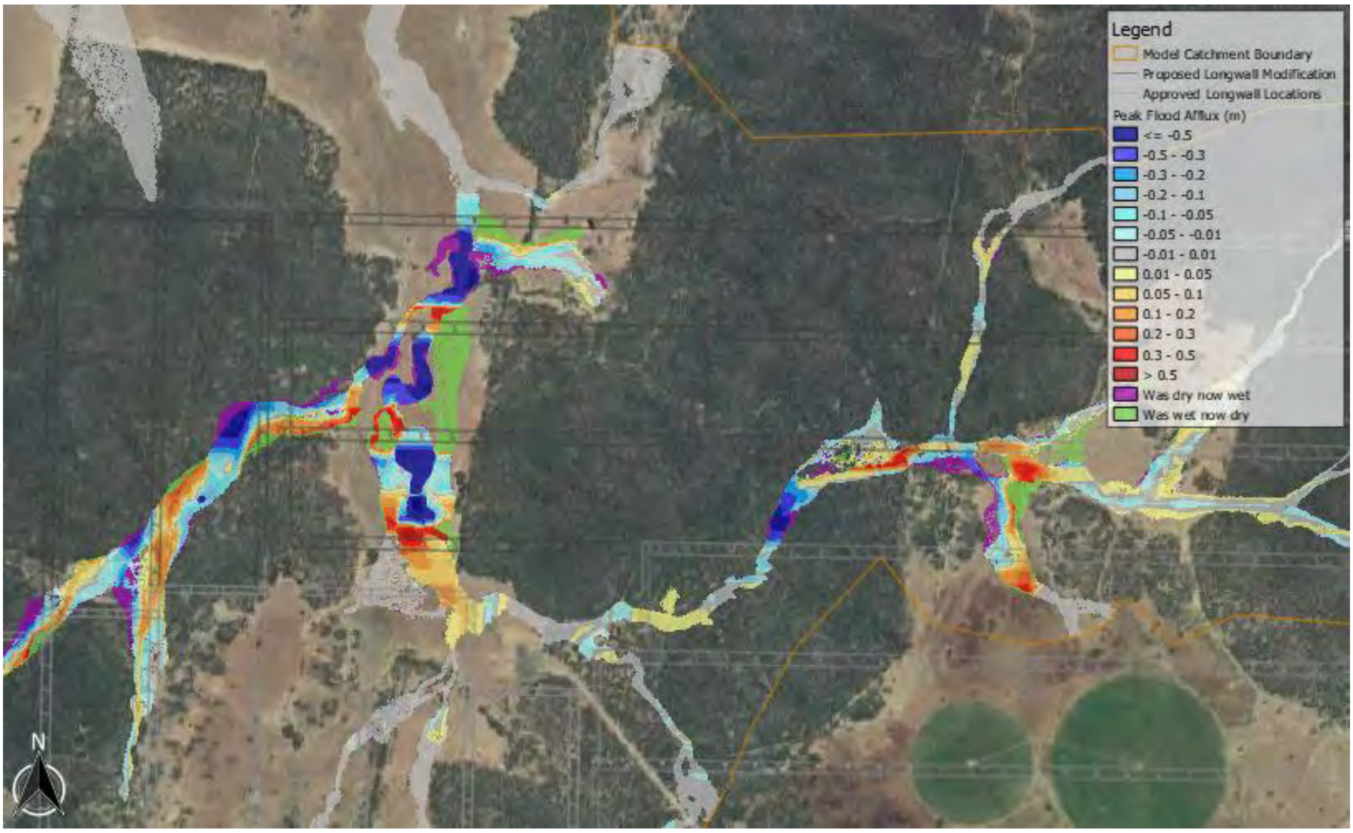

Figure 4.4: 1% AEP Flood Afflux – Option 1 (Base case)

4.3.2 Flood Depth – Option 2

The modelling results for Option 2 of the Proposed Modification are typically consistent with Option 1, as the predicted impacts of the predicted subsidence generally are:

- Pooling on the upstream side of each chain pillar due to the localised flattening of the floodplain.
- Decreases to flood depth downstream of each chain pillar side due to the localised steepening of the floodplain.

As with Option 1, model results from the proposed scenario show that, immediately downstream of the farm dam on Mona Creek, flood flows are concentrated into the channel due to changes in the level of a spill point into an old channel. This has the effect of removing a breakout path across the grassed floodplain area in all modelled events up to and including the 0.1% AEP event. This breakout path is across grassed areas and has been formed due to the construction of the farm dam. Refer to the 'was wet now dry' extents above the proposed longwall locations in Figure 4.5.

For the 1% AEP the modelling indicates localised flood depths of up to 3.4 m within the Mona Creek channel above the proposed longwall extensions with the approved underground mining. These depths are predicted to increase to 4.2 m in localised areas with the Proposed Modification. The predicted 1% AEP flood afflux (i.e. modelling increase in flood depth with the Proposed Modification) is shown in Figure 4.5.

A comparison of the modelled hydrographs for the approved and proposed subsidence within the main channel of Mona Creek indicates that the duration of flooding is unlikely to substantially change as a result of the Proposed Modification. The modelling indicates that flood durations are estimated to increase by approximately 5 minutes for the 1% AEP flood event.

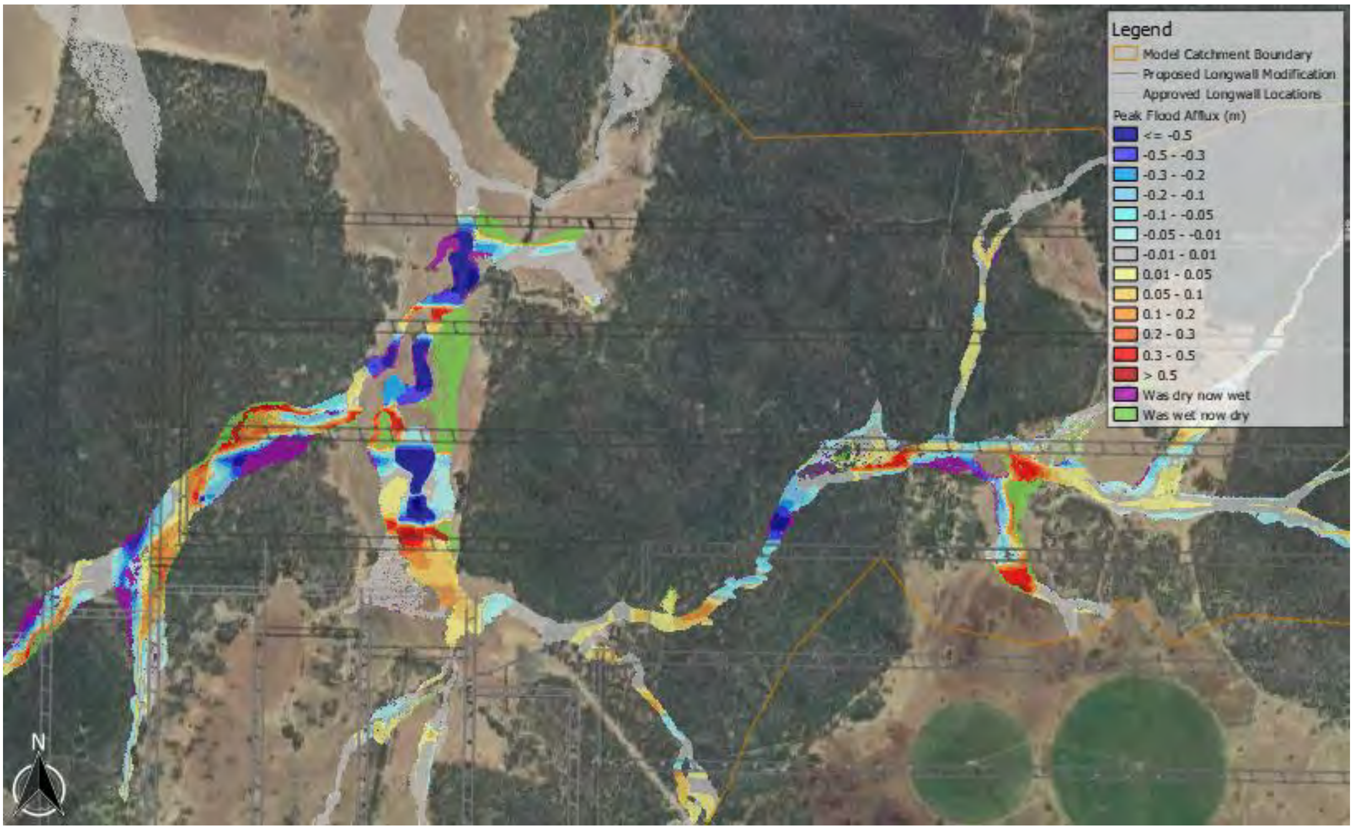

Figure 4.5: 1% AEP Flood Afflux – Option 2 (Flexible)

4.3.3 Watercourse Stability

To assess the potential impact of the two Proposed Modification options on watercourse stability, an analysis of velocity and bed shear stress outputs for both the proposed conditions was undertaken. Results for the 50% AEP event were assessed as impacts to watercourse stability are typically of greater risk in events of this magnitude. Section A.3 outlines watercourse stability indicators and thresholds for velocity and tractive stress for materials typical of channels in the Project Area.

4.3.4 Flood Velocities – Option 1

Modelling results indicate that the impact of the Option 1 predicted subsidence generally results in:

- Increases to peak velocities downstream side of each chain pillar due to the localised steepening of the floodplain.
- Decreases to peak velocities on the upstream side of each chain pillar, due to localised flattening of the floodplain.

Modelled results for the 50% AEP show velocities in the channel of Mona Creek range from 0.5 to 3.2 m/s in approved conditions. The predicted subsidence from the Proposed Option 1 Modification results in increases in velocities in the channel downstream of proposed chain pillars in the region of 1.1 m/s. While a typical decrease in velocities in the region of 1.5 m/s is predicted in areas of the channel where the floodplain is flattening due to predicted subsidence. However, within the predicted subsidence area of the LW W9 extension a higher decrease is observed at a maximum of 3.1 m/s. Typically, reaches show an increase or decrease in velocity due to the predicted subsidence range between 150 m and 300 m depending on the alignment of the channel relative to subsidence bowls.

The modelled velocities for the 1% AEP, within the channel above the proposed longwall extensions, range from approximately 0.2 m/s to 3.7 m/s for the existing approved conditions. The Option 1 predicted subsidence has increased the predicted peak velocity under this AEP event to maximum of 4.7 m/s (refer to Figure 4.6).

The figures in Appendix A show the mapped peak flood velocities for all modelled events.

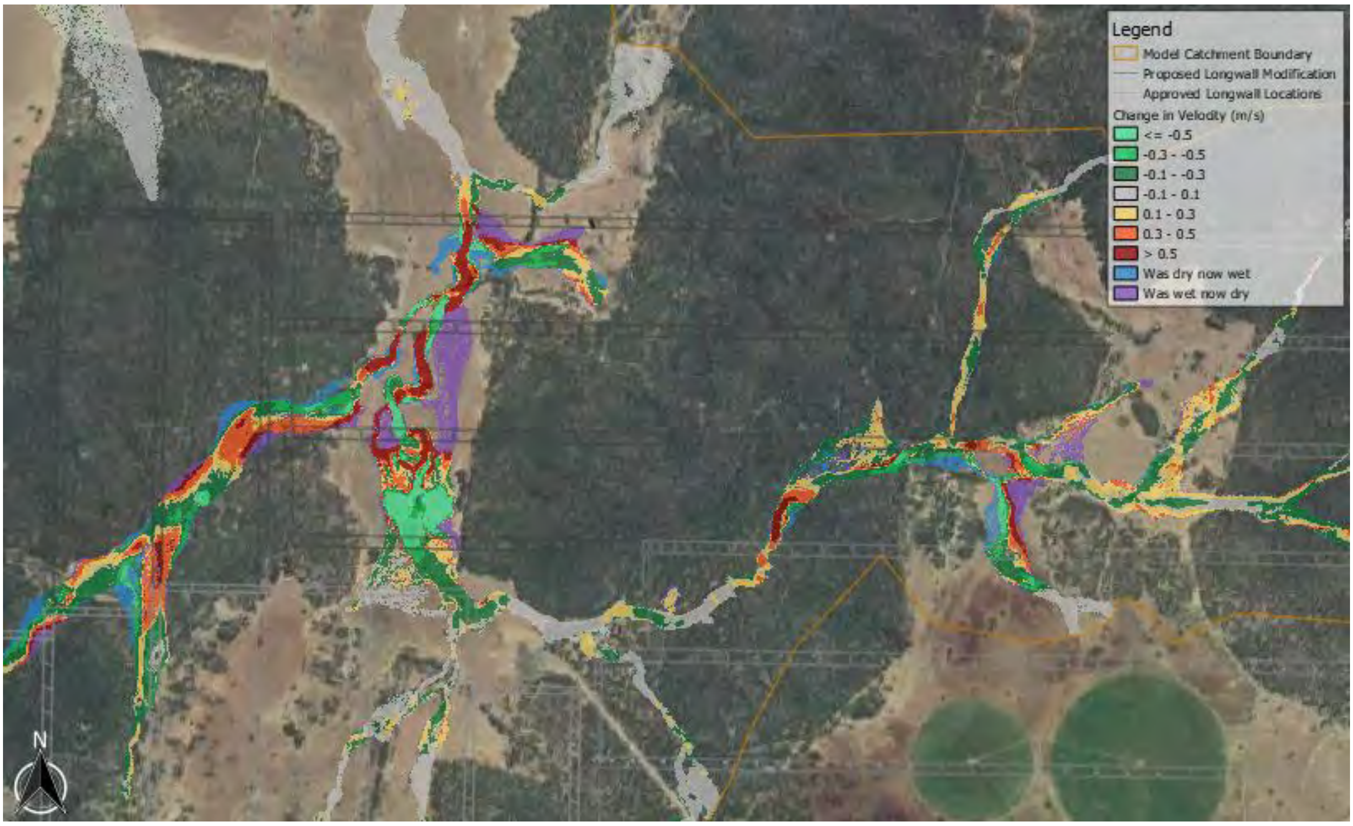

Figure 4.6: 1% AEP Change in Velocity – Option 1 (Base case)

4.3.5 Flood Velocities – Option 2

As with Option 1, the Option 2 modelling results indicate that the impacts of the predicted subsidence generally are:

- Increases to peak velocities downstream side of each chain pillar due to the localised steepening of the floodplain.
- Decreases to peak velocities on the upstream side of each chain pillar, due to localised flattening of the floodplain.

Modelled results for the 50% AEP show velocities in the channel of Mona Creek typically range from 0.5 to 3.2 m/s in approved conditions (refer to Appendix A). The predicted subsidence from the Option 2 Proposed Modification results in increases in velocities in the channel downstream of proposed chain pillars in the region of 1 m/s. While in areas of the channel where the floodplain is flattening due to predicted subsidence a typical decrease in velocities of 1.2 m/s is observed. However, within the predicted subsidence area of the LW W9 extension a higher decrease is observed at a maximum of 2.9 m/s. Typically, reaches show an increase or decrease in velocity due to the predicted subsidence range between 150 m and 300 m depending on the alignment of the channel relative to subsidence bowls.

The 1% AEP modelled velocities within the channel above the proposed longwall extensions range from approximately 0.2 m/s to 3.7 m/s for the currently approved conditions. The Option 2 predicted subsidence has increased the peak velocity under this AEP event to 4.6 m/s (refer to Figure 4.7).

The figures in Appendix A show the mapped peak flood velocities for all modelled events.

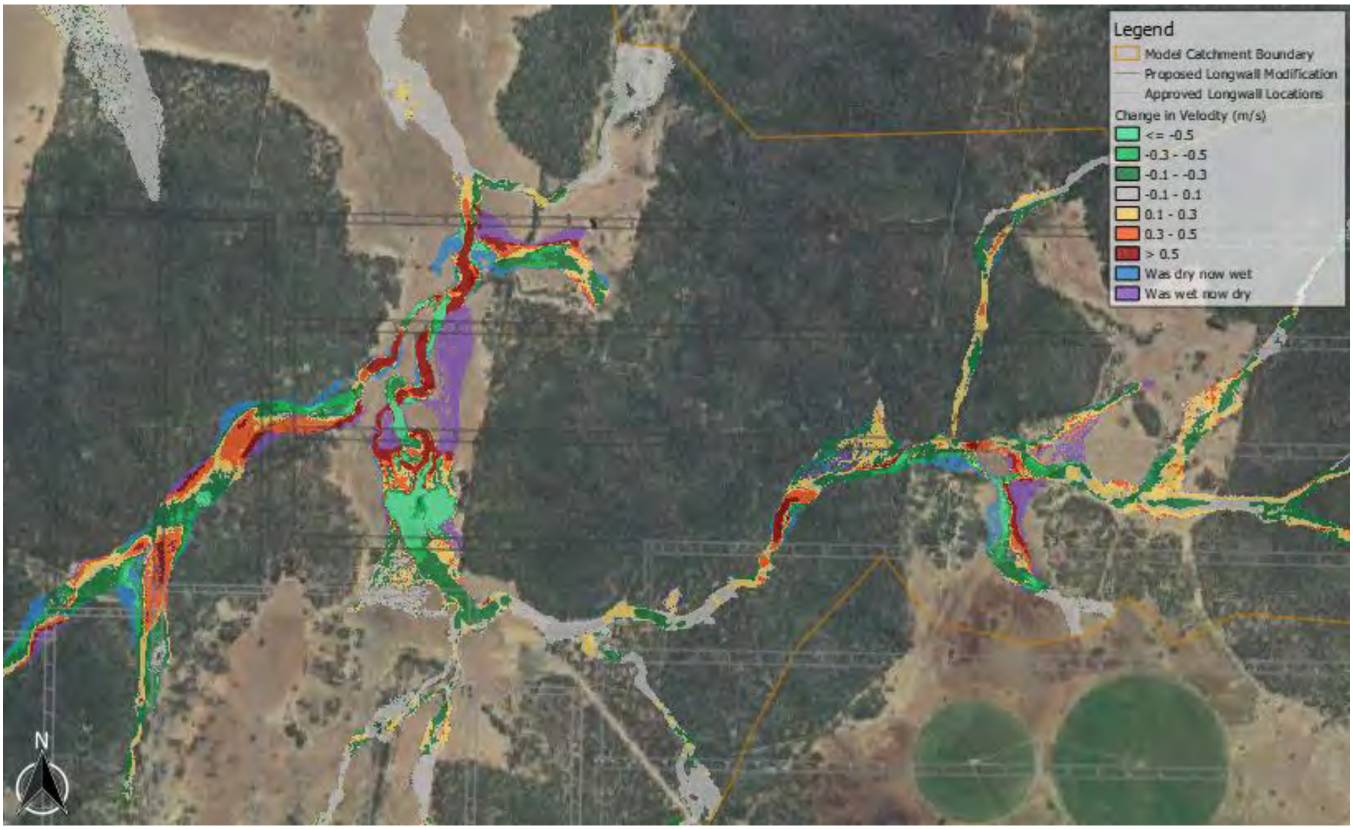

Figure 4.7: 1% AEP Change in Velocity – Option 2 (Flexible)

4.3.6 Tractive Stress

Figures 4.9 to 4.11 show the tractive stress for the 50% AEP under the approved conditions, the Option 1 Proposed Modification, and the Option 2 Proposed Modification, respectively.

Modelling indicates increased velocities in areas where the floodplain is steepening causing a subsequent increase in tractive stresses for both proposed modification options. For the 50% AEP event tractive stresses in the approved conditions are predicted to range from 2.4 to 201.4 N/m^2. The predicted subsidence increases the maximum modelled tractive stress to

229 N/m^2 for Option 1, and to 209 N/m^2 for Option 2. Decreases to floodplain grade on the upstream side of chain pillars has also resulted in localised lowering of modelled tractive stresses (for both modification options) in areas where ponding is increased by predicted subsidence. The modelled tractive stresses are erosive above 3.6 N/m^2 for fine gravels and erosive above 32.1 N/m^2 for hardpan (i.e. the two key bed conditions visible on Mona Creek in the underground mining area) (refer to Table A.5). The results of the modelling (refer to Figure 4.8 to 4.10) indicate areas where erosion will be potentially present in areas that have not yet been undermined. These modelling results are consistent with the observations made during the field inspection. The potential impacts of the predicted changes to tractive stresses are discussed in conjunction with potential impacts due to changes in velocities in Section 4.3.7.

Figure 4.8: 50% AEP Tractive Stress – Approved Conditions

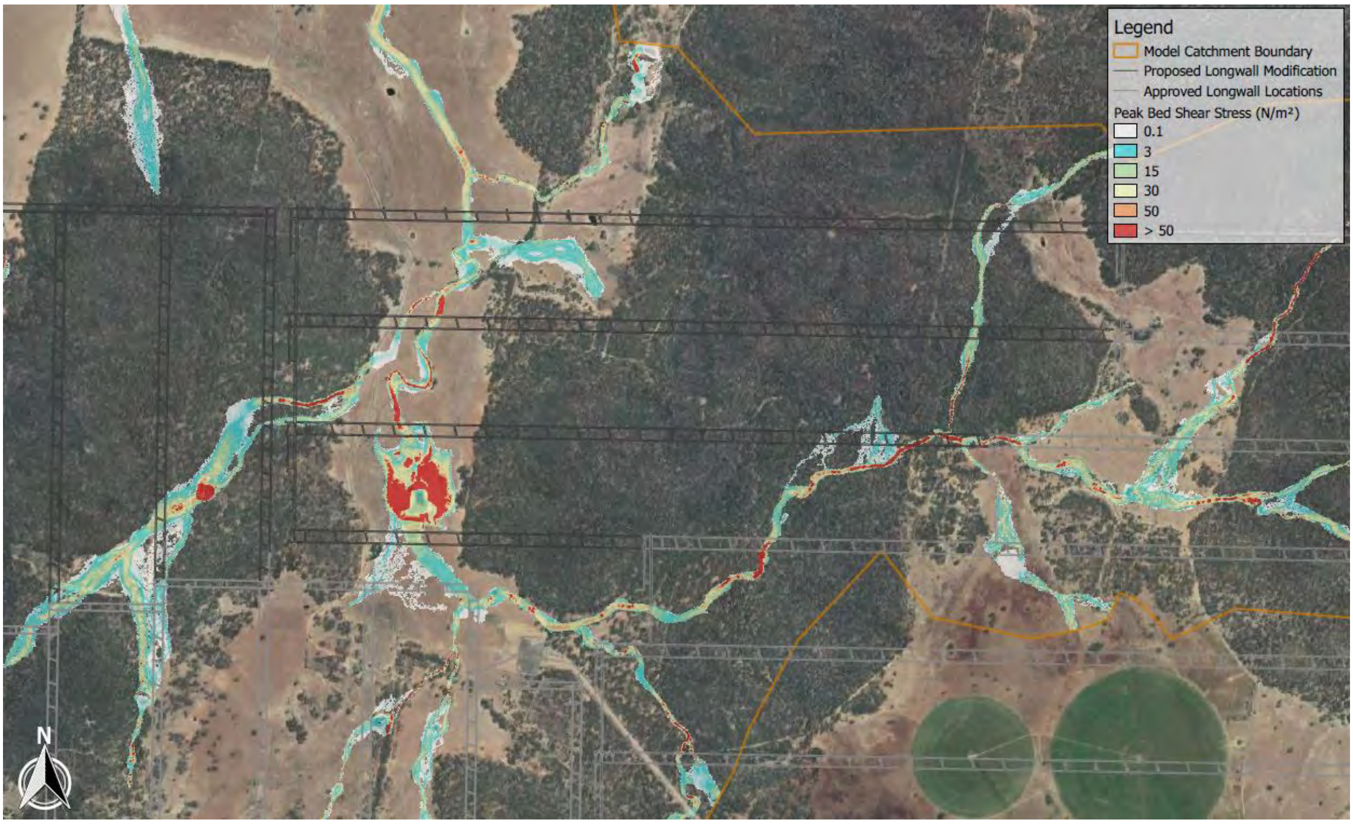

Figure 4.9: 50% AEP Tractive Stress – Option 1 (Base case)

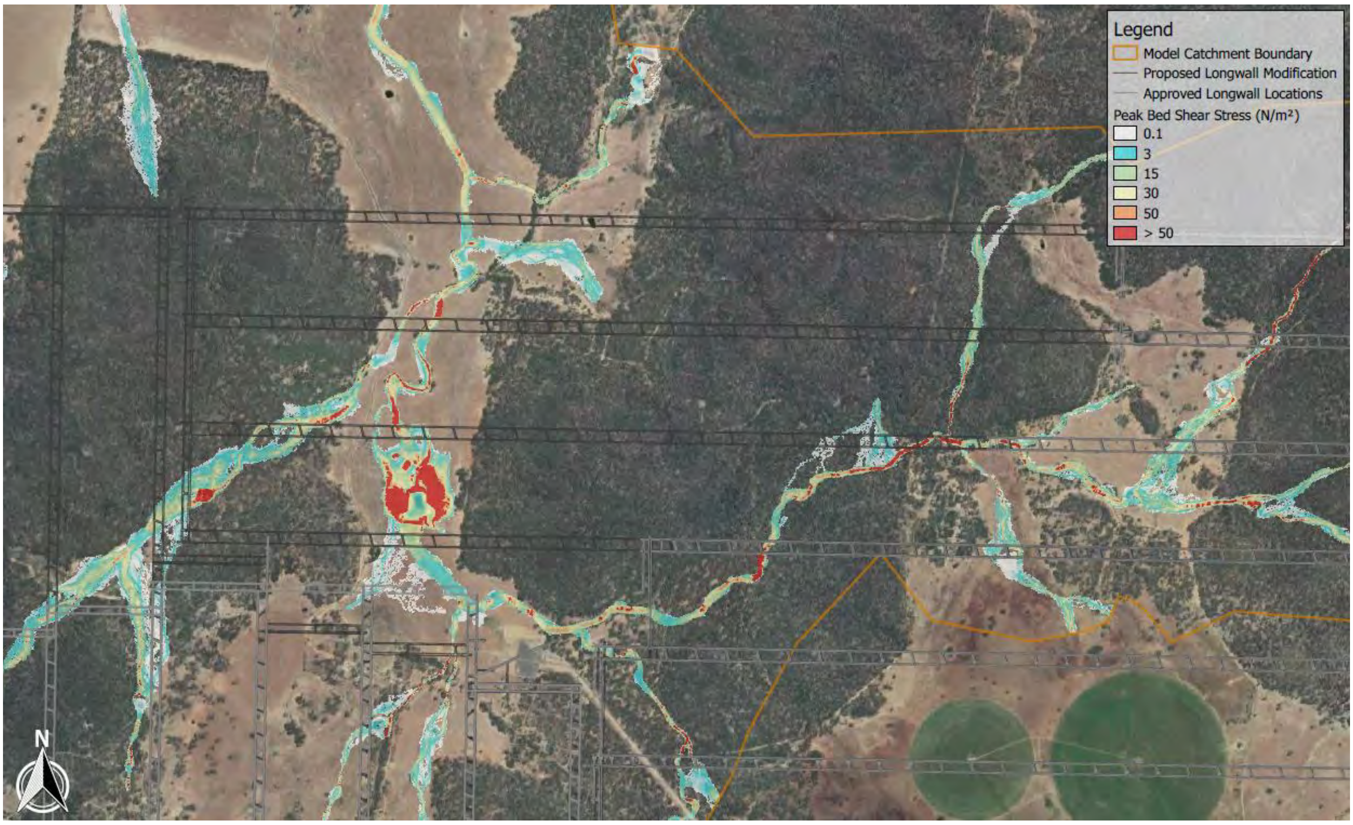

Figure 4.10: 50% AEP Tractive Stress – Option 2 (Flexible)

4.3.7 Channel Stability Impacts

Modelling indicates that the channel of Mona Creek is currently subject to erosive conditions during flood events, although field inspections indicate only minimal undercutting of the banks and a potentially mobile bed. The modelled increases to velocities and tractive stresses in the channel discussed above could potentially result in an increase to the erosive potential in the channel of Mona Creek. With reference to Table A. 5 in Appendix A, sections of the channel downstream of the chain pillars will potentially experience velocities and tractive stresses above the threshold which erosion would be expected. Areas within the channel at risk of potential erosion all occur within landholdings owned by UCMPL.

Due to the increased risk of erosion, monitoring of creek stability will continue to be undertaken by UCMPL. Additionally, minor in-channel works may be required in order to prevent scouring (refer to Sections 6.1 and 6.2).

4.4 REMNANT PONDING

A remnant ponding analysis was undertaken to assess the potential impacts of the two proposed modification options on remnant ponding. Remnant ponding analysis considers the modelled depressions in the landform based on the survey data and the subsidence predictions. This infers areas that could potentially hold water, i.e. remnant ponding, following rainfall events.

Figure 4.11 maps the areas of remnant ponding for the Option 1 landform, and Figure 4.12 maps the areas of remnant ponding for the Option 2 landform.

The analysis indicates that the predicted subsidence for the two options of the proposed modification results in patterns of remnant ponding consistent with the approved subsidence. That is, increases to areas affected by remnant ponding are typically located in-channel or on predominately grassed areas.

Several additional areas within and adjacent to Mona Creek have been identified as potential remnant ponding areas. Another area on a drainage line to the west of Mona Creek has also been identified. Predicted increases in ponding occur within extensions of mining, within troughs where the maximum predicted subsidence occurs.

The currently approved potential maximum area of remnant ponding is approximately 33 ha. Under the Option 1 Proposed Modification, the potential maximum amount of remnant ponding is estimated to be 53 ha. Under the Option 2 Proposed Modification, the potential maximum remnant ponding area is estimated to be 42 ha. The increase in remnant ponding from the pre-mining landform is primarily associated with the extension of the proposed longwall panels into the area to the north of the existing approved longwall mining areas.

Historical and recent site inspections indicate that in most areas where the topographical survey indicates existing remnant ponding, water does not pond in these areas as the soils are sandy and relatively free draining. As such, it is considered unlikely, based on the analysis of the predicted subsidence that any additional remnant ponding will occur within the predicted subsidence affectation area. This is due to both the steepness of the existing landform in upper reaches and typically sandy, free draining soils.

The monitoring program for remnant ponding and potential responses are outlined in Section 6.

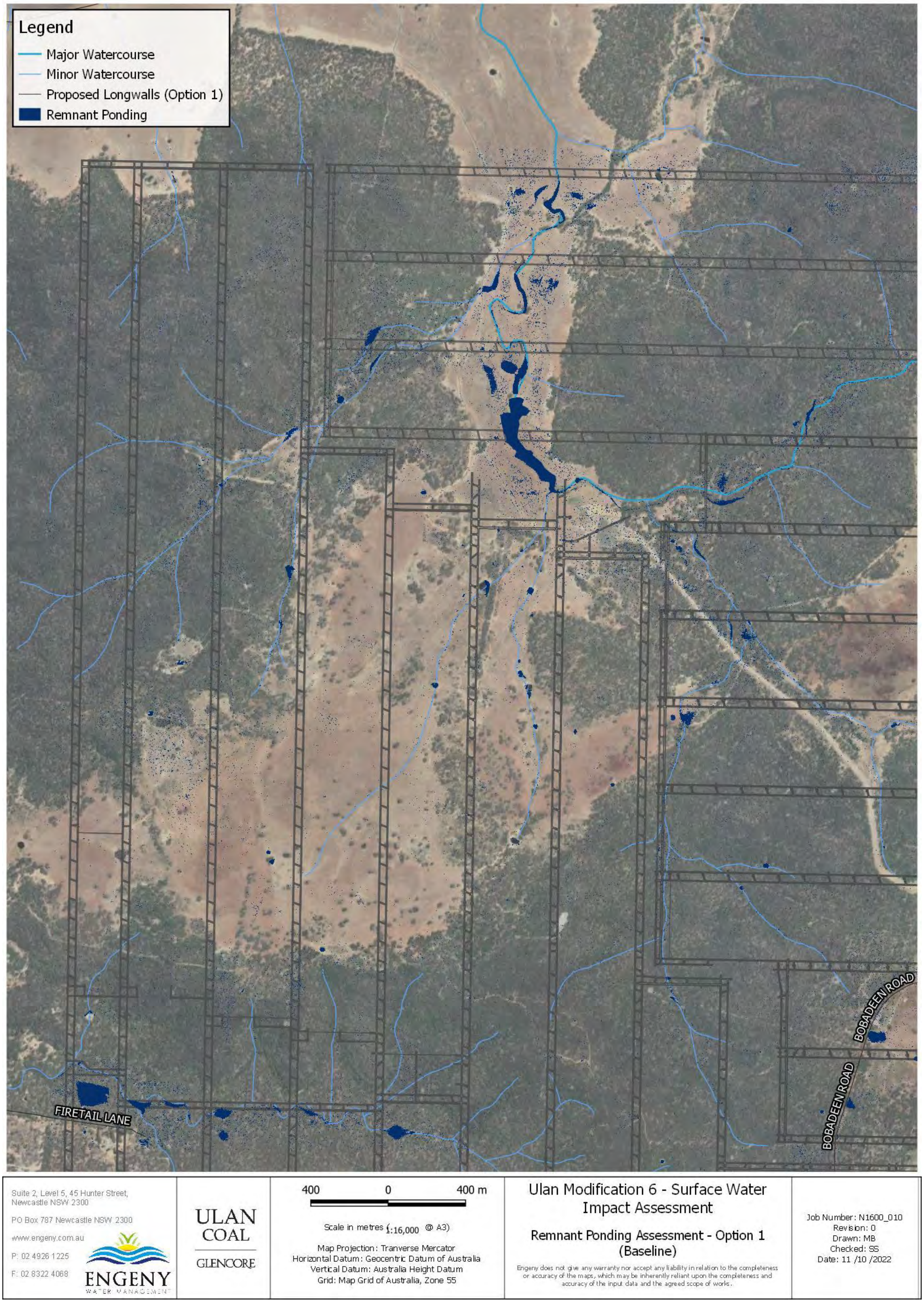

Figure 4.11: Remnant Ponding Assessment – Option 1 (Base case)

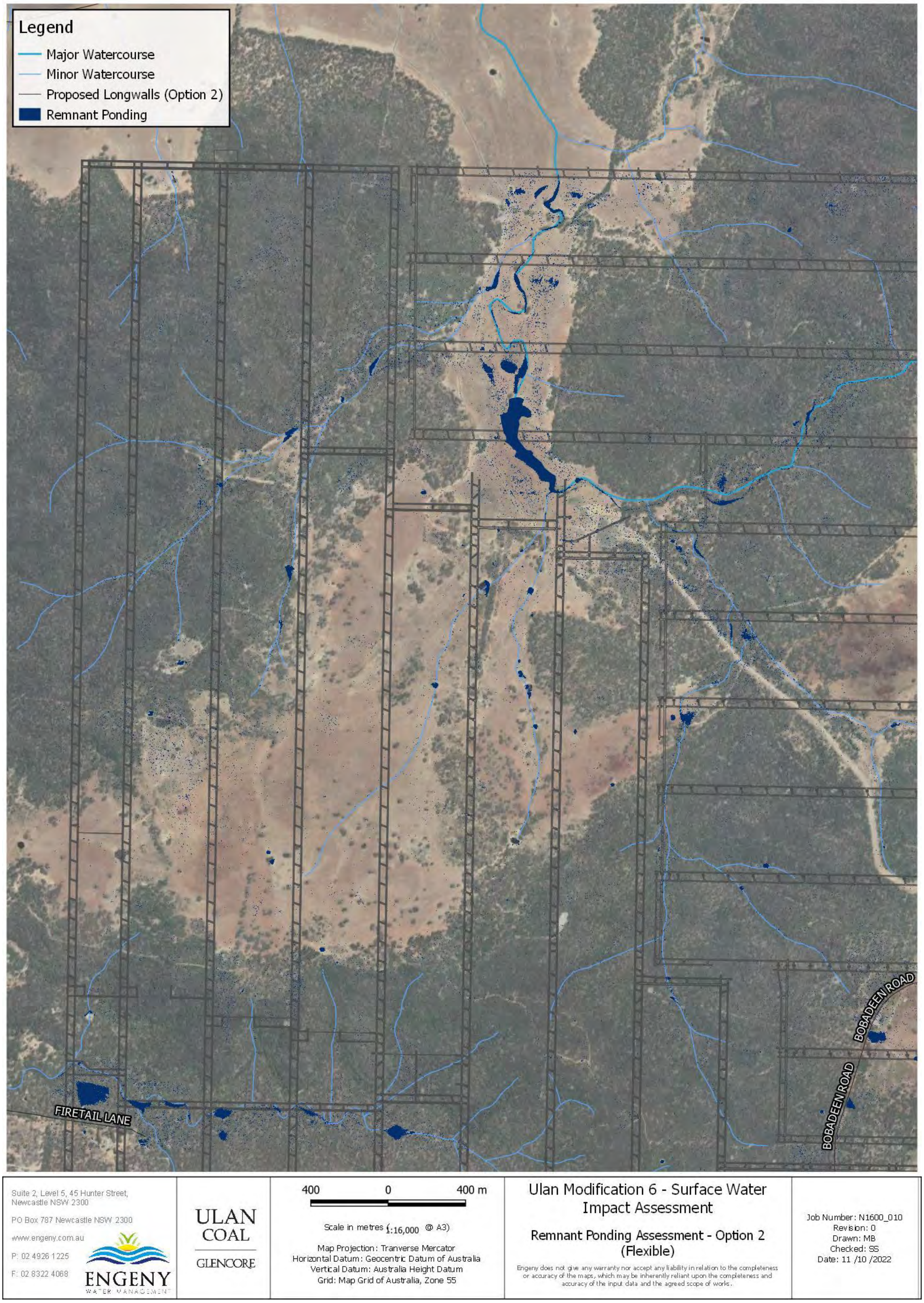

Figure 4.12: Remnant Ponding Assessment – Option 2 (Flexible)

4.5 WATER QUALITY

4.5.1 Subsidence Impacts

The assessment indicates that with the Proposed Modification area the potential impacts will be comparable to those previously approved for the UCC (Umwelt, 2009, 2015 and 2018). The Proposed Modification will be managed in accordance with the existing Project Approval conditions and the existing approved Water Management Plan required by these conditions. A new water quality monitoring location is proposed on Mona Creek downstream of the proposed mining area (refer to Section 6.2).

It is considered that the predicted subsidence impacts will not result in any substantial changes to watercourse stability relative to the current approved impacts. UCMPL proposes to continue to monitor all second order and above watercourses for potential impacts. If any remediation works are identified as being required as a result of the monitoring, the remediation works will be undertaken to maintain channel grades and take into consideration channel stabilities and existing channel characteristics.

During any required remediation works potential short-term impacts on water quality will be considered, both in regard to downstream water users and downstream ecosystems. To mitigate potential water quality impacts UCMPL proposes to implement a number of erosion and sediment control measures (refer to Section 6.3).

4.5.2 Surface Infrastructure

As part of the Proposed Modification, UCMPL proposes to modify the approved surface infrastructure (refer to Figure 1.1). The proposed changes to surface infrastructure are not expected to result in appreciable changes to the quantity or quality of surface water. Construction works for each surface infrastructure area will require erosion and sediment controls to manage sediment laden water generated both during construction and operational phases. The required management measures are set out in detail in the approved Water Management Plan.

4.5.3 Loss of Baseflows

The groundwater assessment predicts negligible changes to the potential loss of baseflows in the Talbragar River system with the proposed modification when compared to the approved project (refer to Table 4.1, Table 4.2 and Table 4.3).

The predicted impacts of increased numbers of dry days, increased duration of dry periods and reductions in annual flow volumes are associated with the approved project. There are negligible changes on these aspects with the proposed modification.

As such any influence on water quality, based on historical data analysis (refer to Section 3.4.4 on Water Quality Trends in the Talbragar River, is not predicted to occur as a result of the proposed modification.

4.6 GEOMORPHOLOGICAL AND HYDROLOGICAL VALUES

The Proposed Modification is not expected to have a significant impact on the geomorphological and hydrological values of local surface water systems. Potential impacts on geomorphological stability and changes to potential erodibility and scour as a result of the Proposed Modification have been assessed and indicate that there is a risk of increased erosion or scour. The predicted areas of risk are consistent with previous analysis (i.e. the approved mine plan) and are located within the sandy channel of Mona Creek downstream of the chain pillars.

4.7 RIPARIAN AND ECOLOGICAL VALUES

The predicted changes to flow regimes both during and following the mining operations associated with the Proposed Modification are predicted to be negligible in the context of ephemeral streams, as well as on the Talbragar River. The changes to flow regimes are also considered to be negligible on a regional scale. The Proposed Modification is consequently considered likely to have negligible impact on ecosystems and downstream users as the predicted impact is within the natural variation of the existing creek systems.

4.8 WATER USERS

As discussed in the Surface Water Assessment for the UCCO Project (Umwelt, 2009), the regions downstream of the UCC are primarily forested within the Goulburn River catchment and irrigated pasture/fodder crops within the Talbragar River catchment. Irrigation water along the Talbragar River is primarily sourced from the river, when flowing, and alluvial systems.

No private landholders have been identified using the surface waters of Mona Creek within or downstream of the additional underground mining area associated with the Proposed Modification, except for stock access via basic landholder rights. The Proposed Modification is not expected to have an impact on basic landholder rights as no change is predicted to baseflows in Mona Creek.

Based on the subsidence assessments (SCT, 2014, 2017 and 2021) it is considered that there is limited potential for minor runoff capture during the time between mining and completion of any required subsidence remediation works. The potential volume and duration of capture is considered minimal due to both the limited upslope catchment areas, that sequential mining will affect only short sections of the creek at any time and routine monitoring will identify works areas promptly.

Similarly, as any cracking will appear very rapidly on the surface after mining, regular cracking and resealing of any in-channel cracks will be undertaken. Progressive remediation works will further limit the potential for loss of surface flows due to subsidence cracking. Monitoring of subsidence impacts is described in Section 6.2.

The potential surface water take and downstream impacts following subsidence in both watercourses and out of channel areas is expected to be negligible (refer to Section 4.2). This assessment is based on consideration of the potential for impact on watercourses as a result of remnant ponding both in and out of drainage lines, surface cracking, as well as consideration of catchment boundaries and watercourse stability. As such it is considered that the proposed modification will not adversely impact on the potential use of water for downstream users or basic landholder rights on local creek systems or rivers.

Gauging stations have been installed at locations downstream of approved mining operations, with a gauging station now in place on the Talbragar River. The monitoring results from these gauging stations will be utilised to assist in understanding surface water flows in the catchment areas and potential impacts of underground mining in the long term. The results from subsidence and watercourse monitoring will be reported in the Annual Reviews.

4.9 ASSESSMENT RELIABILITY

The impact assessment has been undertaken using industry recognised modelling techniques and data obtained from the local catchments over many years, from both UCMPL and external monitoring. While there is limited flow gauging data for ephemeral creek systems due to a discontinuation of WaterNSW monitoring, the quality of the available records is such that they are considered suitable for determining potential streamflow sequences (as discussed in Section 3.3.1). Creek stability monitoring undertaken across UCC over many years as part of current approval conditions has confirmed impacts that are consistent with previous predictions, providing a high level of confidence in the models. As such it is considered that the results described in the sections above are both predictable and scientifically valid. There are no predicted impacts to streamflows associated with the Proposed Modification. The predicted impacts to flooding associated with the Proposed Modification are considered to be negligible and irreversible.

4.10 CUMULATIVE IMPACTS

The Proposed Modification is considered to have negligible impacts on surface water runoff in regard to both quantity and quality to downstream catchment areas. No other mining operations have surface or underground operations in the Mona Creek catchment area. The assessments undertaken to consider the potential impacts of the Proposed Modification on flow regimes, flooding, remnant ponding and water quality all consider the existing mining impacts, including the currently approved impacts. As such the impacts associated with the Proposed Modification are considered to be the same as the cumulative surface water impacts for the Mona Creek catchment. On this basis it is considered that the Proposed Modification will not result in adverse cumulative impacts on water use, flows or qualities in the surrounding surface water systems.

4.11 CLIMATE CHANGE ASSESSMENT

A climate change assessment was undertaken to understand the sensitivity of streamflow and flood impacts to climate change.

The Australian Rainfall and Runoff 2019 (ARR) (Ball, et al., 2019) design rainfall depths do not include potential climate change effects. The recommended process for assessing the impacts of climate change in accordance with Book 1, Chapter 6 of the ARR Guidelines is to increase the rainfall (intensity or depth) by 5% per °C of predicted local warming (i.e. a temperature-scaling approach).

Climate projections for the Proposed Modification were obtained using the Climate Futures Tool provided on the Climate Change in Australia website and applied using methodologies outlined in *Climate Change in Australia Technical Report* (CSIRO, 2015).

Projected changes to the storm rainfall intensity were obtained for the Representative Concentration Pathway 4.5 (RCP 4.5) emission scenarios and modelled for mean predictions for 2050 and 2090.

4.11.1 Flow Regimes

The modelling indicates no impact to the estimated frequency of no flow periods and no increase in average annual dry days (defined as flows less than 0.1 ML/day) in the Talbragar River at both SW09 and Dunedoo as a result of the Proposed Modification relative to the currently approved mining operations for the 2050 and 2090 climate scenarios. The impacts indicated in the modelling are associated with the existing approved mine plan.

4.11.2 Flooding Results

The modelled climate change impacts for both the 2050 and 2090 predictions were assessed for the 1% AEP event, for the existing site conditions and the Proposed Modification options. The figures of these results are presented in Appendix C. Generally, it was found that the modelled depths and velocities do not extend beyond the predicted vertical subsidence affected area, which is consistent with the original model results (baseline results).

An increase in flood extent, compared to the baseline results, has been observed with the RCP 4.5 emission scenarios applied. This displays that, with climate change accounted for, flooding impacts are predicted to worsen in the future. This is shown to be the case under all landform options: existing conditions and Proposed Modification Options 1 and 2.

Model results for the 2050 climate change prediction for both the Proposed Modification scenarios show that immediately downstream of the farm dam on Mona Creek, flood flows are concentrated into the channel due to changes in the level of a spill point into an old channel. This has the effect of removing a breakout path across the grassed floodplain area. This breakout path is across grassed areas and has been formed due to the construction of the farm dam. This effect also occurs to a lesser extent in the 2090 climate prediction, due to increased flood extents. Refer to the 'was wet now dry' extents in the afflux figures of Appendix C.

2050 Velocity Results: the predicted subsidence from the Option 1 Proposed Modification, under the 2050 climate change scenario, has resulted in increases in velocities in the channel downstream of the proposed chain pillars in the region of 1.4 m/s. While in areas of the channel where the floodplain is flattening due to predicted subsidence a decrease in velocity of up to 1.8 m/s is observed. Similarly, the predicted subsidence from the Option 2 Proposed Modification has resulted in increases in velocities in the channel downstream of proposed chain pillars in the region of 1.3 m/s. While in areas of the channel where the floodplain is flattening due to predicted subsidence decrease in velocity up to 1.6 m/s is observed. These results can be viewed within the Appendix C velocity afflux figures.

2050 Depth Results: the modelling results for the average 2050 climate change prediction indicate flood depths up to 4.4 m within the Mona Creek channel, above the proposed longwall extensions. These depths are predicted to increase, in localised areas, by up to 1.3 m in the Option 1 Proposed Modification and by up to 0.8 m in the Option 2 Proposed Modification. These results can be observed in the depth afflux figures of Appendix C.

2090 Velocity Results: the predicted subsidence from the Option 1 Proposed Modification, under the 2090 climate change scenario, has resulted in increases in velocities in the channel downstream of the proposed chain pillars in the region of 2.5 m/s. While in areas of the channel where the floodplain is flattening due to predicted subsidence a typical decrease in velocities of

2.4 m/s is observed. Similarly, the predicted subsidence from the Option 2 Proposed Modification has resulted in increases in velocities in the channel downstream of proposed chain pillars in the region of 2.4 m/s. While in areas of the channel where the floodplain is flattening due to predicted subsidence a typical decrease in velocities of 2.1 m/s is observed. These results can be visualised within the afflux figures of Appendix C.

2090 Depth Results: the modelling results for the average 2050 climate change prediction indicate flood depths up to 4.9 m within the Mona Creek channel, above the proposed longwall extensions. These depths are predicted to increase, in localised areas, by up to 1.4 m in the Option 1 Proposed Modification and by up to 1.2 m in the Option 2 Proposed Modification. These results can be observed in the depth afflux figures of Appendix C.

5 COMMONWEALTH SIGNIFICANT IMPACT GUIDELINES

Detailed environmental studies have been undertaken to inform the proposed conceptual design for the Proposed Modification. The consideration of the outcomes of these studies in the design of the Proposed Modification and integration with the approved operations minimise the potential for impacts on surface water resources. These factors include:

- The management of impacts within the regime established by NSW water and pollution control legislation, which provides for sustainable water take from water sources, management of water quality by imposition of discharge quality criteria and management of salt loads within sustainable targets by managing water discharges to the environment.
- Water management system designed to meet legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas).

These factors reduce the potential for significant impacts on existing surface water resources. A summary of the potential surface water impacts against the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (DoE 2013) is included in Table 5.1.

A list of the supplementary requirements provided by DCCEEW, relevant to the SWIA, and where they are addressed in this report, is included in Table 5.2.

Table 5.1: Assessment Against Significant Impact Guidelines: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources

Aspect	Impact
Flow Regimes	Based on surface water impact assessment and consideration of the existing grades and flooding regimes in Mona Creek, including the previous assessment undertaken for MOD4, it is considered that the Proposed Modification will have impacts on flow regimes (including flood flow velocities, depths, and extents), remnant ponding, and associated potential impacts on downstream landholders and watercourse stability in Mona Creek that are consistent with the current approval.
Recharge Rates; Aquifer Pressure or Pressure Relationships Between Aquifers; Groundwater Table Levels	Refer to Groundwater Assessment.
Groundwater/Surface Water Interactions	Groundwater interactions are discussed and assessed in the groundwater assessment. A review of the likely surface water impacts of the Proposed Modification indicates the predicted baseflow impacts will be negligible, and generally consistent with the existing approved mining operations. This is due to the ephemeral nature of Mona Creek and the predicted subsidence cracking. It is also considered that cracking will likely be, at least in part, self-sealing within the sandy creek bed, i.e. reduce the visible cracking on the surface within the bed or banks of Mona Creek.
River/Floodplain Connectivity	The Proposed Modification is not expected to have an impact on river / floodplain connectivity as no underground mining is proposed in floodplain areas.
Inter-aquifer Connectivity	Refer to Groundwater Assessment.
Coastal Processes	No impacts on coastal process are predicted as a result of the Proposed Modification, which is located well inland, being over 200 km from the coast.
Impact on Water Users	The assessment of impacts on water users indicates that there will be negligible impact on surface water users. All water take associated with the Proposed Modification will be licensed in accordance with the NSW WM Act. The WM Act licensing arrangements have been designed to provide for sustainable take from NSW water sources.
State Water Resource Plans	The surface water sources within and adjacent to the Proposed Modification are managed under WSPs. These are State Water Resource Plans that are governed under the WM Act.

Aspect	Impact
	The NSW Government WSPs provide a regional water balance for these water sources and consider cumulative water use. Water take for the UCC will continue to comply with the above listed WSPs and WM Act which are designed to provide for the sustainable use of NSW's water resources.
Water Quality	Surface infrastructure for the Proposed Modification will be designed and constructed to include erosion and sediment controls in accordance with relevant government standards to minimise potential impacts on downstream water qualities by managing water that has the potential to cause environmental harm. Operational and rehabilitation phases of the Proposed Modification will include water quality control measures in accordance with the relevant government standards will be implemented to minimise potential impacts on water quality.

Table 5.2: DCCEEW Supplementary Requirements and SWIA Sections

Requirement	Report Section
General Requirements	
Impacts	
11. The Modification Report must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including:	
i. a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long-term relevant impacts;	Section 4
ii. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;	Section 4.9
iii. analysis of the significance of the relevant impacts; and	Section 4
iv. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Section 4, Appendix A, B and C
Key Issues	
A water resource, in relation to coal seam gas development and large coal mining development	
Comments	
18. The Modification Report must include a detailed water assessment. The water assessment must be undertaken in accordance with the IESC Information Guidelines (https://iesc.environment.gov.au/information-guidelines) and provide the information outlined in these guidelines.	Whole report Tabulated/summarised in Section 5
i. site specific information based on scientific evidence or modelled data.	Whole report, Appendix A, B and C
ii. a cumulative impact assessment for surface and groundwater resources.	Section 4.9
iii. Information regarding the potential for significant impacts to surface water resources to support or independently assess the impact of the proposed action that include:	Sections 4.1 to 4.10
a) the information on the potential impacts to water resources;	
b) impact assessment data from mining to date; and	
c) predictions of ground water impacts from the proposed action.	
iv. Key Matters Requiring Further Assessments in the Modification Report:	
a) documentation on the predicted nature and extent of subsidence related impacts for locations in and around the project area;	Refer to Modification Report

Requirement	Report Section
b) geophysical information regarding faults and other features identified in the project area with a view to how these may enhance impacts, including incorporation into the groundwater model;	Refer to Modification Report
c) simulations of mining related impacts on The Drip should be reconsidered, as current predictions may not be accurate due to the conceptualised isolation of the feature from other Triassic formations;	Refer to Modification Report
d) a comparison of fracturing height estimates using the Ditton-Merrick method and Tammetta method;	Refer to Modification Report
e) inclusion of accurate climate projections in the modelling;	Section 4.10 and Appendix C
f) a reconsideration of boundary conditions and a reassessment of potential impacts from groundwater drawdown following that reconsideration (if required);	Refer to Modification Report
g) documents outlining the conceptual layout of surface infrastructure;	Refer to Modification Report
h) clarification on the intended storage and treatment of mine-affected water within the proposed action area;	Refer to Modification Report
i) a detailed assessment of potential impacts to flow regimes and water quality within the wider catchment from the proposed modification; and	Sections 4.2, 4.5 and 4.10,
j) stygofauna assessment within the alluvium and colluvium of Mona Creek and Talbragar River.	Refer to Modification Report

6 MITIGATION, MONITORING AND MANAGEMENT MEASURES

6.1 SUMMARY OF MITIGATION MEASURES

UCMPL will continue to utilise subsidence remediation methods and associated erosion and sediment control measures and monitoring programs to manage potential subsidence impacts on watercourses.

Subsidence remediation measures, if required, may include both hard and soft options. The remediation approach will consider the creek bank stability as well as vegetation areas and runoff flow paths. Hard options may include rock armouring of the bed and/or bank, as well as managing bank slopes. Soft options may include revegetation of banks.

For all works suitable erosion and sediment control measures will be designed and constructed to a standard consistent with:

- Managing Urban Stormwater: Soils and Construction (the Blue Book) Volume 1 (Landcom, 2004) and Volume 2E Mines and Quarries (DECC, 2008).
- Draft Guidelines for the Design of Stable Drainage Lines on Rehabilitated Minesites in the Hunter Coalfields (DIPNR undated).

Water quality and erosion and sediment control measures proposed to be implemented for the proposed modification are consistent with those included in the WMP (UCMPL, 2021) and include:

- Clear identification of areas required to be disturbed and ensuring disturbance is limited only to those areas.
- Erosion and sediment control measures are constructed prior to the commencement of any substantial construction works.
- Construction and regular maintenance of sediment fences downslope of disturbed areas.
- Soil amelioration, as required, to minimise potential erosion on disturbed or rehabilitated areas.
- Regular monitoring and maintenance of erosion controls works and rehabilitation areas.
- Prompt revegetation/surfacing of areas as soon as earthworks are complete.

6.2 WATER MANAGEMENT PLAN AND MONITORING

The existing Water Management Plan (WMP) (UCMPL, 2019) and associated sub plans includes details of erosion and sediment controls, surface water and groundwater monitoring programs, as well as a surface and groundwater response plan. The WMP includes specific monitoring for:

- Erosion and sediment control measures.
- Surface water quality monitoring.
- Stream health and channel stability monitoring.

The WMP is reviewed and updated on an annual basis.

6.2.1 Surface Water Monitoring

The current gauge located on Mona Creek (SW10) will be undermined by the Proposed Modification. It is proposed that an additional monitoring point downstream of subsidence impacted areas (potentially immediately upstream of Blue Springs Road) is added to continue to monitor potential water quality impacts in Mona Creek.

6.2.2 Subsidence Monitoring

Current subsidence monitoring at the UCC includes watercourse stability monitoring of second order and higher watercourses. This monitoring program is proposed to continue and will include the sections to be under mined and those immediately downstream within Mona Creek.

The subsidence monitoring relevant to surface water resources includes inspections pre and post mining and includes survey lines, surface water quality monitoring, stream health monitoring, and watercourse stability monitoring.

Where monitoring indicates a potential increase in the rates of erosion and scouring within the affected watercourses, stabilisation works may be required within the affected watercourses.

The requirements for monitoring of watercourses will also be included in the relevant Extraction Plan for the modified longwalls.

6.3 LICENSING REQUIREMENTS

Licensing under the EPL and potential water take under the WM Act are assessed in the Water Balance Assessment (HEC, 2021) and the Groundwater Impact Assessment (AGE, 2022) (refer to the Modification Report).

6.4 REPORTING

A summary of surface water monitoring results will continue to be provided in the Annual Review, which will, at a minimum, include:

- A summary of monitoring results.
- An analysis of monitoring results against impact assessment criteria and historical monitoring results.
- Annual site water balance and comparison against predictions.
- An identification of any trends in the monitoring results.
- Any non-compliances reported during the year.
- Actions taken to address any non-compliances.

In addition, the Annual Review is to include reporting on significant issues regarding the implementation of the WMP, including:

- The effectiveness of the erosion and sediment controls.
- Changes to the site water balance.
- Any identified issues or exceedances of trigger values.

The Annual Review will also document reviews and feedback relating to the maintenance and performance of the WMS.

7 QUALIFICATIONS

a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d) Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

g) This Report does not provide legal advice.

8 REFERENCES

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Australasian Groundwater and Environment Consultants, 2022. Ulan Coal Mines Modification 6 (MOD6) Groundwater impact Assessment

Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, E., Retallick, M., & Testoni, I., 2019. *Australian Rainfall and Runoff: A Guide to Flood Estimation.* Commonwealth of Australia (Geoscience Australia).

CSIRO. (2015). *Climate Change in Australia Technical Report*.

Department of Environment and Climate Change (DECC), 2008. *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries*.

Department of Planning, Industry and Environment (DPIE), 2018. *Macquarie–Castlereagh Surface Water Resource Plan Area Description*.

Department of Planning, Industry and Environment (DPIE), 2020. *Water Quality technical report for Macquarie Castlereagh surface water resource plan area (SW11).*

Department of Environment (DoE), 2013. *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources.*

HEC, 2021. Water Balance Assessment

Engeny Water Managemetn, 2018. *Ulan Coal Mines Limited Modification 4 Surface Water Impact Assessment.*

Fischenich, C., 2001). *Stability Thresholds for Stream Restoration Materials*, EMRRP Technical Notes Collection (ERDC TNEMRRP-SR-29), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Landcom, 2004. *Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition.*

NSW Government, 2010. *Bioregional Assessments: Surface Water Quality*,

https://www.bioregionalassessments.gov.au/assessments/11-context-statement-central-west-subregion/1152-surface-water-quality

Strata Control Technologies, 2017. *Modification 4 Subsidence Assessment – ULA4701*, prepared on behalf of Ulan Coal Mines Limited.

Strata Control Technologies, 2021. Subsidence Assessment for Ulan Coal Mines Modification 6.

UCMPL, 2021. *Ulan Coal Water Management Plan.*

UCMPL, 2021. *Ulan Coal Surface Water Monitoring Program.*

UCMPL, 2021. *Ulan Coal Surface Water and Groundwater Response Plan.*

Umwelt (Australia) Pty Limited, 2009. *Ulan Coal – Continued Operations Environmental Assessment - Surface Water Assessment*, prepared on behalf of Ulan Coal Mines Limited.

Umwelt (Australia) Pty Limited, 2015. *Ulan West Modification – Surface Water Assessment*, prepared on behalf of Ulan Coal Mines Limited.

Yoo, E K, Tadros, N Z, and Bayly, K W, 2001. A Compilation of Geology of the Western Coalfield. Geological Survey of New South Wales, Report GS2001/204 (unpublished).

Appendix A:

Flood Modelling Methodology and Mapping

A.1 HYDROLOGIC MODEL DEVELOPMENT

A.1.1 Overview

Hydrologic modelling for this study was undertaken using the XP-RAFTS software package to estimate catchment runoff for the critical duration at 50% (approximately bank-full flows), 10%, 1% and 0.1% Annual Exceedance Probability (AEP) and PMF. Design storm parameters were sourced from Australian Rainfall and Runoff 2019 (ARR2019) Data Hub (data.arr-software.org).

Subsidence impacts do not extend to the Talbragar River floodplains, therefore, the hydrologic model extent encompasses the Mona Creek catchment to the confluence with the Talbragar River.

A.1.2 XP-RAFTS Model Setup

Sub-Catchment Delineation

Sub-catchment delineation and XP-RAFTS model schematisation was undertaken manually using GIS software (Figure A.1). The following topographic data was used as the basis for sub-catchment delineation:

- 1 m Digital Elevation Model (DEM) created from LiDAR provided by Ulan Coal Mines Pty Limited (UCMPL).
- 2 m DEM, derived from LiDAR data, sourced from NSW Government Spatial Services, dated between October 2015 and November 2015.

Catchment Properties

The following sub catchment characteristics were incorporated into the XP-RAFTS model for the runoff routing calculation:

- Catchment area (pervious and impervious)
- Catchment slope
- Fraction impervious
- Catchment roughness (Manning's n).

Catchment area and slope were generated manually using GIS software and the supplied topographical data. Impervious areas were delineated from aerial photography provided by site. These areas intersected with the delineated sub-catchments to define a weighted fraction impervious for each sub-catchment. As the catchment is predominately rural, no consideration will be given to the calculation of indirectly or directly connected impervious areas.

The catchment roughness (PERN) values adopted in the model are summarised in Table A. 1.

Table A. 1: XP-RAFTS PERN Values

Land Use Type	PERN
Pervious Areas	0.04
Impervious Areas	0.025

A.1.3 Model Verification

Model verification was undertaken using a comparison to the peak flows generated using the ARR2019 Regional Flood Frequency Event (RFFE) tool (rffe.arr-software.org). Figure A. 1 summarises the verification of the hydrologic model against the RFFE results.

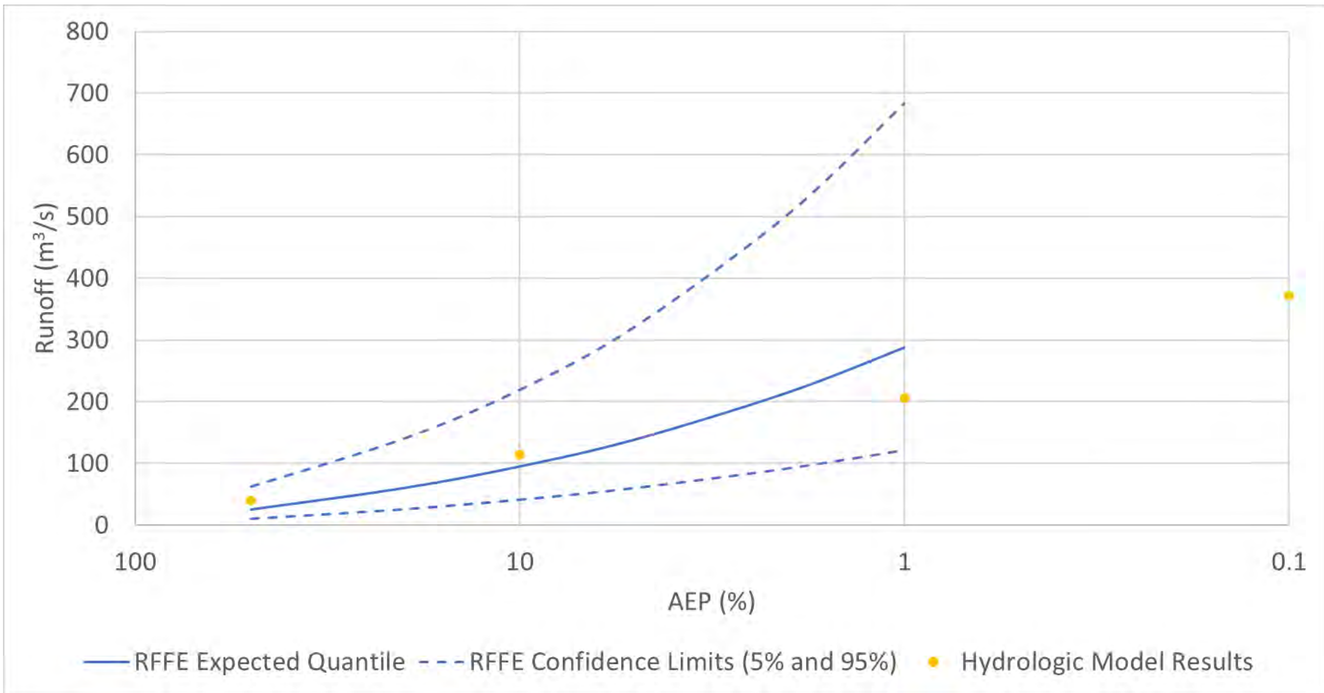

Figure A. 1: Hydrologic Model Comparison

Figure A. 2: Hydrologic Model Overview

Figure A. 3: Hydraulic Model Overview

A.1.4 Rainfall Inputs

Design Intensity-Frequency-Duration (IFD) Data

Design rainfall depths used in the hydrologic modelling were sourced from the Bureau of Meteorology (BoM) ARR Design Rainfall System (bom.gov.au/water/designRainfalls/revised-ifd). Table A. 2 shows a sample of the IFD depths for modelled AEP events and durations.

Table A. 2: Design Storm IFD data

Duration	50% (mm)	10% (mm)	1% (mm)	1 in 1000 (mm)
30 min	18.3	28.2	42.8	64.2
45 min	21	32.3	48.6	73.2
1 hour	23	35.3	52.6	79.4
1.5 hour	25.9	39.7	58.7	88.5
2 hour	28.2	43.1	63.6	95.6
3 hour	31.9	48.7	71.7	107
4.5 hour	36.2	55.6	82.1	122
6 hour	39.8	61.4	91.3	135
9 hour	45.7	71.1	108	159
12 hour	50.5	79.3	122	180
18 hour	58.1	92.5	146	217
24 Hour	63.8	103	165	247

Rainfall Losses

Design storm event initial loss (IL) and continuing loss (CL) values were sourced from the ARR2019 Data Hub. Values of 43 mm and 2.4 mm/hr were given for the IL and CL respectively. OEH have revised the losses estimates in NSW catchments (WMA, 2019) which required the following adjustments to the given losses:

- The continuing loss was scaled by a factor of 0.4 to 0.96 mm/hr, and
- The probability neutral burst losses were used in conjunction with the given rainfall IFD and storm losses to determine the appropriate depth for pre-burst rainfall depths/losses. This value was used in place of the given median pre-burst depths and ratios.

Probable Maximum Precipitation

The Probable Maximum Precipitation (PMP) was determined using the Generalised Short Duration Method (GSDM) (BOM 2003) for durations up to and including 6 hours. GSAM-GTSMR was not considered due to the size of the catchment.

The following parameters were used for the GSDM method:

- Catchment Area: 42.4 km^2
- Elevation Adjustment Factor (EAF): 1
- Moisture Adjustment Factor (MAF): 0.72
- All terrain within the catchment was defined as rough.

The depths presented in were used for the hydrologic model along with the temporal pattern defined by the GSDM method.

Table A. 3: PMP Depths

Duration (hr)	PMP (to nearest 10 mm)
0.25	130
0.5	200
0.75	250
1	300
1.5	390
2	440
2.5	500
3	540
4	610
5	680
6	720

A.2 HYDRAULIC MODEL DEVELOPMENT

A.2.1 Overview

The TUFLOW model includes the reaches and tributaries of Mona Creek and adjacent floodplain, extending from upstream of the predicted subsidence impacts to downstream of the confluence of Mona Creek and the Talbragar River (Figure B.1). Due to the relative difference in the catchment area of the Talbragar River upstream of the confluence with Mona Creek, the critical duration and, therefore, the timing of the peak of the hydrograph for these catchments is likely to differ considerably. As such, coincident flooding was not considered for this assessment. Instead, a steady baseflow was used to reflect the likely conditions in the Talbragar River.

A.2.2 TUFLOW Model Setup

Model Topography and Extent

The 1 m DEMs supplied by UCMPL were used as the base for this model. The DEM was supplemented by the NSW LPI 2 m DEM (2015) where required.

The following scenarios were assessed:

- Current Approved Landform
- Option 1: Base case proposed subsided landform
- Option 2: Flexible proposed subsided landform

Pre-mining LiDAR and/or survey as well as approved subsidence bowls were used to undertake the modelling of the approved subsided landform.

The supplied subsidence contours were used to modify the generated DEM to develop a proposed subsided model topography for the impact assessment using the pre-mining LiDAR and/or survey.

Hydraulic Roughness

Table A. 4: Adopted Hydraulic Roughness Values

Land Use Type	Manning's 'n'
Roads and hardstand	0.020
Open fields	0.035
Moderate vegetation	0.060
Channel with low vegetation	0.035
Channel with moderate to high vegetation	0.055
Floodplain	0.035
Buildings	0.5

Model Boundaries

The following boundaries were applied to the model:

- Model inflow boundaries:
  - Hydrologic model inflows were applied as 'flow over area' boundaries, input at locations representative of the sub-catchments delineated in the hydrologic model.
  - An inflow for the Talbragar River, which simulates a main channel bank full flow event was applied at the upstream end of the channel at the model boundary.
- A model outflow boundary:
  - Applied as normal depth boundary downstream of the confluence of Mona Creek and the Talbragar River, using the automatically generated stage-discharge relationship generated by TUFLOW.
  - The boundary was located at a point sufficiently downstream to have minimal impact on model results in the assessment area.

Structures

All crossings of Mona Creek are considered to be low lying and are expected to either block or overtopped in the smallest modelled event. These structures were not explicitly included in the TUFLOW model.

Grid Size and Time Step

A grid size of 3 m was adopted for the hydraulic model, as it was considered to adequately capture channel geometry and provide a reasonable balance of model precision and run time.

Channel Representation

All channels impacted by subsidence were modelled in the TUFLOW domain.

Initial Conditions

An initial base flow was applied to the Talbragar River main channel which will simulate a "bank full" flow event.

As Mona Creek is ephemeral and includes an inline dam, therefore no baseflow was applied to the creek or any tributaries.

A.3 WATERCOURSE STABILITY INDICATORS

Velocity and tractive stress thresholds were sourced from Fischenich (2001) for the bed and bank materials typical of those observed in watercourses on site. Potential changes to watercourse stability may occur in those reaches of the watercourse where the hydraulic modelling indicates a change in the stability threshold for either the velocity or tractive stress. This method identifies potential changes to watercourse stability using both the magnitude of the modelled changes to velocity and tractive stress as well as the bed and bank materials.

The reference velocity and tractive stress thresholds used in the analysis are summarised in Table A. 5.

Table A. 5: Selected Watercourse Stability Thresholds

Bed and Bank Material	Velocity Threshold (m/s)	Tractive Stress Threshold (N/m^2)
Fine Gravel	0.8	3.6
25 mm Cobble	1.5	15.8
Hardpan	1.8	32.1

A.4 FLOOD MAPPING

The 50%, 10%, 1%, and 0.1% AEP event and the PMF event modelling results for the two options are presented below. Peak flood depth and peak flood velocities are presented for each of the events. A comparison to the approved landform was conducted using afflux and change in velocity. The bed sheer stress results for the 50% AEP event are also presented.

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Map Projection: Tranverse Mercator
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Ulan Modification 6 - Approved Conditions

Peak Flood Depth - 50% AEP Event

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Peak Flood Depth - 10% AEP Event

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Peak Flood Depth - 1% AEP Event

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Peak Flood Depth - PMF Event

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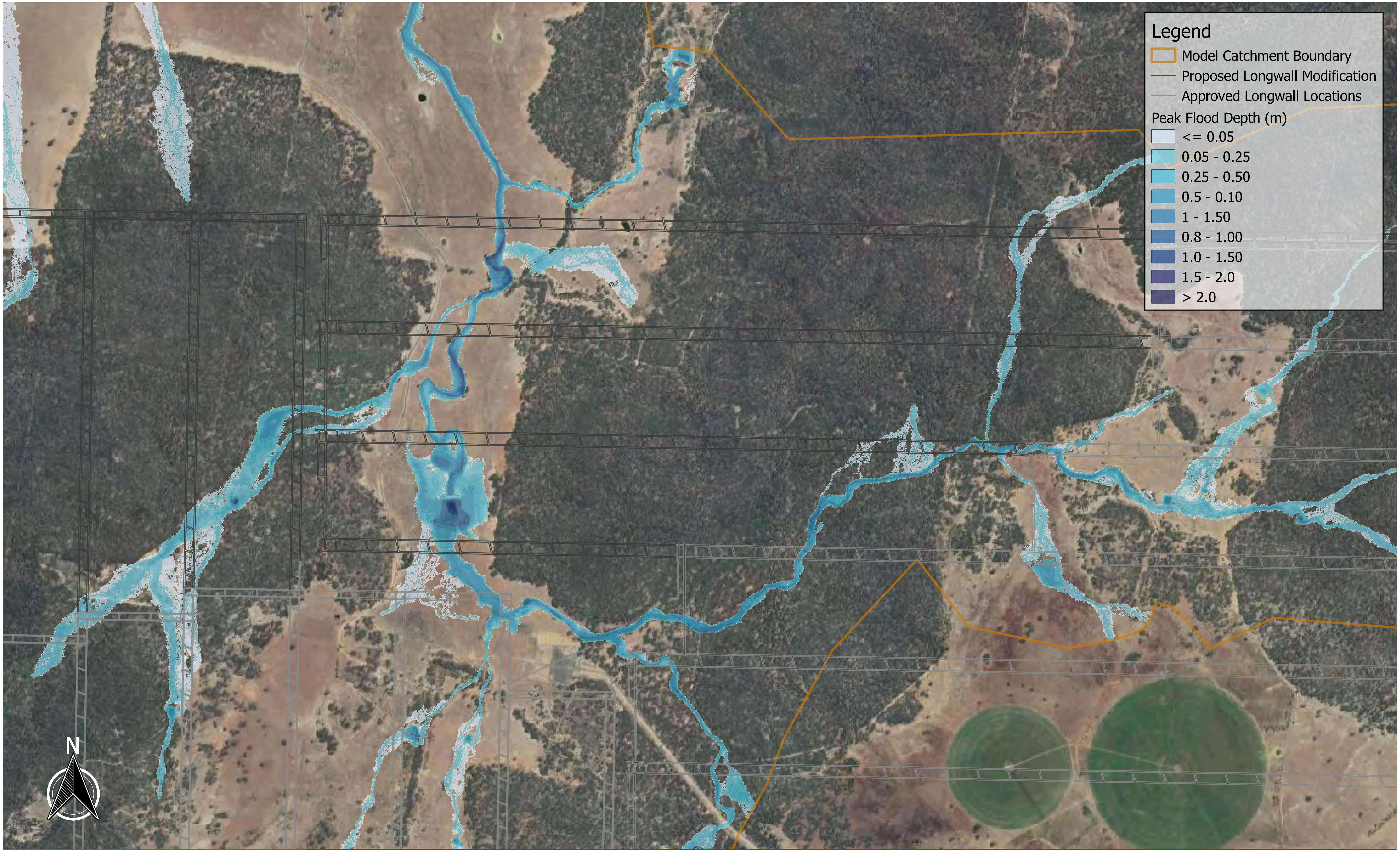

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Ulan Modification 6 - Option 1

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Peak Flood Depth - 0.1% AEP Event

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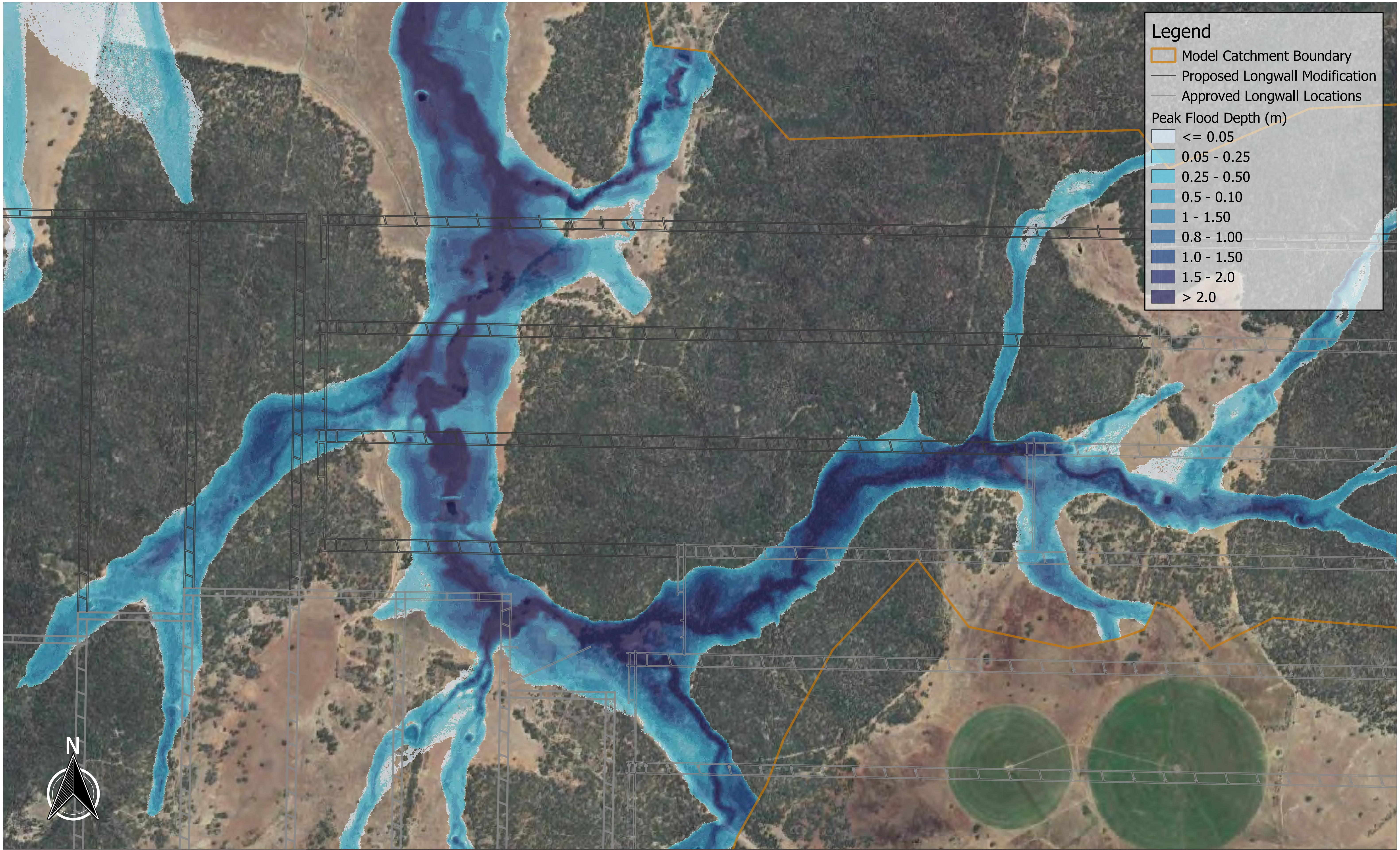

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Ulan Modification 6 - Option 1

Peak Flood Depth - PMF Event

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Ulan Modification 6 - Option 2

Peak Flood Depth - 50% AEP Event

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Ulan Modification 6 - Option 2

Peak Flood Depth - 10% AEP Event

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Peak Flood Depth - 1% AEP Event

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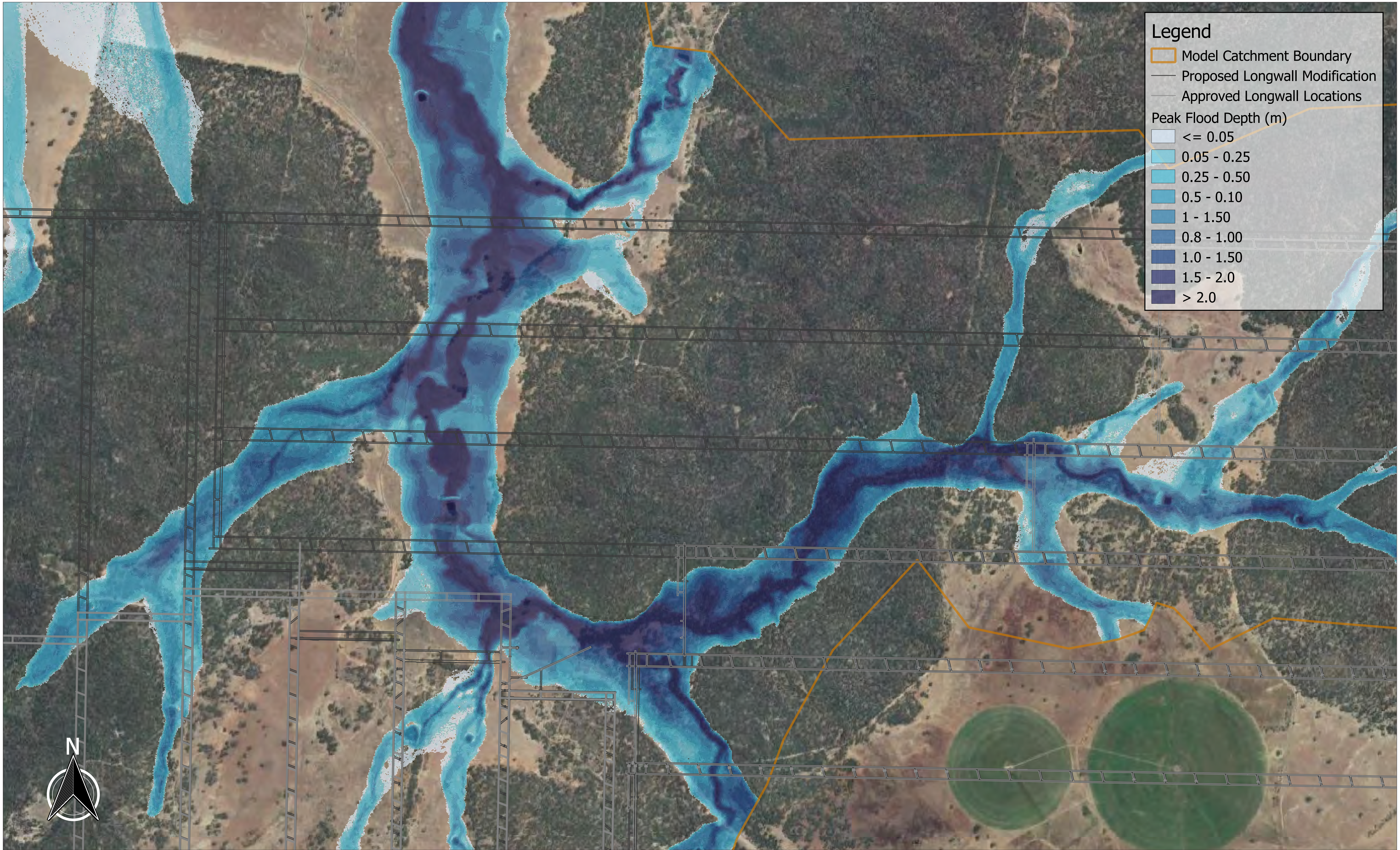

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Peak Flood Depth - PMF Event

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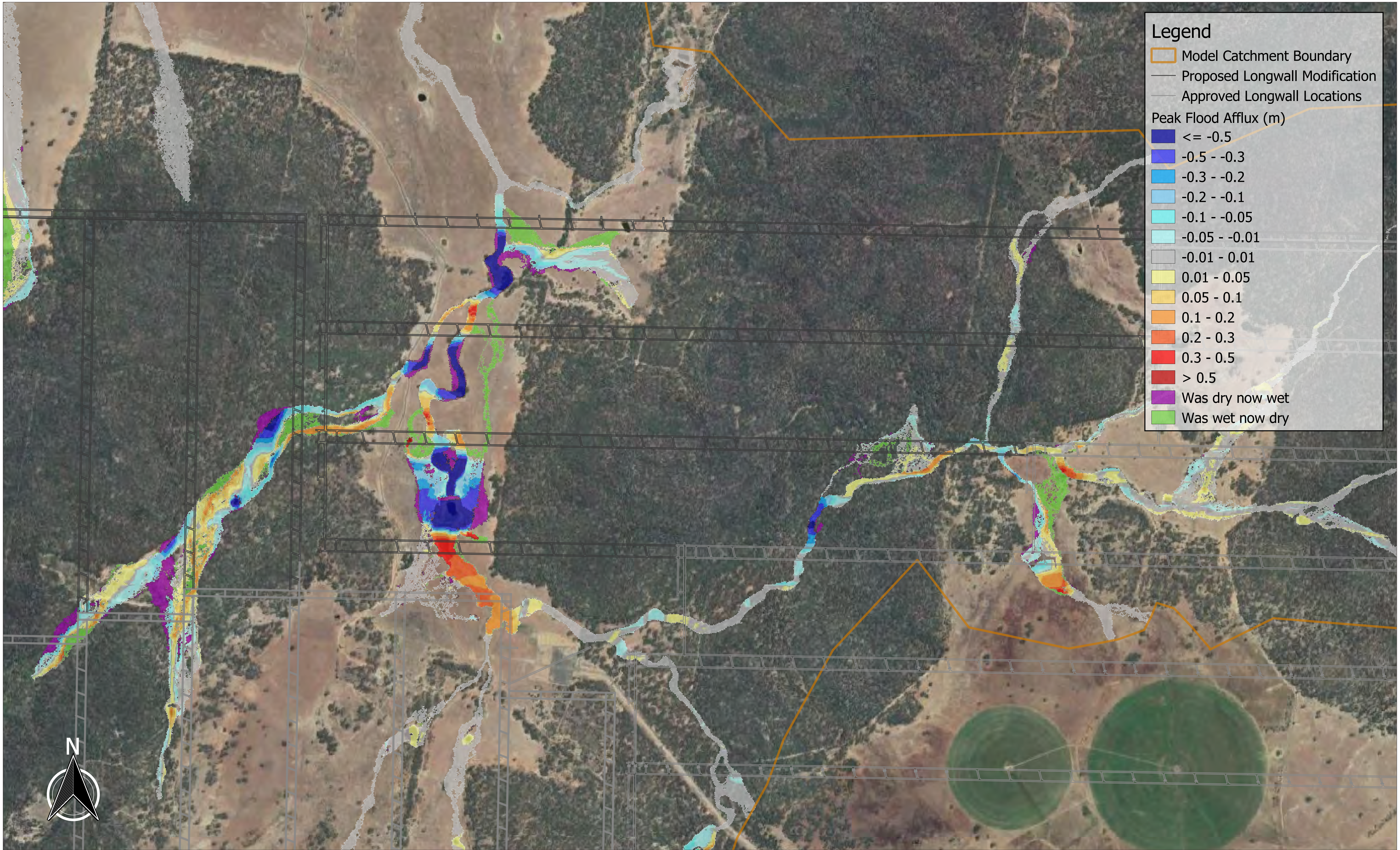

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Ulan Modification 6 - Option 1

Afflux - 50% AEP Event (Proposed Modification vs Approved Conditions)

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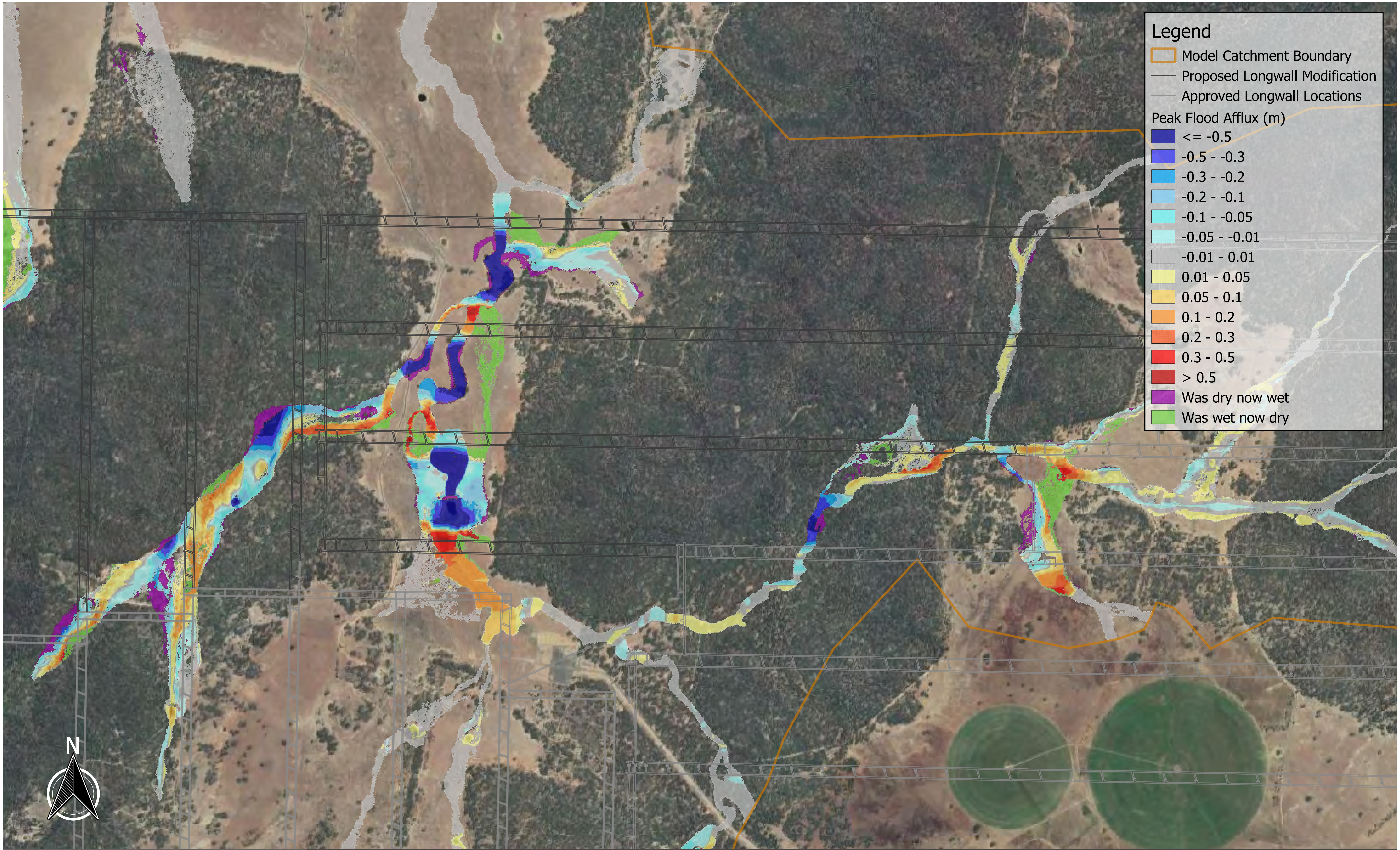

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Ulan Modification 6 - Option 1

Afflux - 10% AEP Event (Proposed Modification vs Approved Conditions)

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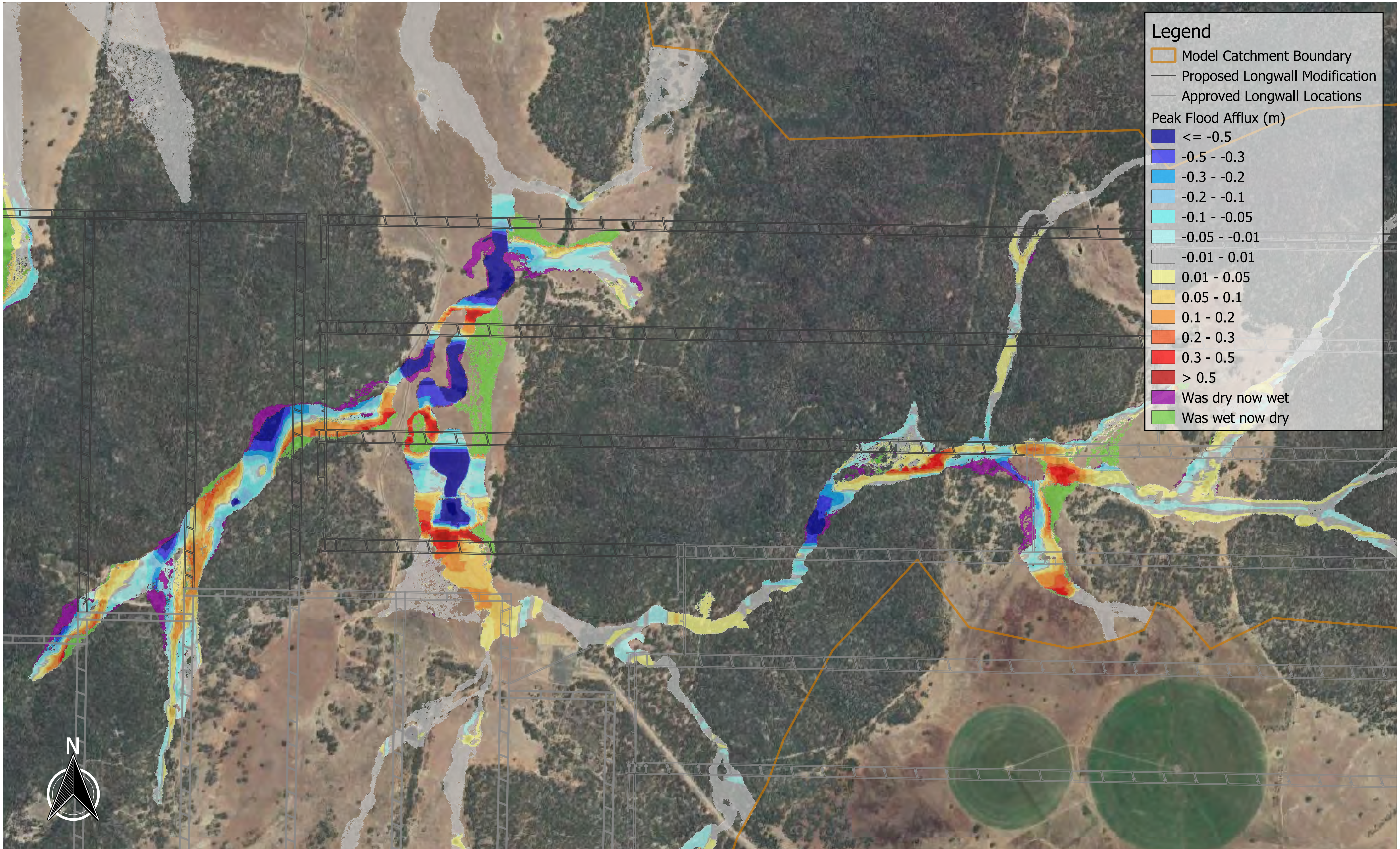

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ULAN COAL

GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 1

Afflux - 1% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
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Drawn: GC
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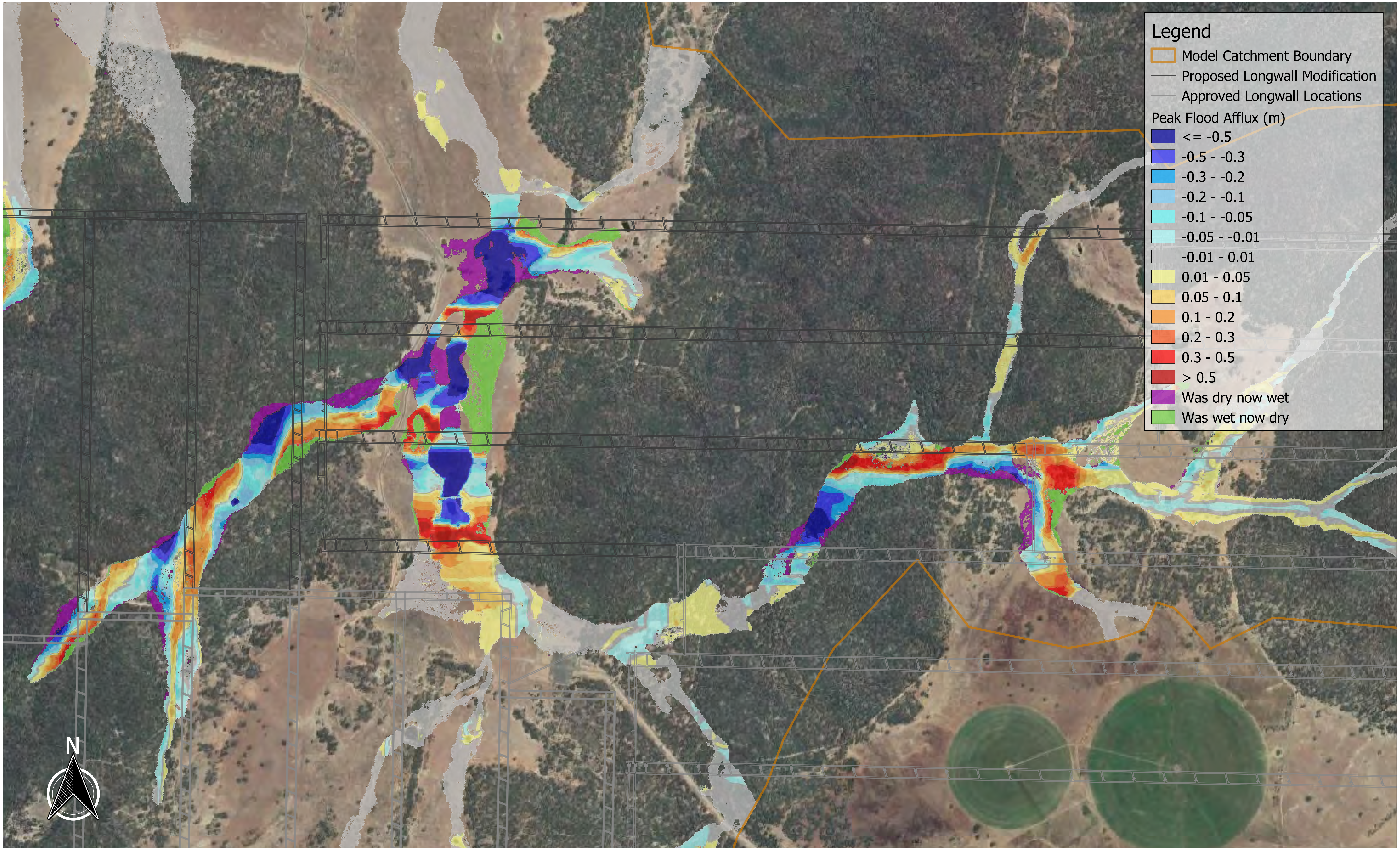
Date: 5 /9 /2022



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ENGENY WATER MANAGEMENT

ULAN COAL

GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

Map Projection: Tranverse Mercator
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Vertical Datum: Australia Height Datum
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Ulan Modification 6 - Option 1

Afflux - 0.1% AEP Event (Proposed Modification vs Approved Conditions)

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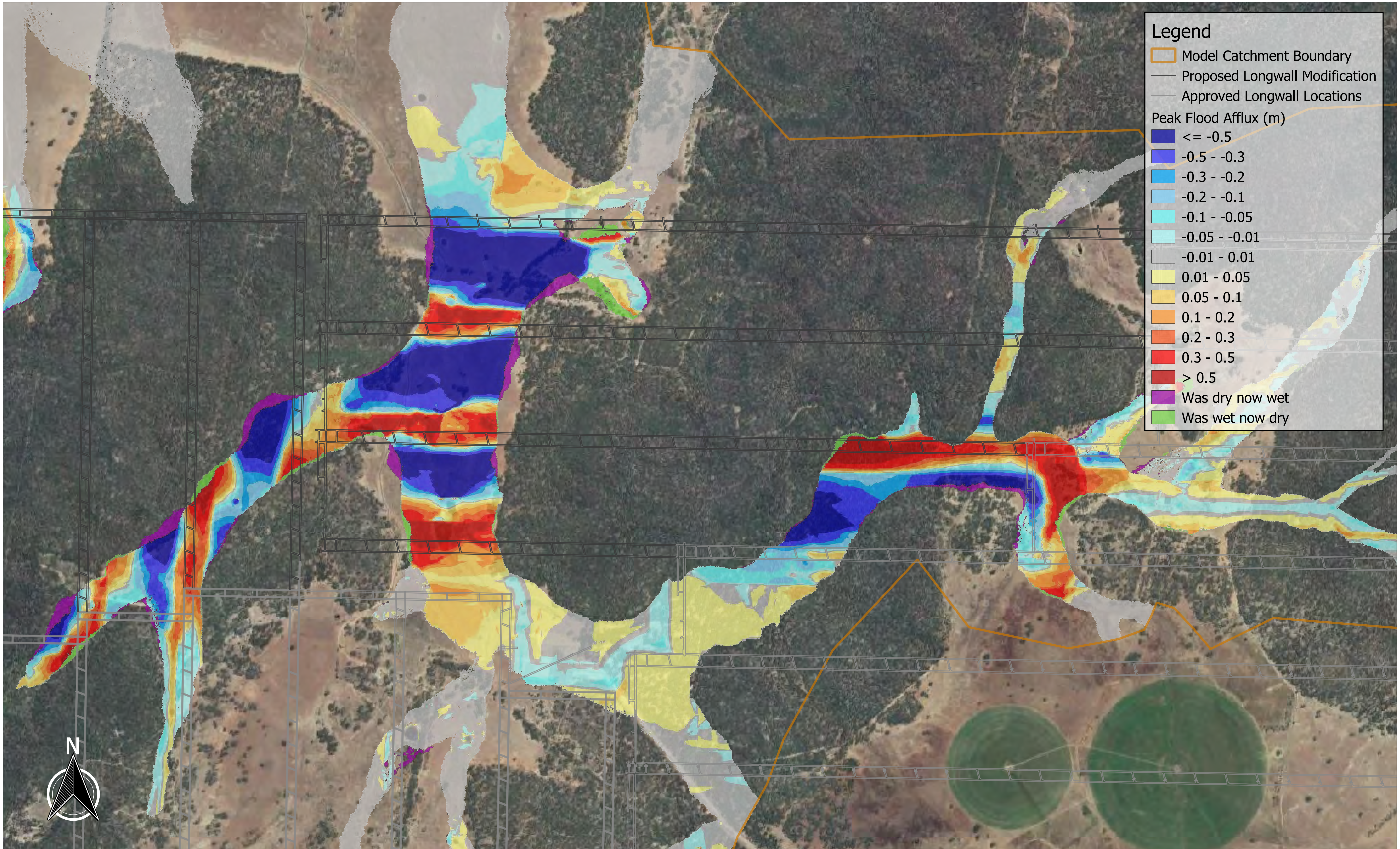

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ENGENY WATER MANAGEMENT

ULAN COAL

GLENCORE

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Ulan Modification 6 - Option 1

Afflux - PMF Event (Proposed Modification vs Approved Conditions)

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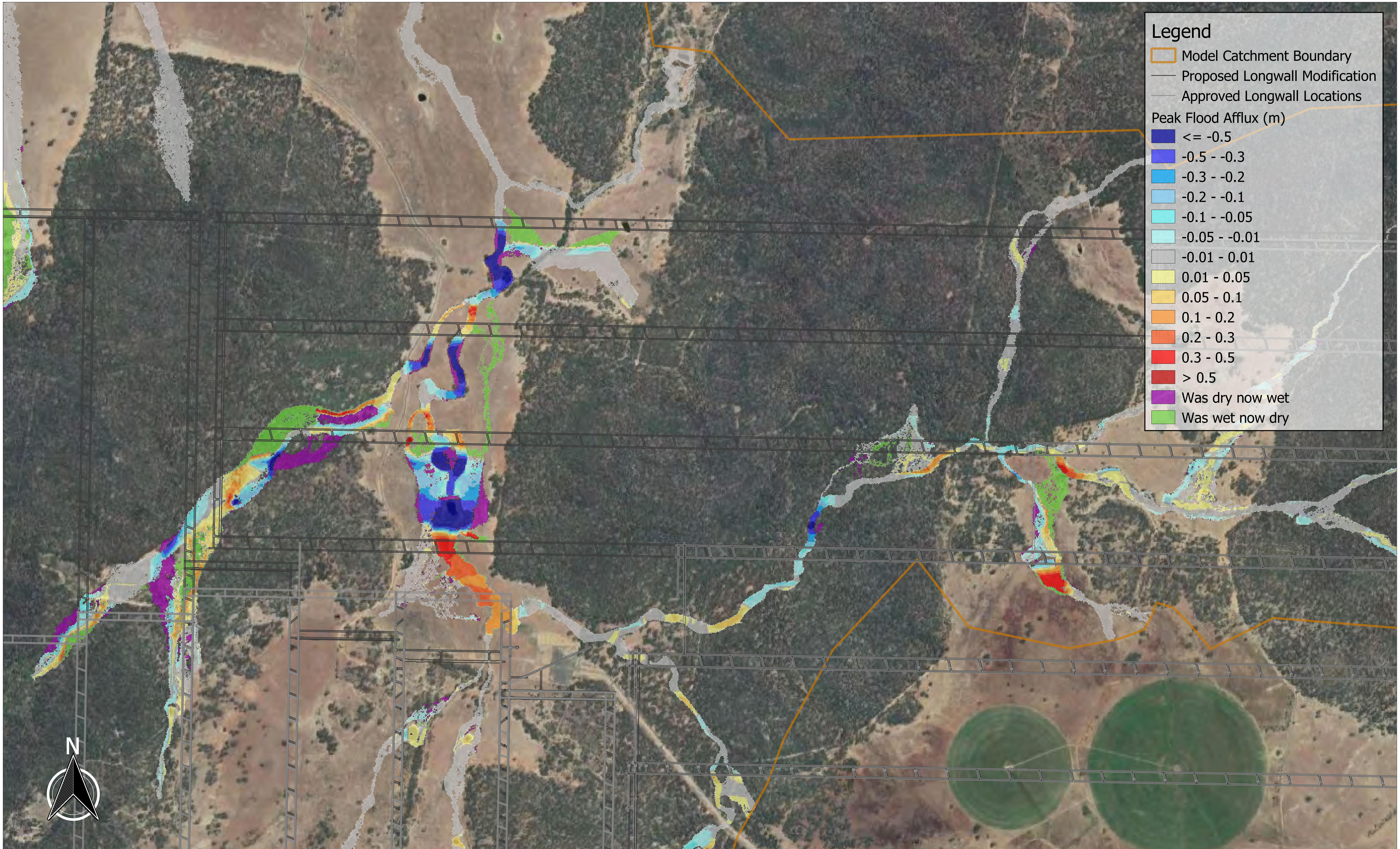
Checked: MB
Date: 5 /9 /2022



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ENGENY WATER MANAGEMENT

ULAN COAL

GLENCORE

0 300 600 m

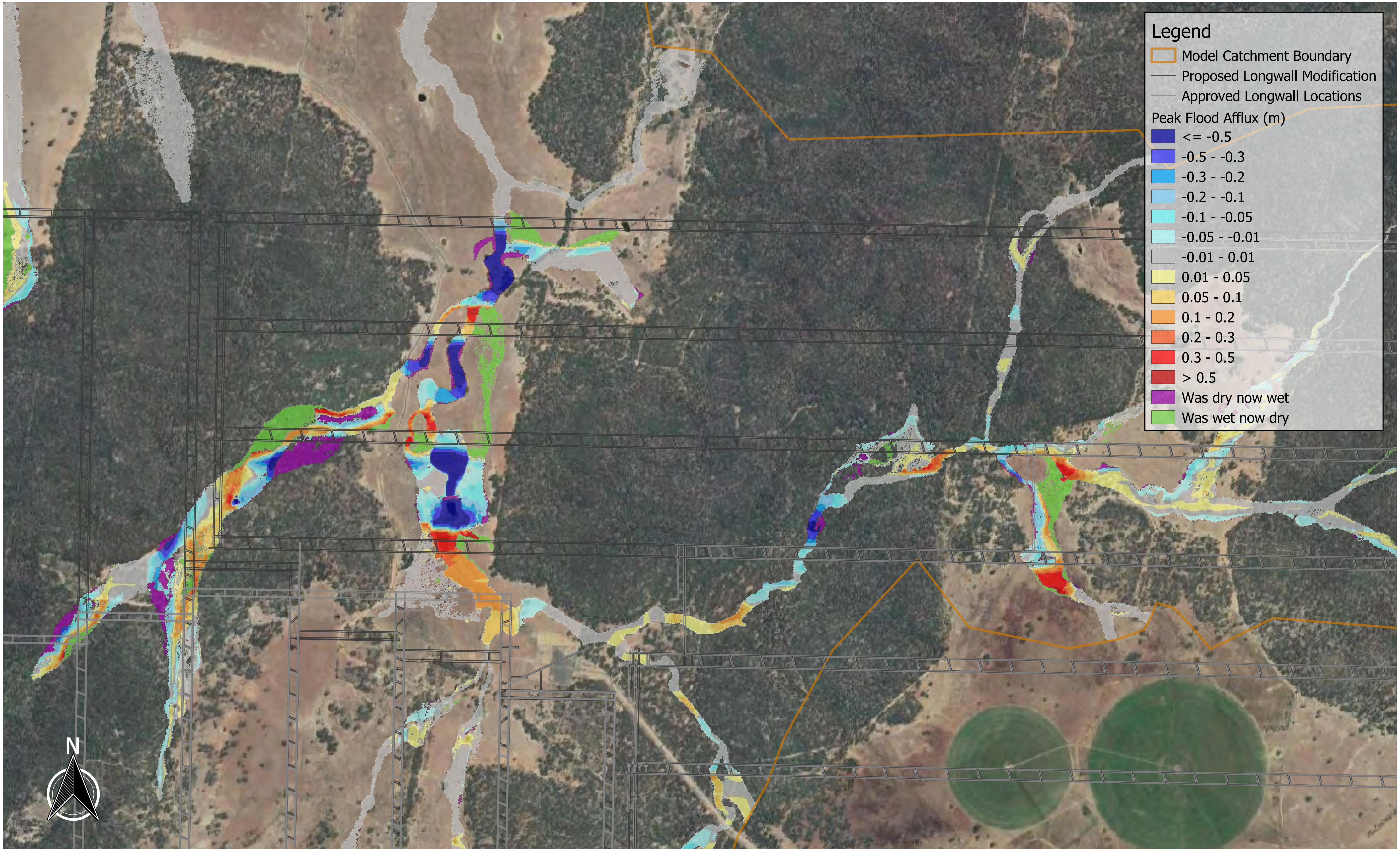
Scale in metres (1:14,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

Afflux - 50% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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Vertical Datum: Australia Height Datum
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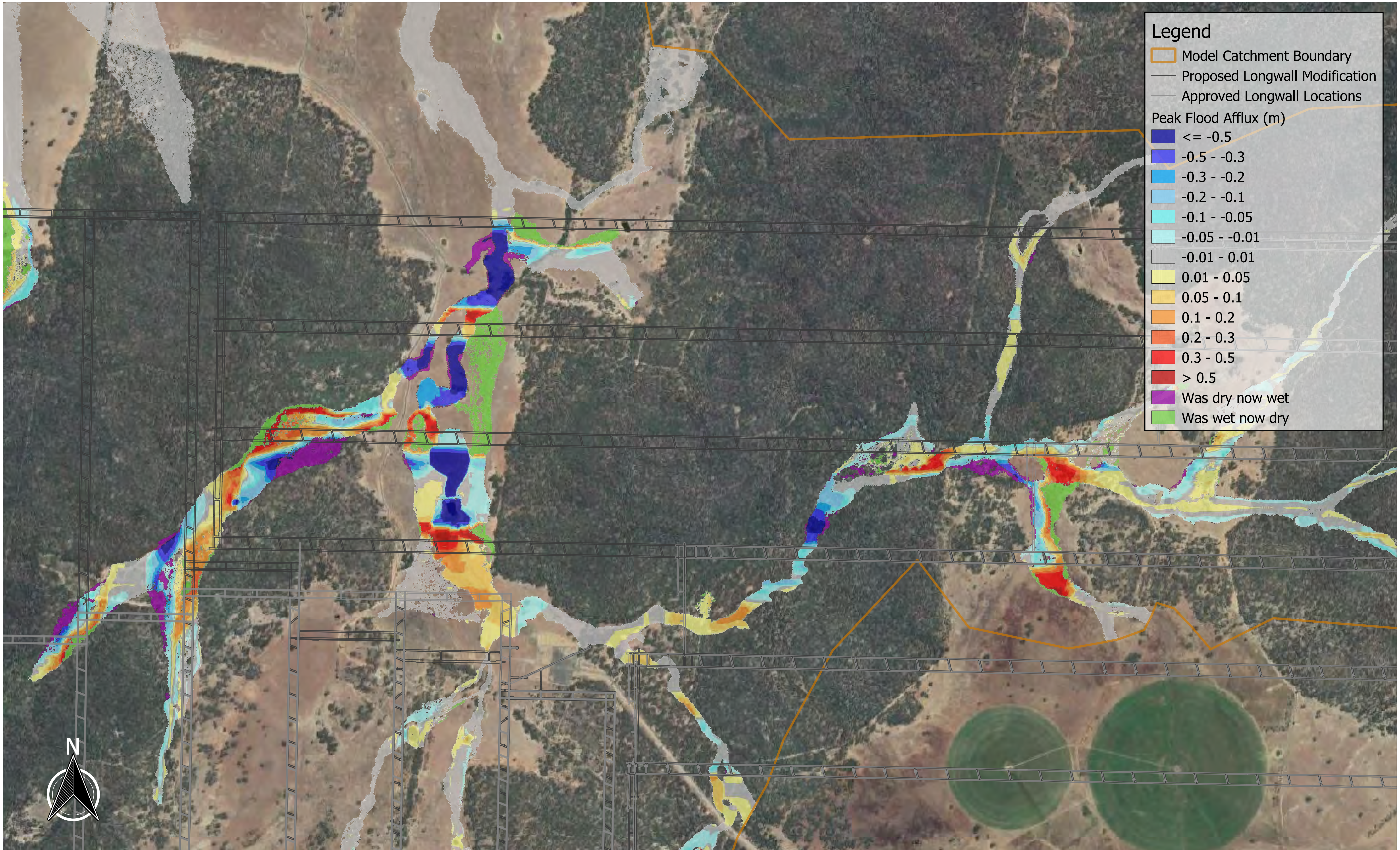
Ulan Modification 6 - Option 2

Afflux - 10% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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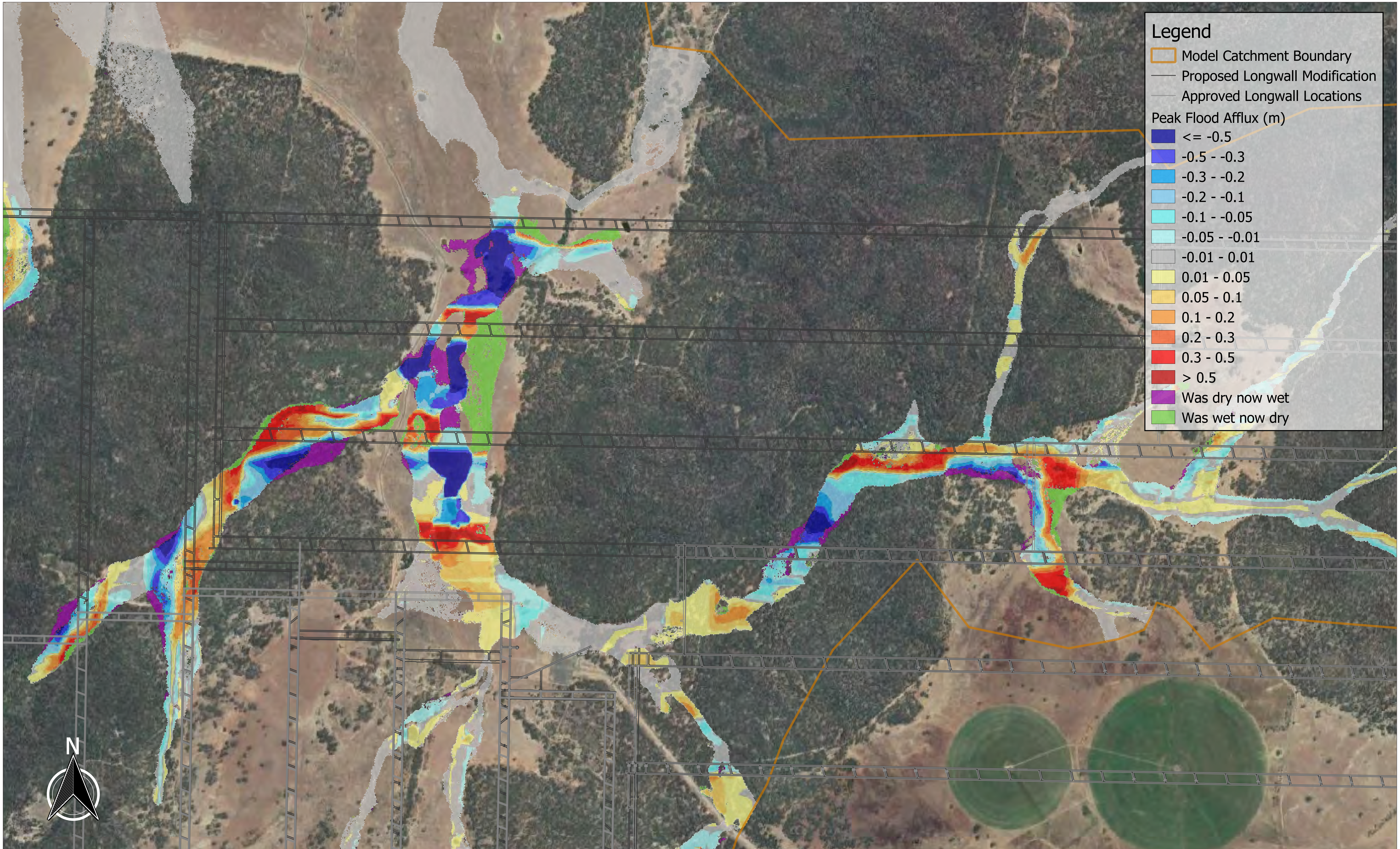
Ulan Modification 6 - Option 2

Afflux - 1% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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ULAN COAL

GLENCORE

Scale in metres (1:14,000 @ A3)

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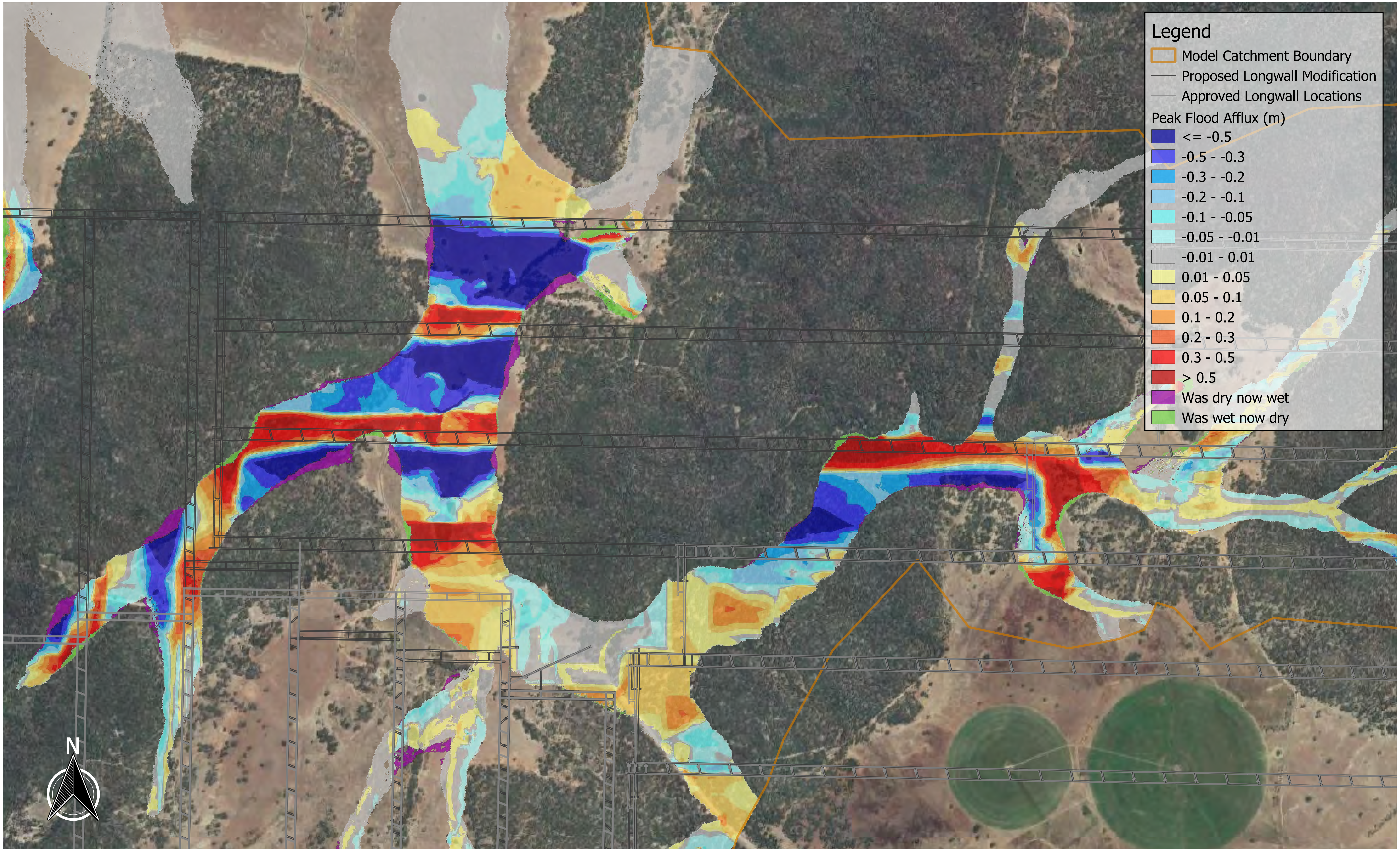
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

Afflux - 0.1% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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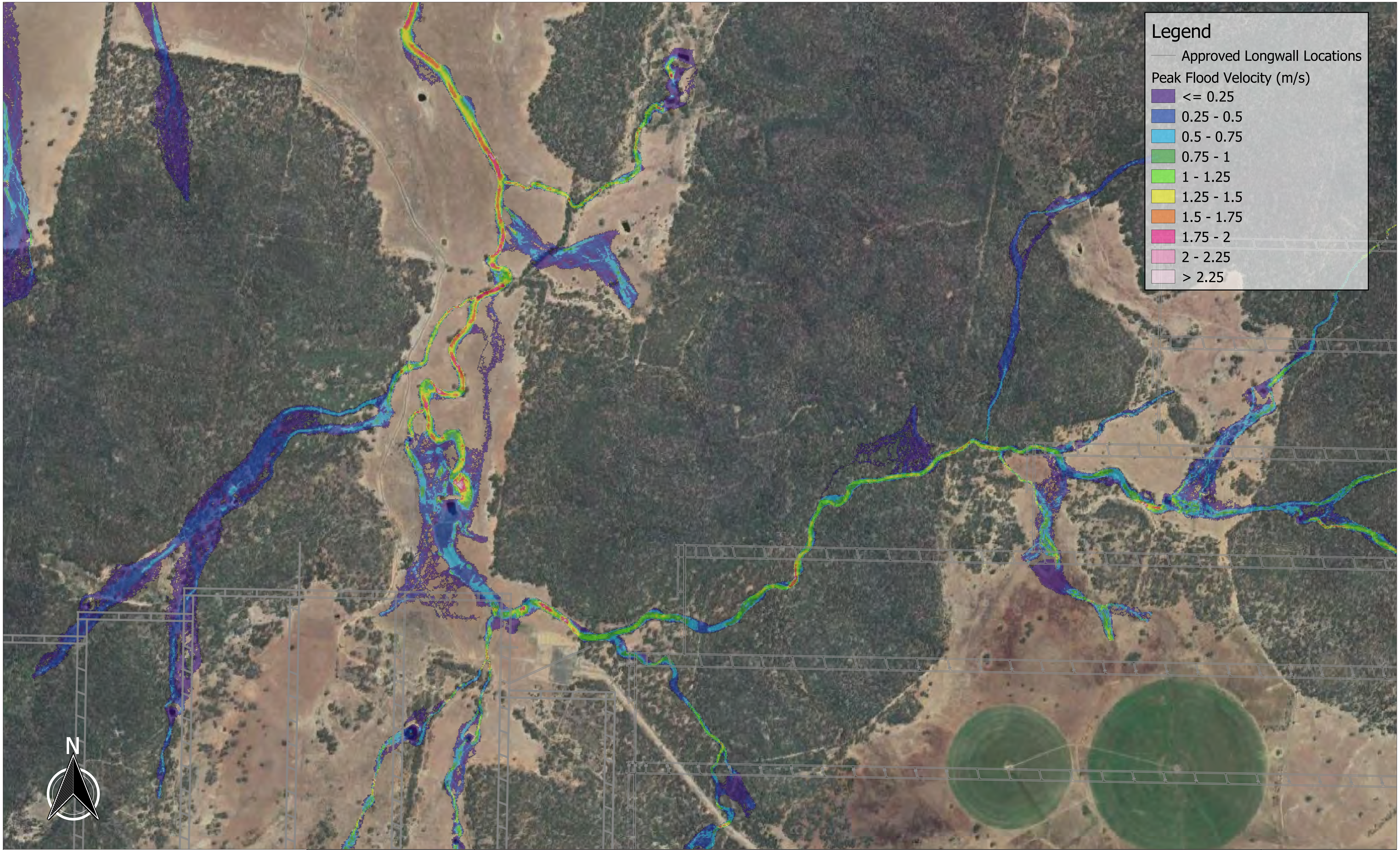
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

Afflux - PMF Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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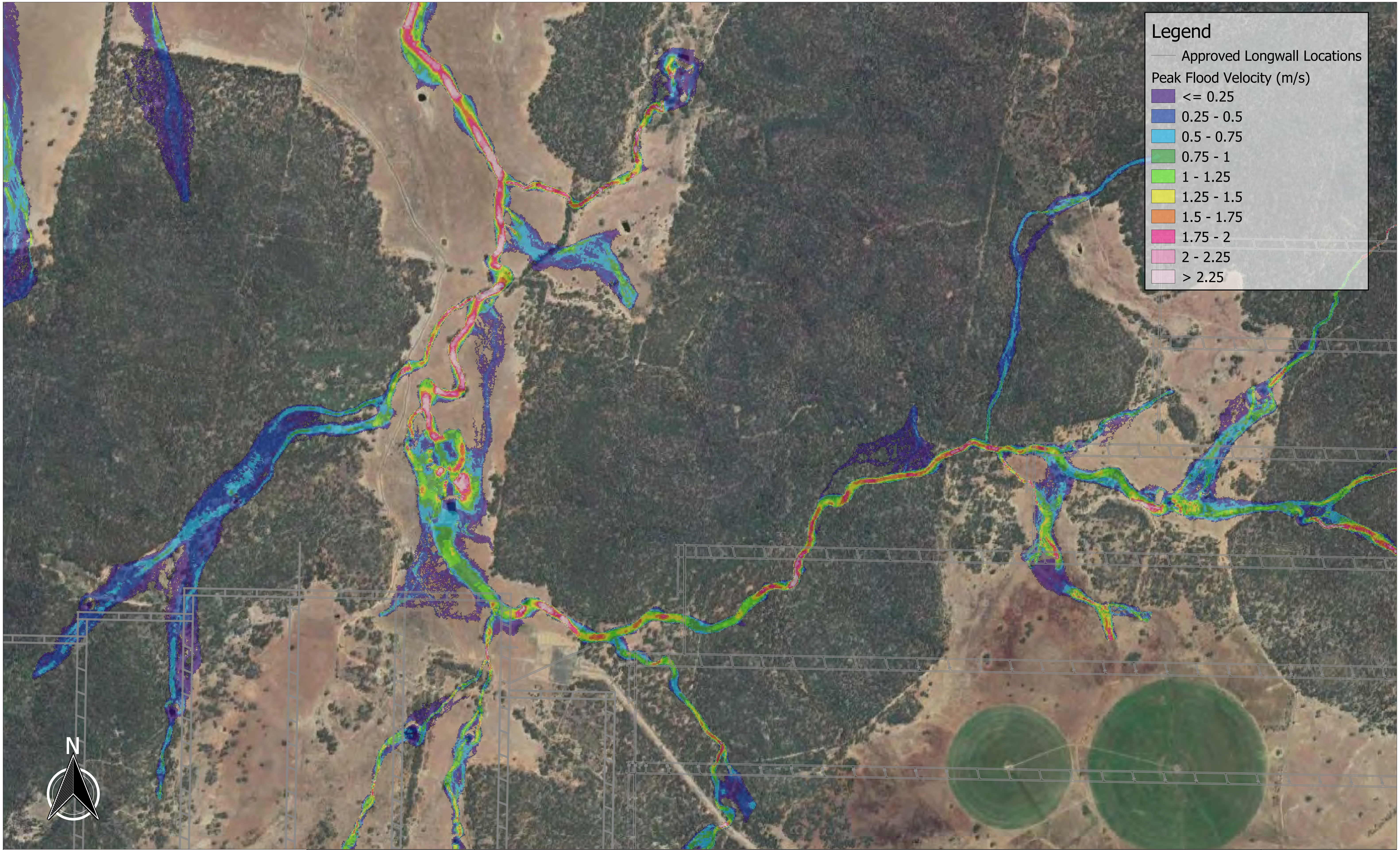
Ulan Modification 6 - Approved Conditions

Peak Flood Velocity - 50% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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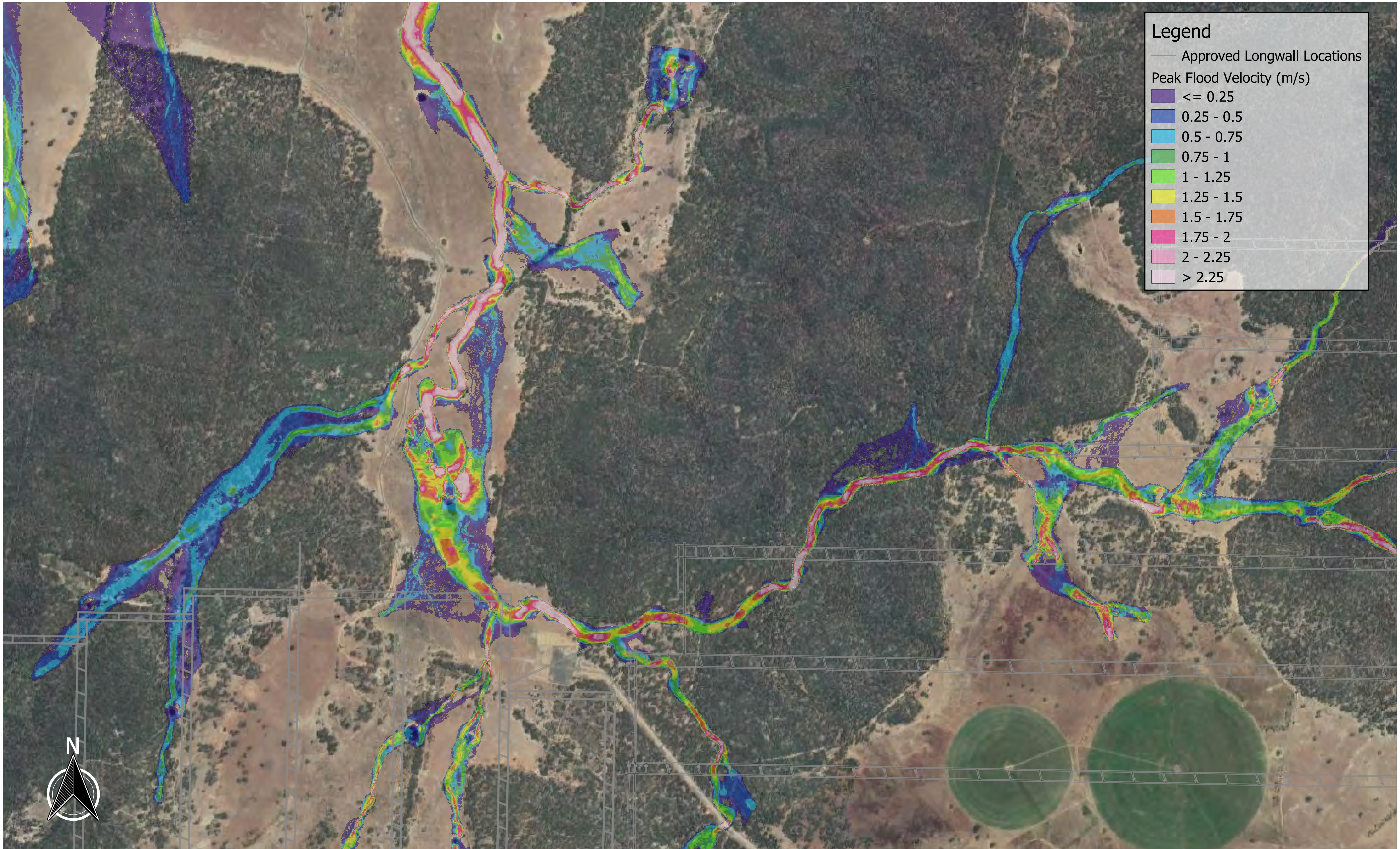
Ulan Modification 6 - Approved Conditions

Peak Flood Velocity - 10% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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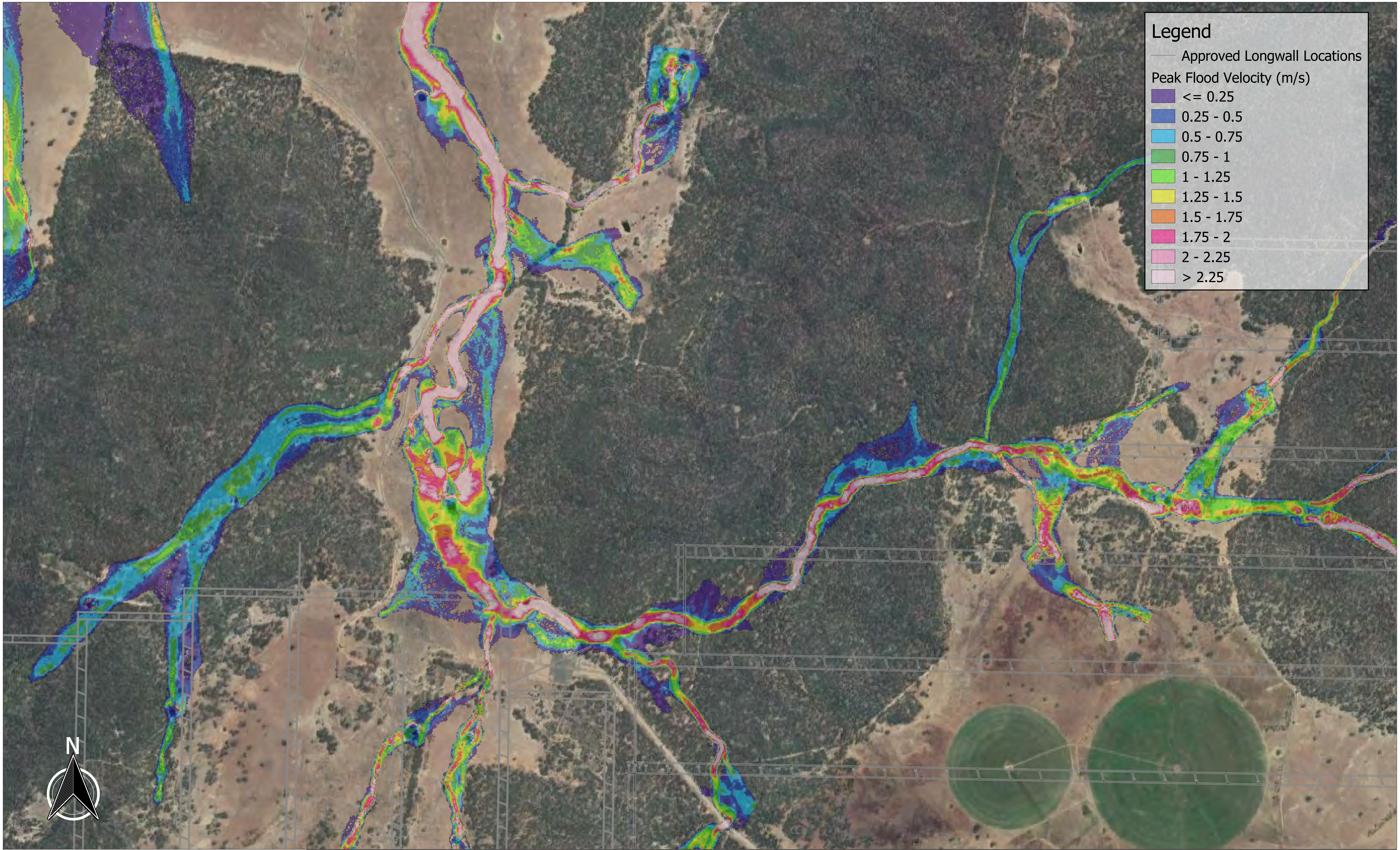
Ulan Modification 6 - Approved Conditions

Peak Flood Velocity - 1% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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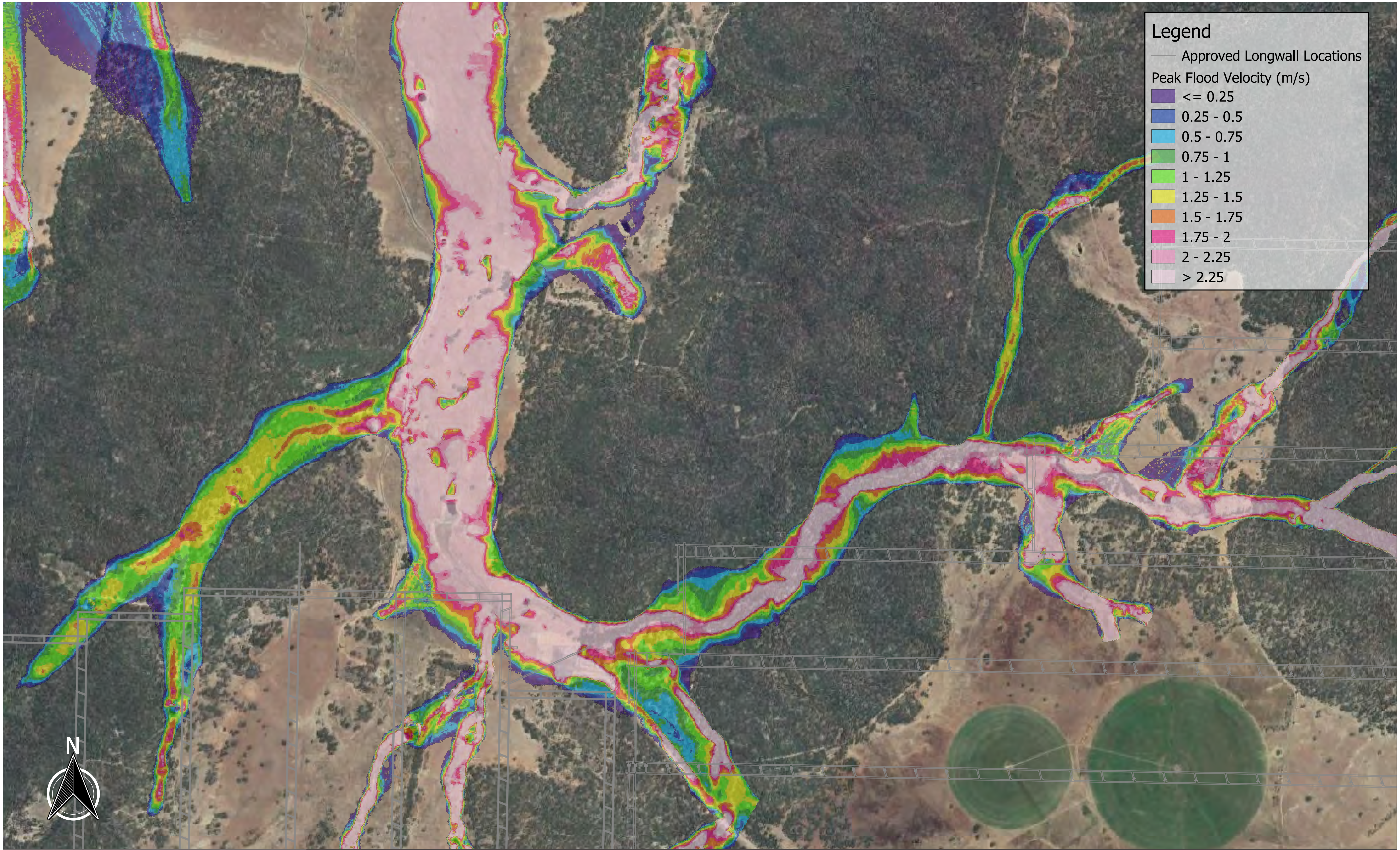
Ulan Modification 6 - Approved Conditions

Peak Flood Velocity - 0.1% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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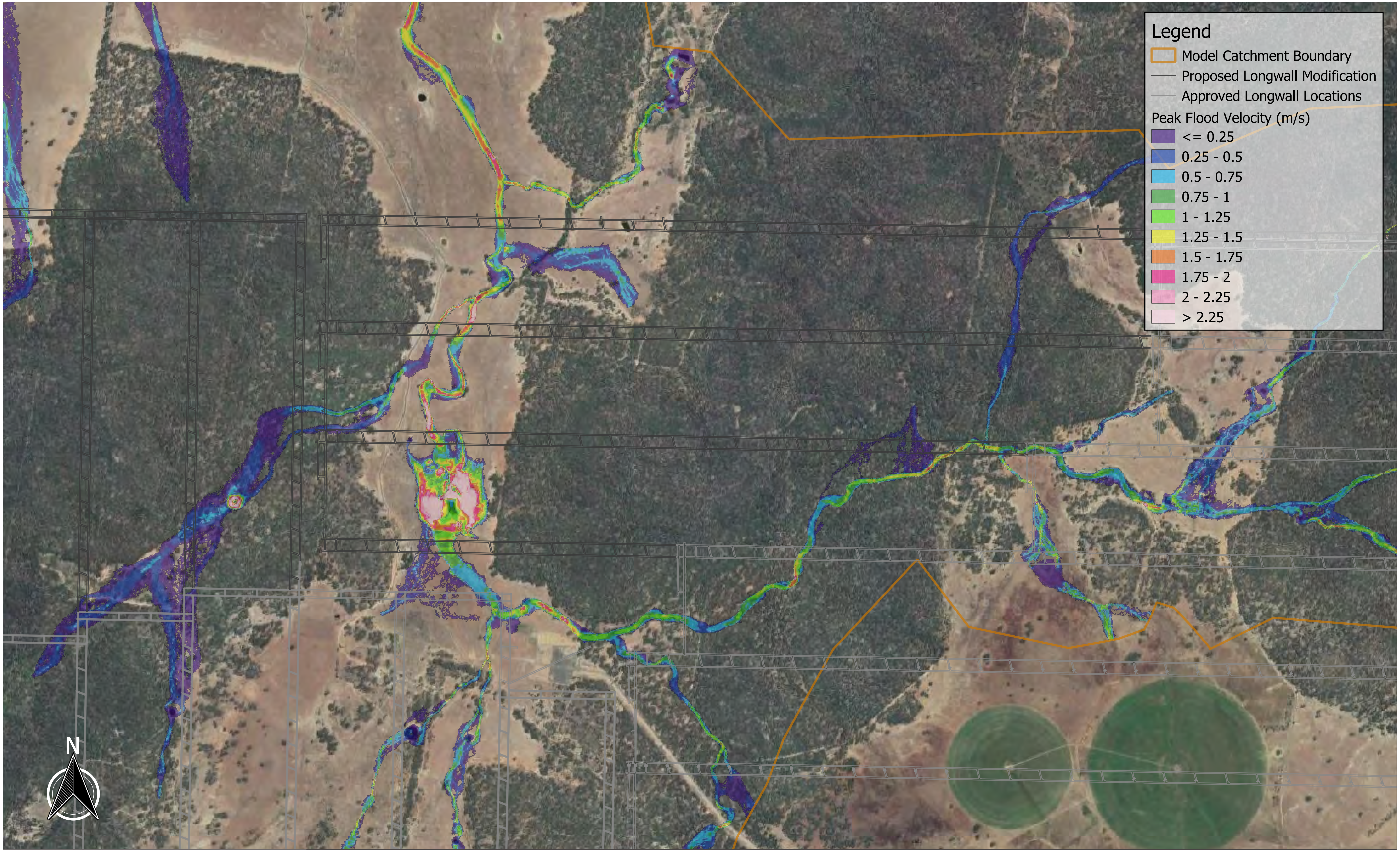
Ulan Modification 6 - Approved Conditions

Peak Flood Velocity - PMF Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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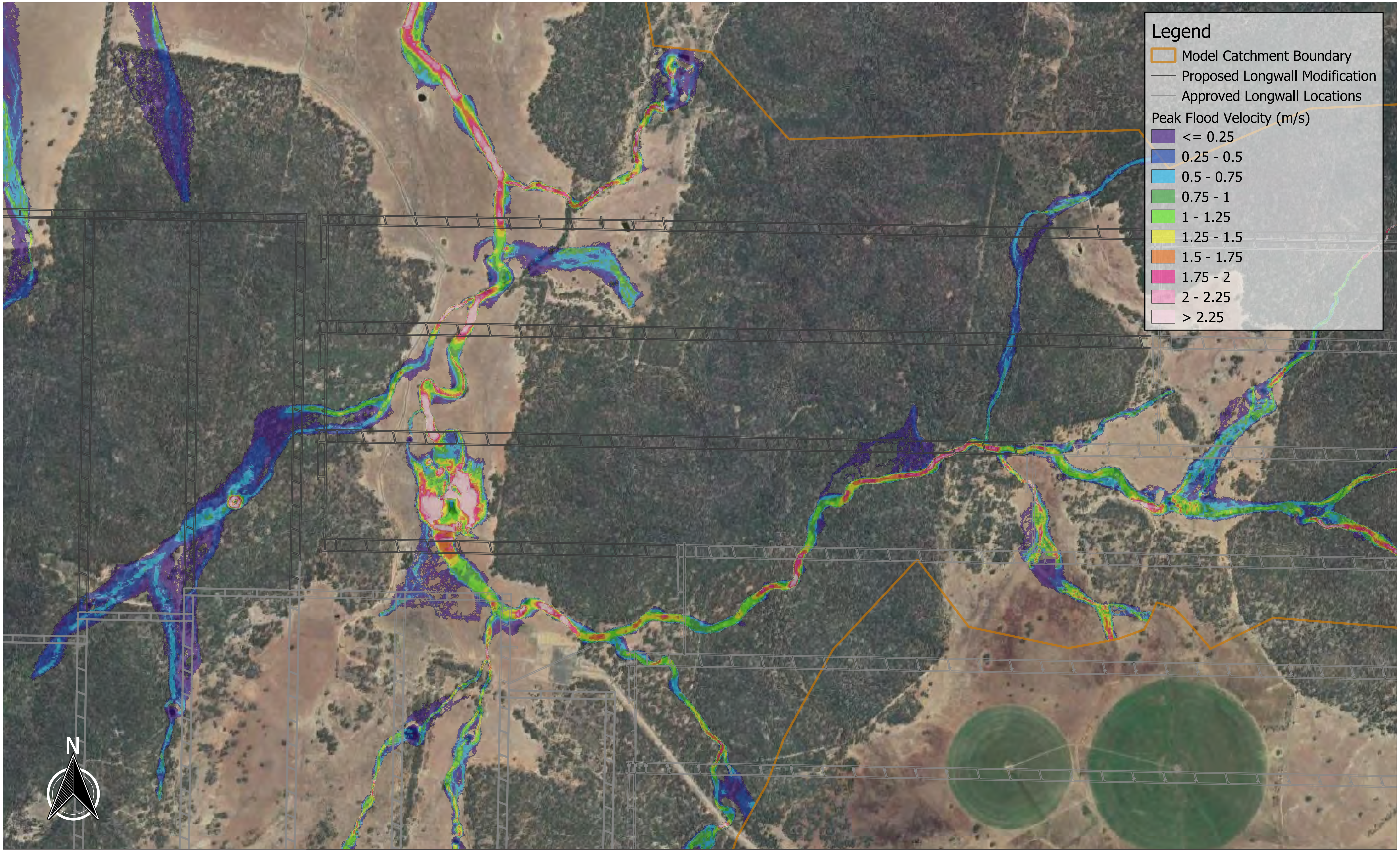
Ulan Modification 6 - Option 1

Peak Flood Velocity - 50% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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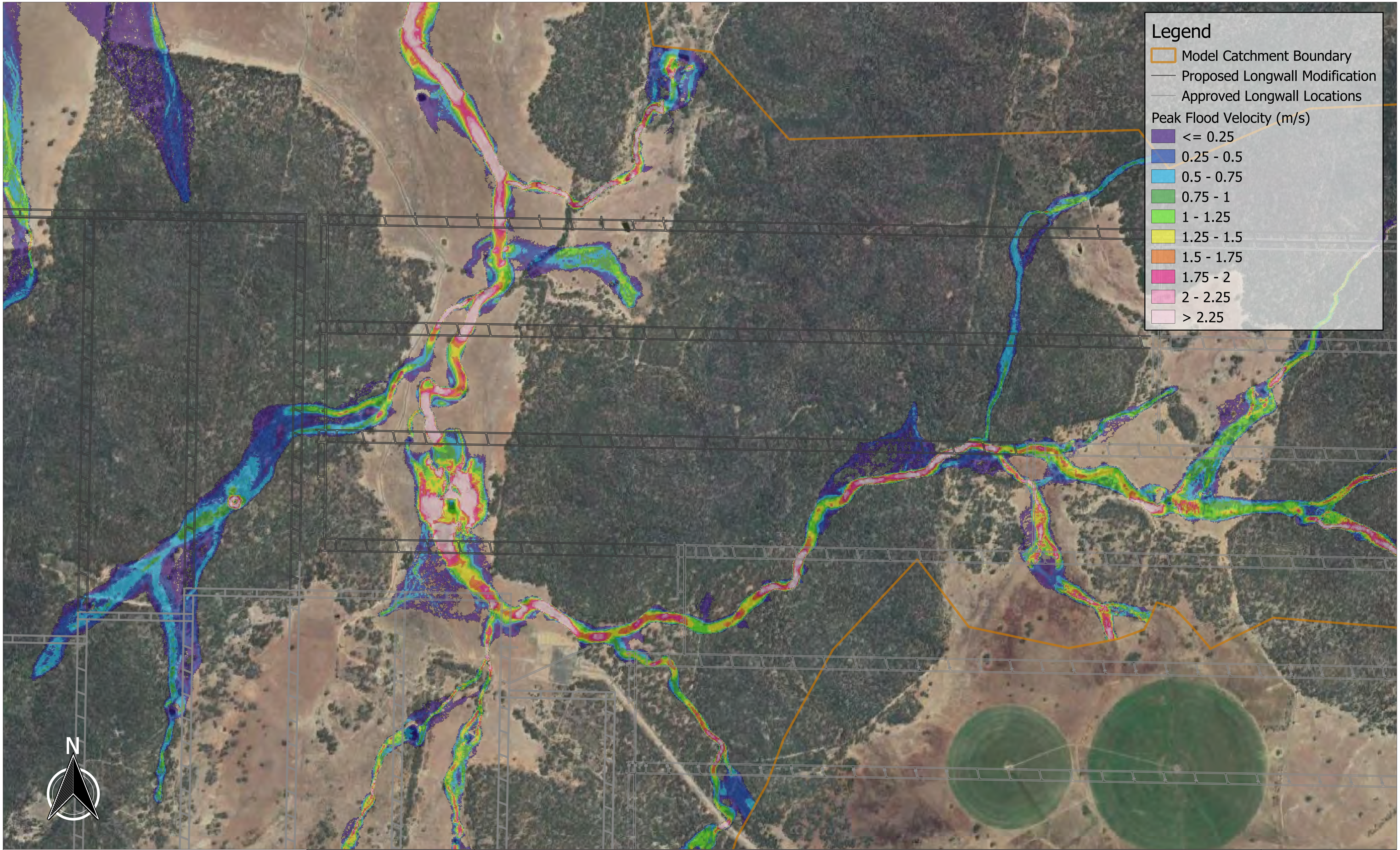
Ulan Modification 6 - Option 1

Peak Flood Velocity - 10% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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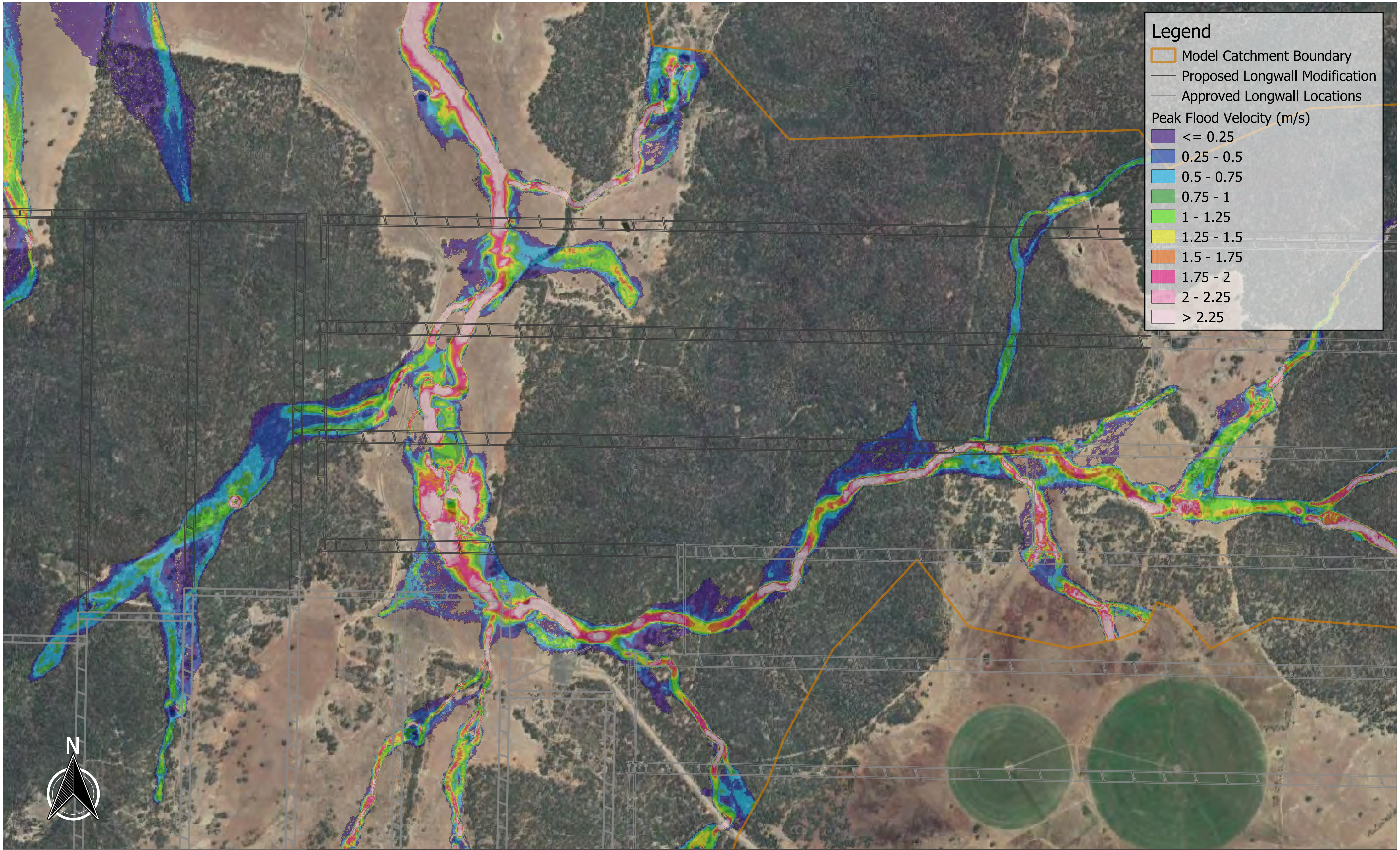
Ulan Modification 6 - Option 1

Peak Flood Velocity - 1% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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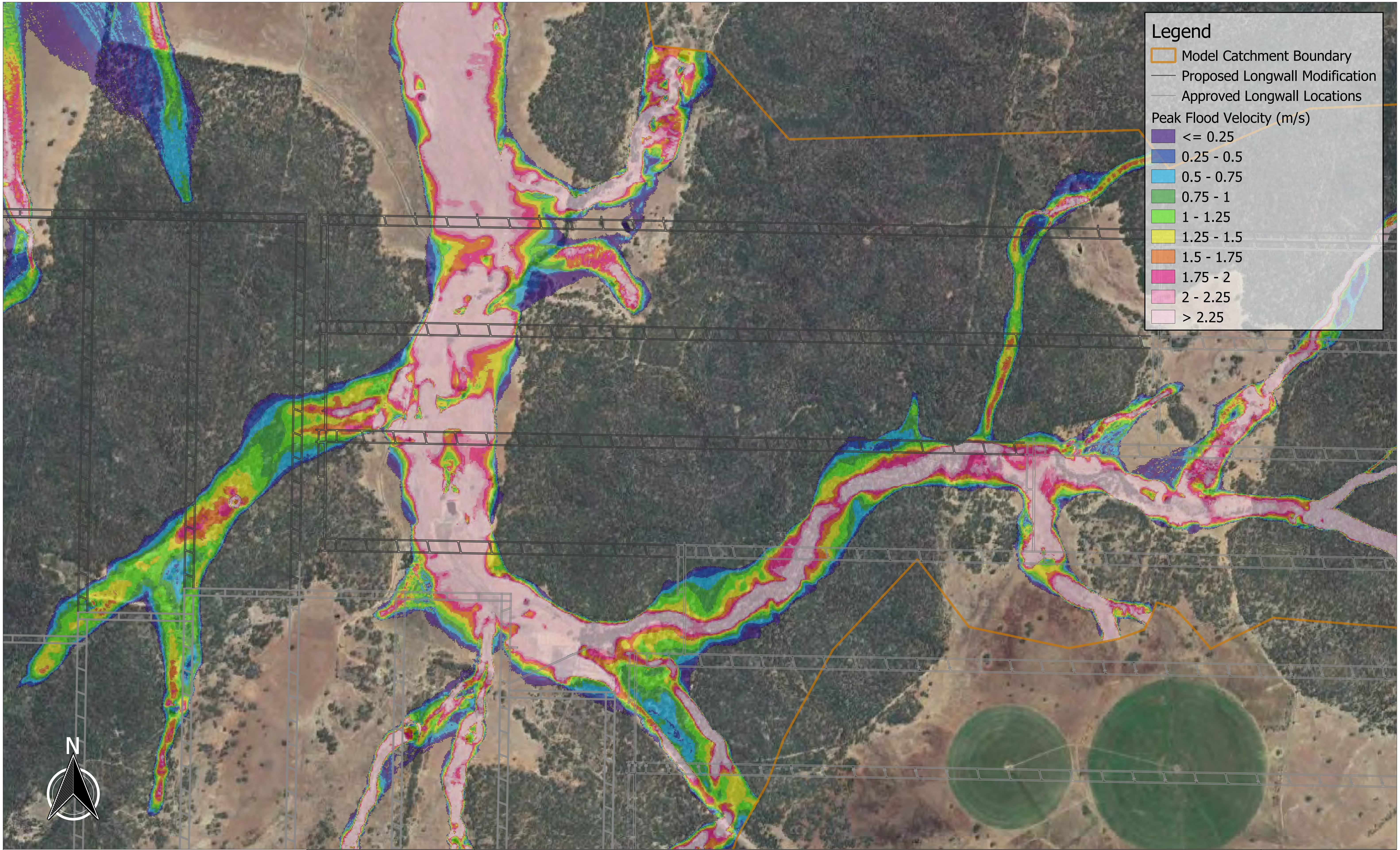
Ulan Modification 6 - Option 1

Peak Flood Velocity - 0.1% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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ULAN COAL
GLENCORE

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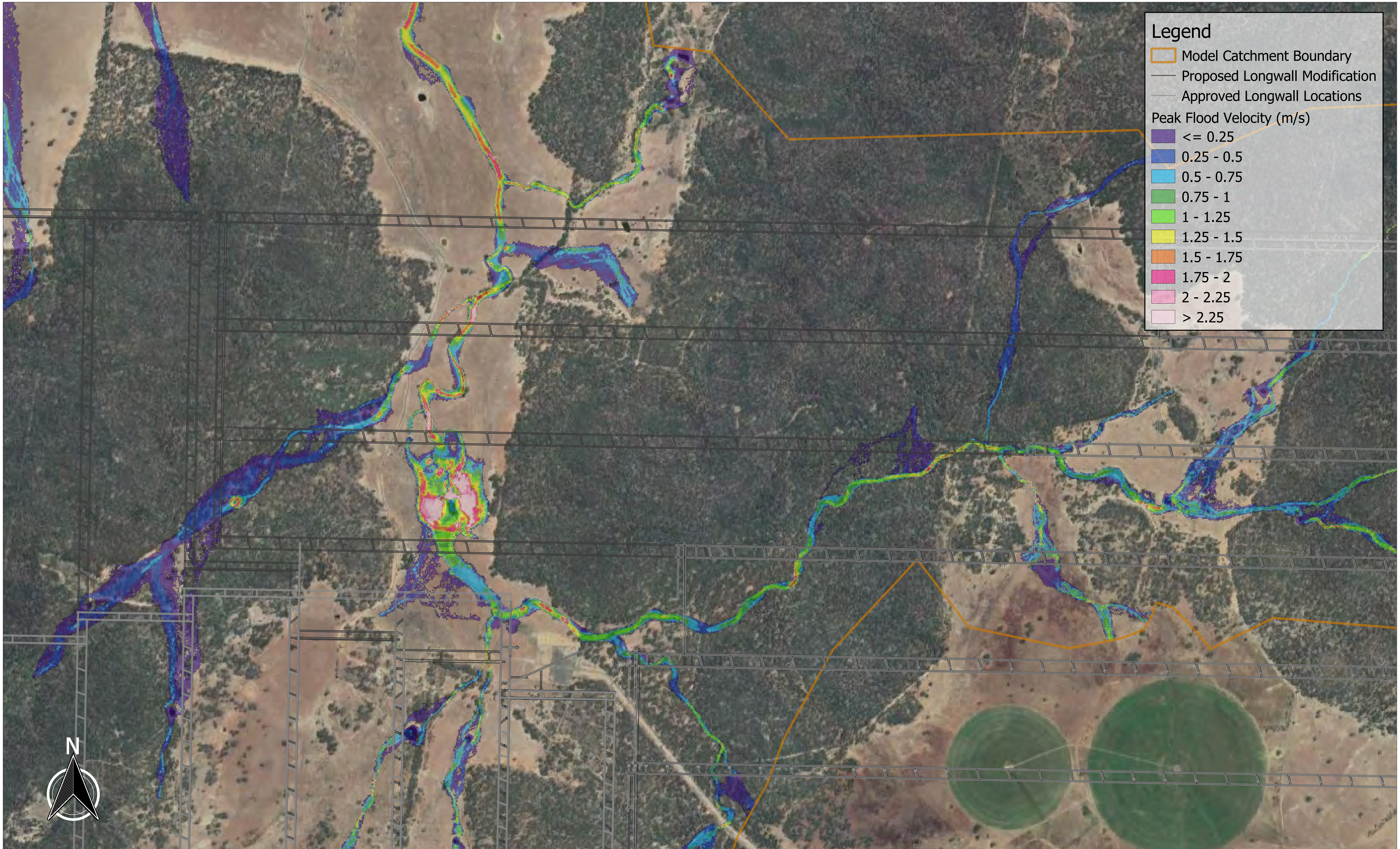
Ulan Modification 6 - Option 1

Peak Flood Velocity - PMF Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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ENGENY WATER MANAGEMENT

ULAN COAL

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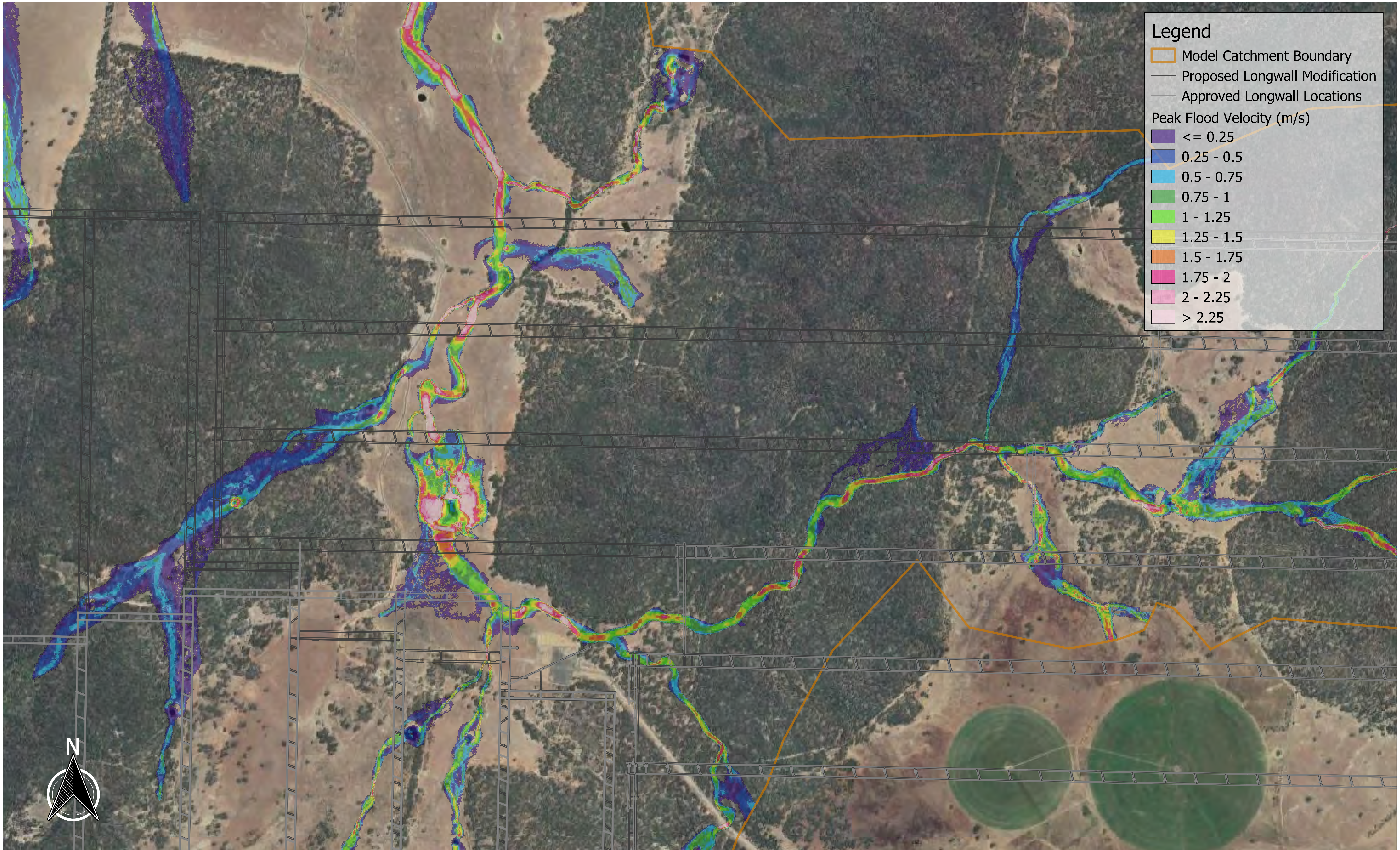
Ulan Modification 6 - Option 2

Peak Flood Velocity - 50% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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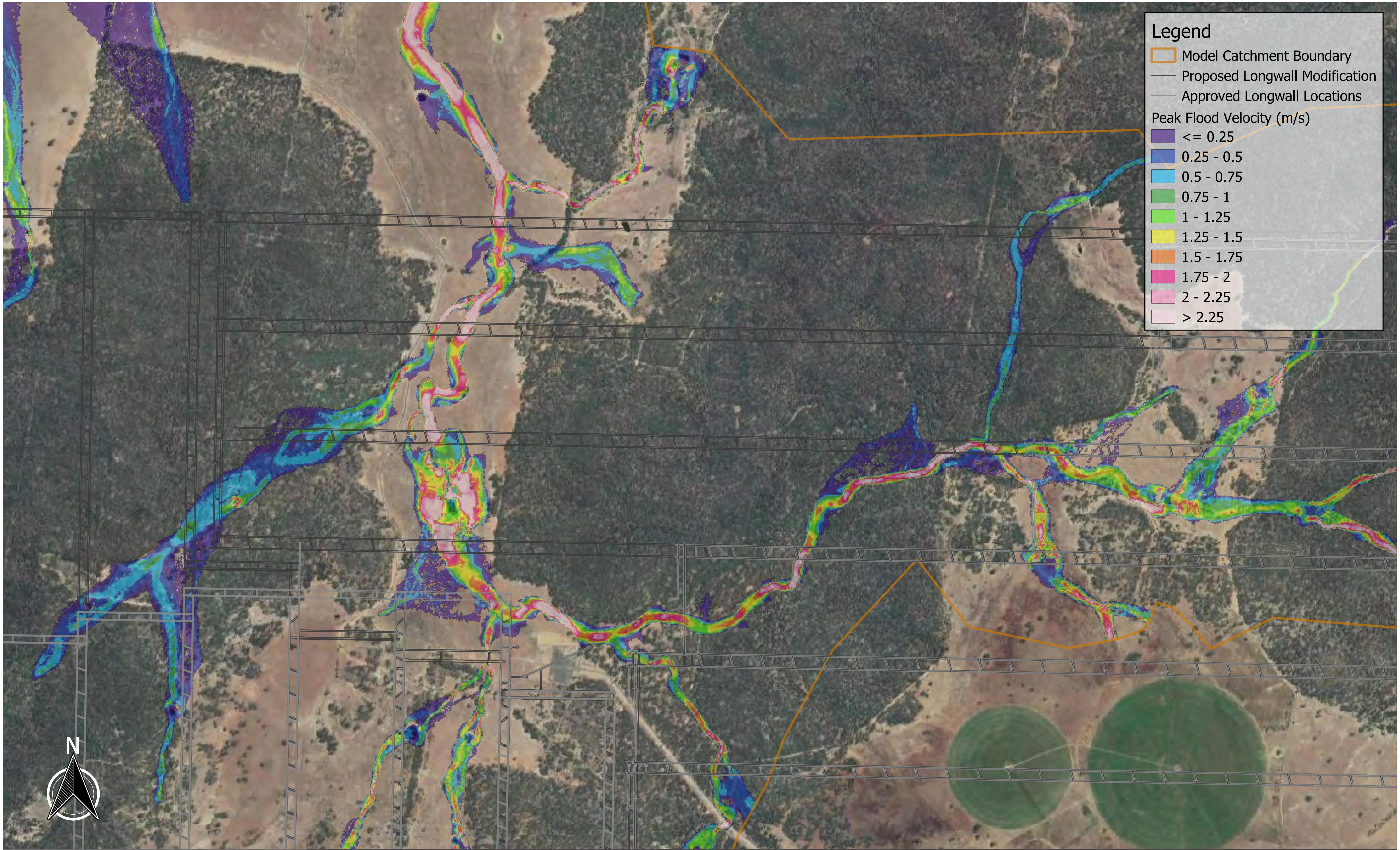
Ulan Modification 6 - Option 2

Peak Flood Velocity - 10% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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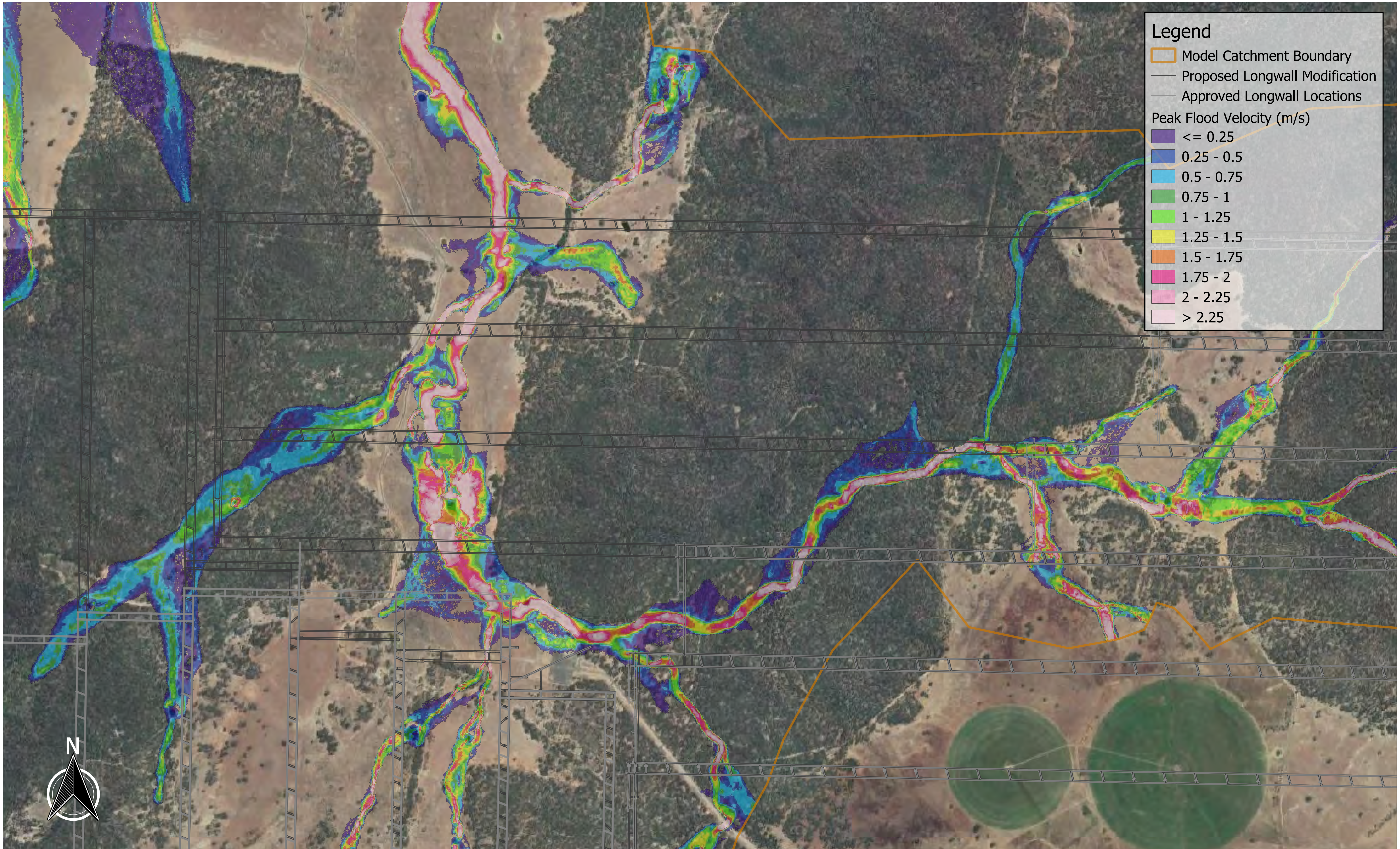
Ulan Modification 6 - Option 2

Peak Flood Velocity - 1% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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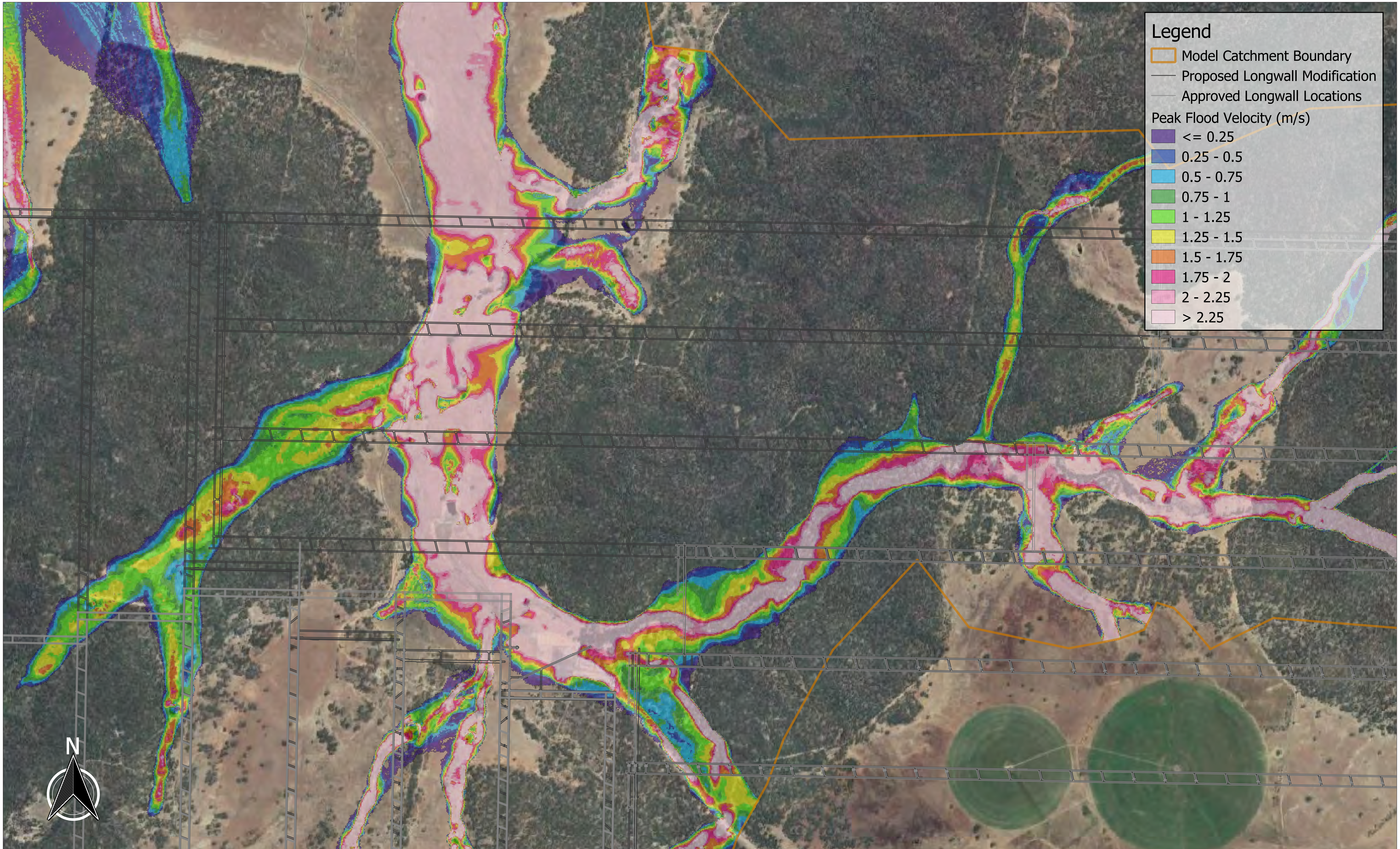
Ulan Modification 6 - Option 2

Peak Flood Velocity - 0.1% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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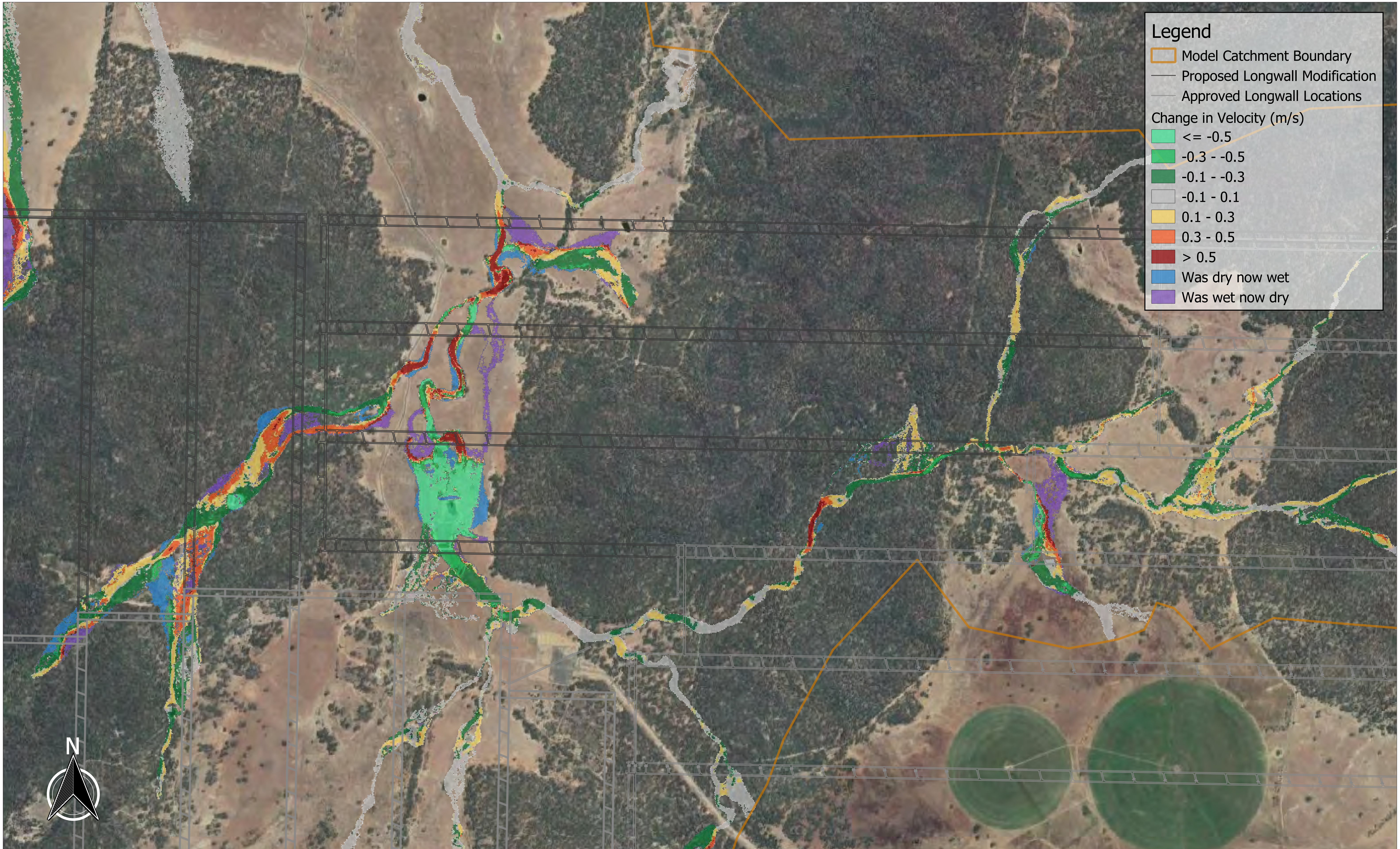
Ulan Modification 6 - Option 2

Peak Flood Velocity - PMF Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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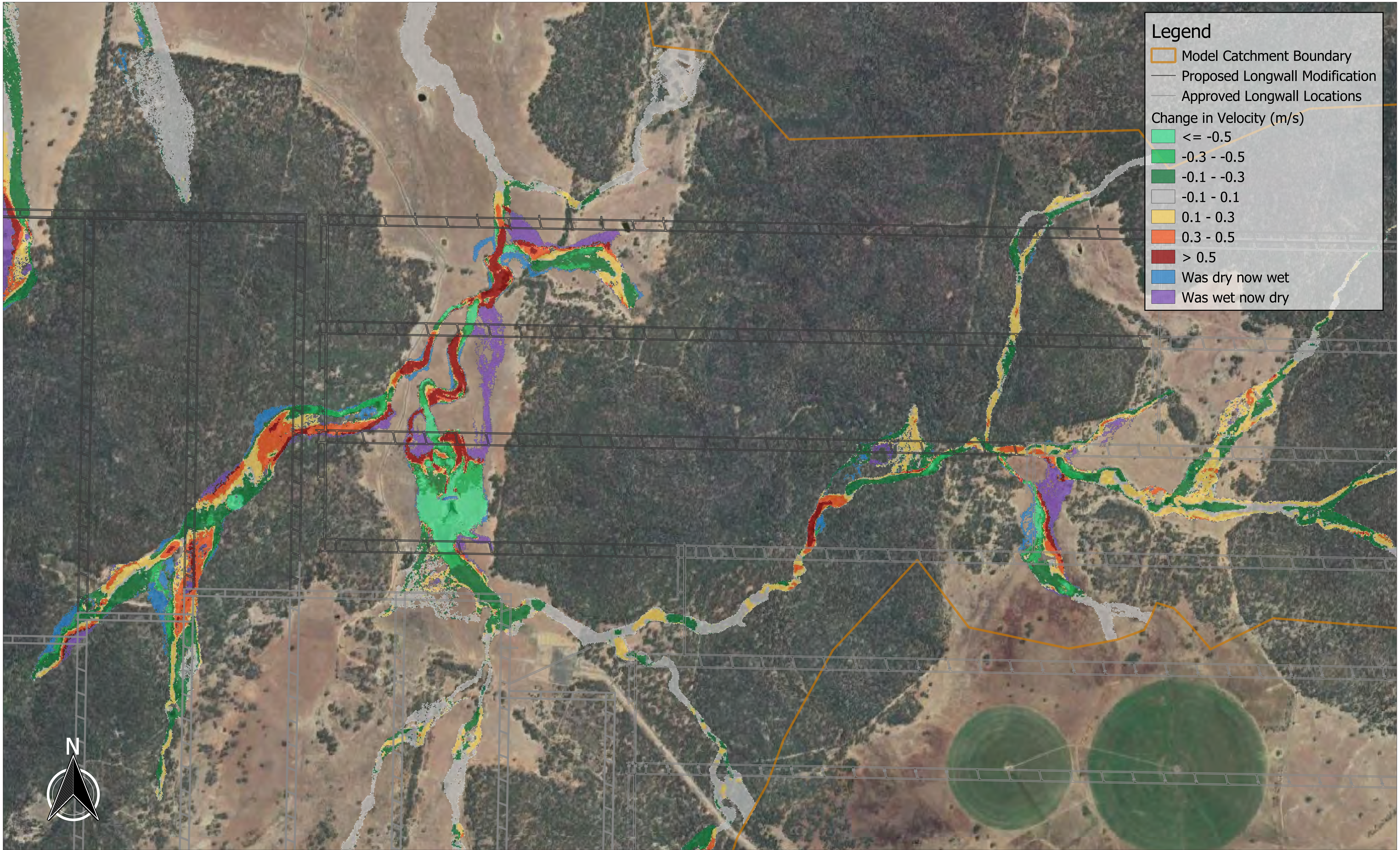
Ulan Modification 6 - Option 1

Change in Velocity - 50% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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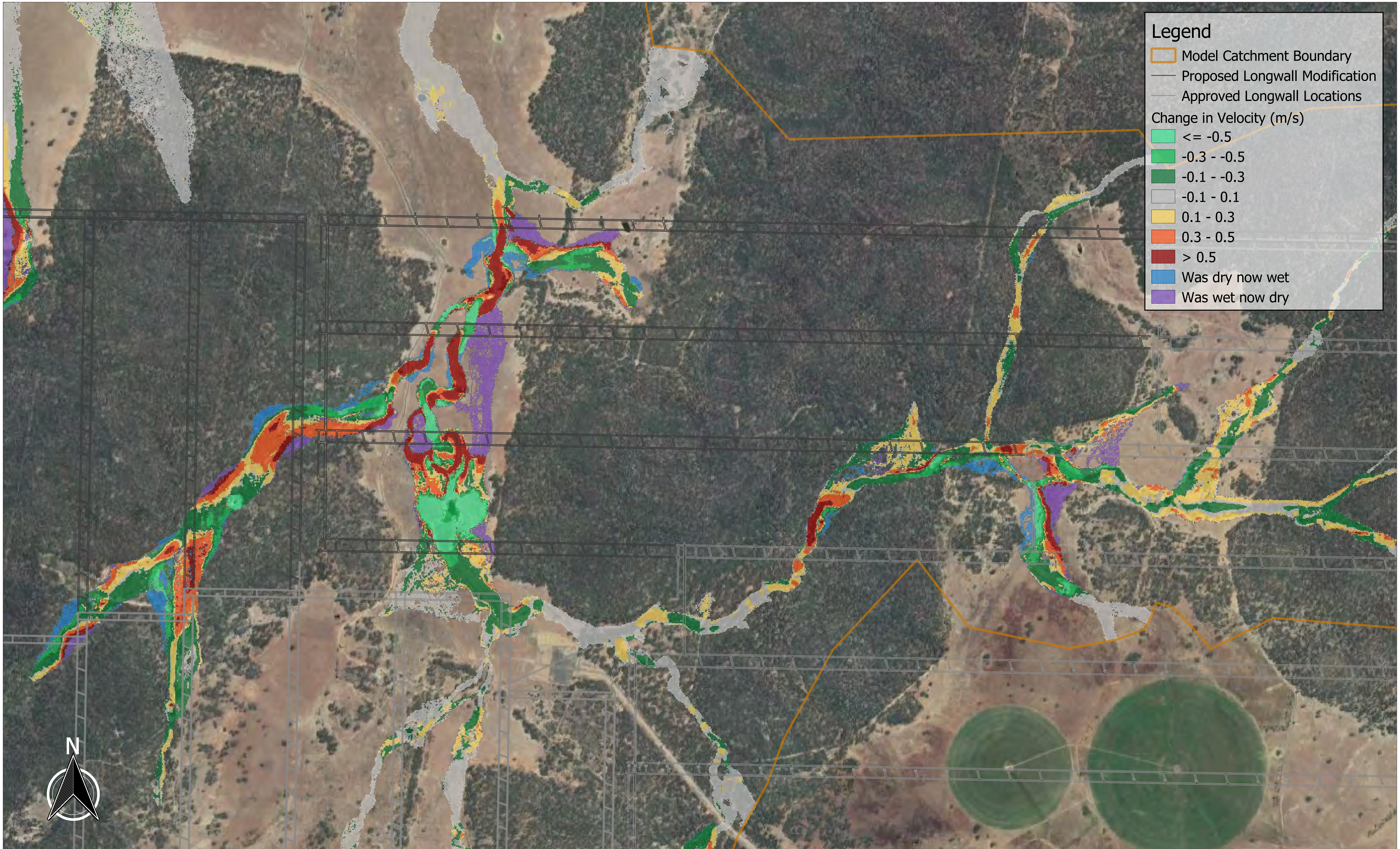
Ulan Modification 6 - Option 1

Change in Velocity - 10% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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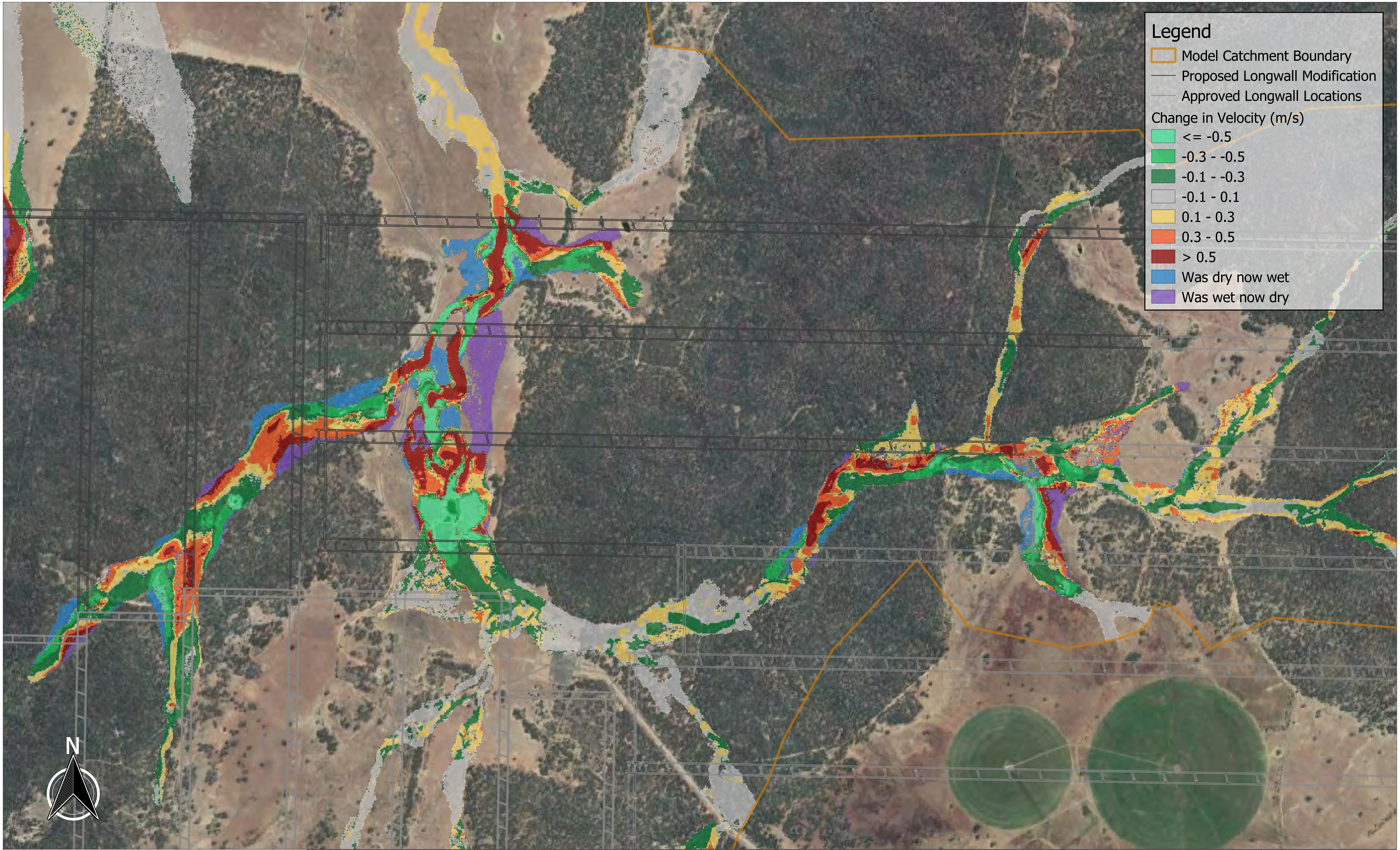
Ulan Modification 6 - Option 1

Change in Velocity - 1% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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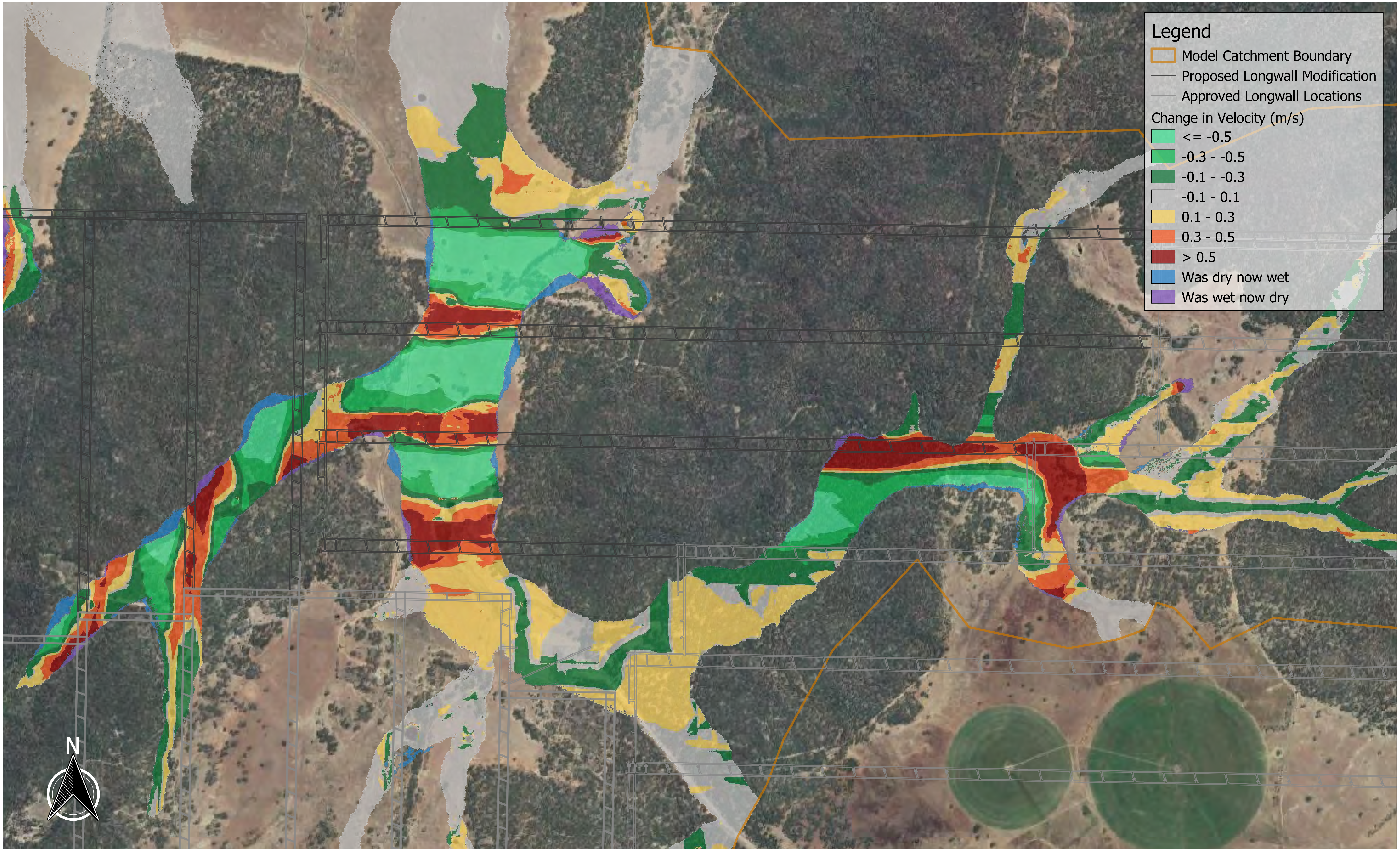
Ulan Modification 6 - Option 1

Change in Velocity- 0.1% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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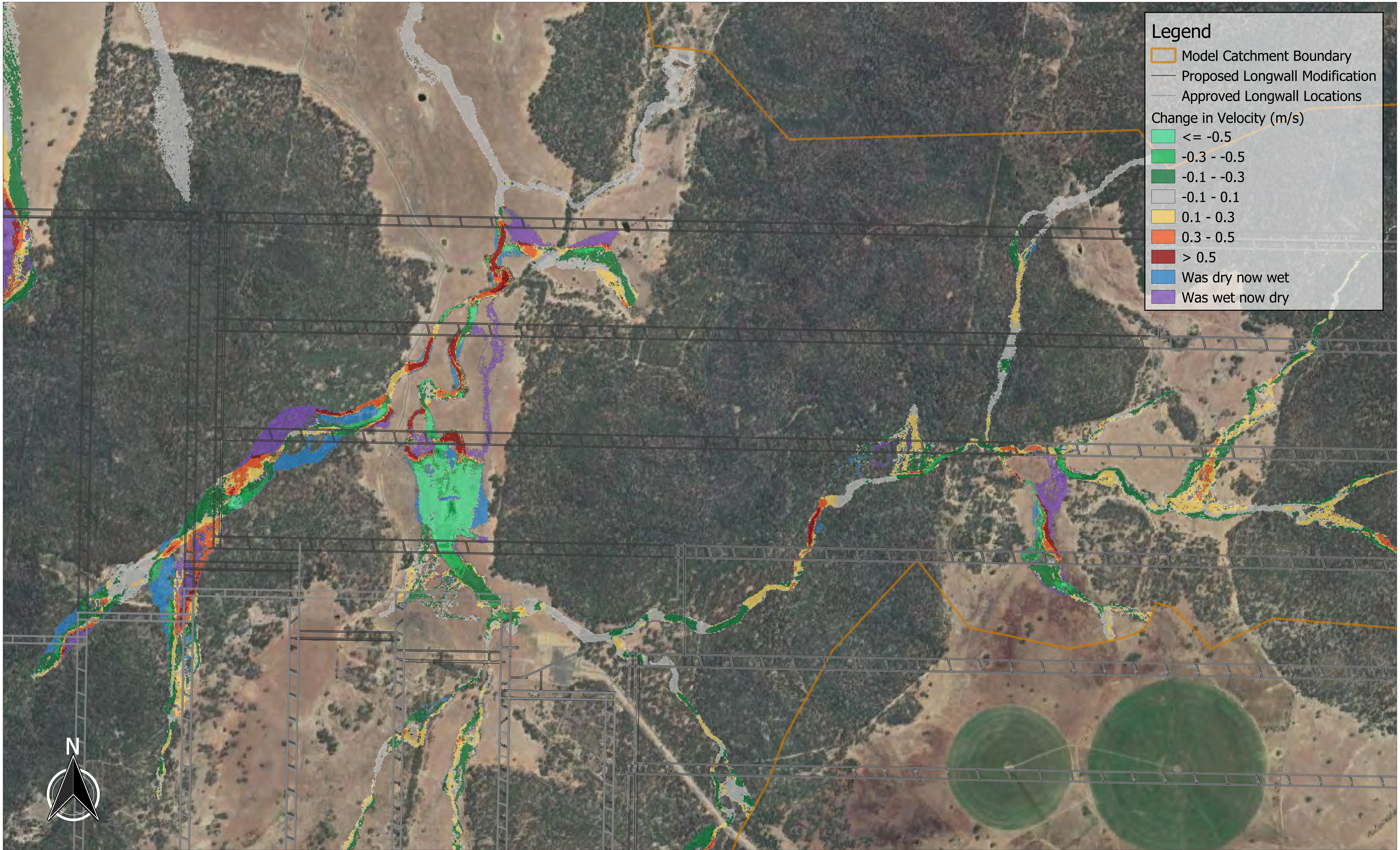
Ulan Modification 6 - Option 1

Change in Velocity- PMF Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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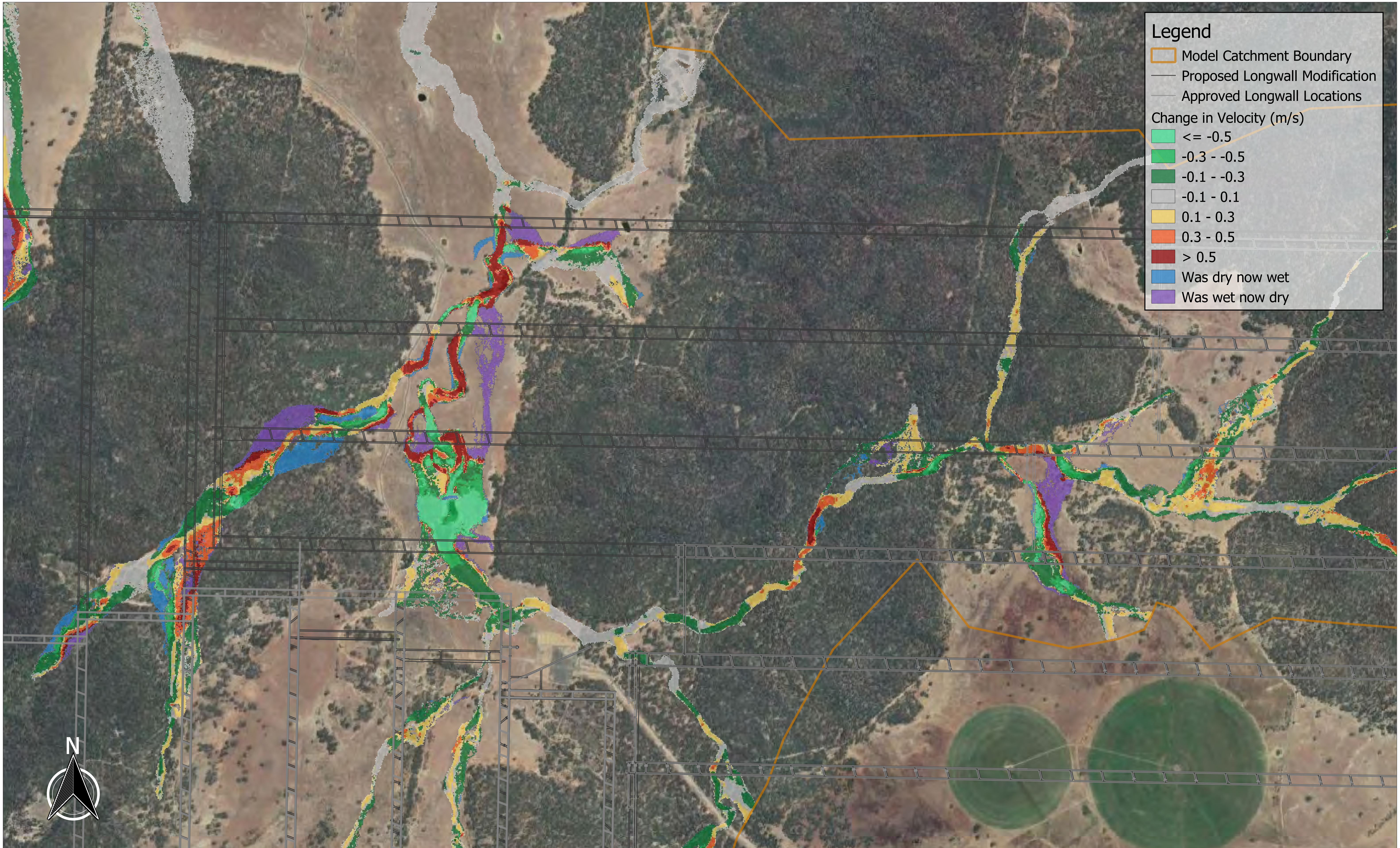
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

Change in Velocity - 50% AEP Event (Proposed Modification vs Approved Conditions)

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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0 300 600 m

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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

Change in Velocity - 10% AEP Event (Proposed Modification vs Approved Conditions)

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Revision: 0
Drawn: GC
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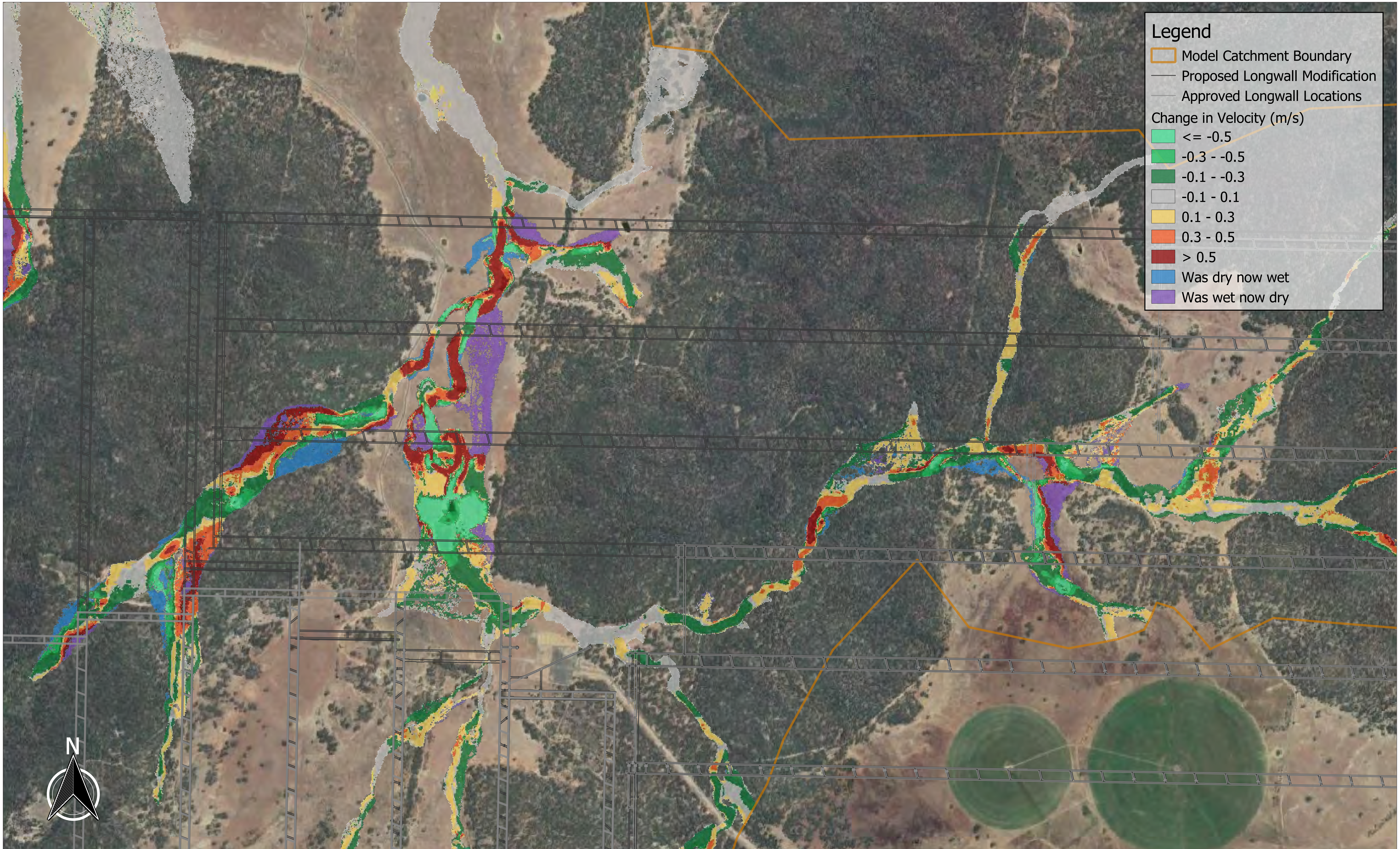
Date: 5 /9 /2022



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Grid: Map Grid of Australia, Zone 56

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Change in Velocity - 1% AEP Event (Proposed Modification vs Approved Conditions)

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Revision: 0
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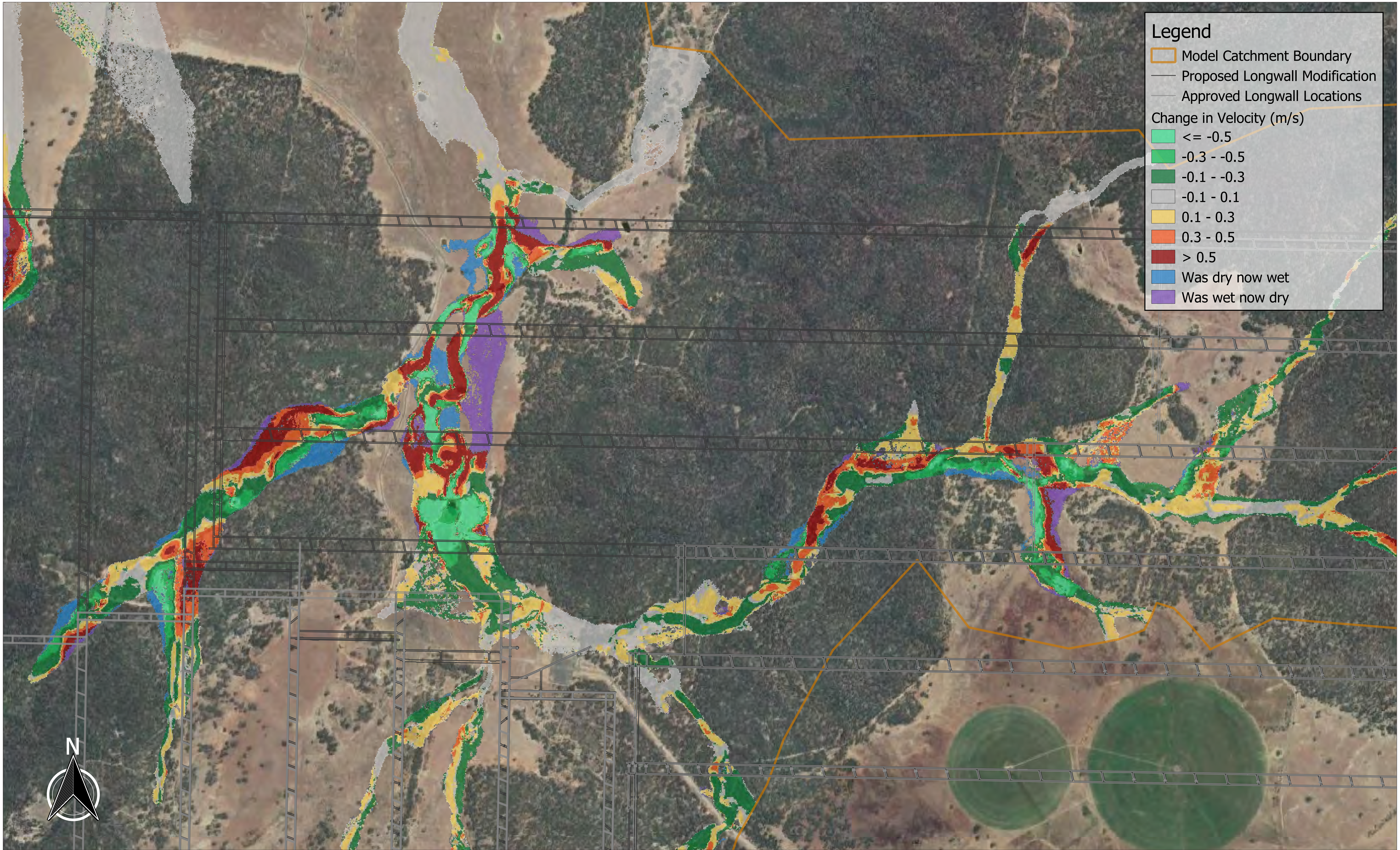
Checked: MB
Date: 5 /9 /2022



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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

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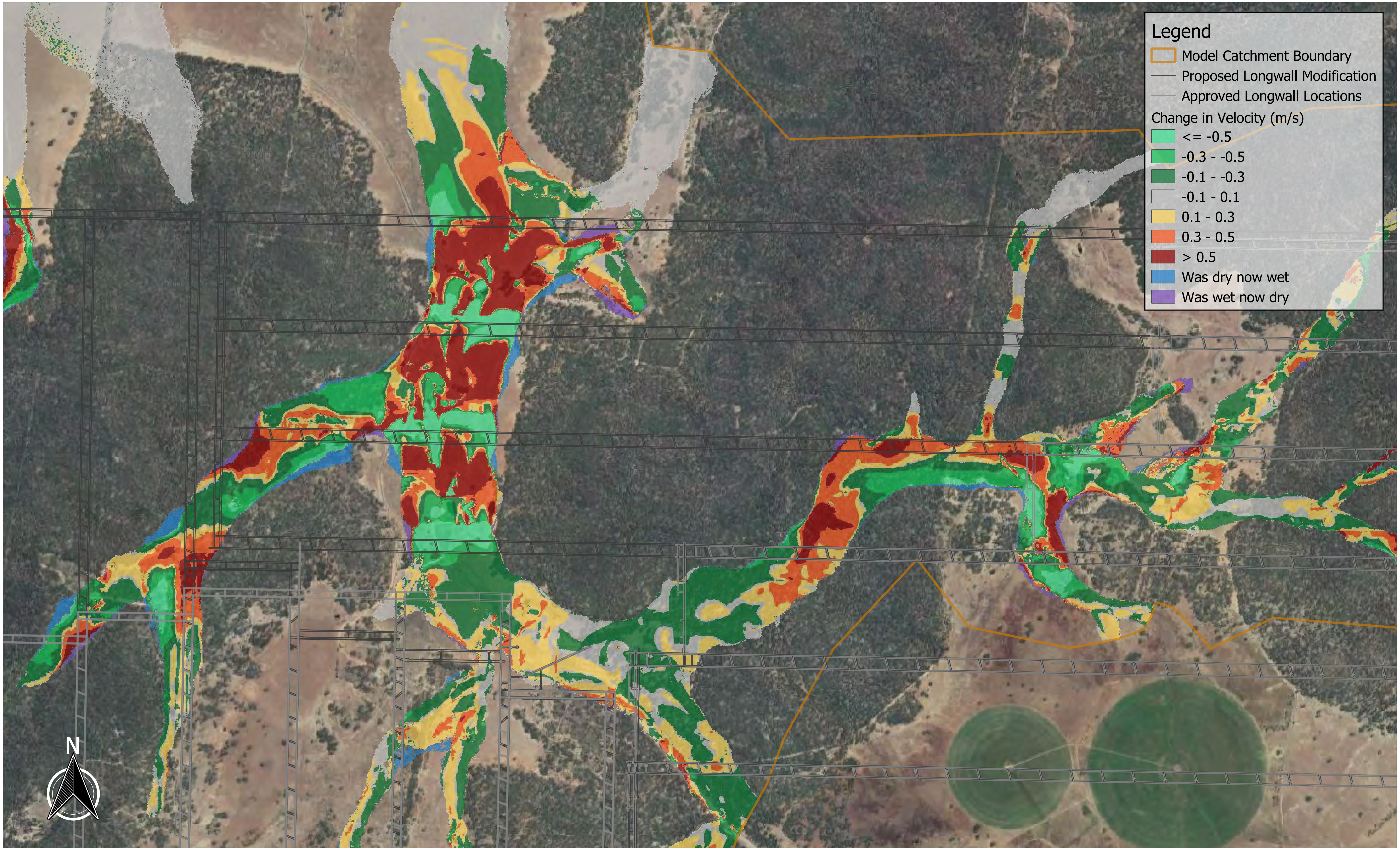
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Option 2

Change in Velocity - PMF Event (Proposed Modification vs Approved Conditions)

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Revision: 0
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0 300 600 m

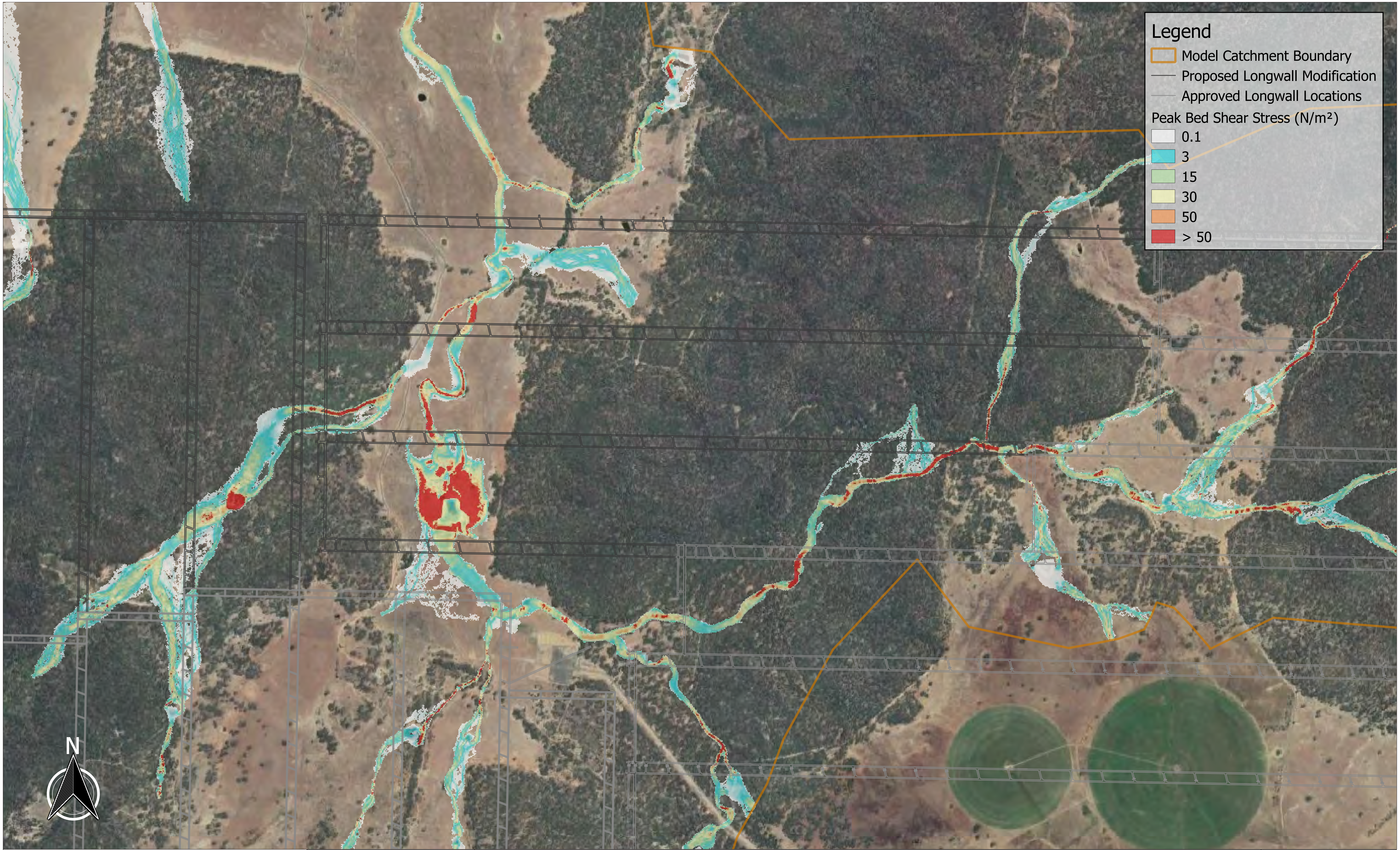
Scale in metres (1:14,000 @ A3)

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Ulan Modification 6 - Approved Conditions

Peak Bed Shear Stress - 50% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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Map Projection: Tranverse Mercator
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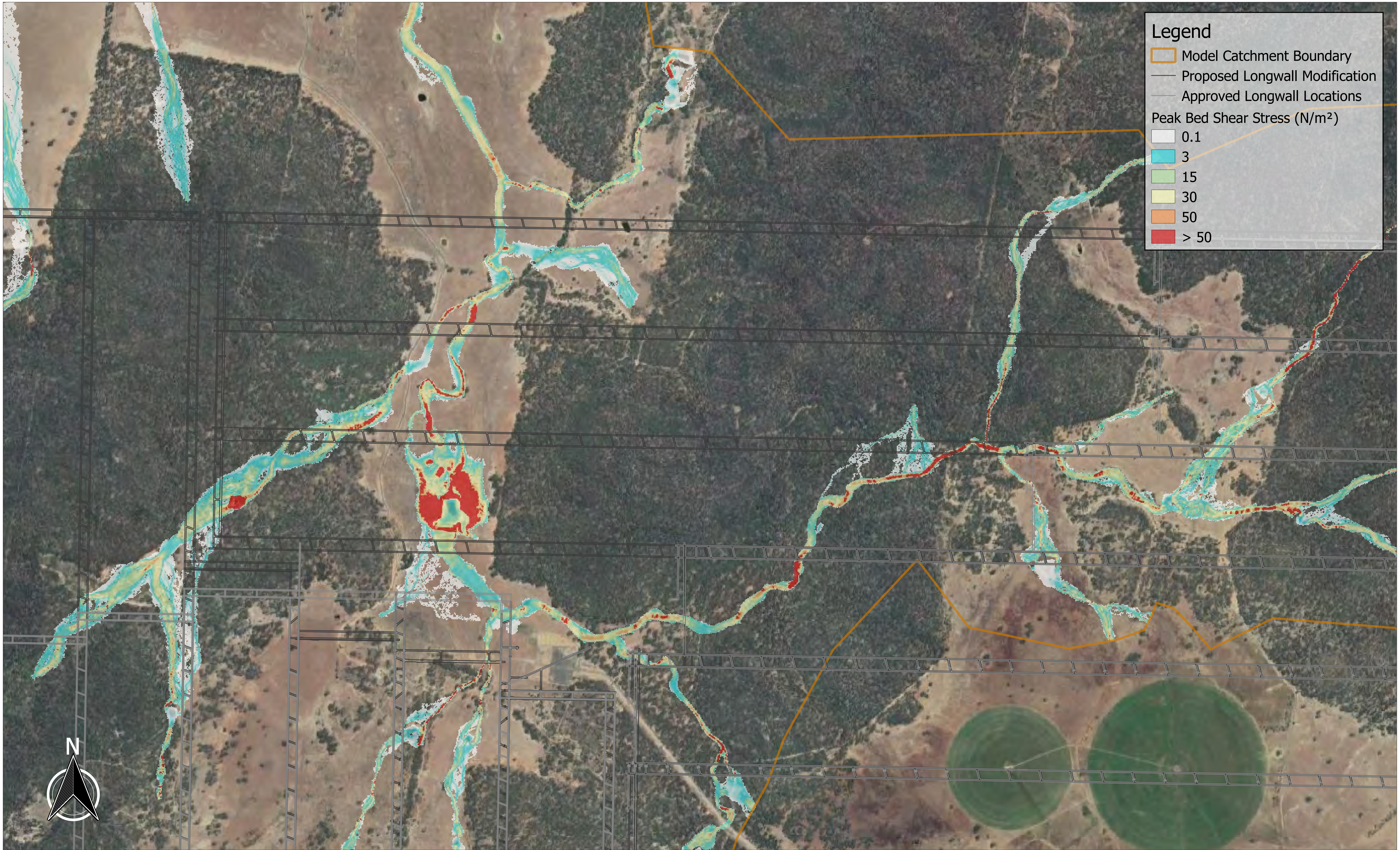
Ulan Modification 6 - Option 1

Peak Bed Shear Stress - 50% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022



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Ulan Modification 6 - Option 2

Peak Bed Shear Stress - 50% AEP Event

Job Number: N4003_010
Revision: 0
Drawn: GC
Checked: MB
Date: 5 /9 /2022

Appendix B:
Water Quality

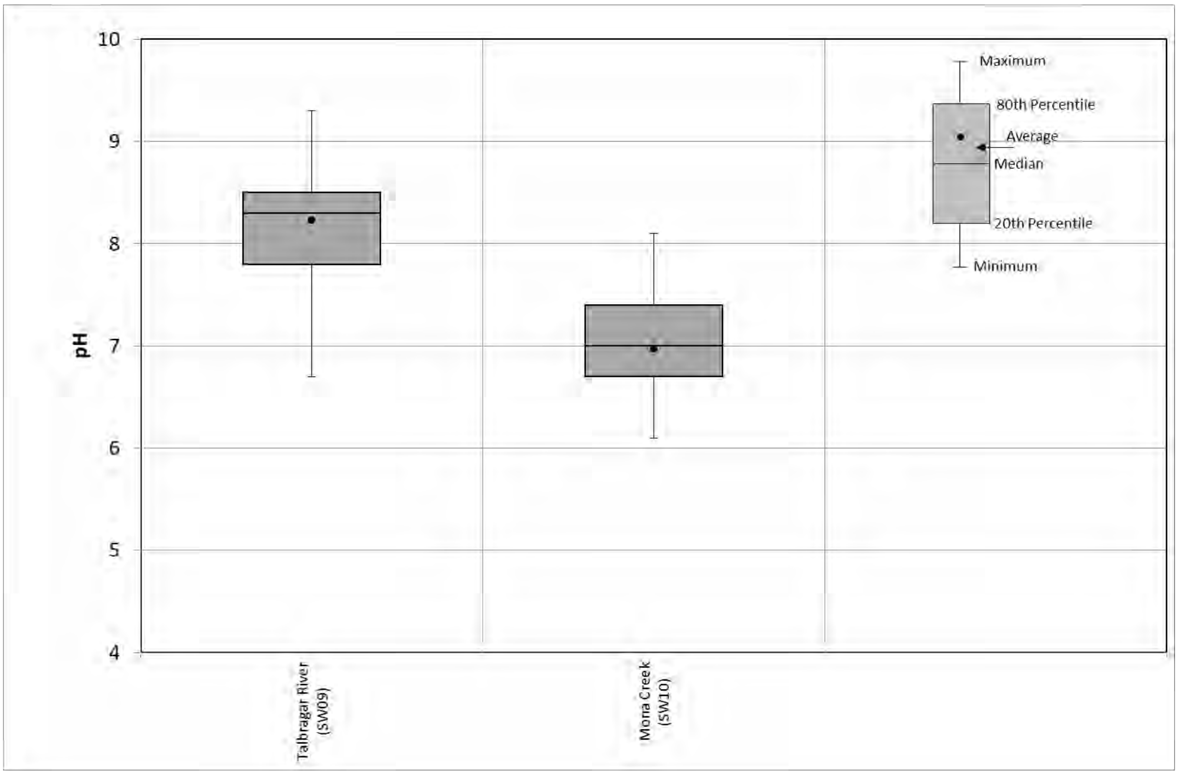

Figure B. 1: pH

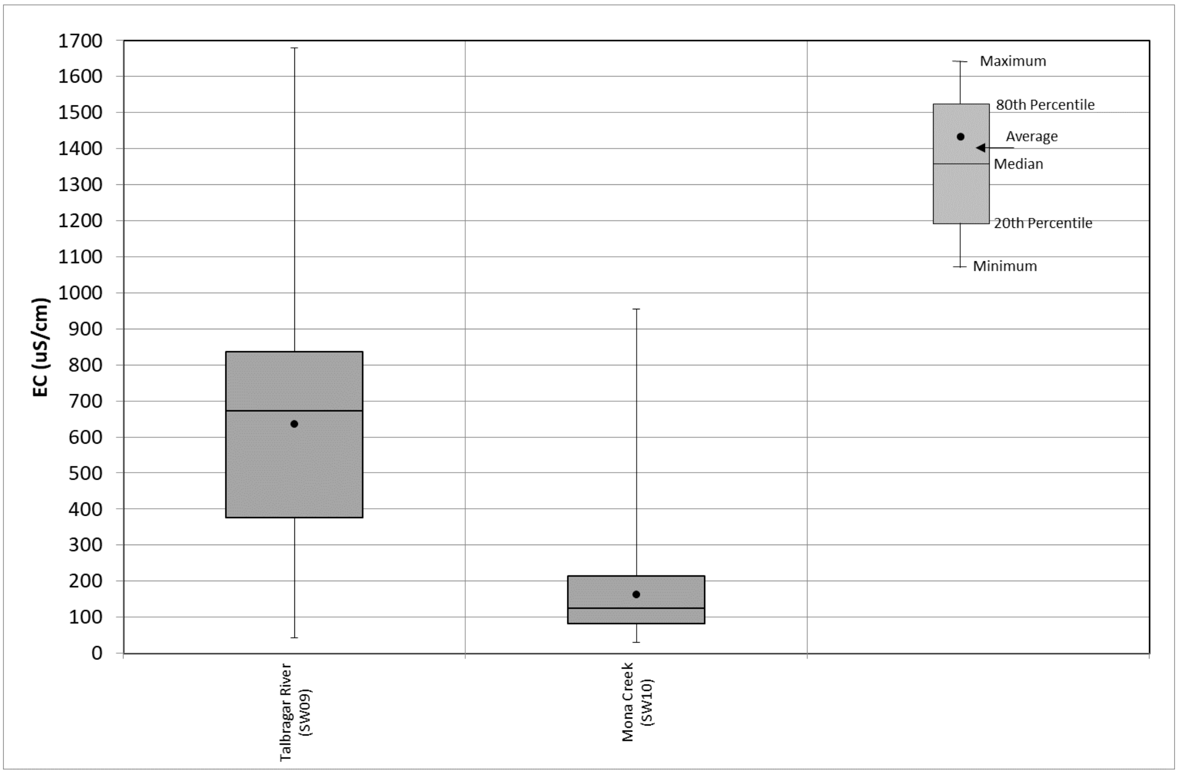

Figure B. 2: EC

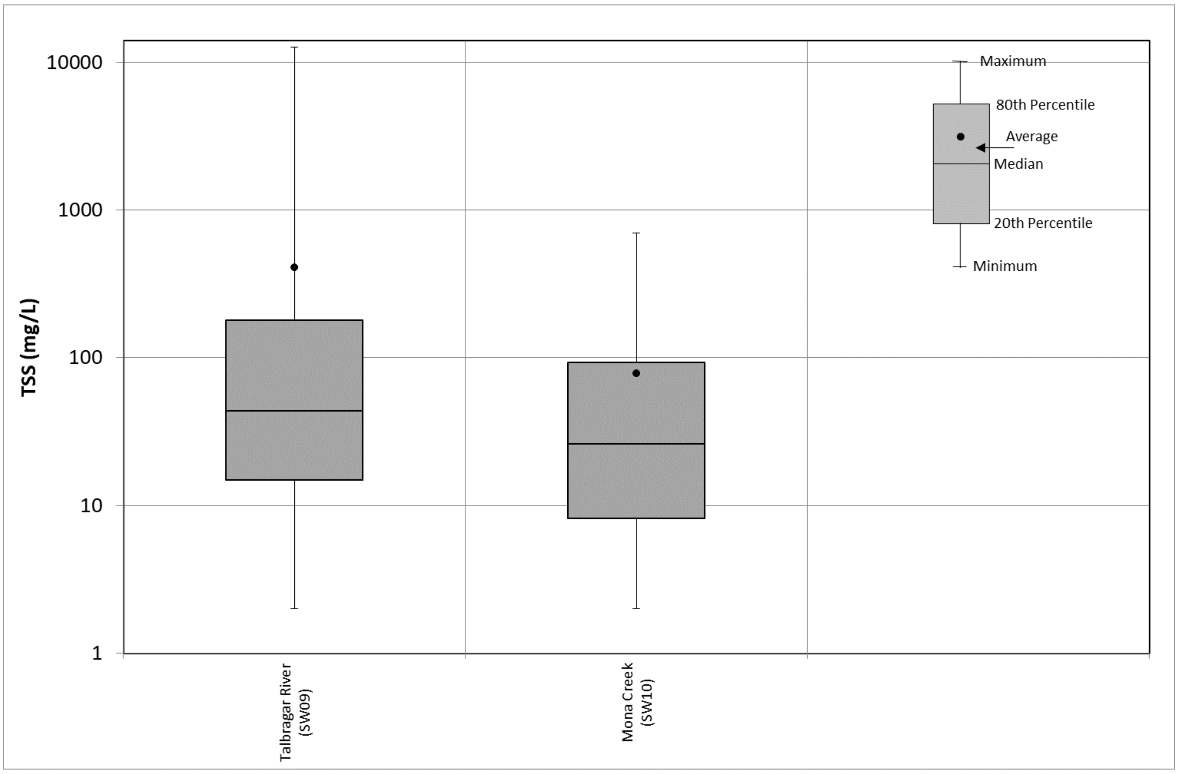

Figure B. 3: TSS

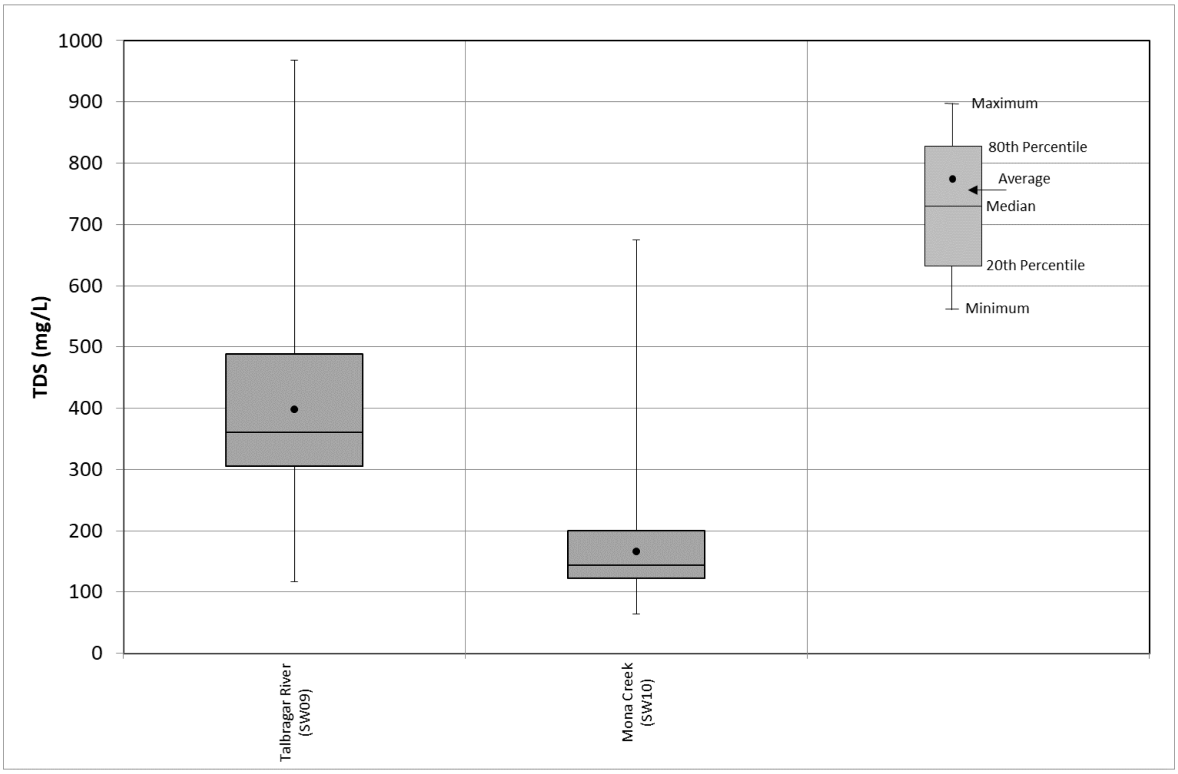

Figure B. 4: TDS

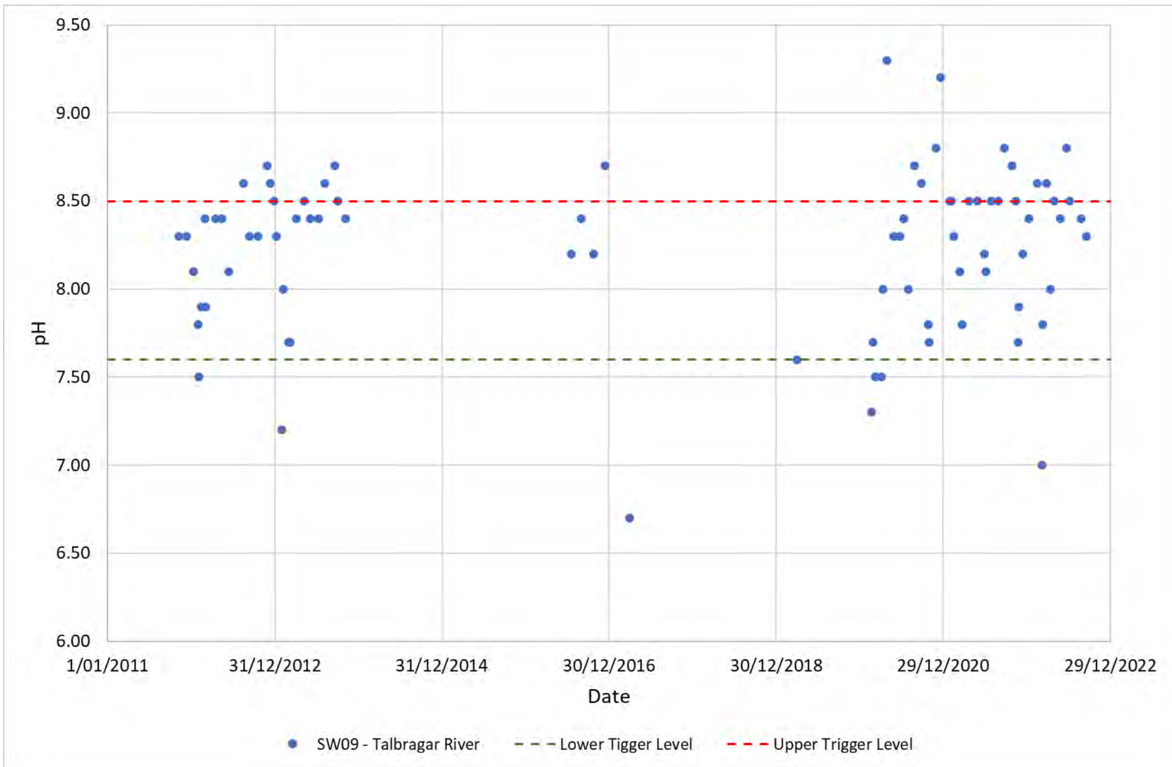

Figure B. 5: Talbragar River (SW09) - pH

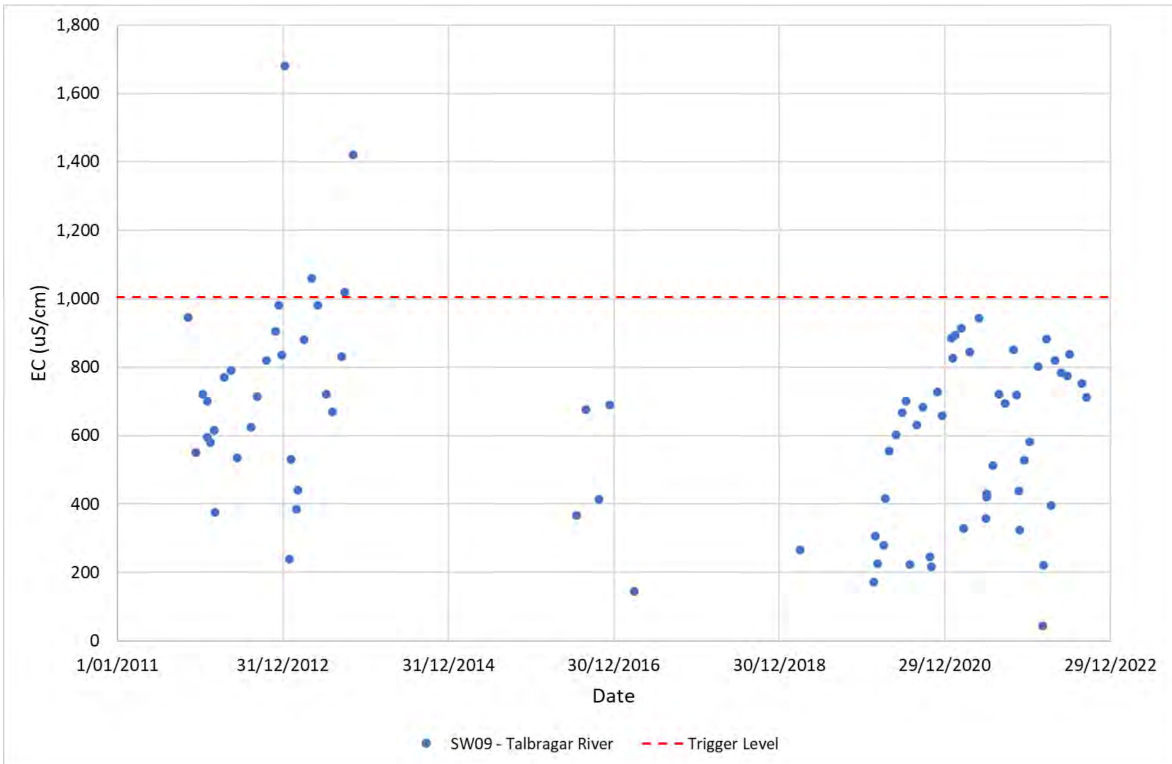

Figure B. 6: Talbragar River (SW09) - EC

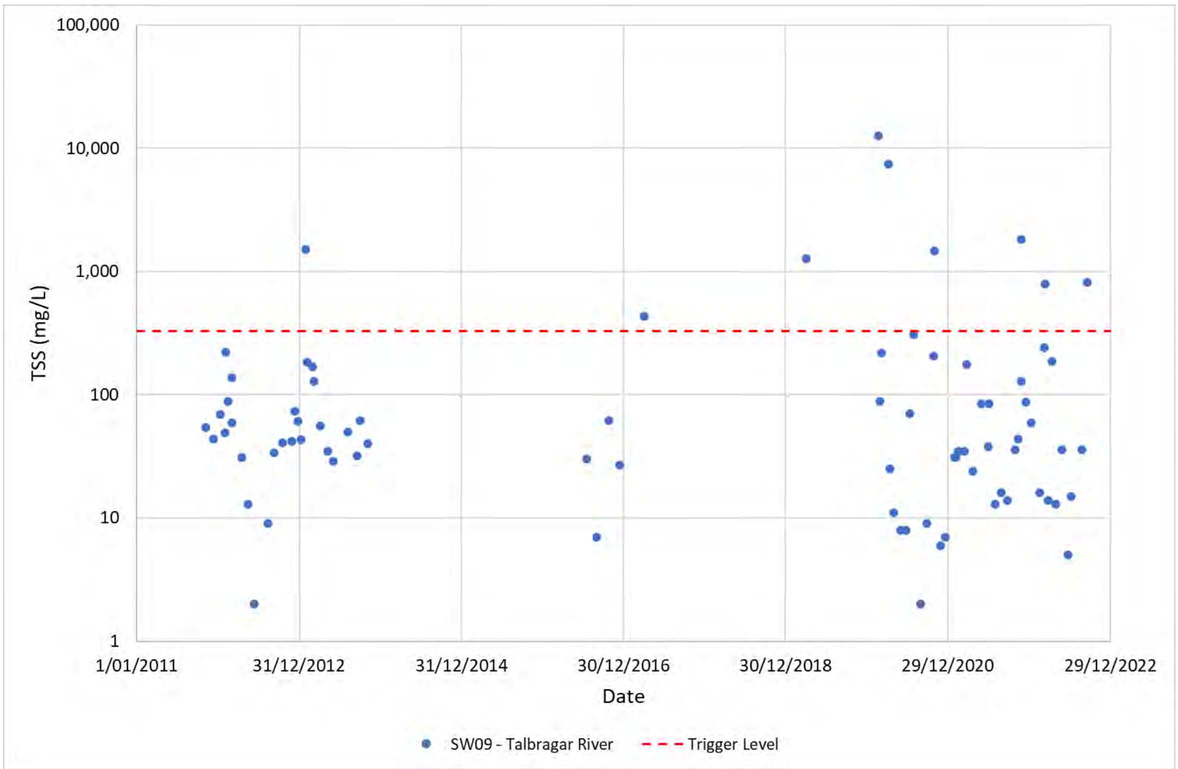

Figure B. 7: Talbragar River (SW09) - TSS

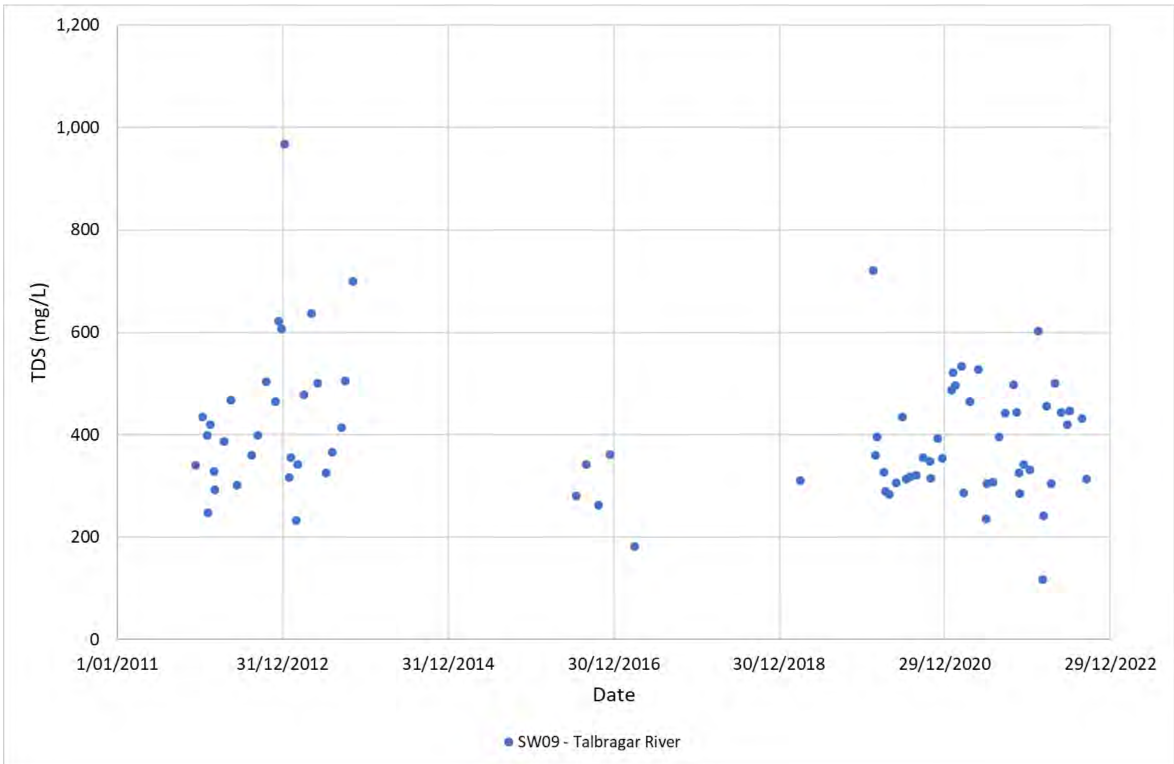

Figure B. 8: Talbragar River (SW09) - TDS

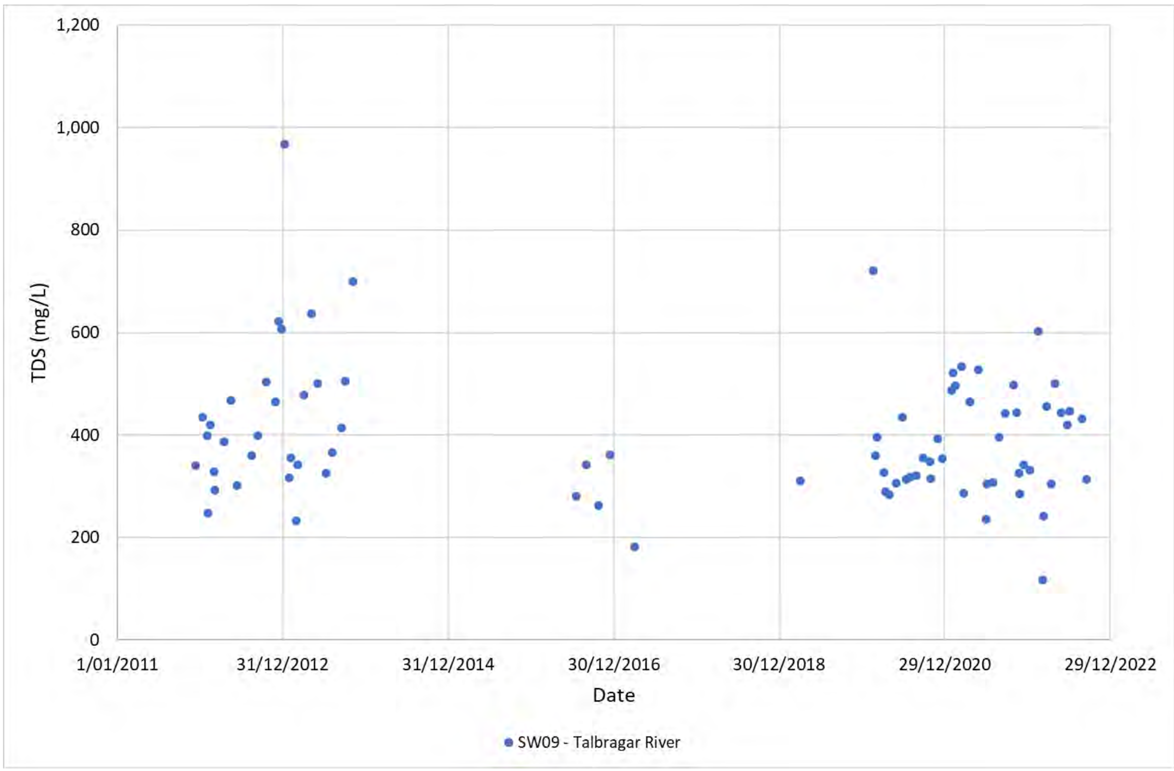

Figure B. 9: Mona Creek (SW10)- pH

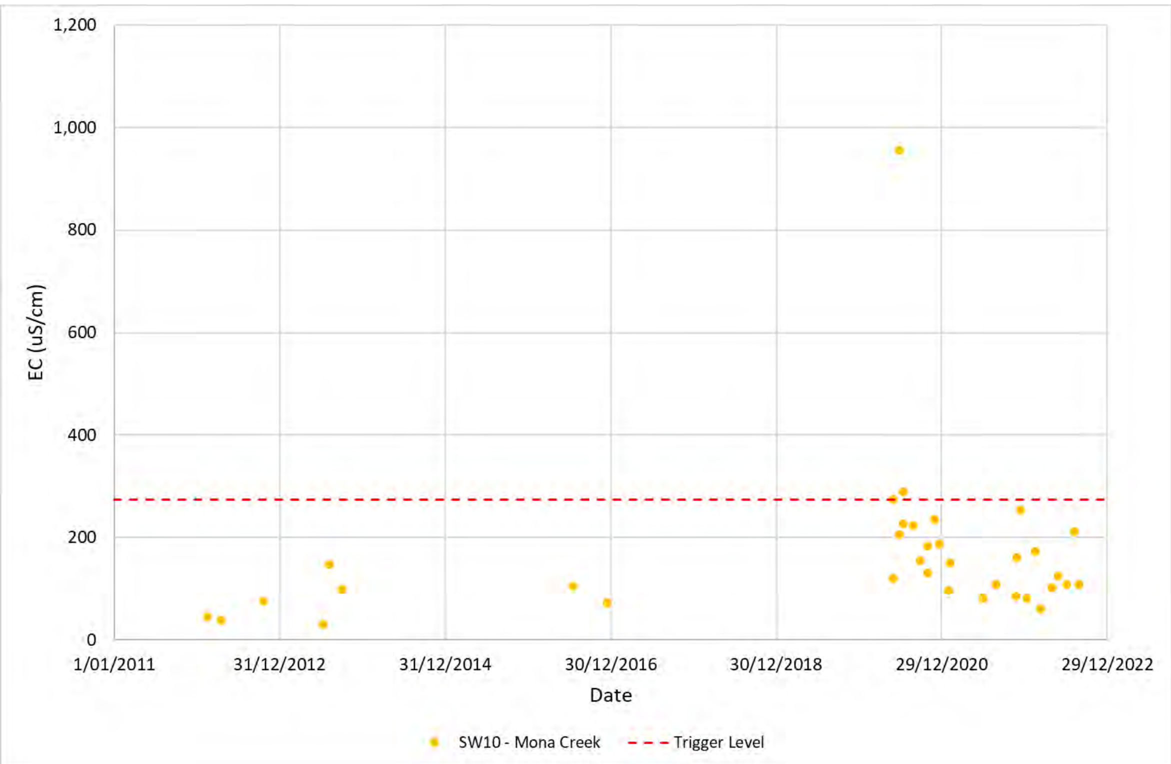

Figure B. 10: Mona Creek (SW10) - EC

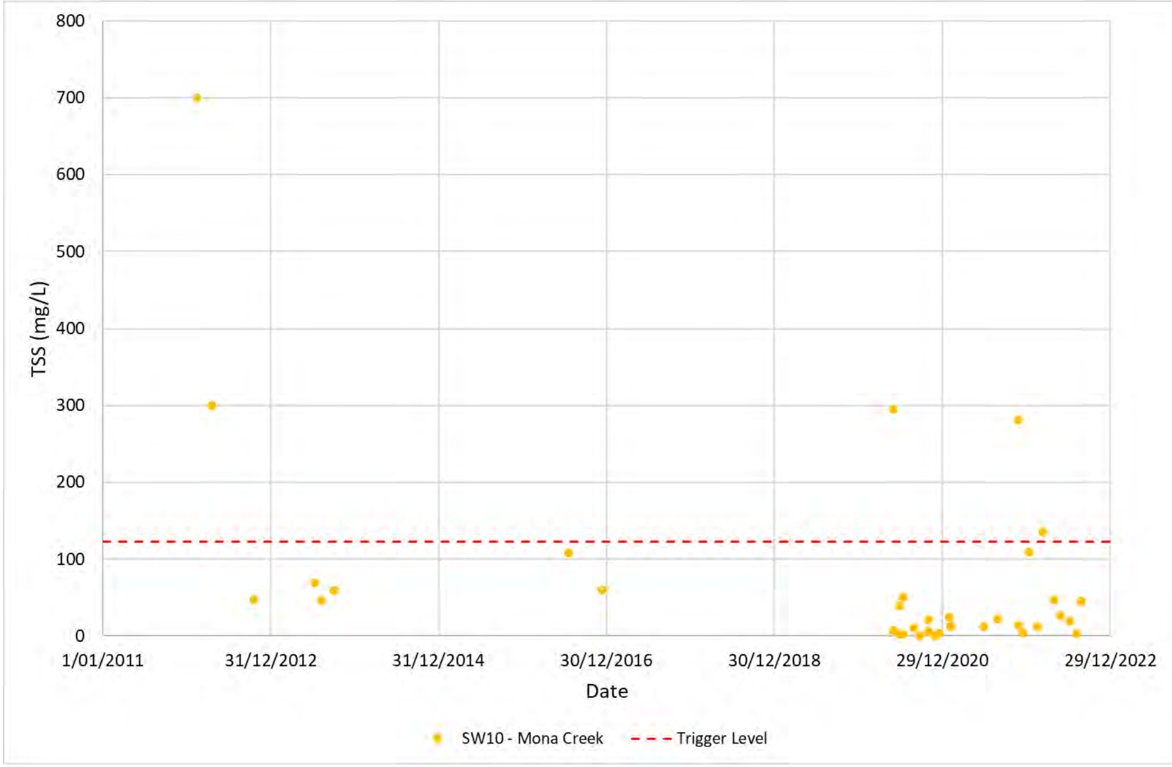

Figure B. 11: Mona Creek (SW10) – TSS

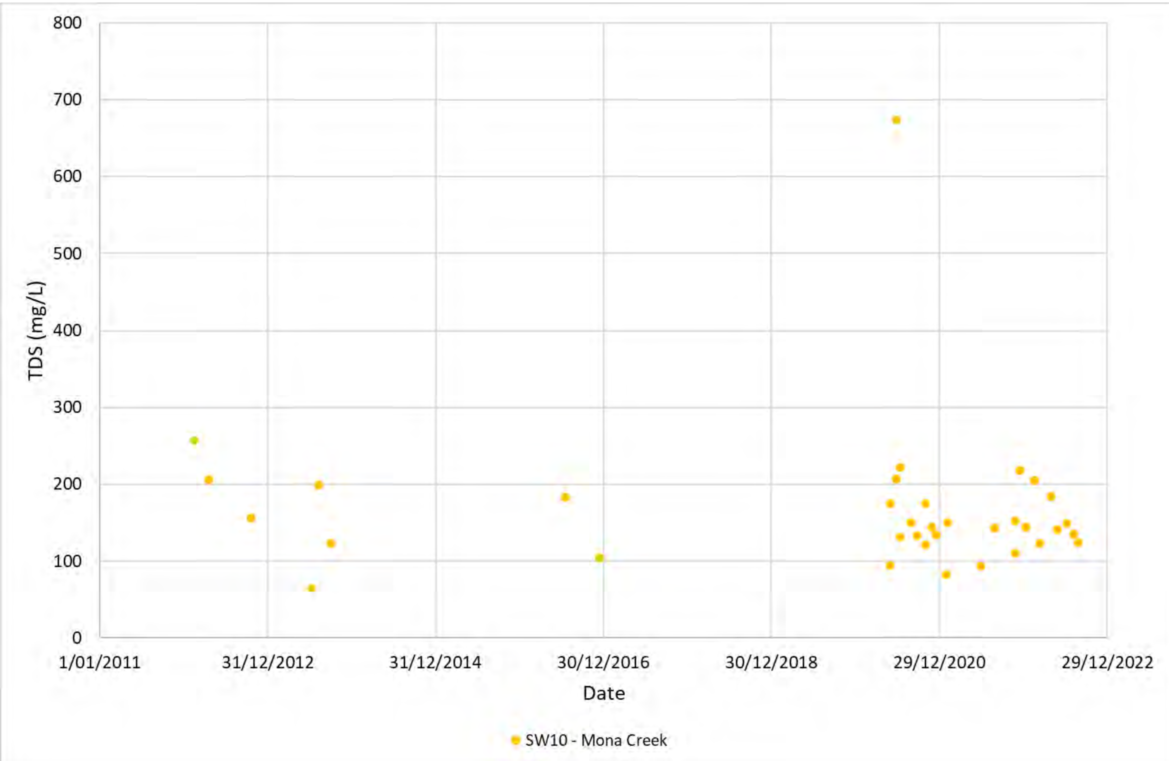

Figure B. 12: Mona Creek (SW10) – TDS

Appendix C:
Climate Change Assessment

C.1 CLIMATE CHANGE PREDICTIONS

A climate change assessment was undertaken to understand the sensitivity of streamflow and flood impacts to climate change.

The Australian Rainfall and Runoff 2019 (ARR) (Ball, et al., 2019) design rainfall depths do not include potential climate change effects. The recommended process for assessing the impacts of climate change in accordance with Book 1, Chapter 6 of the ARR Guidelines is to increase the rainfall (intensity or depth) by 5% per °C of predicted local warming (i.e. a temperature-scaling approach).

Climate projections for the Project were obtained using the Climate Futures Tool provided on the Climate Change in Australia website and applied using methodologies outlined in *Climate Change in Australia Technical Report* (CSIRO, 2015).

Projected changes to the storm rainfall intensity were obtained for the Representative Concentration Pathway 4.5 (RCP 4.5) emission scenarios. RCP 4.5 is an intermediate emission scenario, and hence considered the most realistic to be applied to the analysis. Data from the Central Slopes area of Australia was used as this is the region that the Proposed Modification is located within.

The projected changes to annual temperature, rainfall and evaporation for the 2050 and 2090 projection years are provided in Table C. 1, which also summarises the equivalent rainfall depth AEP associated with the change in rainfall for the emission scenario.

Table C. 1: Projected Mean Changes in Rainfall using the Climate Futures Tool – RCP 4.5

Projection Year	Change in Mean Surface Temperature	Increase in Rainfall Intensity	Increase in Annual Rainfall	Increase in Annual Evaporation
2050	1.452°C	7.3%	0.67%	-4.20%
2090	2.095°C	10.8%	4.85%	6.75%

C.2 FLOW REGIMES

Flow regimes in the river and creek systems which are expected to be impacted by the Proposed Modification were modelled to assess the impact of any potential reduction in baseflows. The estimated baseflow loss provided by the Groundwater Impact Assessment (AGE, 2022) was applied to the calibrated models discussed in Section 3.3 to determine any impacts on baseflows to affected rivers and creeks. The baseflow losses were estimated to be the same for Option 1 (base case) and Option 2 (flexible) mine plans.

C.2.1 Talbragar River

Talbragar River at SW09

Table 4.3 and C.3 show the modelled scenarios and the predicted impact on annual flow conditions as a result of the Proposed Modification for 2050 and 2090.

Table C. 2: Talbragar River at SW09 Flow Duration Analysis - 2050

Scenario	**Catchment Area (km^2)**	**Mining Induced Baseflow Losses (ML/d)**	**Average Annual Dry Days**	**Average Annual Flow Volume (ML/yr)**	Average duration of dry periods (days)
Existing	66,360	-	284	27,580	146
Approved Conditions	66,360	0.00804	287	27,575	147
Proposed Modification	66,360	0.00819	287	27,575	147

Table C. 3: Talbragar River at SW09 Flow Duration Analysis - 2090

Scenario	Catchment Area (km^2)	Mining Induced Baseflow Losses (ML/d)	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)	Average duration of dry periods (days)
Existing	66,360	-	321	22,845	163
Approved Conditions	66,360	0.02724	324	22,840	165
Proposed Modification	66,360	0.02739	324	22,840	165

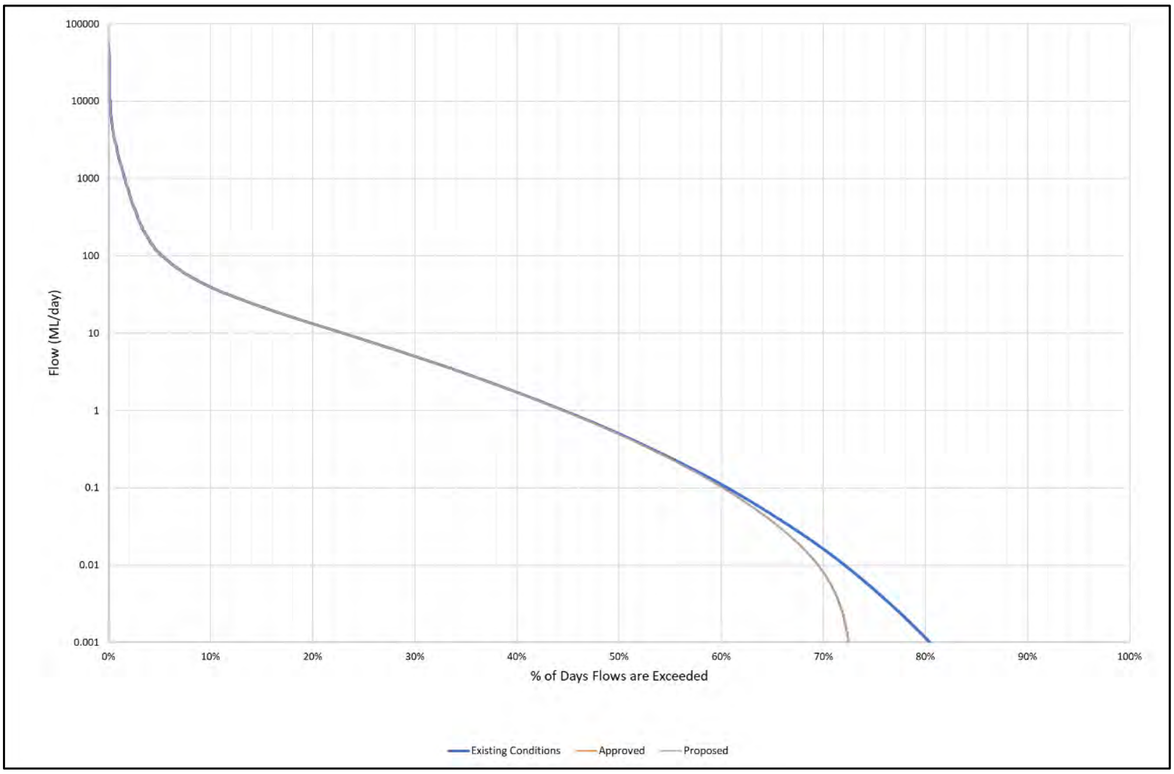

Figure C.1: Talbragar River at SW09 Modelled Flow Duration – 2050

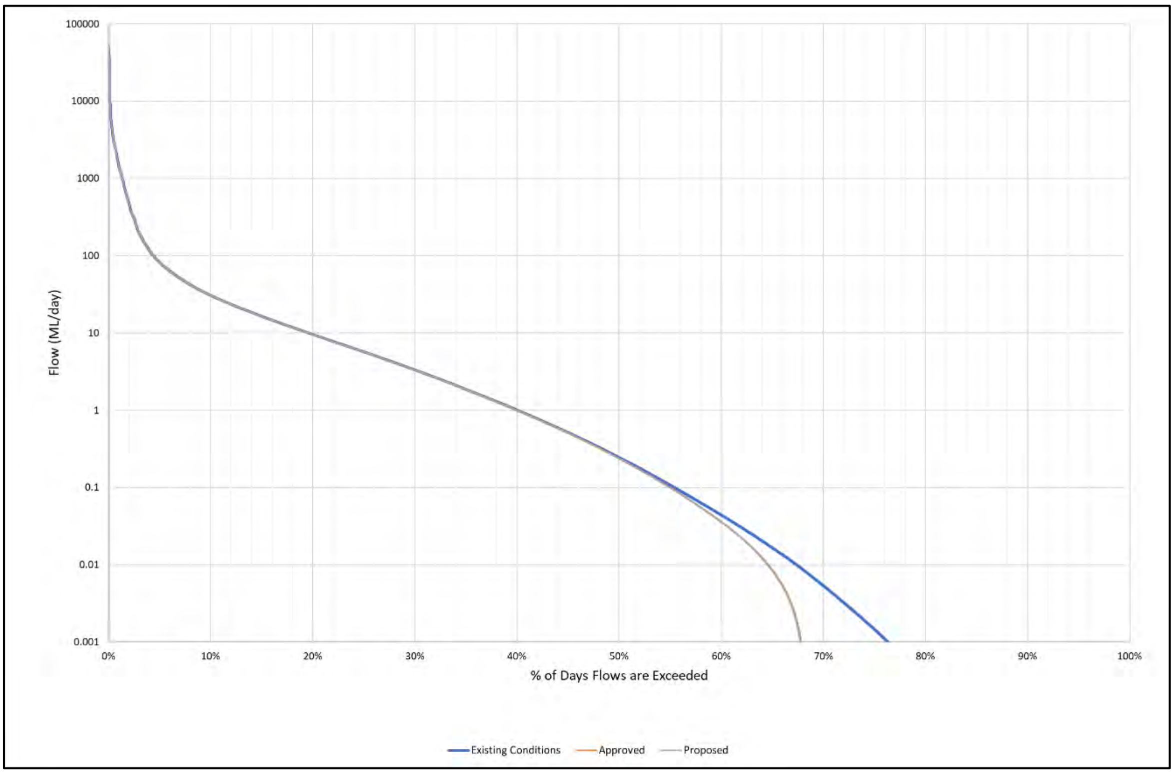

Figure C.2: Talbragar River at SW09 Modelled Flow Duration – 2090

The modelling indicates no impact to the estimated frequency of no flow periods and no increase in average annual dry days (defined as flows less than 0.1 ML/day) in the Talbragar River at SW09 as a result of the Proposed Modification relative to the currently approved mining operations for the 2050 and 2090 climate scenarios.

Talbragar River at Dunedoo

Tables C.4 and C.5 show the modelled scenarios and the predicted impact on annual flow conditions as a result of the Proposed Modification for 2050 and 2090.

Table C.4: Talbragar River at Dunedoo Flow Duration Analysis - 2050

Scenario	Catchment Area (km^2)	Mining Induced Baseflow Losses (ML/d)	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)	Average duration of dry periods (days)
Existing	200,260	-	309	41,555	170
Approved Conditions	200,260	0.05375	327	41,540	173
Proposed Modification	200,260	0.05484	327	41,540	173

Table C.5: Talbragar River at Dunedoo Flow Duration Analysis - 2090

Scenario	Catchment Area (km^2)	Mining Induced Baseflow Losses (ML/d)	Average Annual Dry Days	Average Annual Flow Volume (ML/yr)	Average duration of dry periods (days)
Existing	200,260	-	346	33,630	192
Approved Conditions	200,260	0.05375	363	33,620	192

Proposed Modification	200,260	0.05484	363	33,620	192

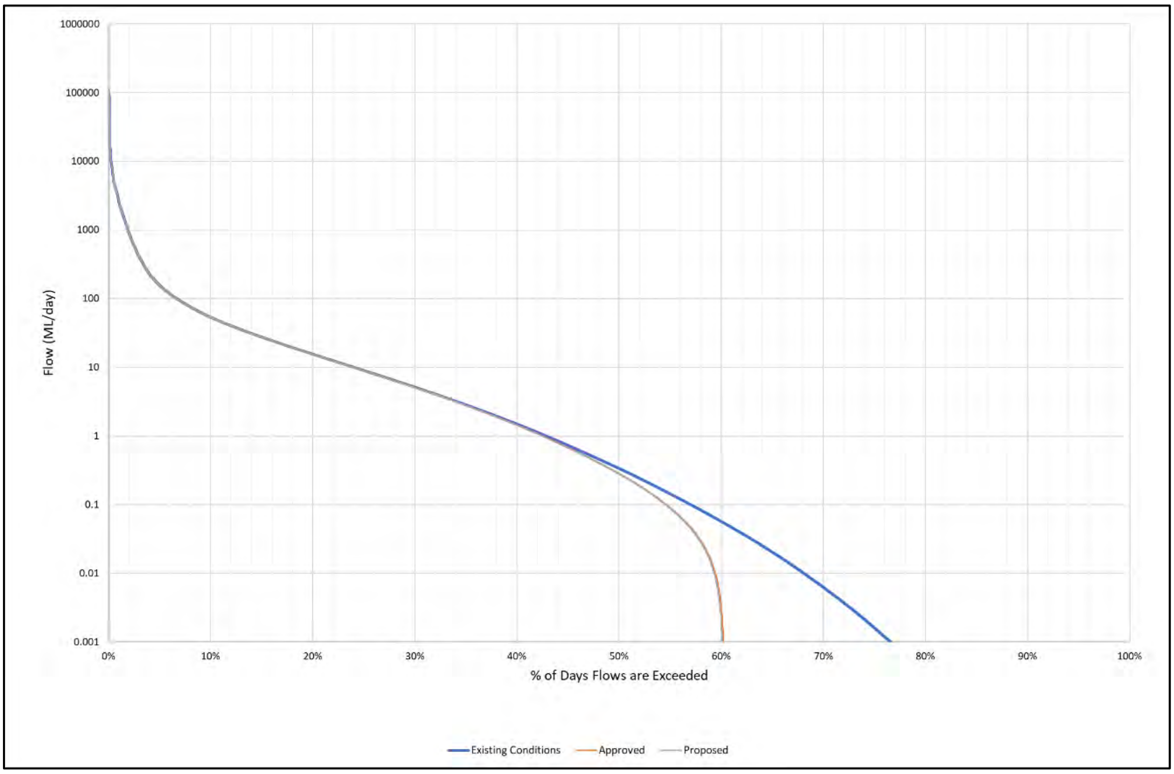

Figure C.3: Talbragar River at Dunedoo Modelled Flow Duration – 2050

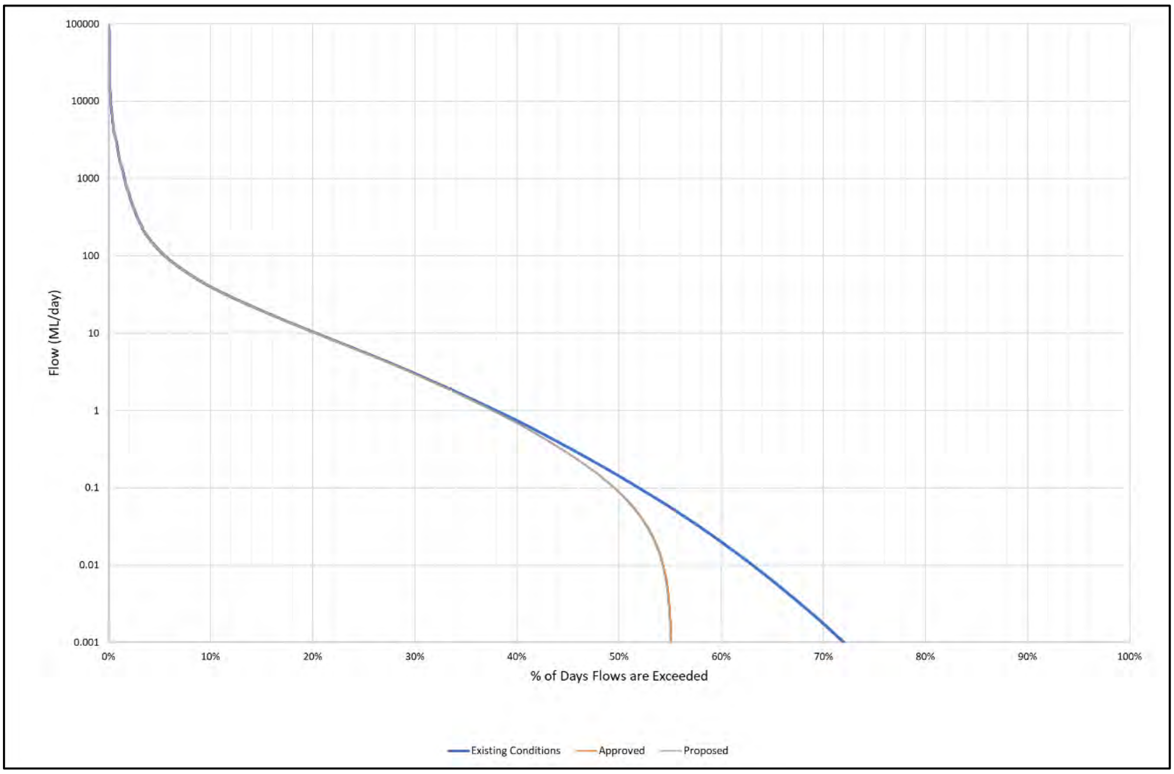

Figure C.4: Talbragar River at Dunedoo Modelled Flow Duration - 2090

The modelling indicates no impact to the estimated frequency of no flow periods and no increase in average annual dry days (defined as flows less than 0.1 ML/day) in the Talbragar River at Dunedoo as a result of the Proposed Modification relative to the currently approved mining operations for the 2050 and 2090 climate scenarios.

C.3 FLOODING

The adjusted 1:100 AEP design rainfall intensities were applied to the XP-RAFTS model (refer to Appendix A) to determine the expected change in peak flows and impacts for the Modification.

The following scenarios were assessed for the 2050 and 2090 climate change scenarios:

- Current Approved Landform
- Option 1: Base case proposed subsided landform
- Option 2: Flexible proposed subsided landform

The 1% AEP event modelling results for the two climate change scenarios for the two options are presented below. Peak flood depth and peak flood velocities are presented for each of the events. A comparison to the approved landform was conducted using afflux and change in velocity.

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Figure C.5: Ulan Modification 6 - Approved Conditions

Climate Change Impacts - Baseline

Peak Flood Depth - 1% AEP Flood Event

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Figure C.6: Ulan Modification 6 - Approved Conditions

Climate Change Impacts - RCP 4.5 2050

Peak Flood Depth - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022

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Horizontal Datum: Geocentric Datum of Australia
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Grid: Map Grid of Australia, Zone 56

Figure C.7: Ulan Modification 6 - Approved Conditions

Climate Change Impacts - RCP 4.5 2090

Peak Flood Depth - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
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Date: 26 /10 /2022

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Figure C.8: Ulan Modification 6 - Option 1

Climate Change Impacts - Baseline

Peak Flood Depth - 1% AEP Flood Event

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Revision: 0
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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.9: Ulan Modification 6 - Option 1

Climate Change Impacts - RCP 4.5 2050

Peak Flood Depth - 1% AEP Flood Event

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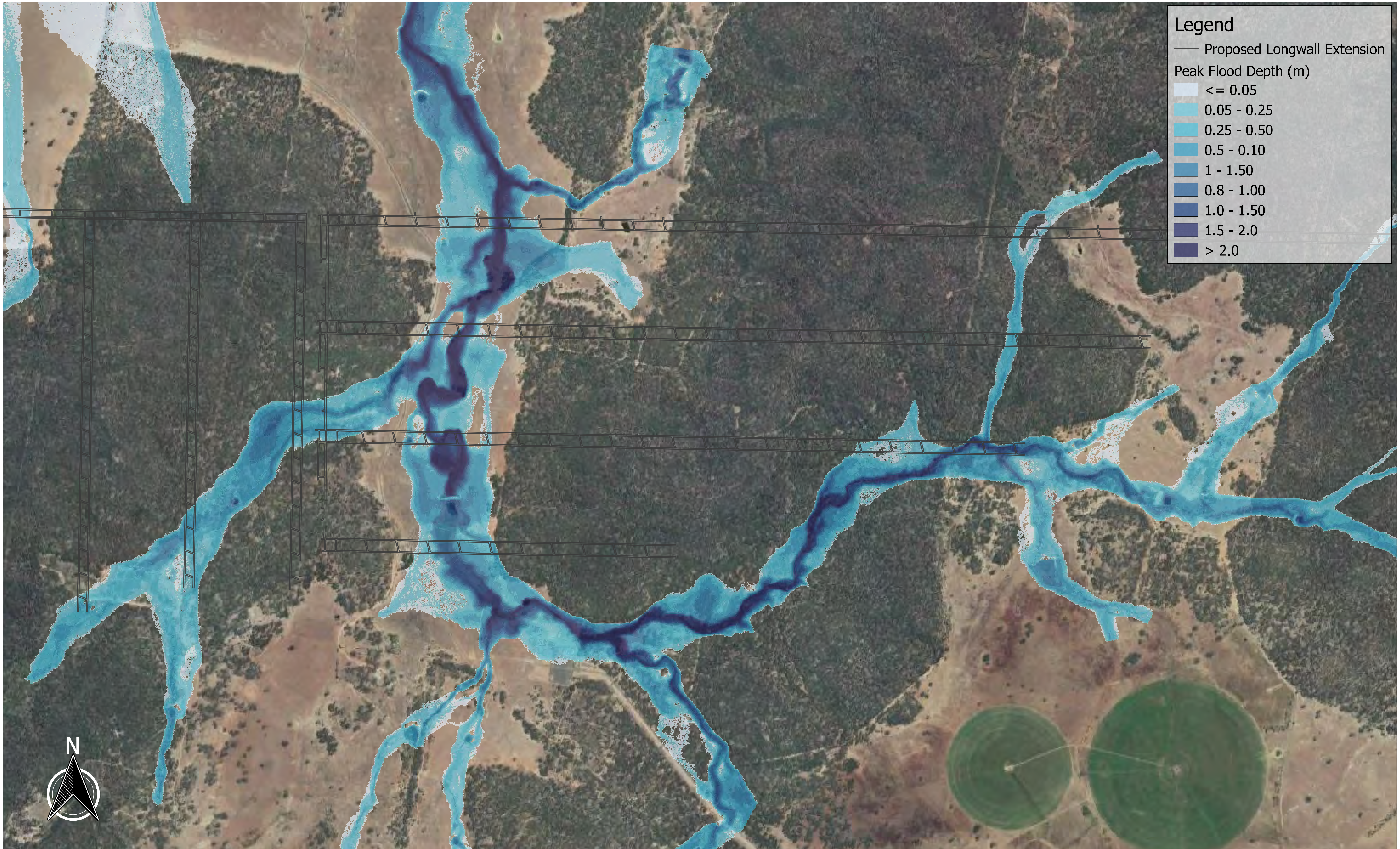
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Grid: Map Grid of Australia, Zone 56

Figure C.10: Ulan Modification 6 - Option 1

Climate Change Impacts - RCP 4.5 2090

Peak Flood Depth - 1% AEP Flood Event

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Revision: 0
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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.11: Ulan Modification 6 - Option 2

Climate Change Impacts - Baseline

Peak Flood Depth - 1% AEP Flood Event

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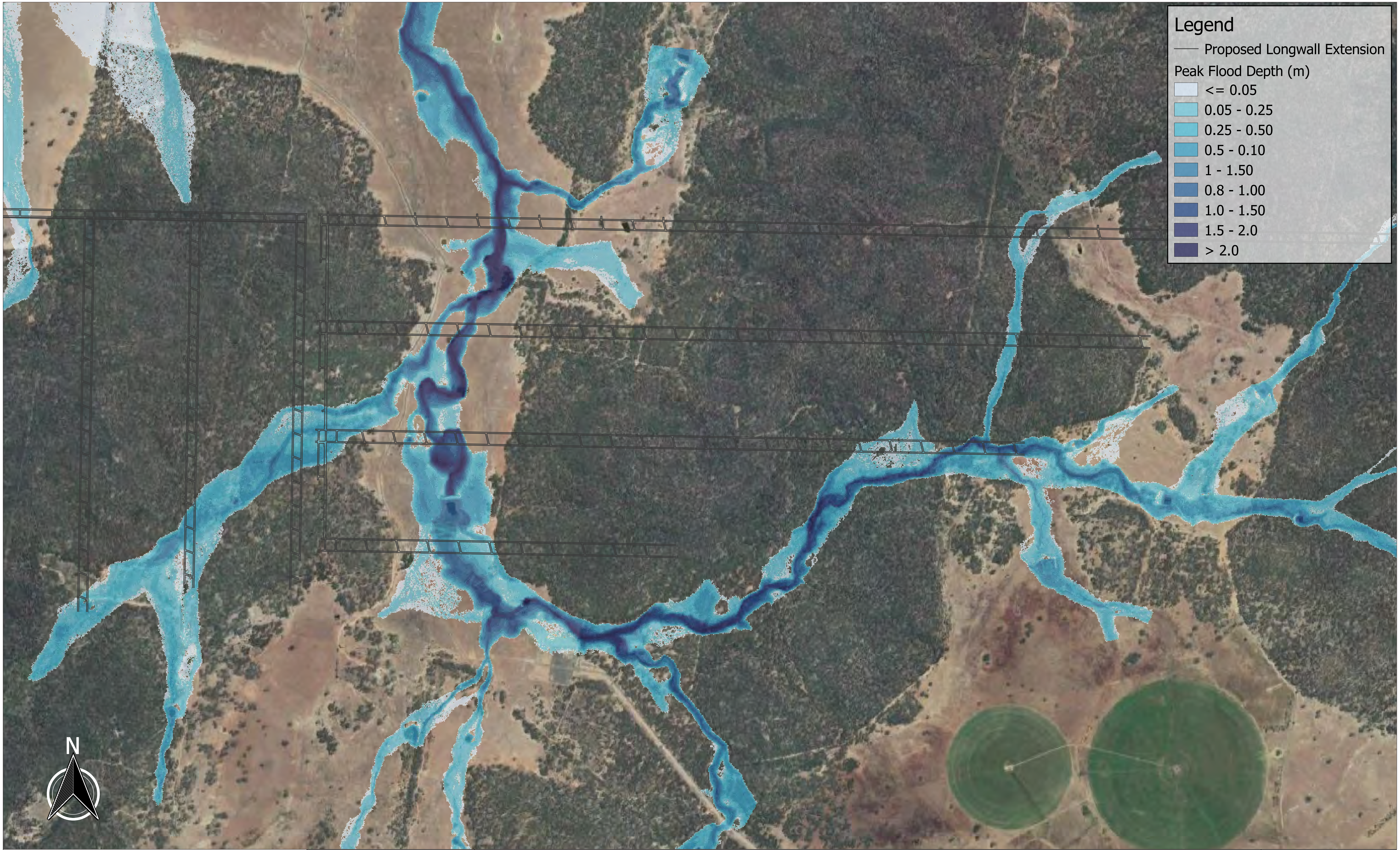
Checked: MB
Date: 26 /10 /2022



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Grid: Map Grid of Australia, Zone 56

Figure C.12: Ulan Modification 6 - Option 2

Climate Change Impacts - RCP 4.5 2050

Peak Flood Depth - 1% AEP Flood Event

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Revision: 0
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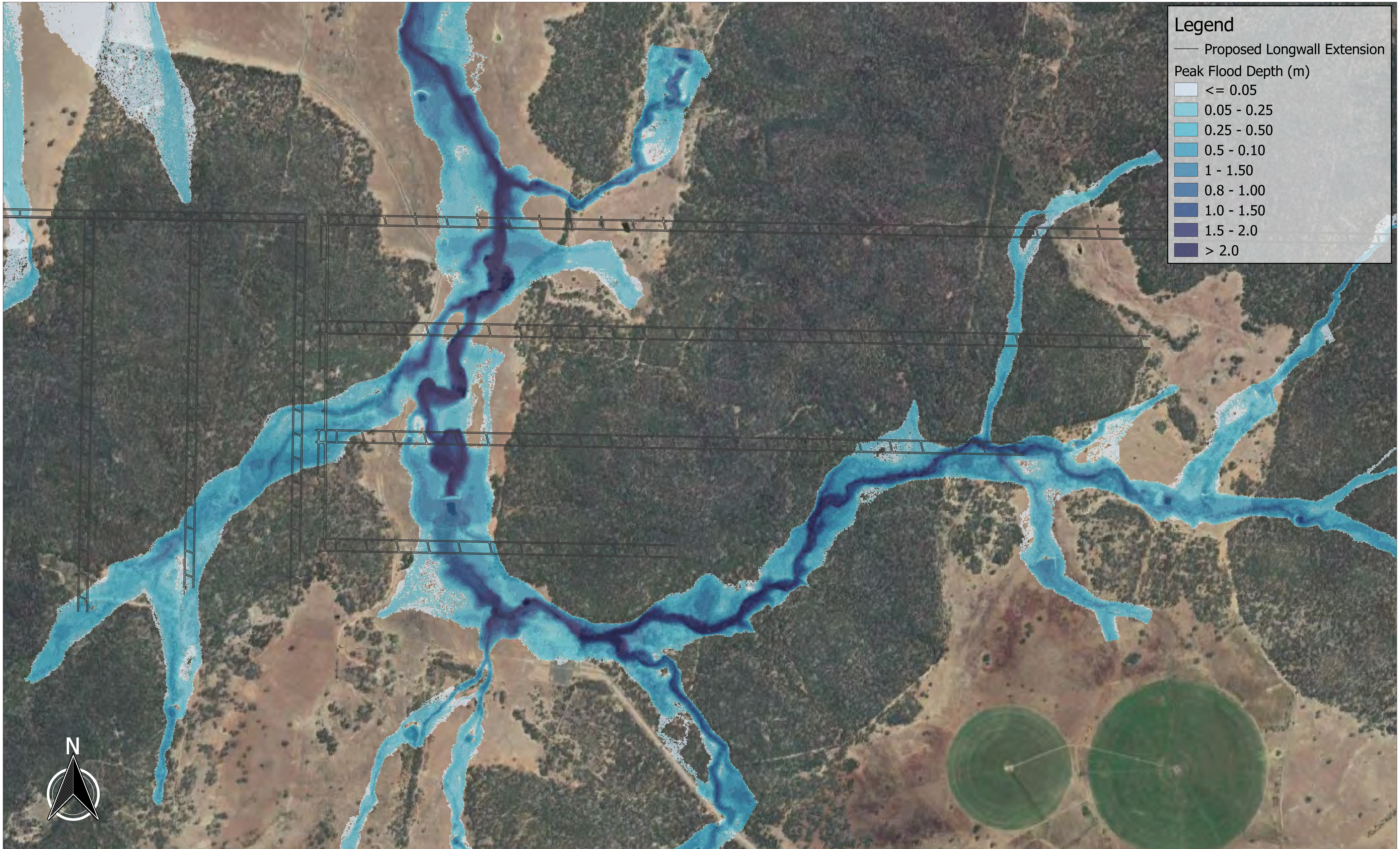
Checked: MB
Date: 26 /10 /2022



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Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.13: Ulan Modification 6 - Option 2

Climate Change Impacts - RCP 4.5 2090

Peak Flood Depth - 1% AEP Flood Event

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Revision: 0
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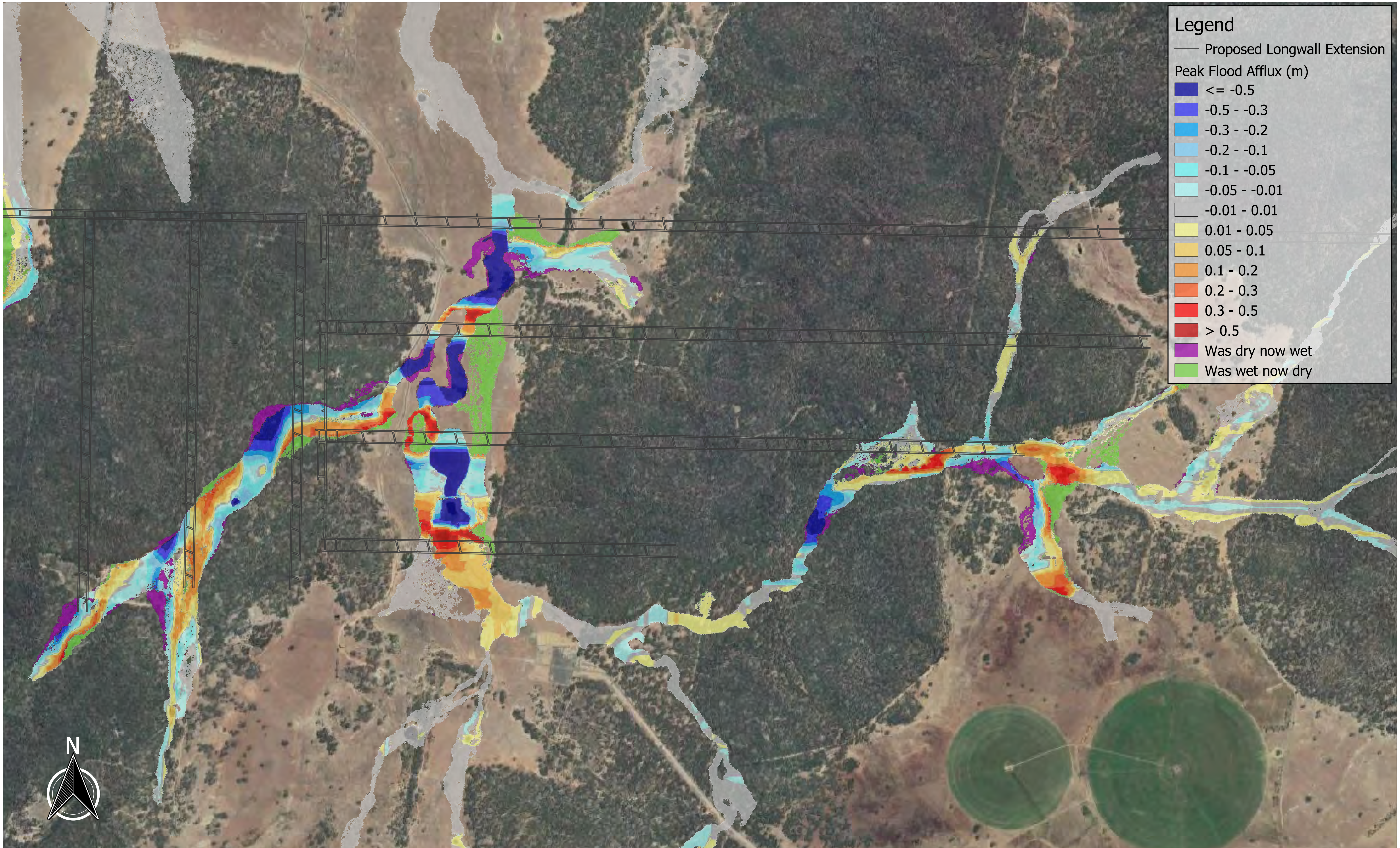
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

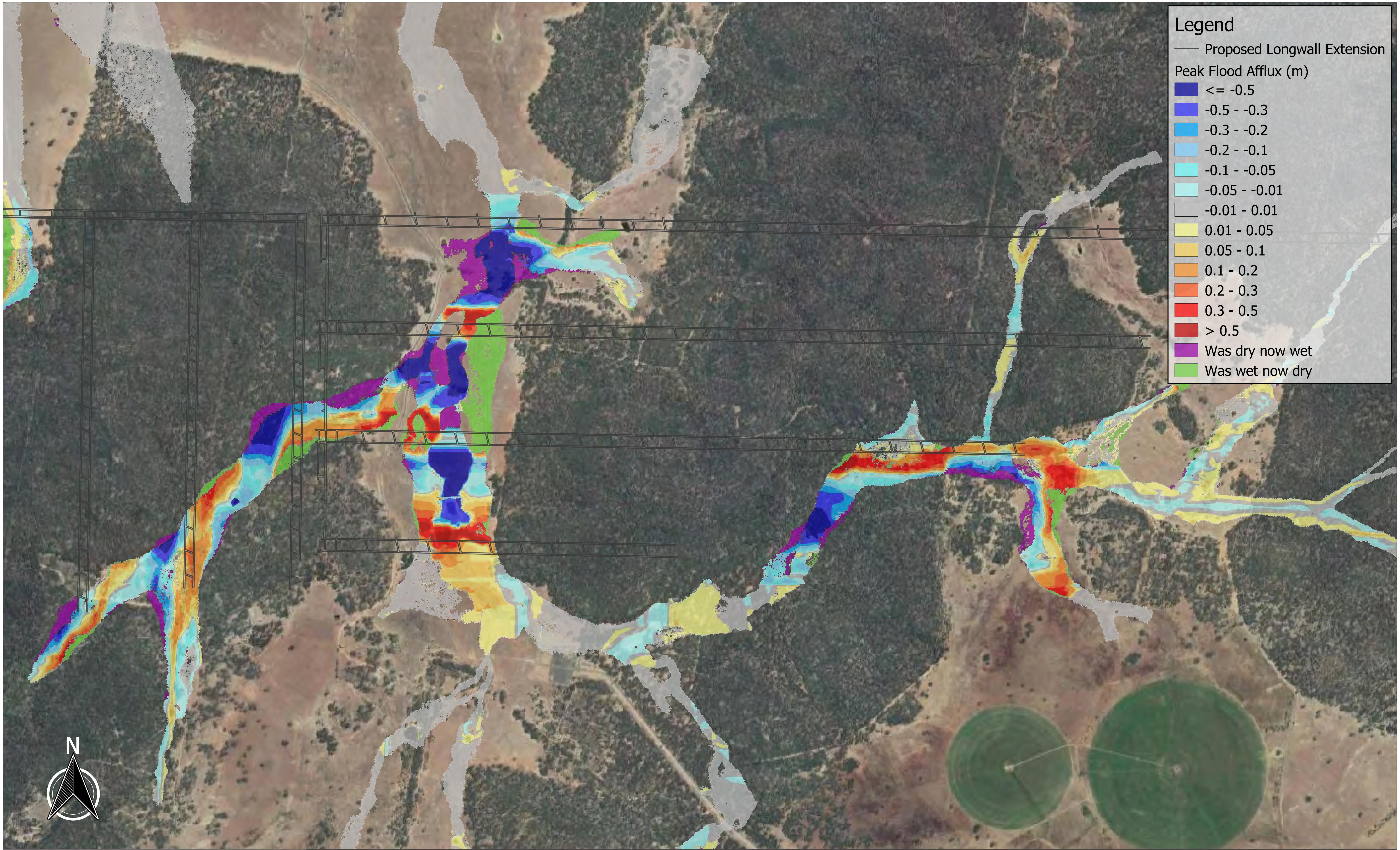
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.14: Ulan Modification 6 - Option 1 vs Existing Conditions

Climate Change Impacts - Baseline

Afflux - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

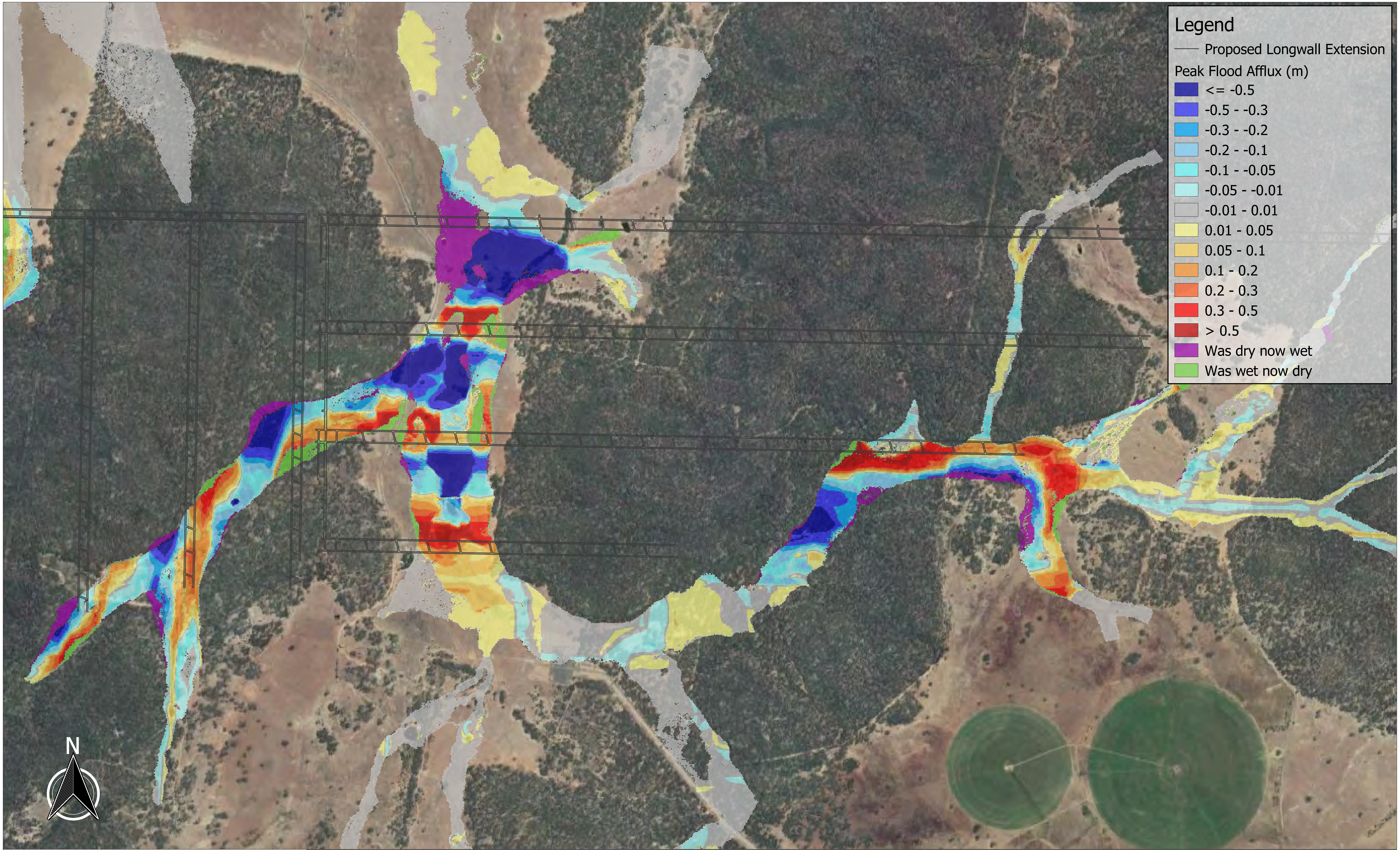
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.15: Ulan Modification 6 - Option 1 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2050

Afflux - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

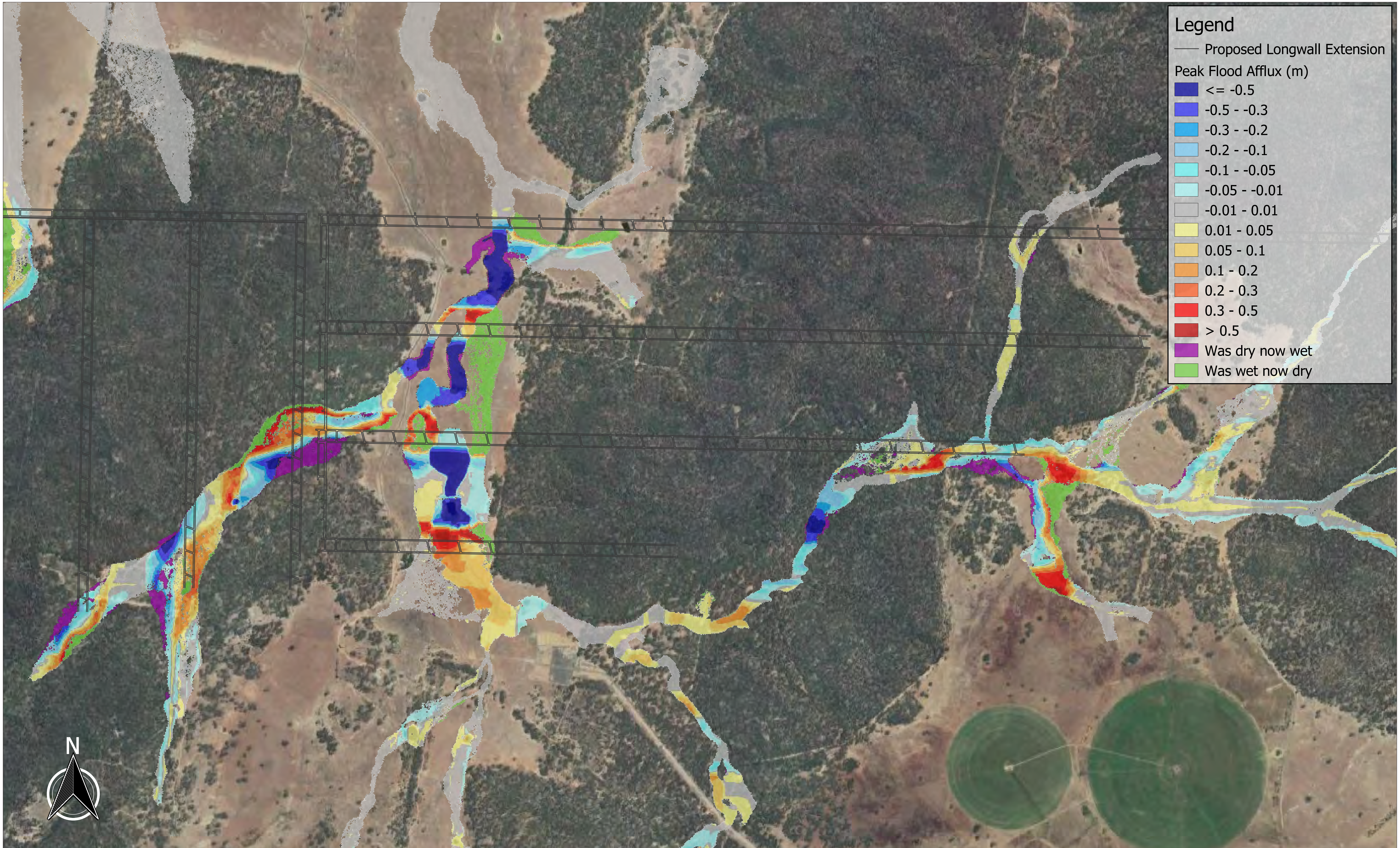
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.16: Ulan Modification 6 - Option 1 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2090

Afflux - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

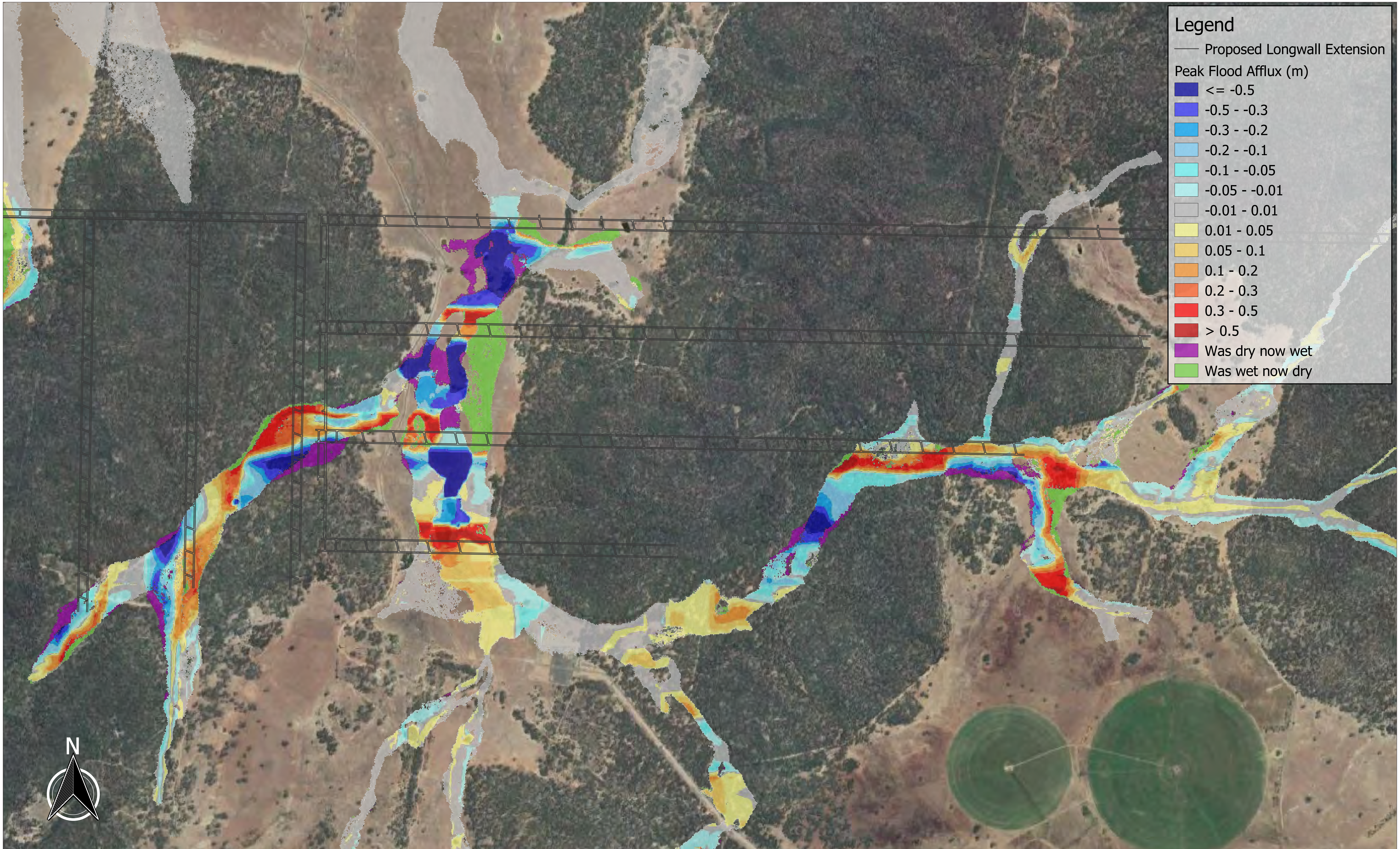
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.17: Ulan Modification 6 - Option 2 vs Existing Conditions

Climate Change Impacts - Baseline

Afflux - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

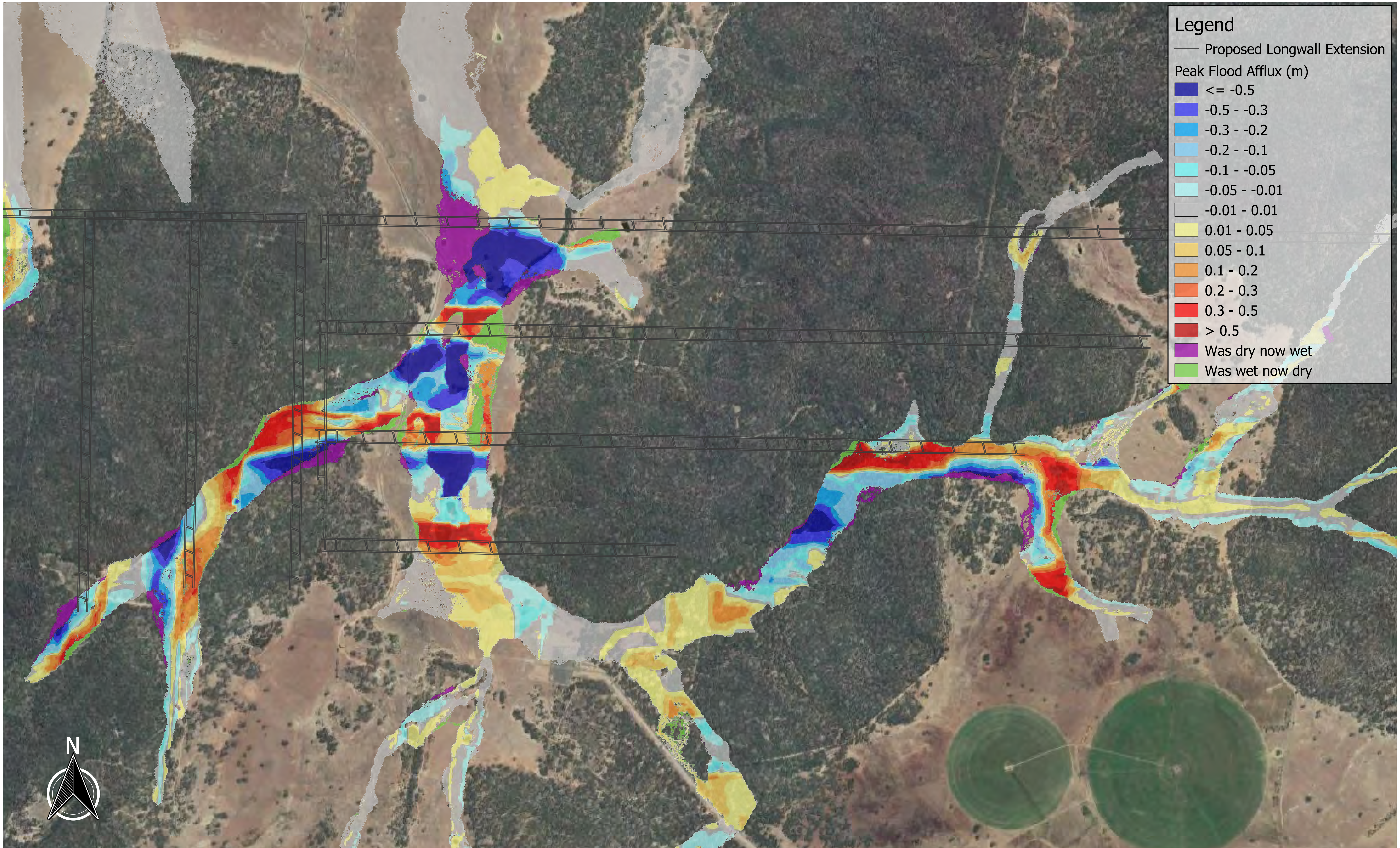
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.18: Ulan Modification 6 - Option 2 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2050

Afflux - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

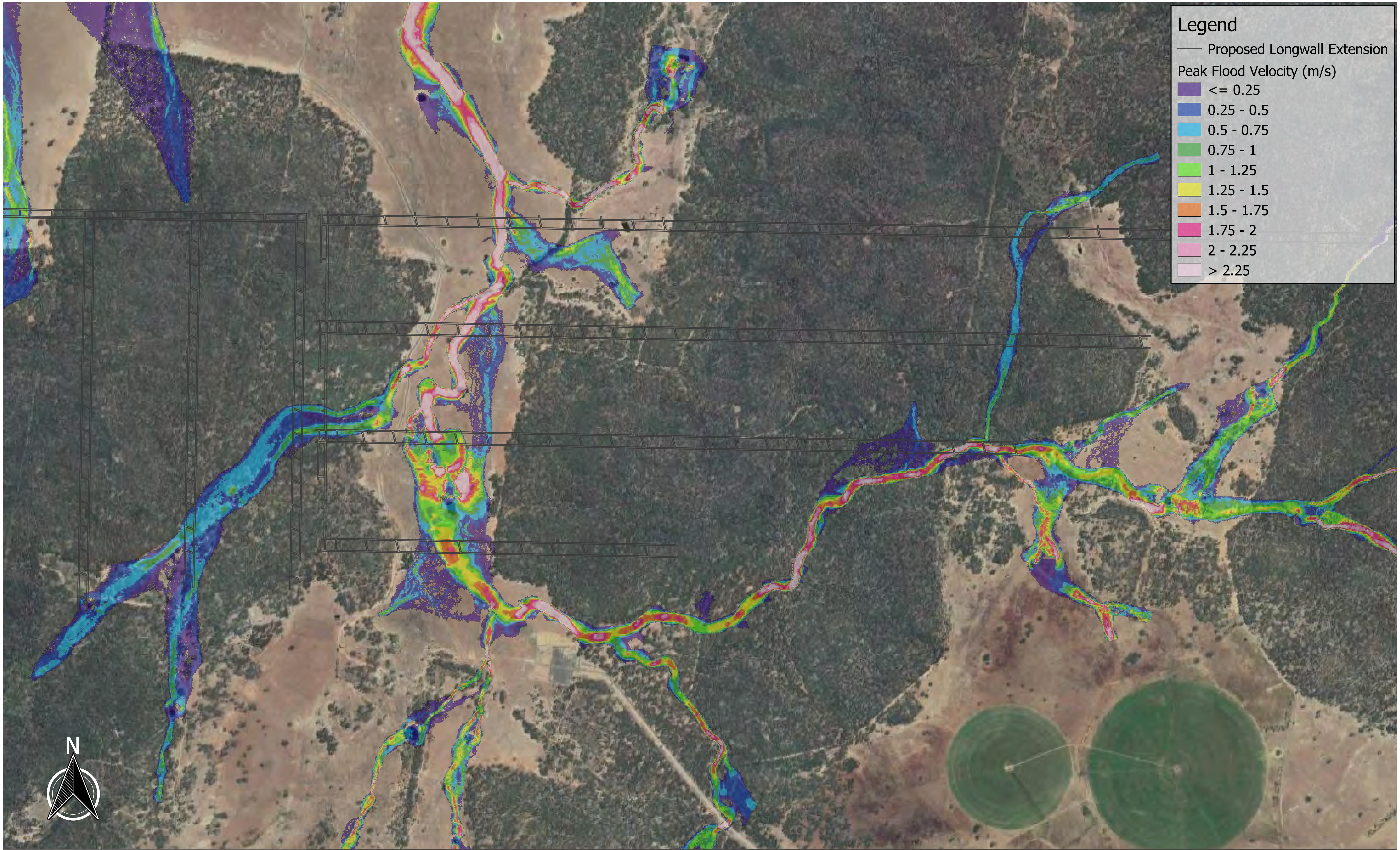
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.19: Ulan Modification 6 - Option 2 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2090

Afflux - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Scale in metres (1:14,000 @ A3)

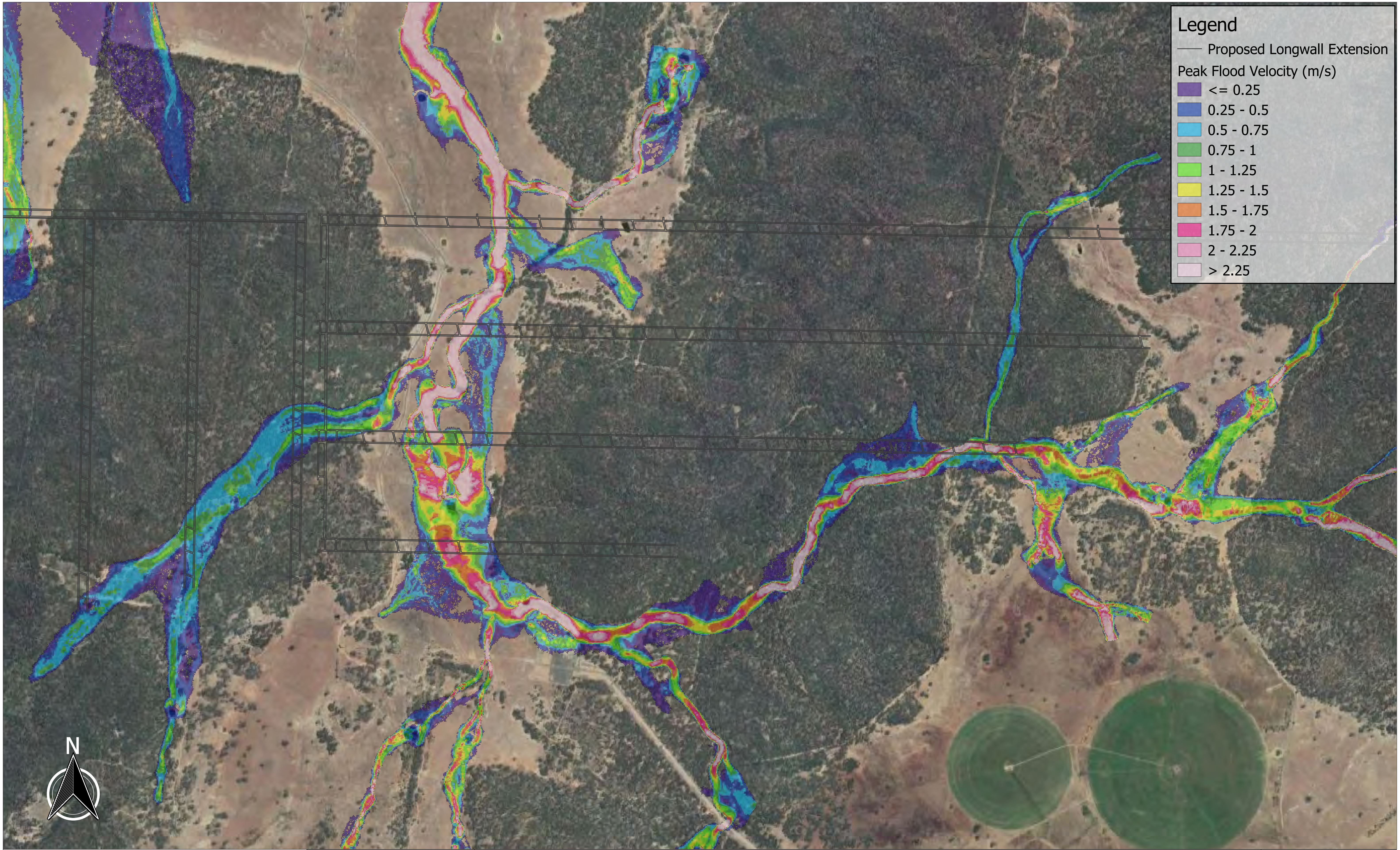
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.20: Ulan Modification 6 - Approved Conditions

Climate Change Impacts - Baseline

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

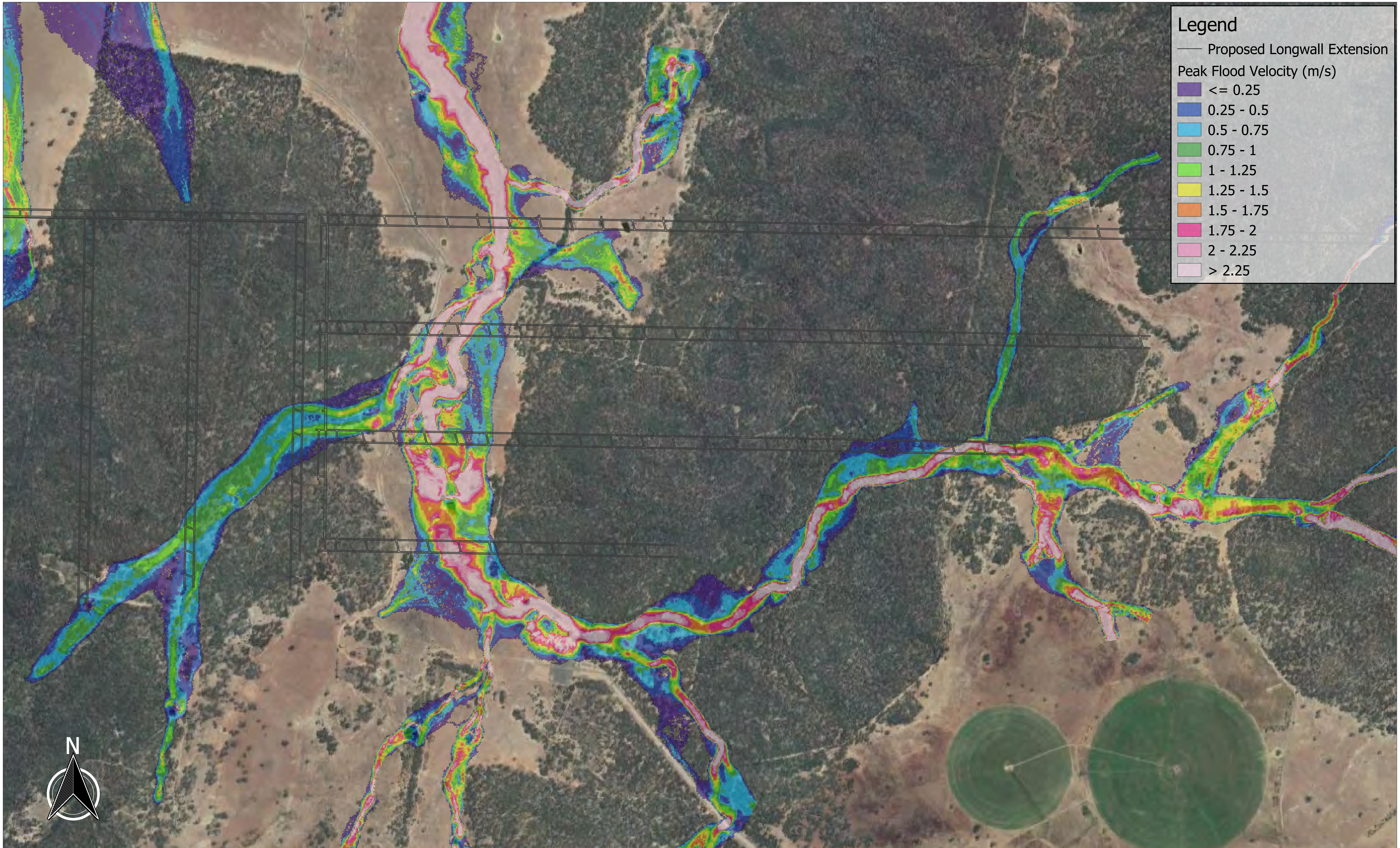
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.21: Ulan Modification 6 - Approved Conditions

Climate Change Impacts - RCP 4.5 2050

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

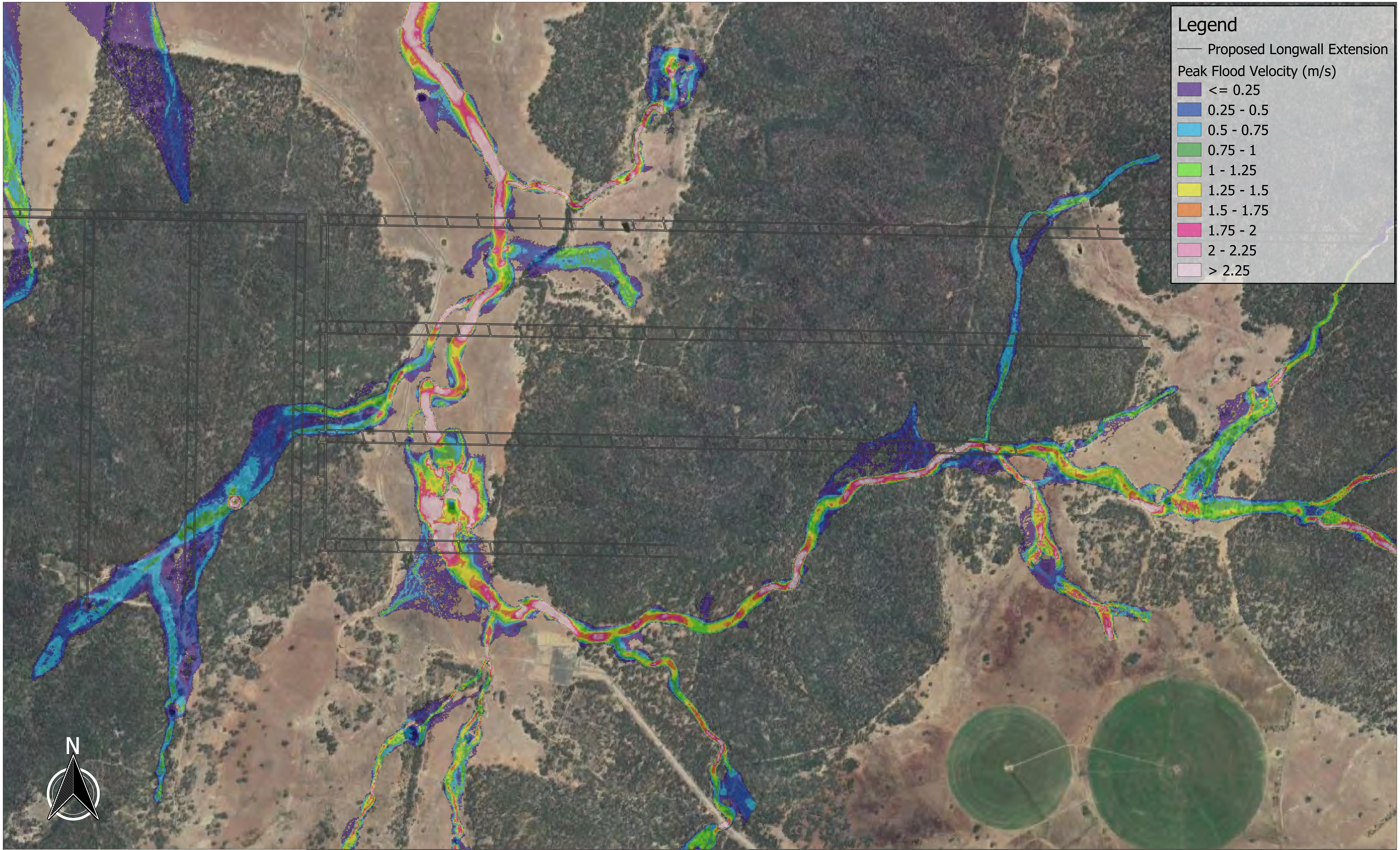
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.22: Ulan Modification 6 - Approved Conditions

Climate Change Impacts - RCP 4.5 2090

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

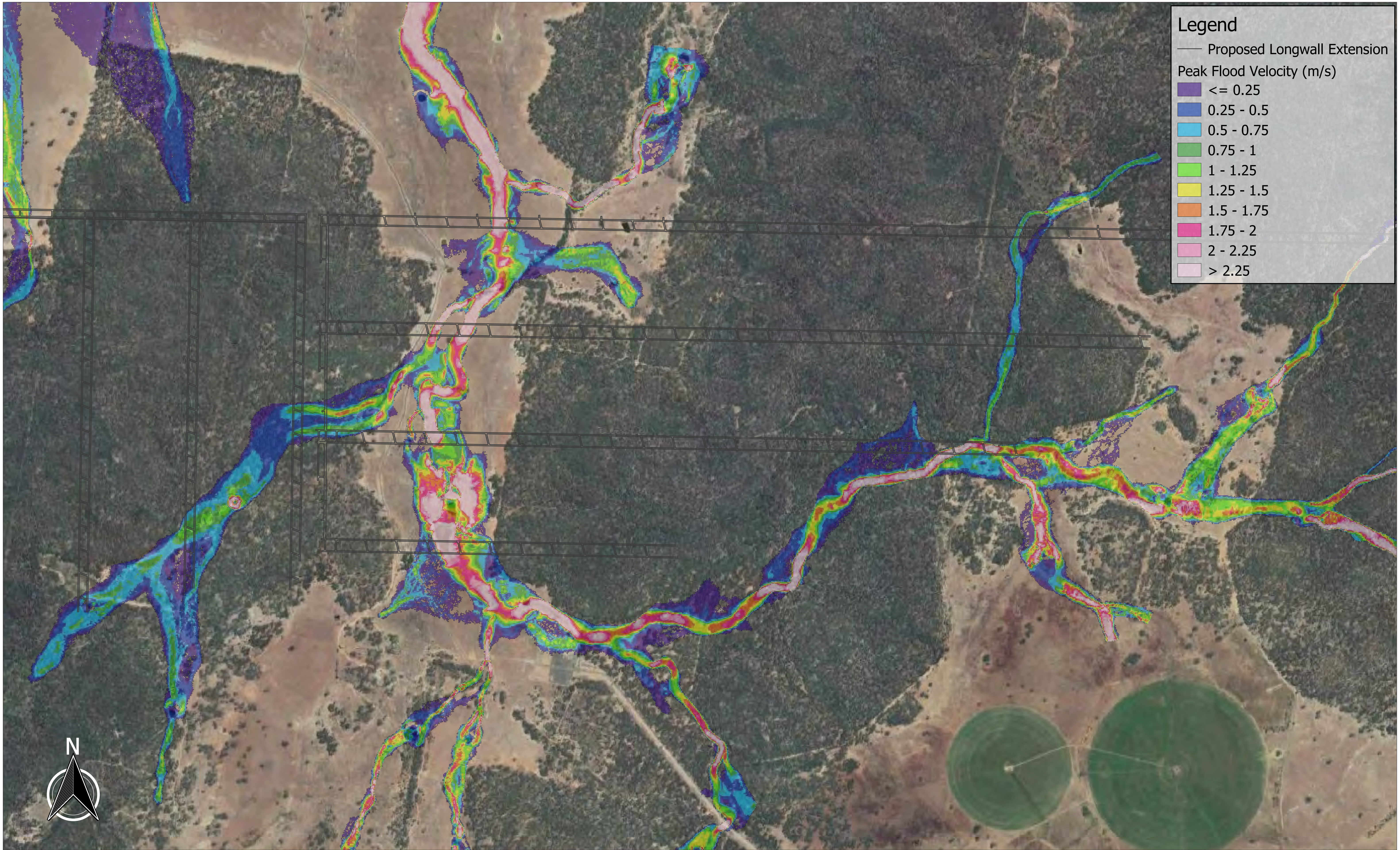
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.23: Ulan Modification 6 - Option 1

Climate Change Impacts - Baseline

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

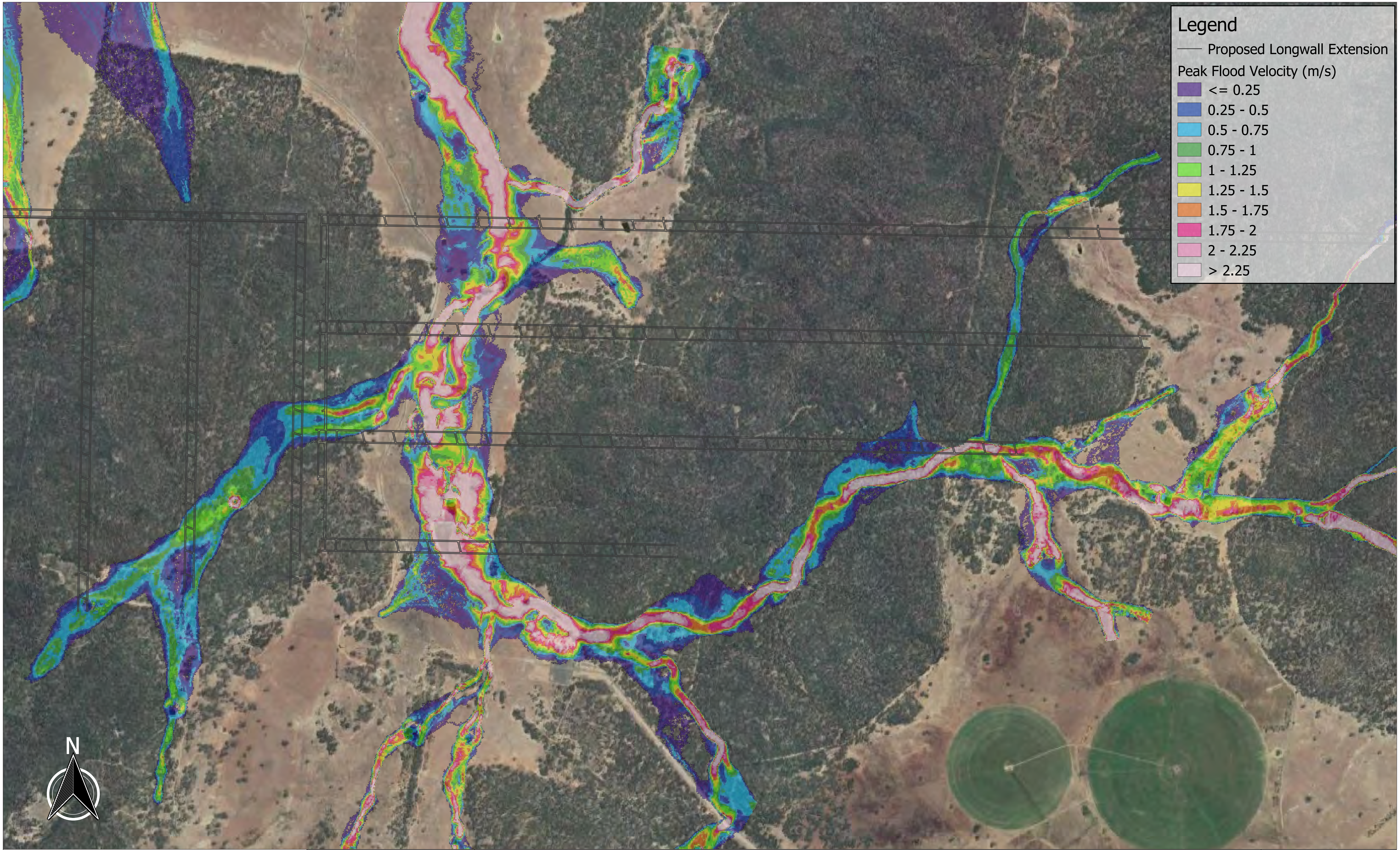
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.24: Ulan Modification 6 - Option 1

Climate Change Impacts - RCP 4.5 2050

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Scale in metres (1:14,000 @ A3)

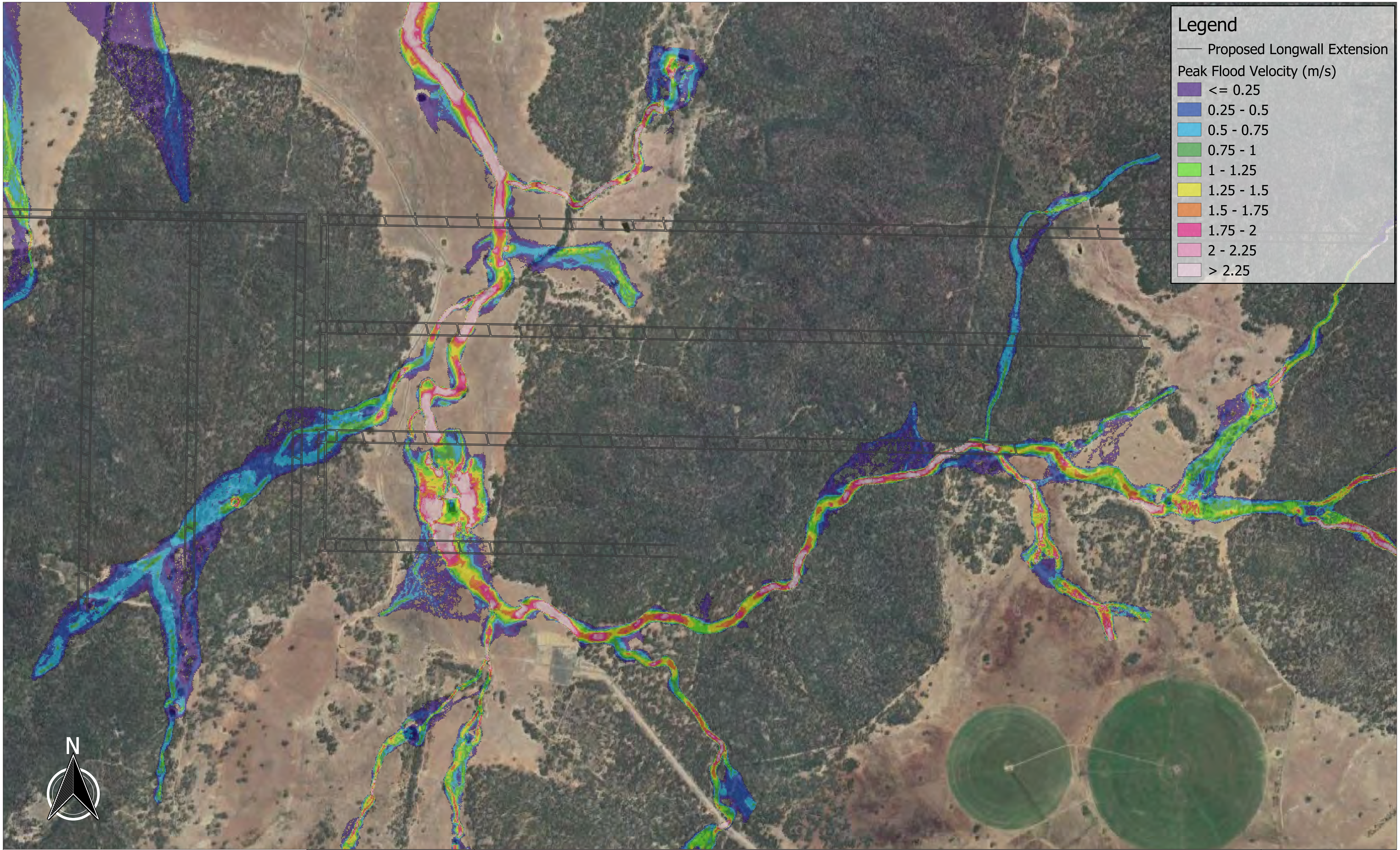
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.25: Ulan Modification 6 - Option 1

Climate Change Impacts - RCP 4.5 2090

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

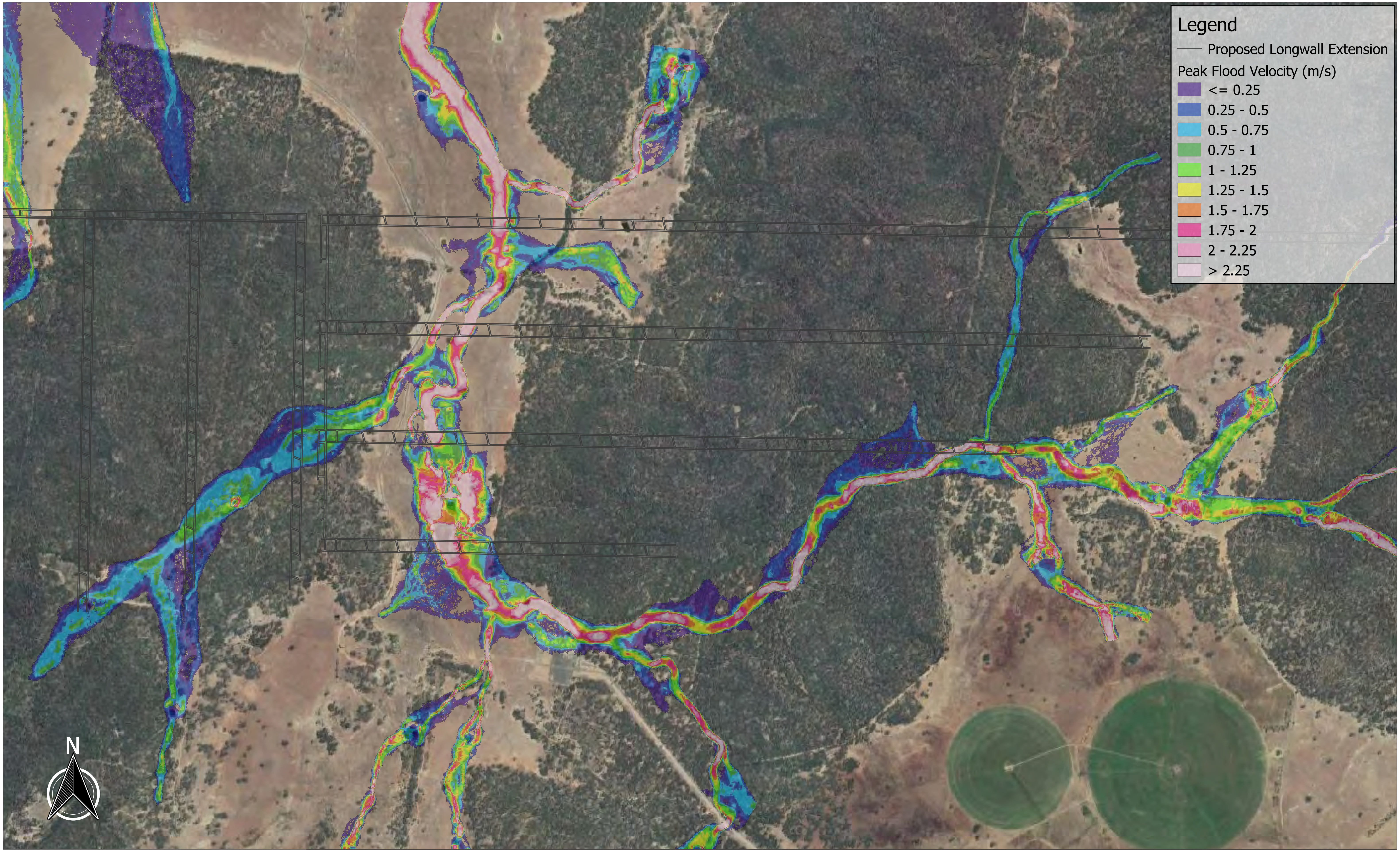
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.26: Ulan Modification 6 - Option 2

Climate Change Impacts - Baseline

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

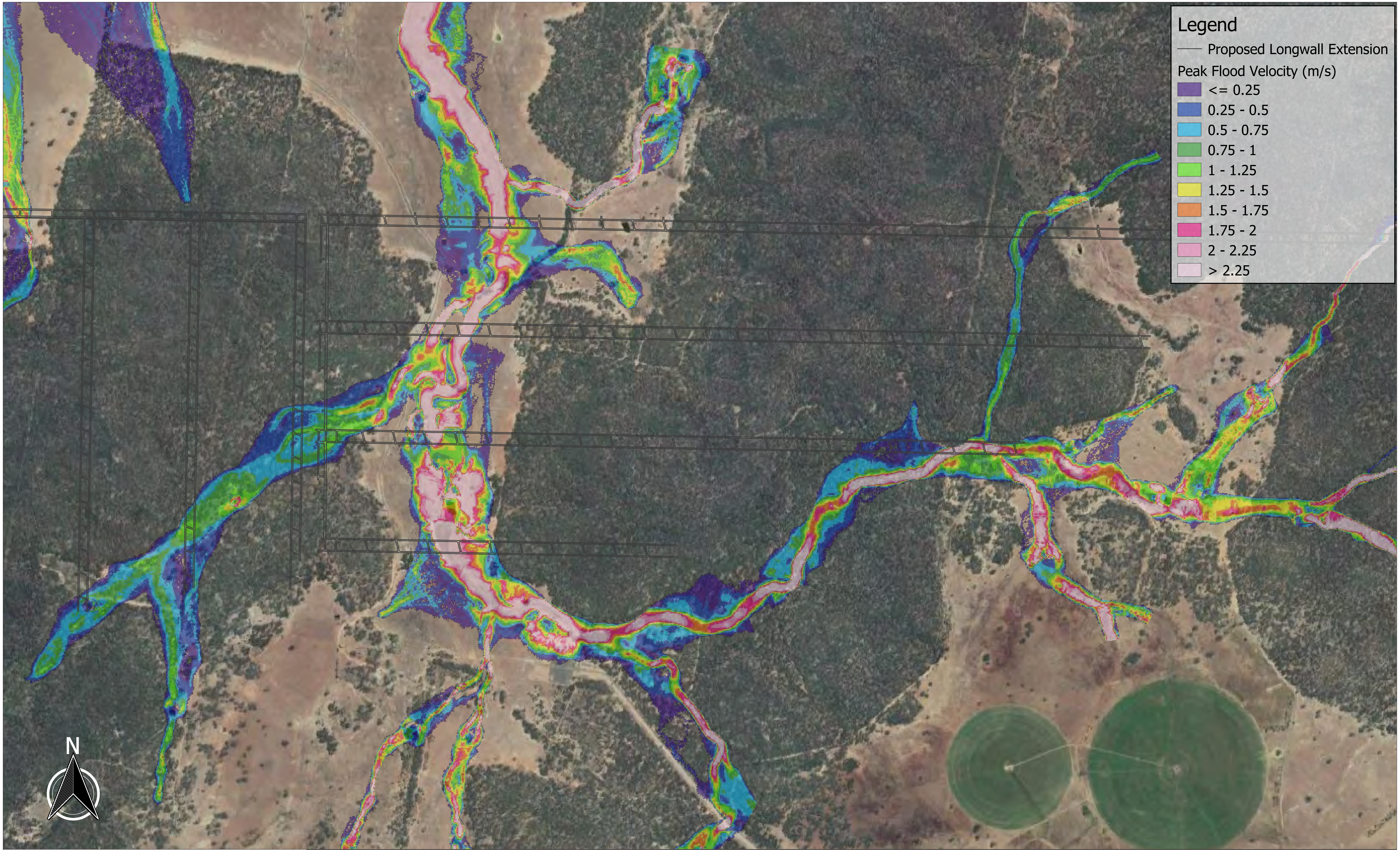
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.27: Ulan Modification 6 - Option 2

Climate Change Impacts - RCP 4.5 2050

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

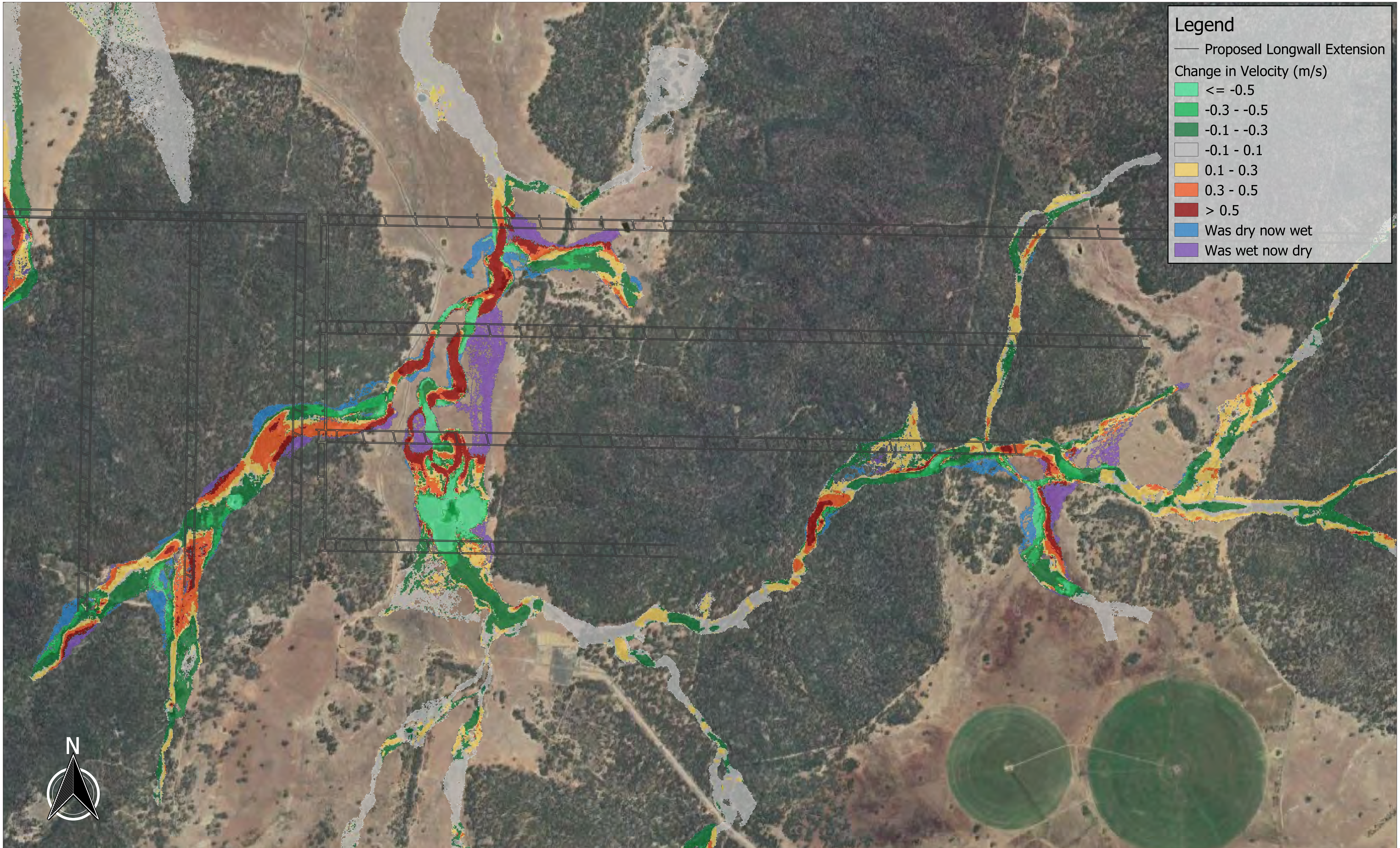
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.28: Ulan Modification 6 - Option 2

Climate Change Impacts - RCP 4.5 2090

Maximum modelled flood velocities - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Scale in metres (1:14,000 @ A3)

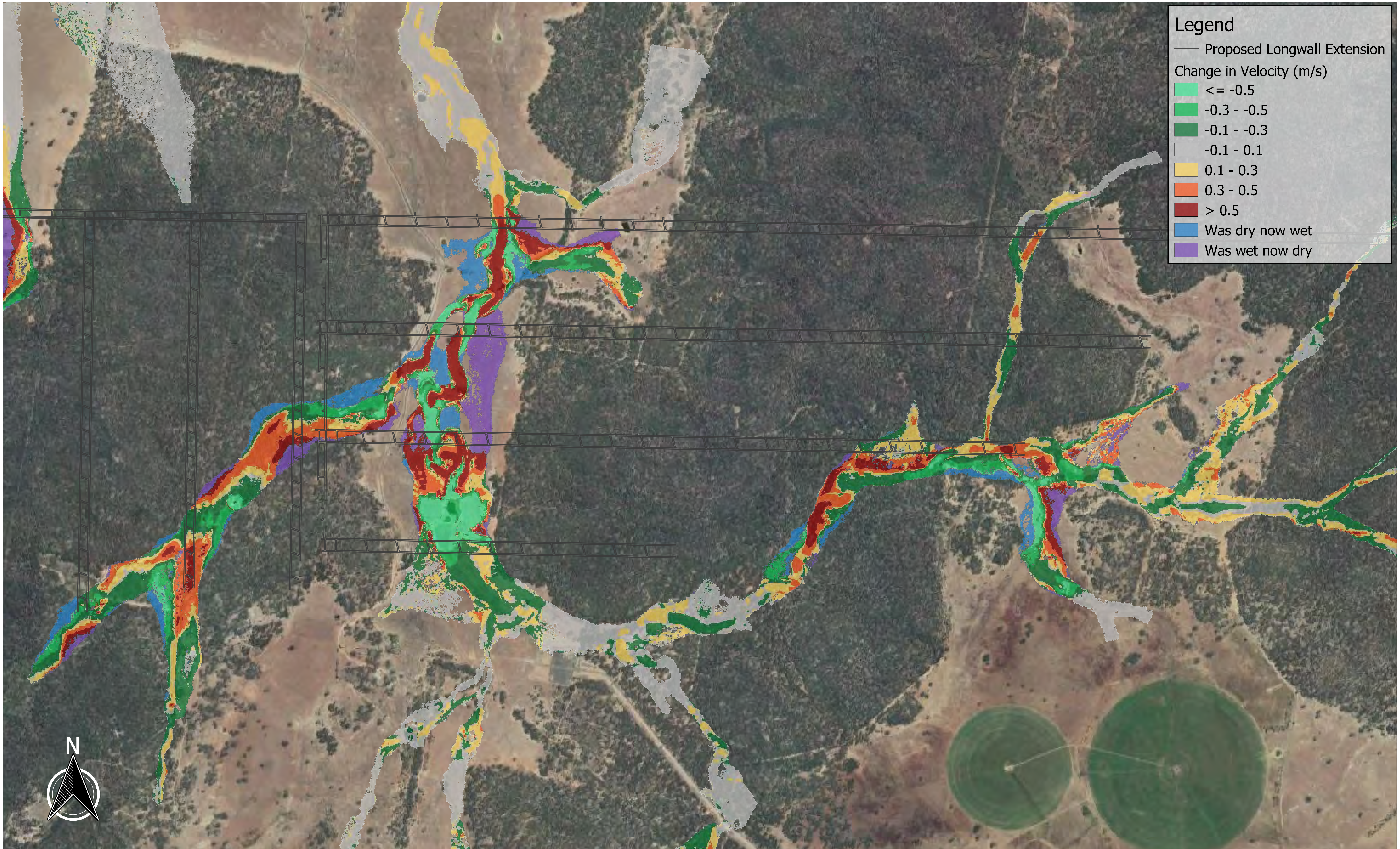
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.29: Ulan Modification 6 - Option 1 vs Existing Conditions

Climate Change Impacts - Baseline

Change in Velocity - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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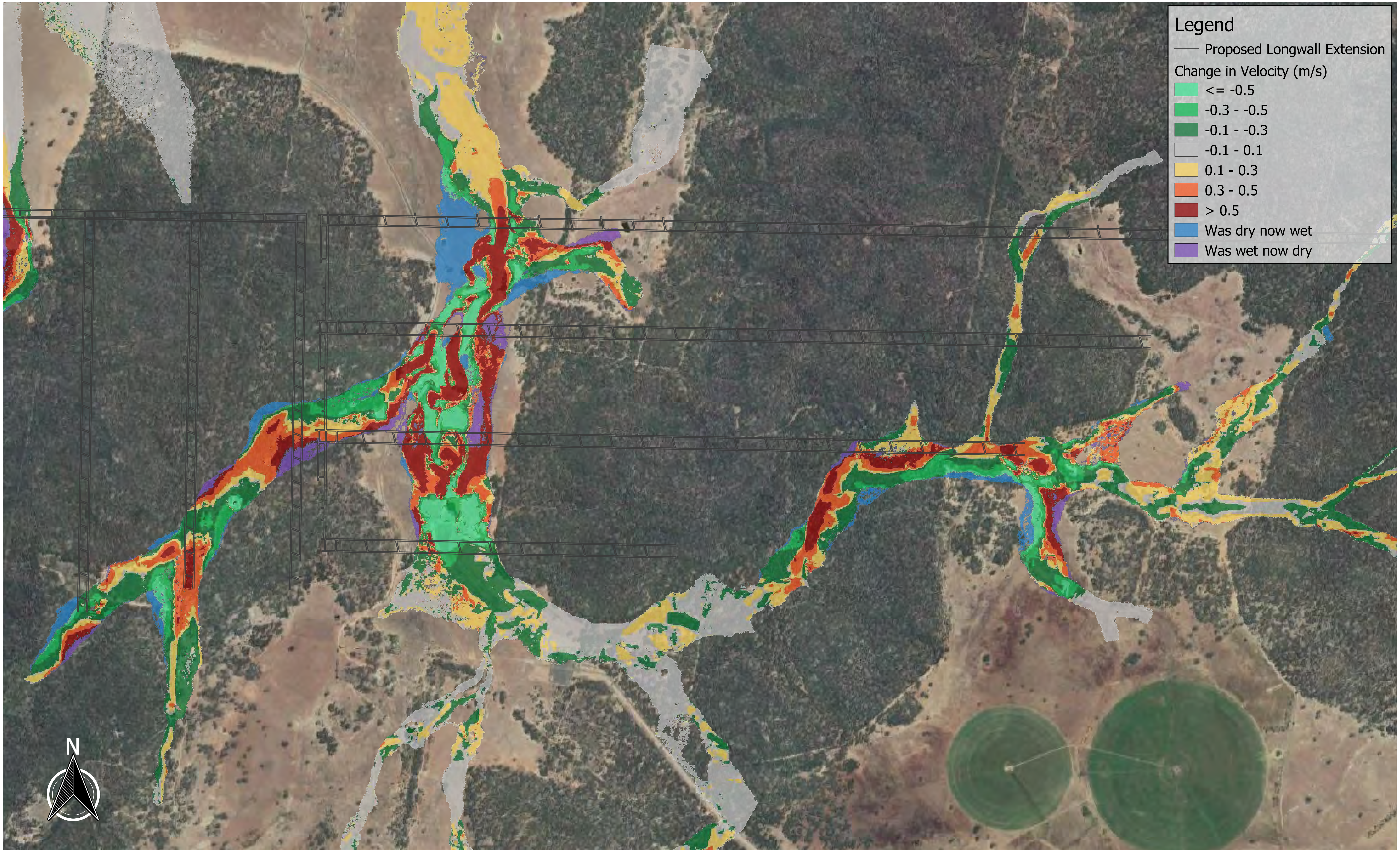
Grid: Map Grid of Australia, Zone 56

Figure C.30: Ulan Modification 6 - Option 1 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2050

Change in Velocity - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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GLENCORE

0 300 600 m

Scale in metres (1:14,000 @ A3)

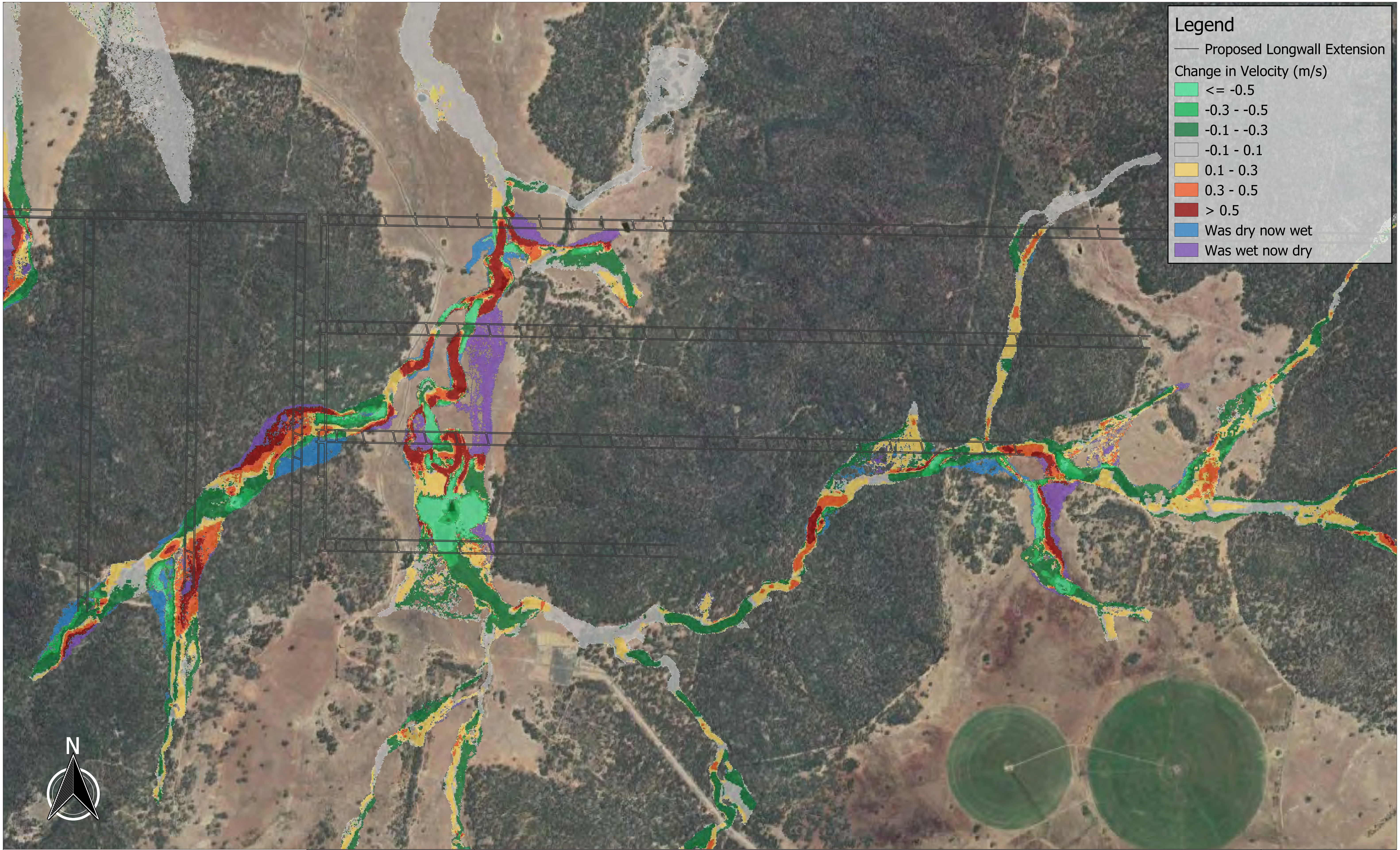
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.31: Ulan Modification 6 - Option 1 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2090

Change in Velocity - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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0 300 600 m

Scale in metres (1:14,000 @ A3)

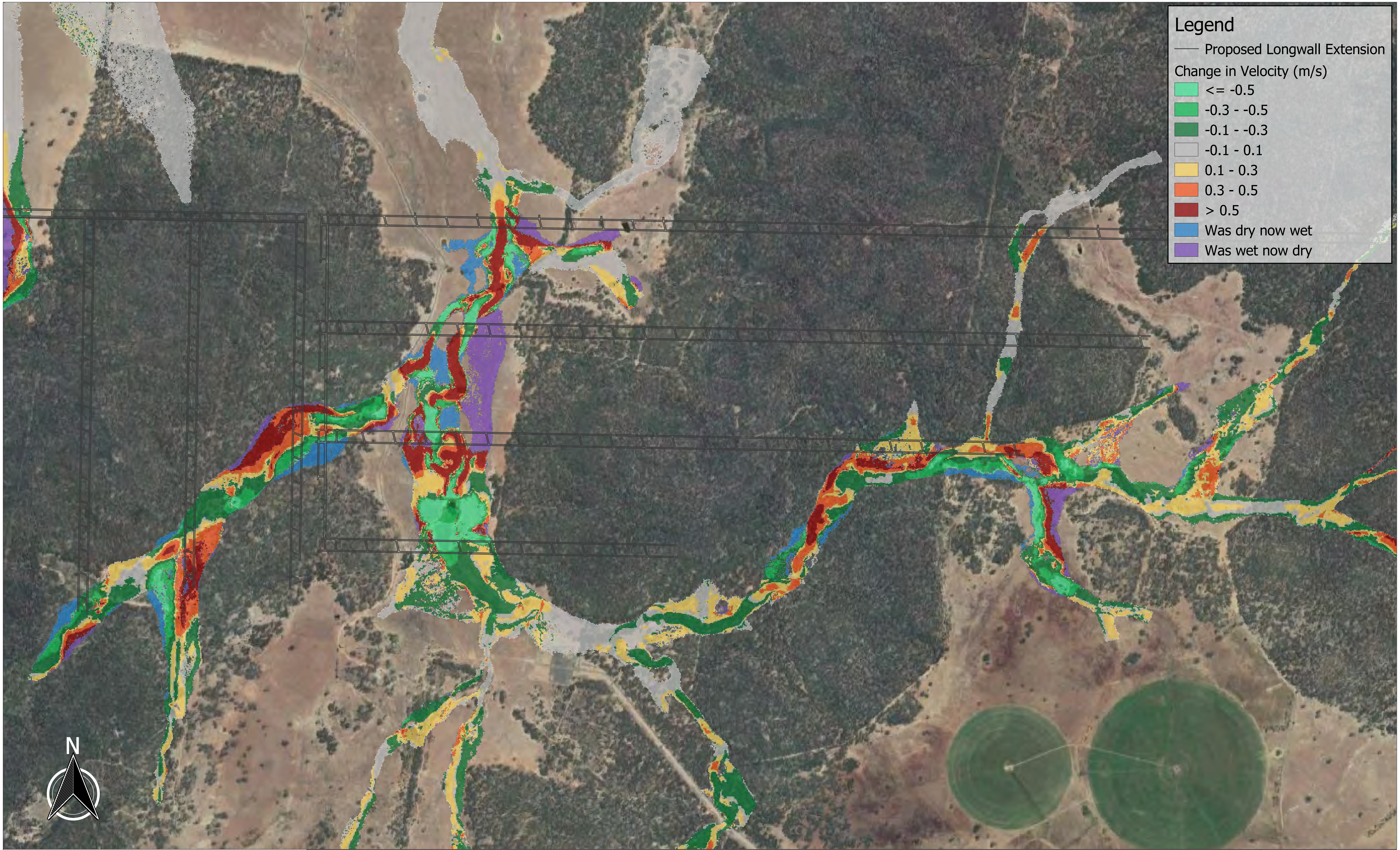
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.32: Ulan Modification 6 - Option 2 vs Existing Conditions

Climate Change Impacts - Baseline

Change in Velocity - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Scale in metres (1:14,000 @ A3)

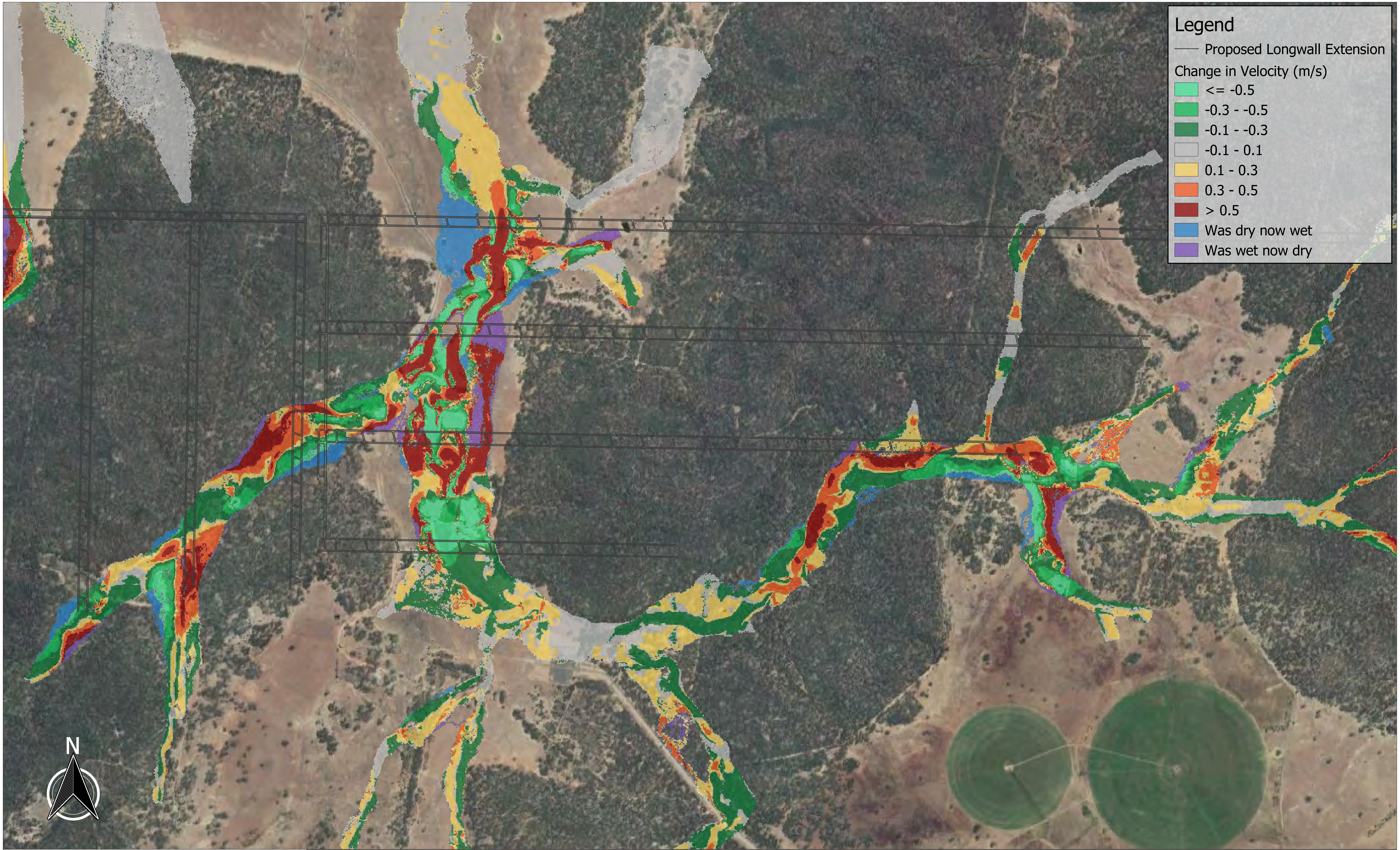
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.33: Ulan Modification 6 - Option 2 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2050

Change in Velocity - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
Drawn: SGG
Checked: MB
Date: 26 /10 /2022



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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

Figure C.34: Ulan Modification 6 - Option 2 vs Existing Conditions

Climate Change Impacts - RCP 4.5 2090

Change in Velocity - 1% AEP Flood Event

Job Number: N4003_010
Revision: 0
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Date: 26 /10 /2022

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