APPENDIX H FLOOD STUDY

NEOEN AUSTRALIA PTY LTD

CULCAIRN SOLAR FARM

CONCEPT STORMWATER MANAGEMENT PLAN

NOVEMBER 2019

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Culcairn Solar Farm
Concept Stormwater Management Plan

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ABBREVIATIONS

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARR	Australian Rainfall and Runoff
CSMP	Concept Stormwater Management Plan
DCP	Development Control Plan
EAF	Elevation Adjustment Factor
FPL	Flood Planning Level
GHS	Greater Hume Shire
GSDM	Generalised Short-Duration Method
ha	hectares
IFD	Intensity Frequency Duration
LEP	Local Environment Plan
m	metres
m^3/s	Cubic metres per second
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
SRTM	Shuttle Radar Topography Mission
UAV	Unmanned aerial vehicle

1 PROJECT BACKGROUND

1.1 THE PROJECT

This Concept Stormwater Management Plan (CSMP) has been prepared on behalf of Neoen Australia to provide supporting information for an application to Greater Hume Shire for a 'Renewable Energy Facility', triggered under the *Environmental Planning and Assessment Act 1979* and Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*. The proposed works is assessable under the Greater Hume Local Environmental Plan 2012.

The CSMP includes strategies to manage potential stormwater quality and quantity impacts caused by the proposed development. Key elements include:

— review of natural flow paths on the existing site

— identification of potential flooding and stormwater quantity and quality impacts on the proposed development

— description of the outcomes of the study including key design assumptions and recommendations.

1.2 THE SITE

The site for the proposed solar farm development is located south of Walbundrie Road, Culcairn and within the Greater Hume Shire local government area. The township of Culcairn is approximately 5 km to the east of the site where the site meets Walbundrie Road. The site has an area of 1360 ha. Refer to the figure below for a locality map.

The site has frontages to Walbundrie Rd and Cummings Road. Vehicle access to the site is currently via Walbundrie Rd, Cummings Rd, Weeamera Road and Schoffs Lane.

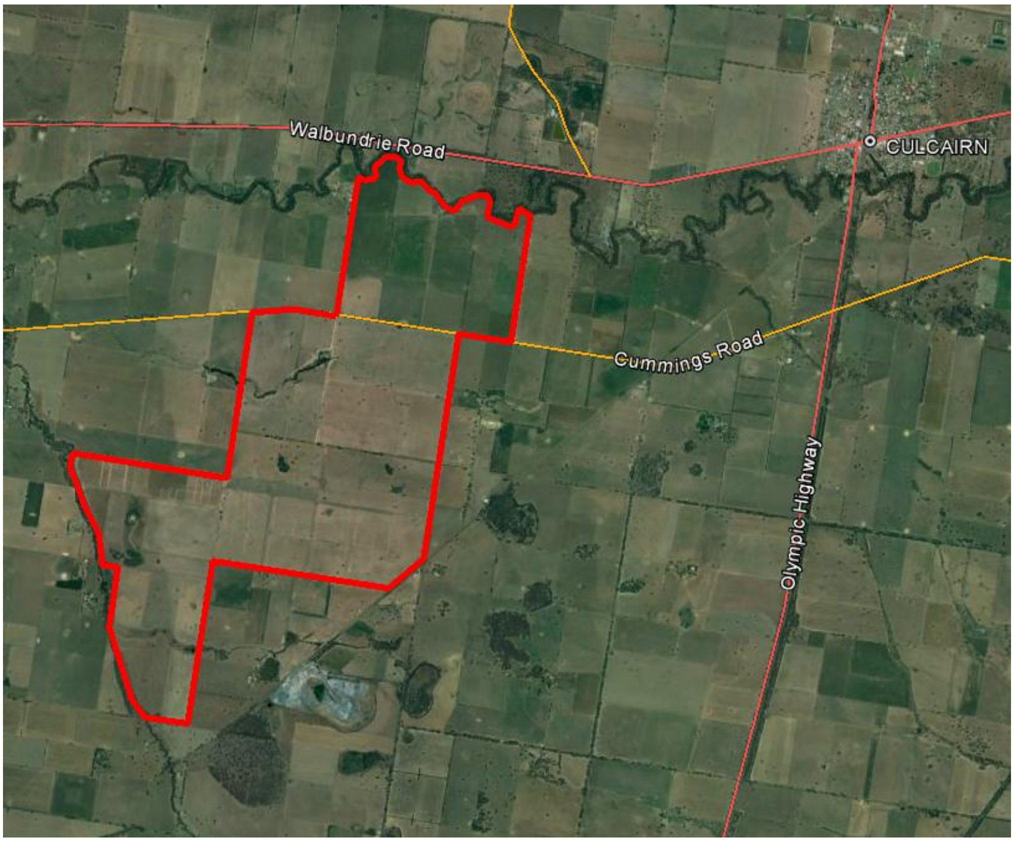


Figure 1.1 Site boundary, local roads and Culcairn township (Google Earth satellite photo dated December 2017)

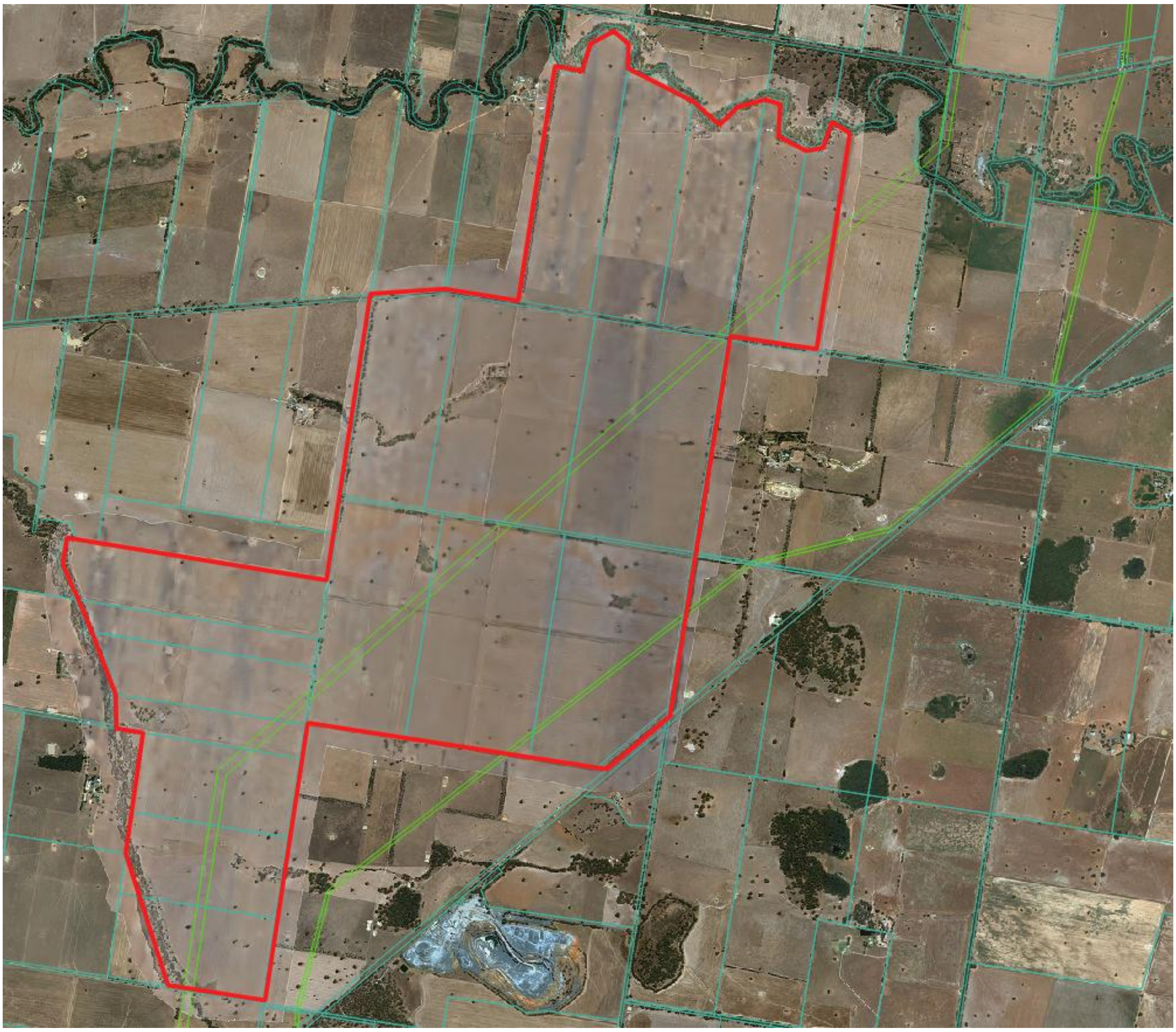


Figure 1.2 Site boundary, cadastral boundaries and easements (aerial image dated February 2019 merged with another image external to site)

2 POLICIES, STANDARDS AND GUIDELINES

2.1 GREATER HUME LOCAL ENVIRONMENT PLAN 2012

The Greater Hume Local Environment Plan 2012 was reviewed and Clauses *6.1 Earthworks*, *6.1A Flood planning* and *6.3 Riparian land and watercourses* are considered relevant to the project. These clauses are reproduced in Appendix C.

2.2 GREATER HUME DEVELOPMENT CONTROL PLAN 2013

The Greater Hume Development Control Plan 2013 was reviewed and Section 8.0 Flood Liable Land is relevant to the project and is reproduced in Appendix D.

2.3 AUSTRALIAN RAINFALL & RUNOFF: A GUIDE TO FLOOD ESTIMATION

Australian Rainfall & Runoff: A Guide to Flood Estimation (ARR, 1987) covers a broad range of disciplines related to flood estimation. ARR1987 hydrology was used in the Culcairn (WMAwater, 2013) regional flood study for Billabong Creek and the methods and data available from the 1987 edition of ARR have been adopted for the local catchment model for continuity and consistency.

The disciplines of interest to this CSMP relate to the estimation of hydrographs and peak flow from catchments by computer modelling.

2.4 NSW FLOODPLAIN DEVELOPMENT MANUAL

Reference is made to the *Floodplain Development Manual the management of flood liable land* (DIPNR, 2005). The manual does not specifically mention solar farms but only general requirements and considerations for development on floodplains. Appendix I (Section I6.3.6) of the manual talks about *developments outside those identified as appropriate by the management plan*. Solar Farms may fall under this type of development.

The regional and local flood assessment undertaken in subsequent sections of this study consider specific aspects of flood characteristics including flood depth, velocity and debris potential in regards to solar array posts, electrical components and panels. Recommendations for the placement of solar arrays to minimise impacts by flood water to the solar array infrastructure and by solar array infrastructure to the flood water are made.

The 1% AEP event has been adopted as the Flood Planning Level (FPL) for the solar farm development.

2.5 FLOODPLAIN MANAGEMENT PLAN

Reference is made to the *Billabong Creek Floodplain Management Plan* (Department of Natural Resources, 2006). The management plan covers the Billabong Creek floodplain downstream of the subject site as shown below. The Billabong Creek FMP does not apply to Culcairn and the site location (refer section 1.2.1 of the *Billabong Creek Floodplain Management Plan*).

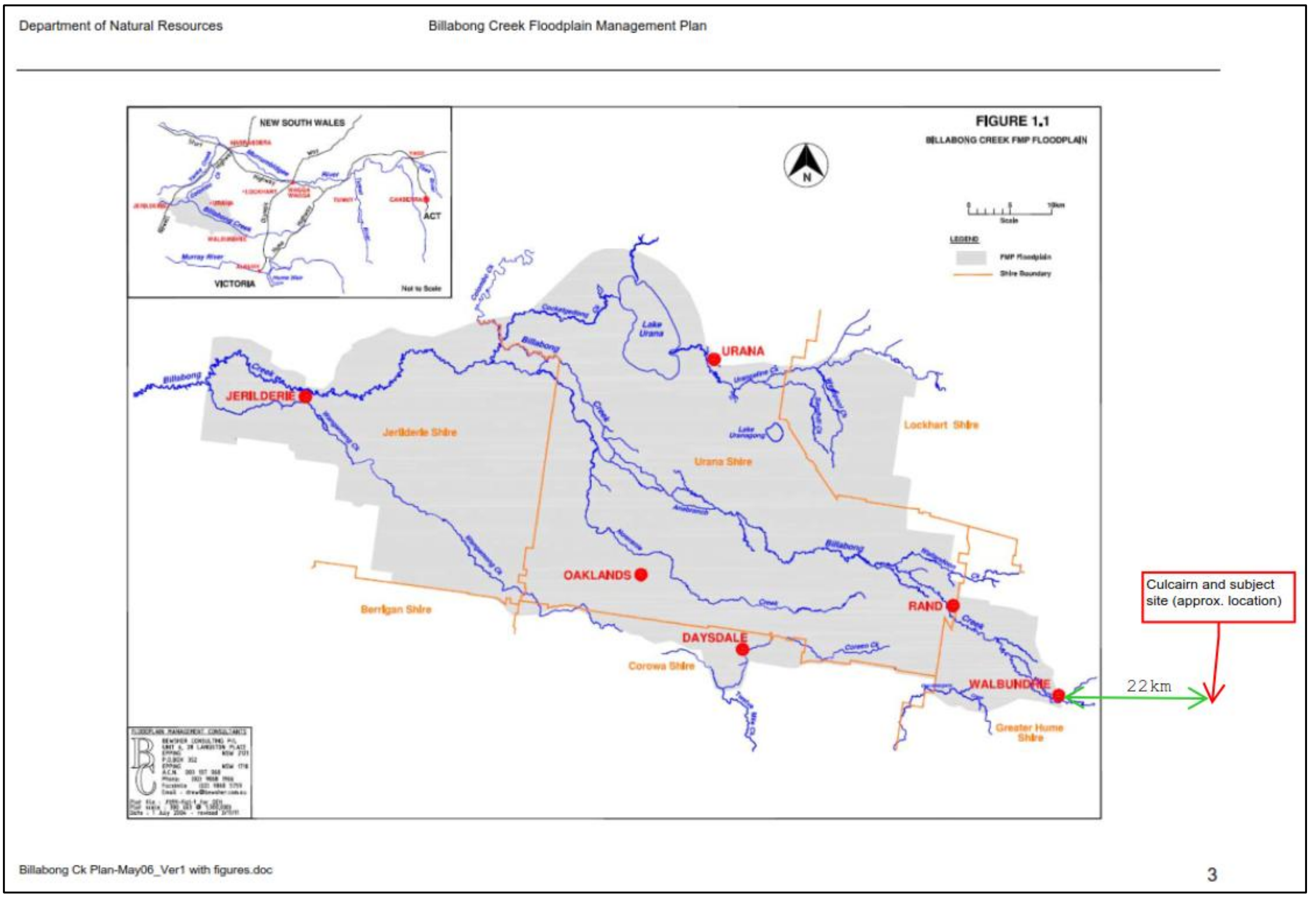


Figure 2.1 Billabong Creek FMP floodplain (Department of Natural Resources, 2006)

2.6 NSW GOVERNMENT PLANNING AND ENVIRONMENT

The *Culcairn Solar (SSD 10288) Environmental Assessment Requirements* letter to Mr Antoine Lajouanie from Nicole Brewer (NSW Government Planning & Environment) dated 03/05/19 lists the requirements for 'Water'. This report responds to particular items relevant to the scope of this study.

2.7 OTHER GUIDELINES

Concept layouts of the proposed solar arrays, infrastructure and earthworks were not available at the time of this report therefore a specific assessment of the developed conditions could not be made as part of this study. The following guidelines are applicable to the proposed development in relation to flooding and stormwater management and must be followed when undertaking designs.

— Managing Urban Stormwater: Soils & Construction (Landcom)

— Guidelines for Controlled Activities on Waterfront Land (Department of Industry, NSW Government)

— Guidelines for Watercourse Crossings on Waterfront Land (Department of Industry, NSW Government).

3 EXISTING SITE CHARACTERISTICS

3.1 EXISTING FLOOD STUDIES

The Culcairn Floodplain Risk Management Study & Plan by WMAwater (2017) does not cover the lots for the proposed solar farm. The downstream boundary conditions of the Culcairn study are located upstream (east) of the proposed solar farm. This flood study does not provide detail on the hydrological calculations, catchment areas or extents or flood hydrographs downstream of Culcairn. It only provides the peak discharges in Billabong Creek for various events at the railway bridge, upstream of the Olympic Highway, reproduced below.

Table 3.1 Peak discharges in Billabong Creek at railway bridge, upstream of Olympic Highway (WMAwater, 2017)

EVENT	5Y	10%	5%	2012 EVENT	2%	2010 EVENT	1%	0.5%	PMF
Peak discharge (m^3/s)	247	314	424	469	552	613	686	812	7306

The flood planning area and the location of the proposed solar farm are shown in the figure below.

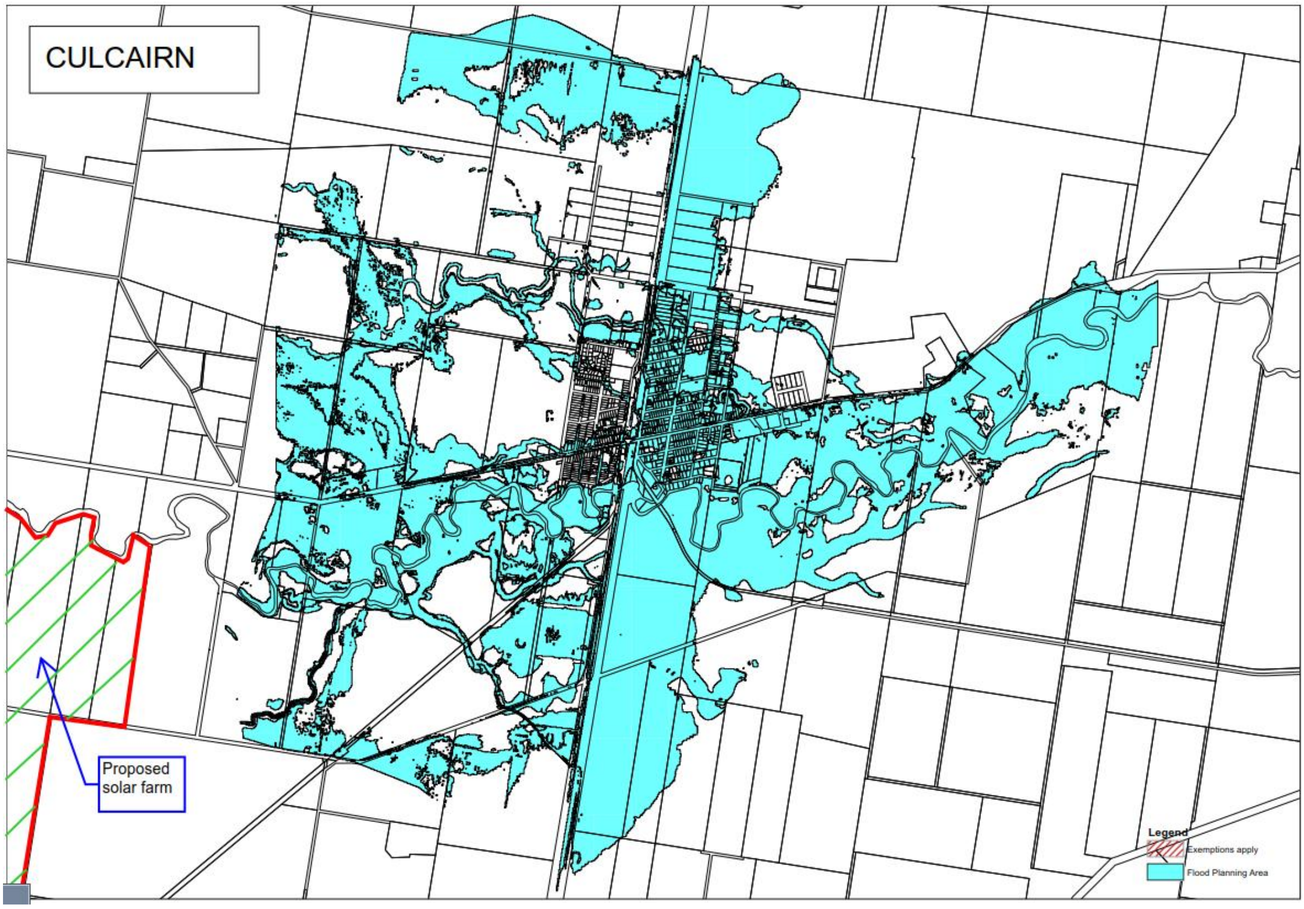


Figure 3.1 Culcairn Flood Planning Area wide view (GHS, 2017)

The design flood critical duration for Billabong Creek at Culcairn is 24 hours.

No flood study information was available for Billabong Creek from the Australian Flood Risk Information Portal (Geoscience Australia, 2019) as shown in the figure below.

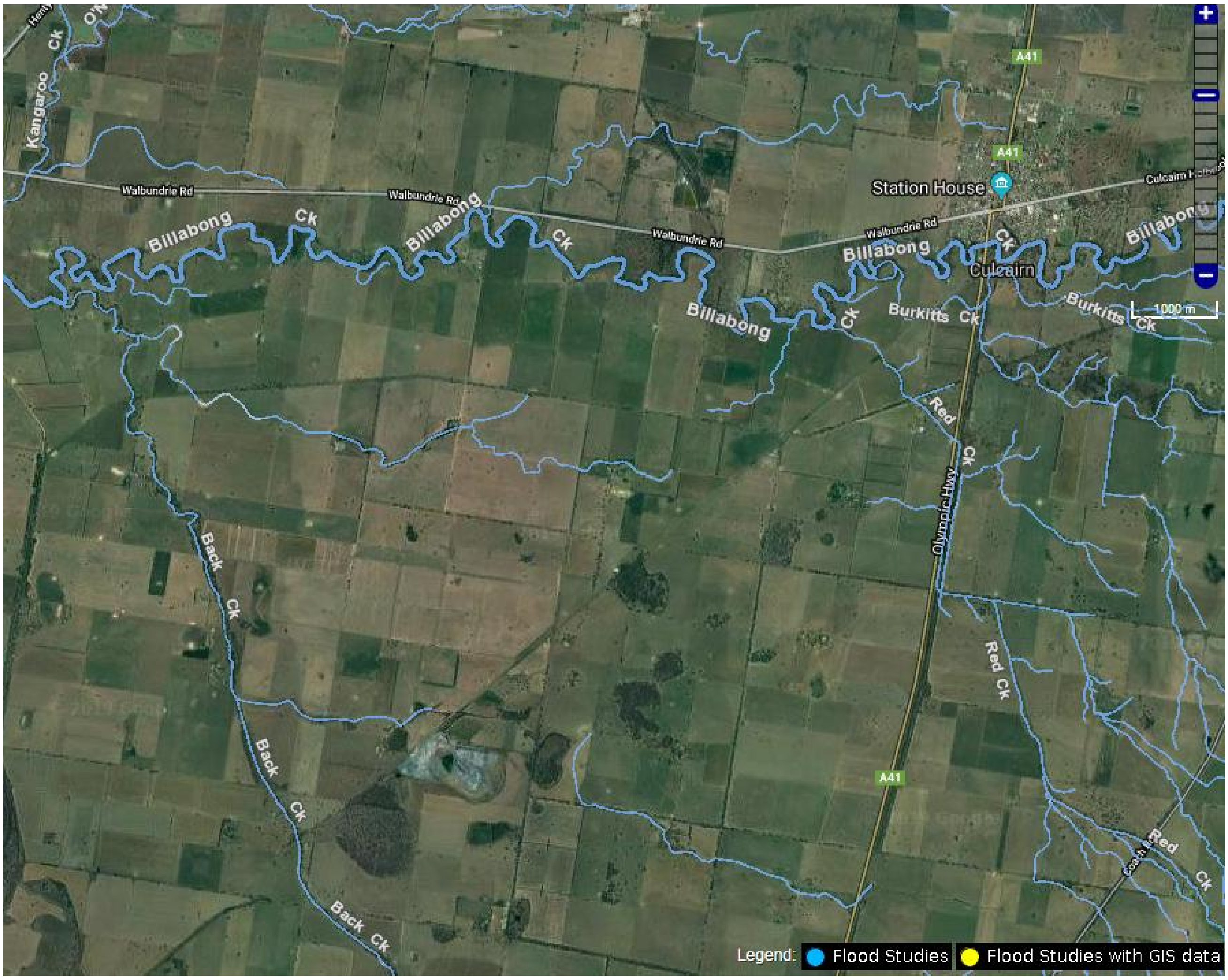


Figure 3.2 Screenshot from Australian Flood Risk Information Portal (Geoscience Australia, 2019)

3.2 TOPOGRAPHY AND DRAINAGE CHARACTERISTICS

The site has a gradual fall from east to west with typical slope of 0.1% to 0.2%. The difference in elevation from east (high side) to west (low side) is generally 1 to 2 metres. Traversing the site at three locations are shallow watercourses that convey minor surface runoff across the site. These watercourses ultimately drain to Billabong Creek or to Back Creek then Billabong Creek. Most runoff crosses the site as overland sheet flow. In some locations, there are minor drainage (irrigation) channels that have been constructed as part of primary production purposes. There are some small farm dams scattered across the site but these provide negligible storage of site runoff.

The figure below shows the elevations on the site using a colour ramp. Site contours are shown at 1 metre intervals.

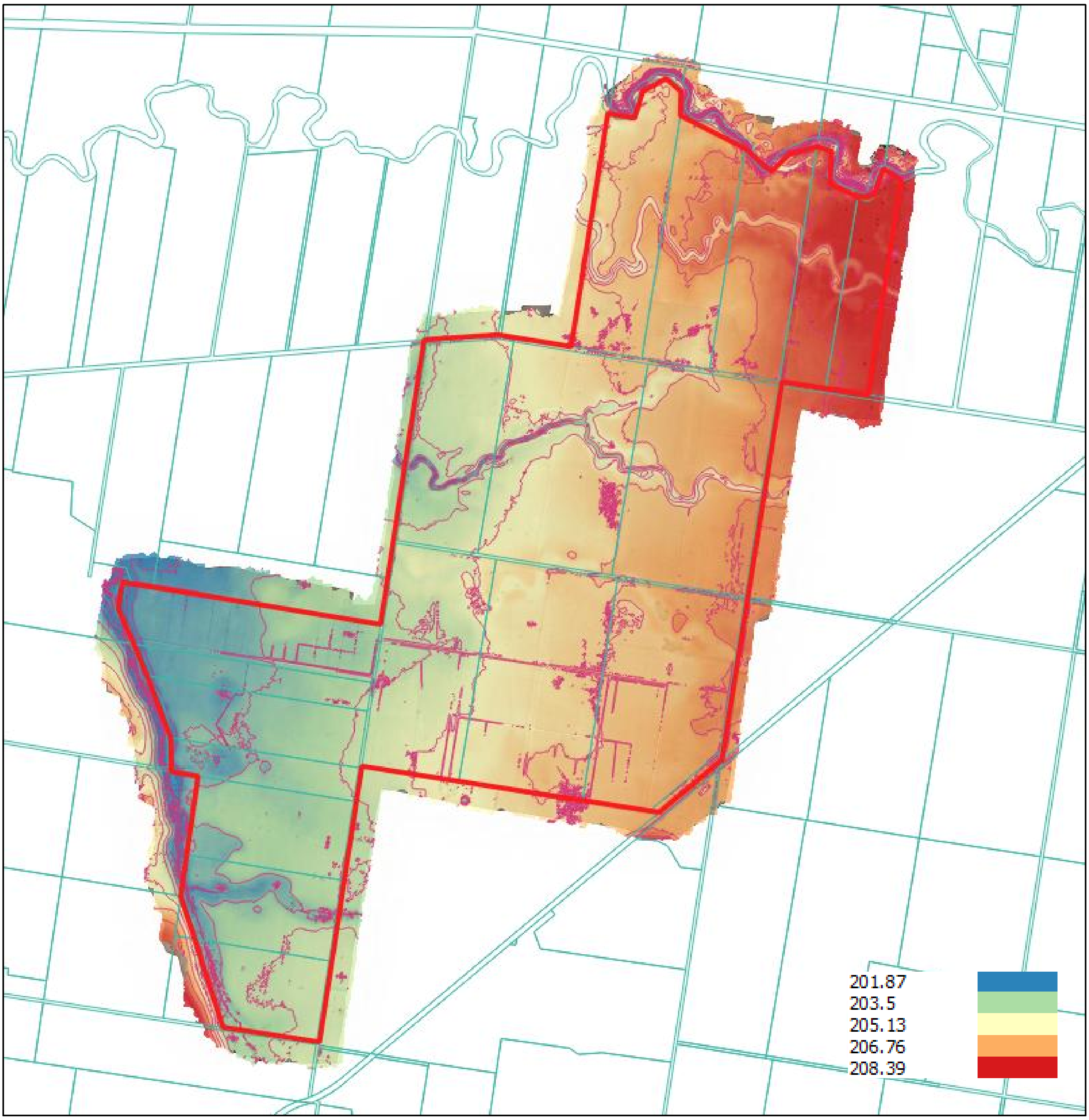


Figure 3.3 Site terrain elevations and 1 m contours

3.3 LAND USES

The site is zoned for Primary Production (Zone RU1), which allows solar energy production approval with consent (Greater Hume Local Environment Plan, 2012).

3.4 VEGETATION

The site is predominantly covered by grass. There are some strips of thicker vegetation within watercourses and some copses of trees scattered throughout the site (see Figure 1.2).

4 PROPOSED SITE DEVELOPMENT

The layout of the proposed solar arrays and infrastructure used to assess hydraulic impacts is shown in Figure 4.1.

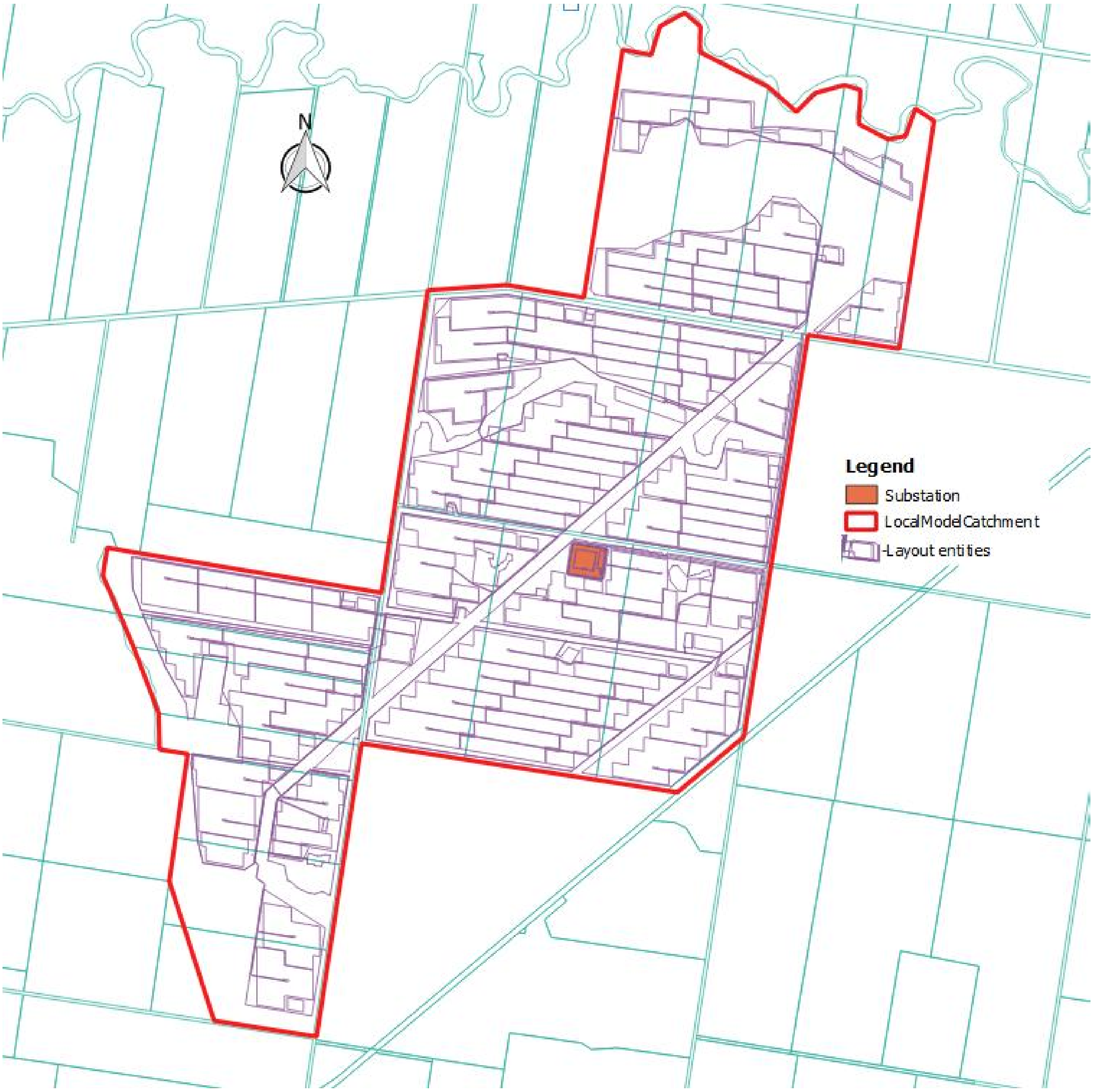


Figure 4.1 Solar Farm Concept Layout

It is understood that:

- Solar panel arrays and other infrastructure will be excluded from areas where the 1% AEP flood exceeds depths or velocities that may cause damage to arrays and array driver mechanisms.
- Installation of solar panels will increase the imperviousness of the installation area by 10%[1].
- No major earthworks are proposed for the site that would significantly change the existing drainage regime of the floodplain or minor watercourses.
- A vegetation management plan (VMP) is proposed to maintain existing vegetation coverage by means of re-introduction of livestock (sheep) grazing or manual maintenance (manual cutting). However, modelling has adopted a worst case impact assessment approach, whereby it has been assumed that grass cover will increase on the site due to the cessation of existing livestock grazing.
- All access tracks will be located and designed so as not to impede or concentrate overland flows through the site.

4.1 AVAILABLE LAND

The figure below shows areas of land that may be available for solar arrays and infrastructure (green shaded areas). This land area may reduce depending on the conditions imposed by Greater Hume Shire and Department of Planning, Industry and Environment (DPIE) so there are no impacts caused by flood water on site infrastructure and conversely that site infrastructure does not cause impacts on flood water.

Clause 6.3 of the GHS LEP applies to land identified as waterways on the site and land within 40 metres of the top of bank of these waterways. Site infrastructure may also not be permitted by Greater Hume Shire within the 40 metre buffer zone (40 m buffer zone not shown on figure).

The purple areas in the figure below are dependent on Aboriginal Heritage survey results, which also coincide with the 40 m waterway buffer zone in some areas (waterways shown in Figure 7.1).

[1] A study by Cook and McCuen (2013) found that the impacts of solar panels on runoff volumes, peaks and times to peak was negligible provided adequate grass cover was maintained beneath, between and beside the panels. Use of a fraction of impervious of 10% allows for some increase in runoff should the grass cover not be continuous, and is considered to be conservative.

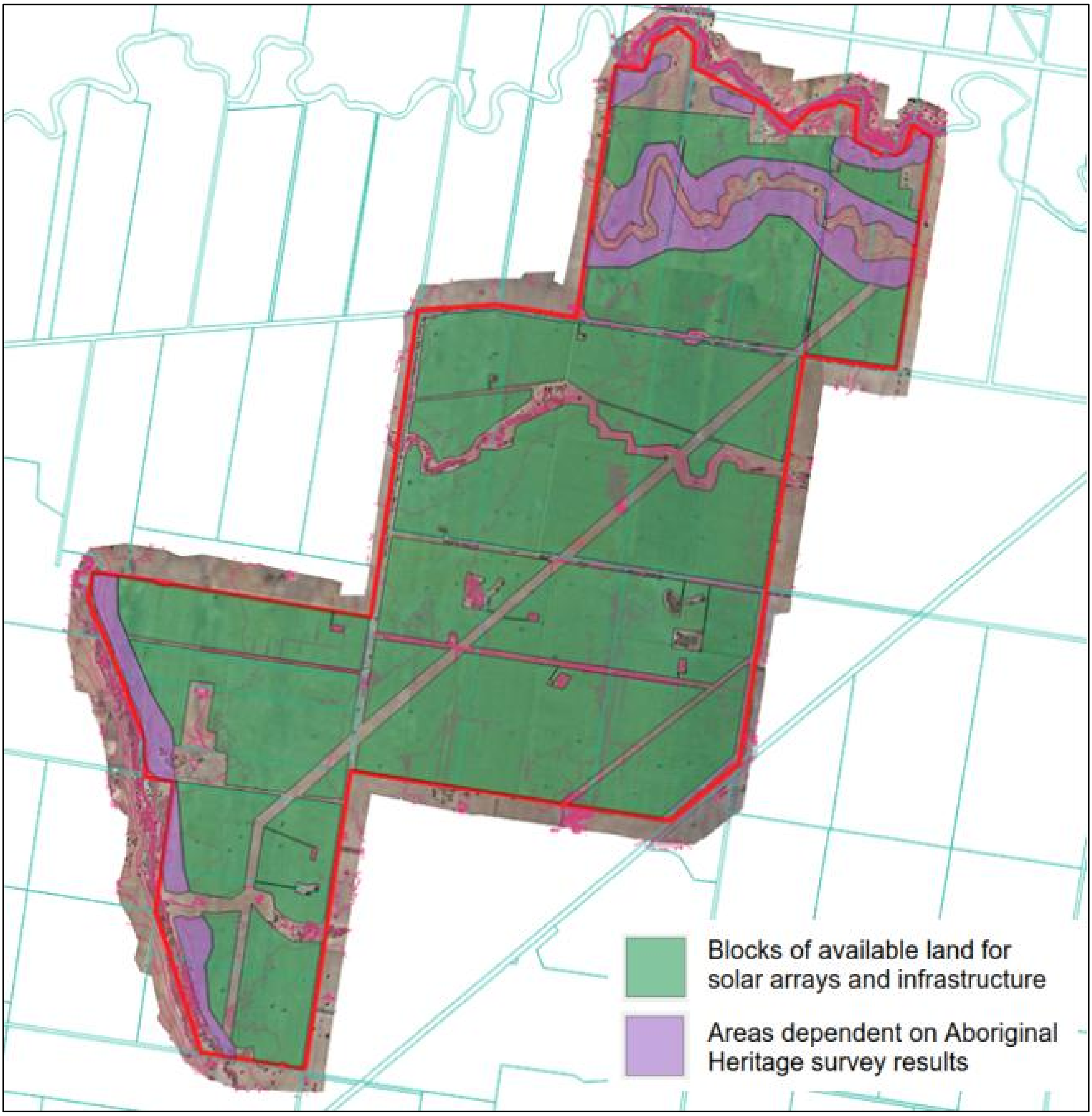


Figure 4.2 Available land for solar arrays and infrastructure

4.2 TYPICAL GROUND COVER

For developed conditions, it has been assumed that ground cover vegetation will become well established beneath the proposed tracking solar panel arrays. This assumption is based on previous experience noted at other similar solar farm sites, as shown in Figure 4.3. Ground that is predominantly covered by perennial grass of moderate length is recommended for solar farms to reduce erosion potential and enhance infiltration of rainfall and solar panel runoff.

Figure 4.3 Example of grass growth underneath solar panels (panel style indicative only) [2]

[2] Photo Sourced May 3, 2017 from https://www.google.com.au/search?q=moree+solar+farm+images&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiooIvtxK_TAhXCGpQKHR35DowQ_AUIBygC&biw=1745&bih=849&dpr=1.1#imgrc=C2WBeV59W7WO1M:&spf=217

5 STORMWATER INFRASTRUCTURE

The survey did not find any piped stormwater infrastructure within the site boundary.

6 HYDROLOGY AND HYDRAULICS

The impact of local and regional flooding on the site has been assessed. This includes flows through Billabong Creek and its floodplain at the northern boundary of the site. The peak discharge in Billabong Creek at the railway bridge adjacent to the Olympic Highway was adopted as the inflow boundary condition to the regional model.

The XP-SWMM hydrologic and hydraulic model (version 2018.2.2) was chosen to estimate design hydrographs for the local catchment model as this software can represent a range of physical characteristics that influence runoff behaviour such as variable rainfall patterns, catchment shape, catchment slope, variations in catchment land use, drainage features and channel and floodplain storage. The hydraulics were modelled within this software with a gridded 2D solution method.

The 5%, 1%, 0.5% and 0.2% Annual Exceedance Probability (AEP) storm events and the Probable Maximum Flood (PMF) have been investigated for this study. This design event terminology is in accordance with ARR1987. ARR1987 hydrology was used in the Culcairn (WMAwater, 2013) study.

6.1 INITIAL AND CONTINUING LOSSES

The XP-SWMM model converts rainfall to runoff by applying rainfall losses to both the impervious and pervious catchments within the model to produce effective rainfall hyetographs. An initial and continuing loss model was adopted for this study based on values obtained from Australian Rainfall and Runoff 1987 (ARR) for this location. For pervious catchments, an initial loss of 15 mm and a continuing loss of 2.5 mm/hour were adopted. The catchments were treated as fully pervious in the existing scenario.

The developed scenario included impervious areas. Areas populated with solar panels were treated as 10% impervious and the substation area treated as 100% impervious. For impervious areas an initial loss of 0 mm and a continuing loss of 0 mm/hour were adopted.

Rainfall depths adopted for this investigation were downloaded from the Bureau of Meteorology Rainfall IFD Data System.

6.2 MANNING'S ROUGHNESS COEFFICIENTS

Manning's roughness coefficients were adopted in accordance with Natural Channel Design Guidelines (BCC, 2003) and Google Earth and client supplied aerial imagery of the site. The Manning's roughness coefficients adopted within the XP-SWMM model are presented in the table below.

Table 6.1 Manning's roughness coefficients adopted

LOCATION	MANNING'S ROUGHNESS	
	BASE CASE	DEVELOPED CASE
Thick Grass (No Grazing)	-	0.055*
Medium Grass (Grazed Paddock)	0.045	0.045
Creek vegetation	0.08	0.08
Dense creek vegetation	0.10	0.10

*It should be noted that the modelled values for the developed case assumed no VMP (i.e. worst case with no grazing). However, a Neon Australia Pty Ltd has advised that a VMP is proposed to be implemented to maintain the existing vegetation coverage within the site. The resulting flood mapping will therefore represent a conservative developed case, which may be updated during the detailed design phase.

6.3 TEMPORAL PATTERNS AND CATCHMENTS

The site lies within Zone 2 of the Zones for Temporal Patterns (Figure 3.2) from ARR1987 Volume 2.

The catchment areas and slopes were determined from 2014 ortho-photogrammetry with point density of 1 point every 5 m. The horizontal accuracy is +/- 1.25 m and vertical accuracy of +/- 0.9 m (95% confidence interval). Ten (10) metre interval SRTM contours from Queensland Globe were used to define the extent and surface slope of some upper catchments. Site catchment boundaries were drawn using UAV terrain data supplied by the client. Catchments are shown in Figure 6.1 for the local catchment model. Catchments and contours near the site are shown in Figure 6.2.

Figure 6.1 Local catchment model catchment plan

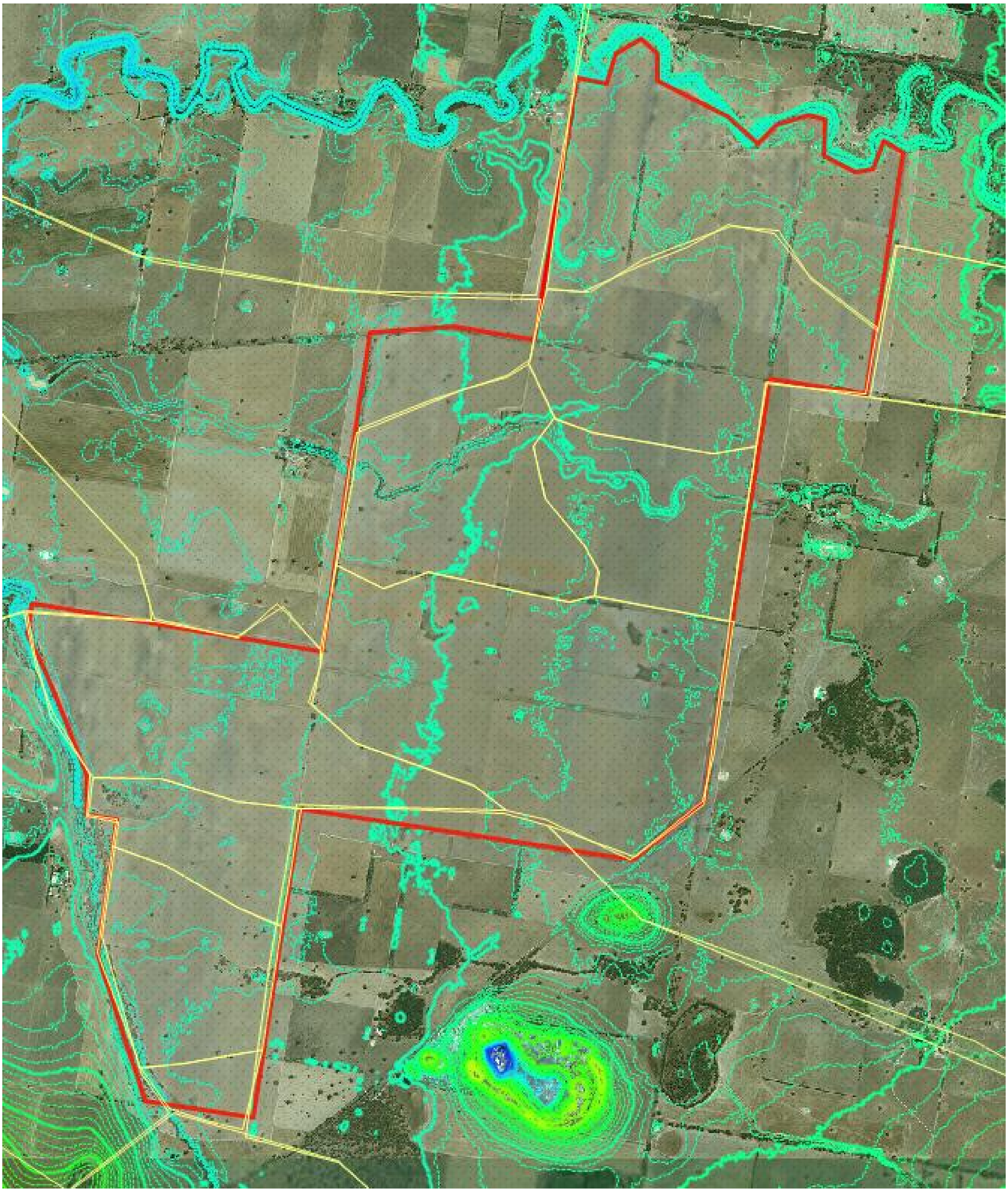


Figure 6.2 Local catchment model catchment plan and contours (Major contour interval: 5 metre, Minor contour interval: 1 metre)

6.4 DESIGN STORM DURATION

The critical design storm duration for sub catchments draining to the site was determined for the local flood model. Using the DEM, model links were created to represent the length and typical cross section of the natural drainage paths for the upper catchment. A free outfall was adopted as the downstream boundary condition for all drainage paths modelled.

The local flood model was run for a range of design storm durations from 45 minutes to 24 hours. The site has multiple stream flow paths, each with varying catchment sizes. The model results were analysed to identify the peak duration for runoff from the site. The peak duration identified for the site for each AEP event investigated is presented in Table 6.2.

Table 6.2 Local Flood Model Critical Storm Durations

ANNUAL EXCEEDANCE PROBABILITY (AEP)	PEAK STORM DURATION
5% AEP	4.5 hours
1% AEP	4.5 hours
0.2% AEP	4.5 hours
0.5% AEP	4.5 hours
Probable Maximum Flood (PMF)	3 hours

A critical duration of 24 hours was used in the regional flood model for all events in accordance with the WMAwater report (2017).

6.5 PROBABLE MAXIMUM PRECIPITATION (PMP)

The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method (GSDM) (Hydrometeorological advisory service, June 2003) outlines the method for calculating the Probable Maximum Precipitation in Australia. The site is located within the zone limited to catchments up to 1000 km^2 in size and up to 3 hours critical storm duration (Figure 2, GSDM). The site elevation varies between 200 m and 209 m AHD. An Elevation Adjustment Factor (EAF) is only required for sites with an average elevation greater than 1500 m therefore the EAF value has been determined to be 1. The proposed site falls on the Moisture Adjustment Factor (MAF) 0.07 line (Figure 3, GSDM, 2003). The location of the site on GSDM Figures 2 and 3 is shown in Figure 6.3 below. The GSDM was used to estimate the PMP for the site for different storm durations up to 3 hours. The estimated values for PMP are provided in Table 6.3.

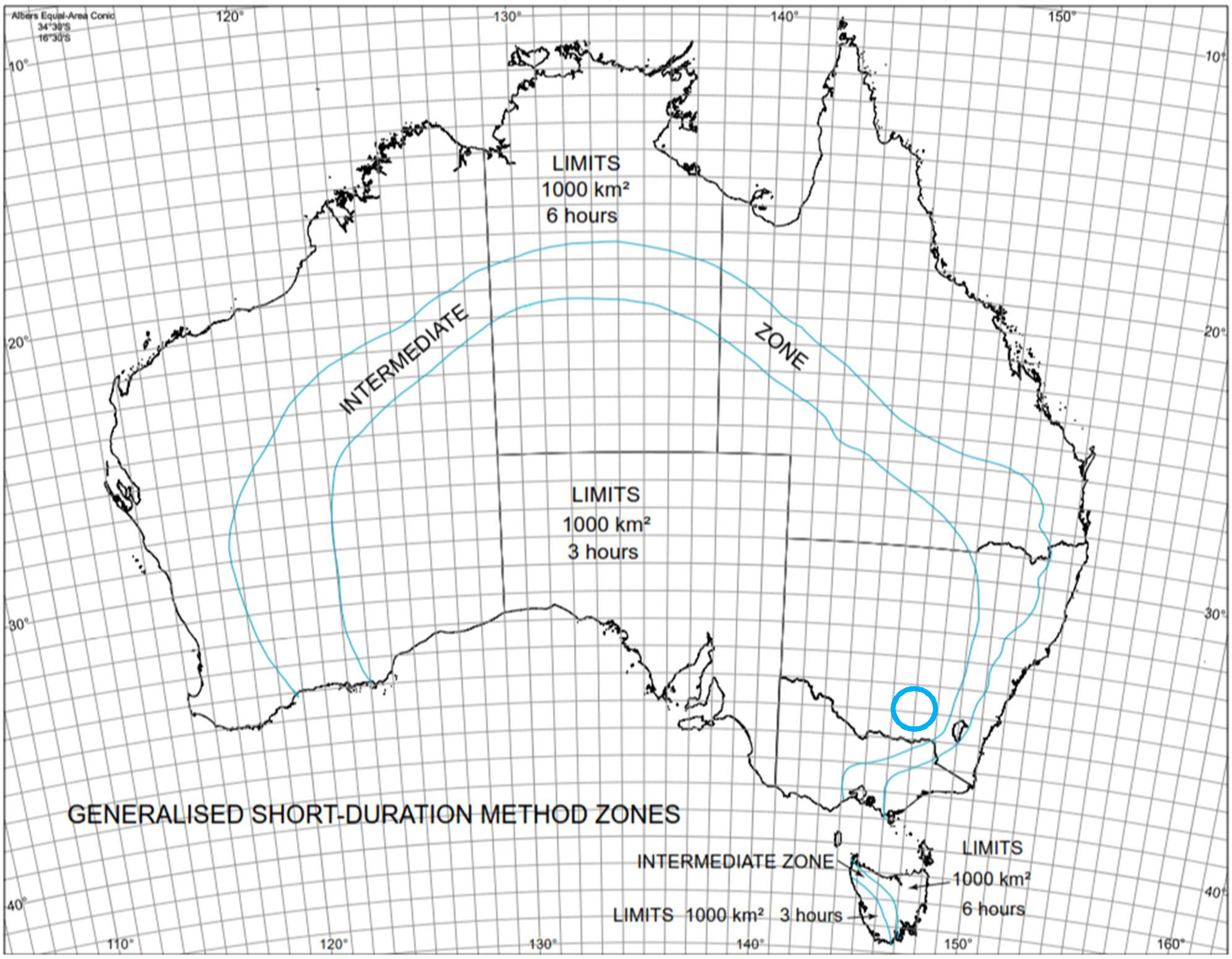


Figure 6.3 Site location in GSDM Figures 2 and Figure 3 (GSDM, 2003)

Table 6.3 PMP

STORM DURATION (HOURS)	PROBABLE MAXIMUM PRECIPITATION (MM)
0.25	87.5
0.5	129.5
0.75	164.5
1	199.5
1.5	234.5
2	262.5
2.5	287
3	315

The regional model had a critical duration of 24 hours (WMAwater, 2017). This was beyond the limits of the GSDM. The PMP for the 24 hour storm was estimated by increasing the 1% AEP 24 hour rainfall depth in accordance with the ratio between the 1% AEP and the PMF peak discharges outlined in Billabong Creek flood report by WMAwater (2017). This ratio was calculated to be 10.65. The PMP 24 hour rainfall depth adopted was 1229 mm.

6.6 2D XP-SWMM MODELS

A 2D XP-SWMM model (XP-SWMM Version 2018.2.2) was built for the site, to map the flood inundation extents across the site. The 2D XP-SWMM model was used for regional flood simulation for flows in Billabong Creek using the peak catchment discharge from WMAwater (2017). A separate local catchment flood simulation for discharges from catchments downstream of the Olympic Highway using flood hydrographs from XP-SWMM was also undertaken.

6.6.1 REGIONAL FLOOD MODEL

The 2D model was prepared using the 2014 5 m contour data, with a modelled 2D cell size of 20 metres. These 2D cell sizes were considered appropriate based on the terrain model to ensure a reasonable run time.

The Billabong Creek peak catchment discharge from the WMAwater flood model (2017) was entered into the regional model to generate maximum regional flood depths on the site for each event. The 5%, 1% and 0.5% AEP storm events and the PMF were investigated with the regional model. The 0.2% AEP event was not investigated with the regional model because Billabong Creek flows were not available for this event. The inflows used in the regional model are provided in Table 6.4.

Table 6.4 Regional Model: Billabong Creek In-Flows[3]

ANNUAL EXCEEDANCE PROBABILITY (AEP)	WBNM MODEL PEAK FLOWS
5% AEP	424 (m^3/s)
1% AEP	686 (m^3/s)
0.2% AEP	Not available
0.5% AEP	812 (m^3/s)
Probable Maximum Flood (PMF)	7306 (m^3/s)

The 2D model downstream boundaries were adopted as head-flow boundaries that calculate normal depth based on the hydraulic gradient and cross sectional area of the flow path. These model boundaries were located several hundred metres downstream of the site boundary.

[3] Billabong Creek, near Olympic Highway- WBNM Model Peak Flows. WMAwater 2017 (p.14, Table 2)

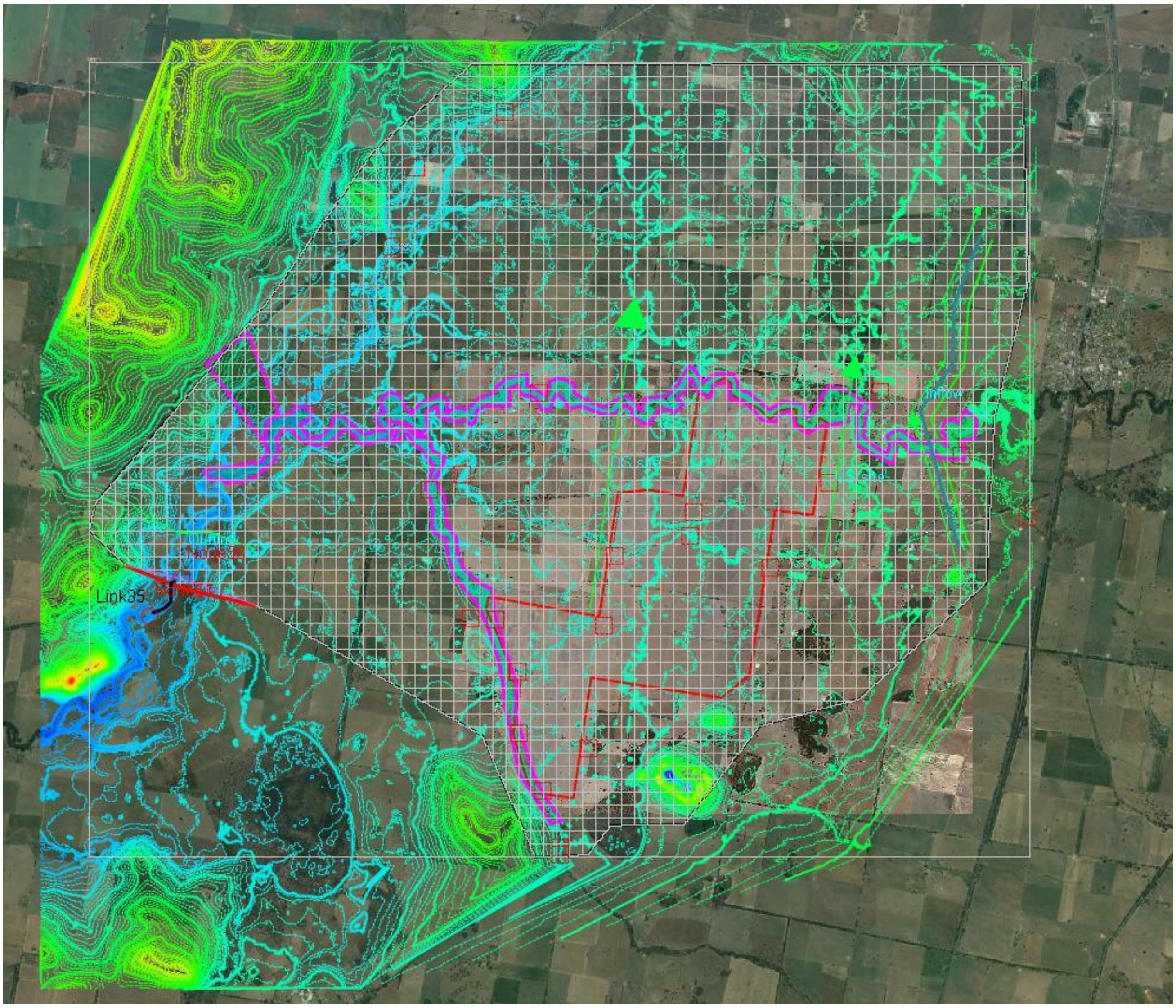


Figure 6.4 2D XP-SWMM regional flood model arrangement

6.6.2 LOCAL FLOOD MODEL

The 2D model was prepared using the 2014 5 m contour data, with a modelled 2D cell size of 20 metres.

To model the site's hydraulic behaviour, the catchment runoff hydrographs calculated in XP-SWMM runoff mode were released into the 2D XP-SWMM hydraulics grid. Due to the topography of the site, it is expected that much of the runoff will comprise sheet flow rather than concentrated channel flow. To model this sheet flow, rainfall catchments close to the site were released to the grid via rainfall polygons rather than as point inflows. For catchments upstream of the site with 1D links, runoff was released into the model via flow lines.

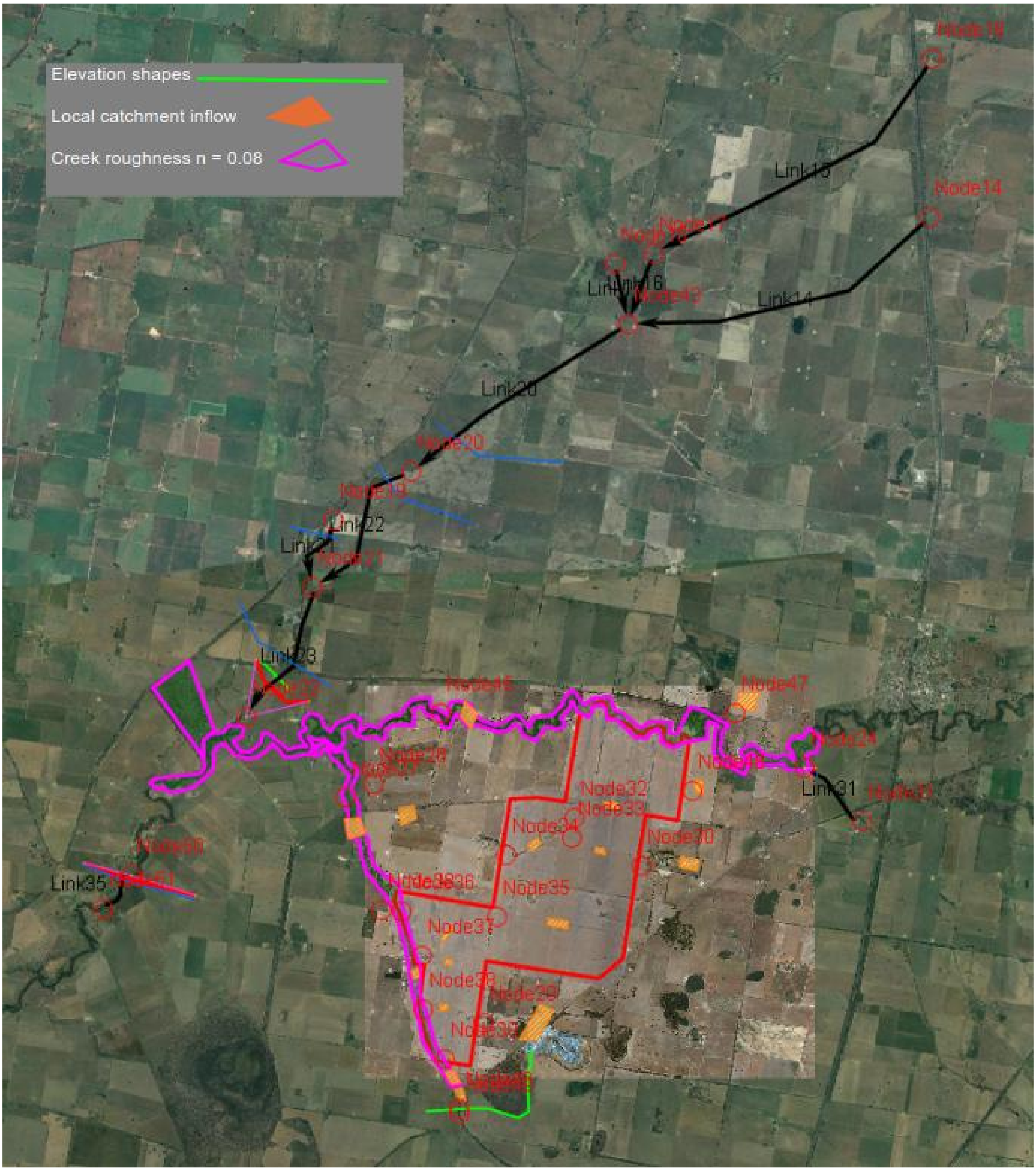


Figure 6.5 2D XP-SWMM local flood model arrangement

The 5%, 1%, 0.5% and 0.2% AEP storm events and the PMF were investigated with the local model for both existing and design cases.

The solar panel and infrastructure layout used to assess the impacts of the development is shown in Figure 4.1. The area of the site to be populated with solar panels and infrastructure is approximately 620 ha.

As previously discussed, the area to be populated with solar panels has been treated as having an effective impervious area percentage of 10% in the developed case. Additionally, it has been conservatively assumed that livestock will be excluded from the solar farm site, which will therefore encourage a more well established vegetation coverage over the site. The expected increase in grass cover due to the cessation has been modelled by increasing Manning's roughness from 0.045 to 0.055 for all areas within the site. It is acknowledged that this assumption is conservative as Neon Australia Pty Ltd has advised that a VMP is proposed to be implemented to maintain vegetation throughout the site. The flood inundation mapping provide herein will therefore be conservative in terms of peak flood levels, depths and extent. This aspect may be re-addressed during the detailed design phase, but it is a robust approach for this concept and approvals phase.

6.7 PEAK DISCHARGES

6.7.1 REGIONAL FLOOD MODEL

Regional flood maps for the site are provided in Appendix F for the existing conditions. A map is provided for each of maximum water level, maximum depth, maximum hazard (NSW Floodplain Management Manual) and maximum velocity for the 5%, 1%, and 0.5% AEP and the PMF regional flood.

The peak catchment discharge from WMAwater (2017) was entered into the model along with the 24 hour storm to generate maximum regional flood depths on the site for each AEP and the PMF.

Site discharge rates from the site are not quoted as the total flood flow spreads beyond the site boundary.

The regional model was not simulated for the developed case scenario. Whilst an increase in hydraulic roughness (i.e. Manning's 'n' values) will likely result in an increase in predicted water levels, the proposed panels are located in low conveyance areas (typically flood depths less than 0.5 m), so will not be subjected to high flow conditions in the event of a regional flood. Accordingly, it is expected that the location of the panels, combined with the proposed VMP over the site, will not result in any adverse impacts to regional flood levels in the post developed state. Figure 6.6 and Figure 6.7 below present a representative cross section through the site depicting the proposed panel locations and the regional model 1% AEP water surface levels.

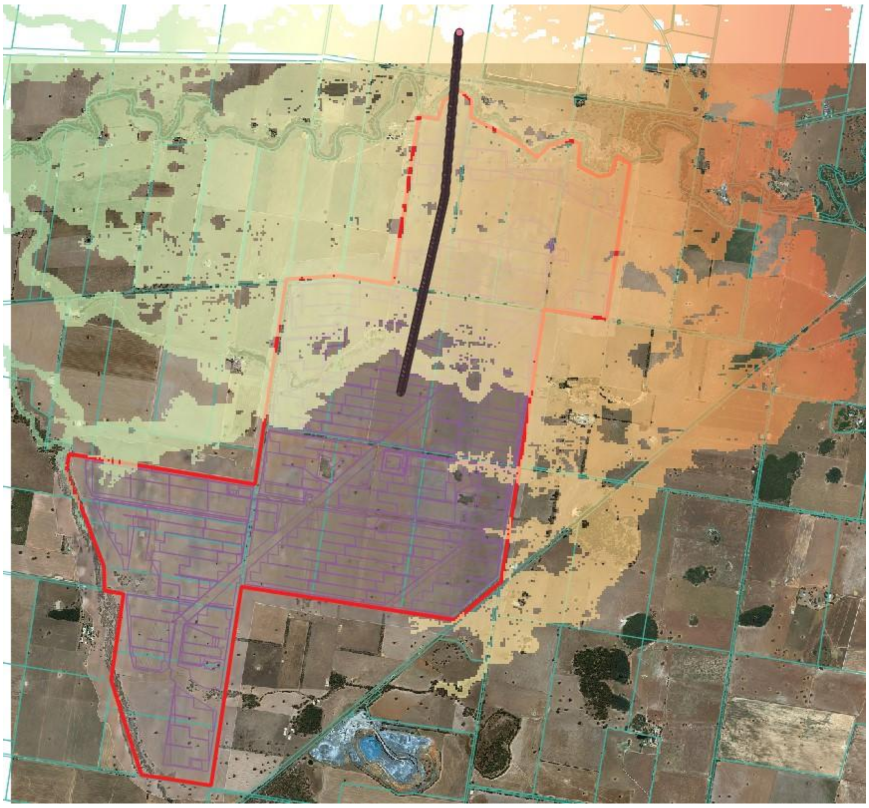


Figure 6.6 "Regional 1% AEP Cross Section Location"

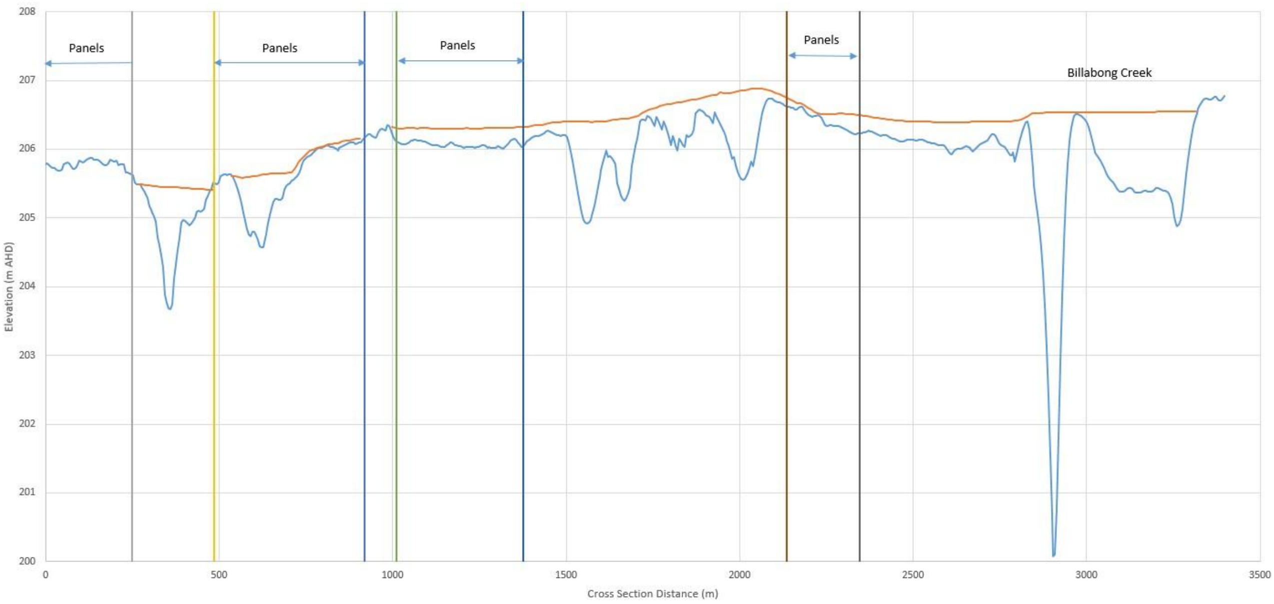


Figure 6.7 "Regional 1% AEP Water Surface Level Cross Section Through Site"

6.7.2 LOCAL FLOOD MODEL

Local flood maps for the site are provided in Appendix G. For the existing conditions, a map is provided for each of maximum depth and maximum velocity for the 5%, 1%, 0.5% and 0.2% AEP and the PMF local flood. Impacts of the proposed development are shown on the flood afflux map (including wet/dry) provided for each event.

The peak discharge rates at the site's inflow boundaries and site boundary discharge locations are provided in Table 6.5, Table 6.6 and Table 6.7 for the 5%, 1% and 0.5% AEP events respectively. The 2D flow reporting locations are shown in Figure 6.8. These are the locations where simulated runoff enters and leaves the site. The 1% AEP maximum flood extent is also shown. The change in peak discharge is reported for each location as both an increase in flow rate and as a percentage of the existing peak discharge (negative value means a reduction in peak flow).

Table 6.5 Peak discharges for the local flood model – 5% AEP, 4.5 hour storm duration

2D MODEL FLOW REPORTING LOCATION	EXISTING CASE PEAK DISCHARGES (M^3/S)	DEVELOPED CASE PEAK DISCHARGES (M^3/S)	INCREASE M^3/S	INCREASE %
US site [1]	23.50	23.50	0.00	0.0
DS site [1]	13.10	13.20	0.10	0.8
Line 1 [1]	18.04	17.66	-0.38	-2.1
Line 2 [1]	1.08	1.05	-0.03	-2.8
Line 3 [1]	78.69	78.30	-0.39	-0.5
Line 4 [1]	1.12	1.07	-0.05	-4.5
Line 5 [1]	1.44	1.44	0.00	0.0
Line 6 [1]	15.39	15.38	-0.01	-0.1

Notes: 1. Refer to Figure 6.8 for location of 2D model flow reporting lines

Table 6.6 Peak discharges for the local flood model – 1% AEP, 4.5 hour storm duration

2D MODEL FLOW REPORTING LOCATION	EXISTING CASE PEAK DISCHARGES (M^3/S)	DEVELOPED CASE PEAK DISCHARGES (M^3/S)	INCREASE M^3/S	INCREASE %
US site [1]	40.00	39.95	-0.05	-0.1
DS site [1]	28.40	28.30	-0.10	-0.4
Line 1 [1]	32.77	32.03	-0.74	-2.3
Line 2 [1]	2.23	2.18	-0.05	-2.2
Line 3 [1]	140.30	138.10	-2.20	-1.6
Line 4 [1]	2.06	1.97	-0.09	-4.4
Line 5 [1]	2.67	2.57	-0.10	-3.7
Line 6 [1]	28.08	28.06	-0.02	-0.1

Notes: 1. Refer to Figure 6.8 for location of 2D model flow reporting lines

Table 6.7 Peak discharges for the local flood model – 0.5% AEP, 4.5 hour storm duration

2D MODEL FLOW REPORTING LOCATION	EXISTING CASE PEAK DISCHARGES (M^3/S)	DEVELOPED CASE PEAK DISCHARGES (M^3/S)	INCREASE M^3/S	INCREASE %
US site [1]	54.00	53.89	-0.11	-0.2
DS site [1]	38.40	38.70	0.30	0.8
Line 1 [1]	42.01	41.04	-0.97	-2.3
Line 2 [1]	2.97	2.82	-0.15	-5.1
Line 3 [1]	178.32	174.39	-3.93	-2.2
Line 4 [1]	2.64	2.53	-0.11	-4.2
Line 5 [1]	3.31	3.25	-0.06	-1.8
Line 6 [1]	36.12	36.08	-0.04	-0.1

Notes: 1. Refer to Figure 6.8 for location of 2D model flow reporting lines

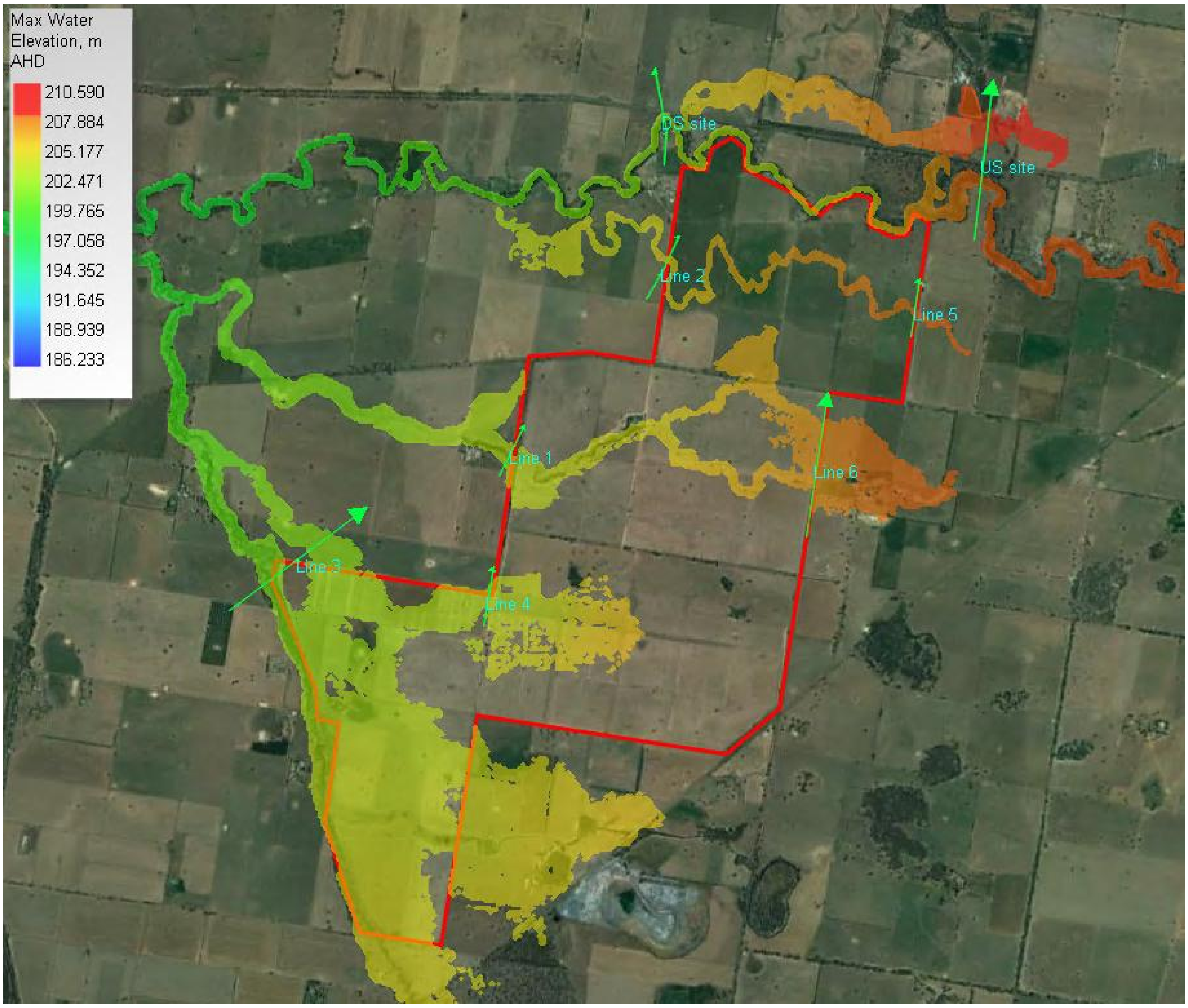


Figure 6.8 2D flow reporting locations and 1% AEP maximum flood extent

The peak discharge rates at the site's inflow boundaries and site boundary discharge locations are provided in Table 6.8 for the 0.2% AEP. Due to the wider flood extents for this event, an extended flow reporting line, Line 9, replaces Line 1 and the additional flow line, Line 8, is required to report a new discharge. Refer to Figure 6.9 for the location of Lines 8 and 9.

Table 6.8 Peak discharges for the local flood model – 0.2% AEP, 4.5 hour storm duration

2D MODEL FLOW REPORTING LOCATION	EXISTING CASE PEAK DISCHARGES (M^3/S)	DEVELOPED CASE PEAK DISCHARGES (M^3/S)	INCREASE M^3/S	INCREASE %
US site [1]	61.60	61.84	0.24	0.4
DS site [1]	48.94	48.91	-0.03	-0.1
Line 8 [1]	0.13	0.17	0.04	30.8
Line 9 [1]	56.33	54.96	-1.37	-2.4
Line 2 [1]	3.92	3.89	-0.03	-0.8
Line 3 [1]	240.56	235.28	-5.28	-2.2
Line 4 [1]	3.73	3.55	-0.18	-4.8
Line 5 [1]	4.92	4.49	-0.43	-8.7
Line 6 [1]	48.91	48.71	-0.20	-0.4

Notes: 1. Refer to Figure 6.8 for location of 2D model flow reporting lines

The site is fully inundated by the local PMF event. Comparison of peak discharge for the PMP was done at a location approximately 4 kilometres downstream of the site at a location where the flow was unidirectional. This is reported as flow line 7 in Table 6.9. Refer to Figure 6.9 for the location of Line 7.

Table 6.9 Peak discharges for the local flood model – PMF, 3 hour storm duration

2D MODEL FLOW REPORTING LOCATION	EXISTING CASE PEAK DISCHARGES (M^3/S)	DEVELOPED CASE PEAK DISCHARGES (M^3/S)	INCREASE M^3/S	INCREASE %
Line 7 [1]	2055.06	2029.62	-25.44	-1.2

Notes: 1. Refer to Figure 6.8 for location of 2D model flow reporting lines

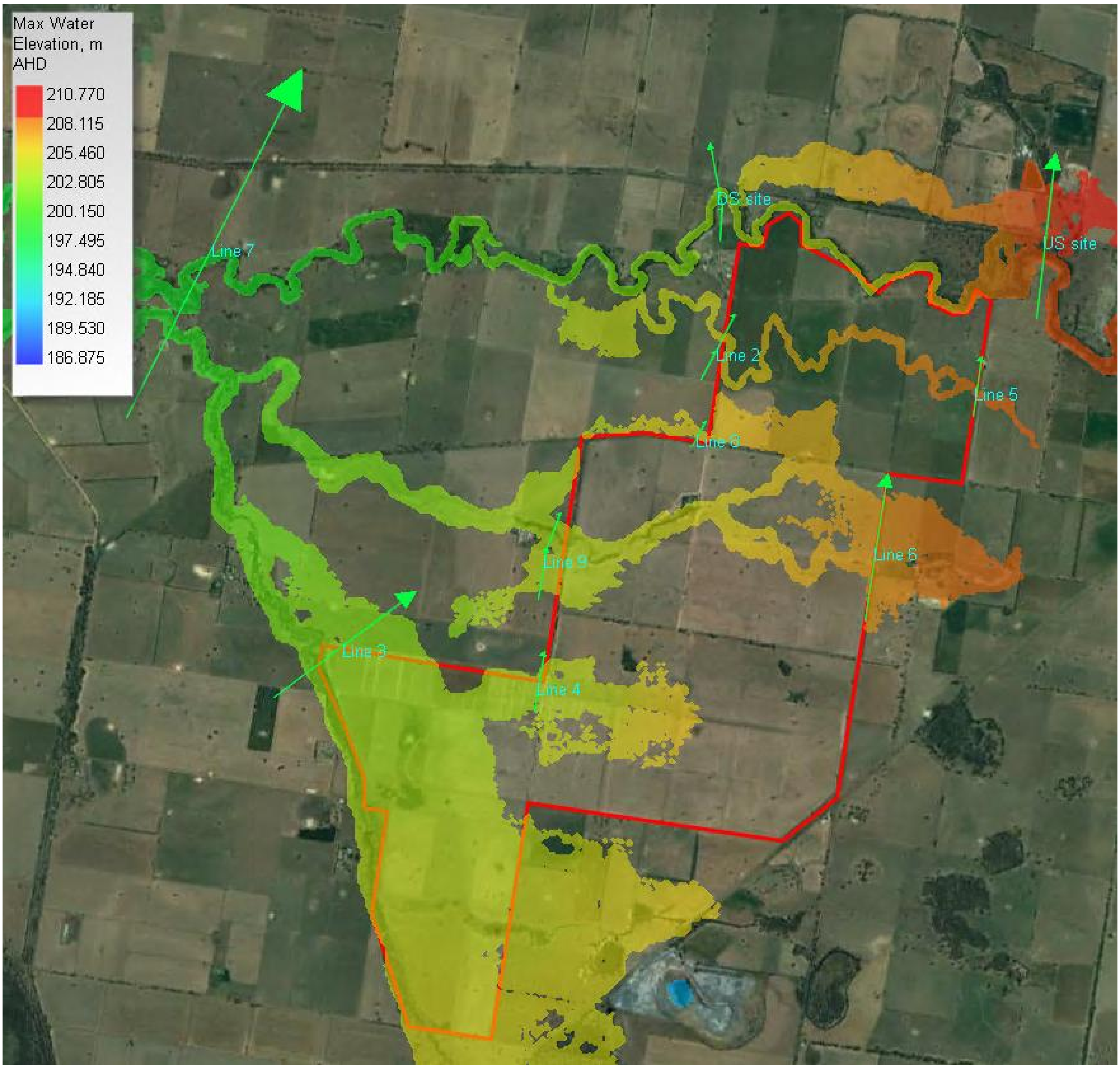


Figure 6.9 2D flow reporting locations and 0.2% AEP maximum flood extent

Treatment of solar panels as 10% impervious increased the rate of runoff from the panel areas. It was assumed that grazing of the site would cease (worst case). Increase in site roughness due to the cessation of grazing, reduced the rate of runoff across the site. The combined effect on peak discharge rates at the site downstream boundary varies between location and event. As may be seen from Table 6.5 through Table 6.7 there were small reductions in peak discharge at all site discharge locations for the 5%, 1% and 0.5% AEP events. This is accompanied by increased flood depths across the site and into adjacent properties. Afflux exceeds 50 mm within one watercourse. Elsewhere, afflux is 50 mm or less, both within and beyond the site, in these events. Flood depth afflux maps for these events are provided in Appendix G: Figures G11, G12 and G13.

For the 0.2% AEP event, Table 6.8 shows that there were small reductions in peak discharge at all site discharge locations but one. The exception is flow reporting line 8 where a 0.04 m^3/s increase in peak discharge was reported. No flow discharges at this location in the 5%, 1%, or 0.5% AEP events. Flood depth afflux for this event is shown in Appendix G: Figure G14. Afflux exceeds 50 mm within one watercourse. Elsewhere, afflux is 50 mm or less, both within and beyond the site.

For the local PMF event, there is a reduction in peak discharge of 1.2% at a location approximately 4 kilometres downstream of the site. Comparison of peak discharge at the site boundary was not appropriate due to the spread of the flow for this event. Flood depth afflux for the PMF is shown in Appendix G: Figure G15. Afflux in excess of 50 mm occurs across approximately one third of the site and extends beyond the site boundary in several locations. The maximum afflux is 130 mm. This occurs in the southern part of the site and adjacent property.

No modelling of mitigation options has been undertaken. Options that may improve the results include allowing grazing to continue on the site which help maintain the existing Manning's roughness across the site or providing additional storage within the site (basins or stream channel improvements). The impacts of these options have not been assessed. It is expected that the implementation of a VMP to maintain the existing state of vegetation cover across the site will eliminate the predicted offsite flood impacts reported herein.

It is recommended that re-modelling of the proposed developed case (including implementation of the proposed VMP) be undertaken at the detailed design phase, to better capture the recommendations of the VMP and to incorporate any subsequent topographic changes and/or design changes.

7 ASSESSMENT AGAINST GUIDELINES

7.1 GREATER HUME LOCAL ENVIRONMENT PLAN 2012

7.1.1 EARTHWORKS

Reference is made to Clause 6.1 of the LEP ‘Earthworks and is reproduced in Appendix C (C1).

No major earthworks are proposed for the site that would significantly change the existing drainage regime of the floodplain or minor watercourses.

Future designs must abide by the conditions in Clause 6.1.

7.1.2 FLOOD PLANNING

Reference is made to Clause 6.1A of the LEP ‘Flood planning’ and is reproduced in Appendix C (C2). This clause applies to land at or below the flood planning area which is defined as the 1:100 Average Recurrence Interval. This is equivalent to the 1% AEP.

An assessment of the flood characteristics was undertaken in Section 6. For the local 5% and 1% AEP events, there were small reductions in peak discharge at all site discharge locations (Table 6.5 and Table 6.6). This is accompanied by increased flood depths across the site and into adjacent properties. Afflux exceeds 50 mm within one watercourse. Elsewhere, afflux is 50 mm or less, both within and beyond the site. Flood depth afflux maps for these events are provided in Appendix G: Figures G11 and G12. An object of Clause 6.1 is to “avoid significant adverse impacts on flood behaviour and the environment”. The term “significant” is not defined. While there are changes to peak discharge and depths, guidance is not given as to whether these are significant changes or not. Flow paths remain unchanged and only minor changes to the flood extents as shown by the “was wet now dry” layer on the afflux maps included in Appendix G.

7.1.3 RIPARIAN LAND AND WATERCOURSES

Reference is made to Clause 6.3 of the LEP ‘Riparian land and watercourses’ and is reproduced in Appendix C (C3).

Waterways bounding the site are as follows:

— Billabong Creek along the northern boundary

— Back Creek along part of the western boundary.

Clause 6.3 of the GHS LEP applies to land identified as waterways on the site and land within 40 metres of the top of bank of these waterways.

The solar panel layout provided excludes solar panels and other infrastructure from the waterways on the site and land within 40 metres of the top of bank of these waterways. As reported in Section 6.7 the changes in peak discharge from the site due to the proposed development are minor and, in most cases, a reduction in peak discharge. The afflux maps in Appendix G show no increase in peak flood depth in Billabong Creek for events up to the PMF (not including). In the PMF the depth increase is less than 100 mm. In Back Creek the increase in peak flood depth is 30 mm or less for events up to the PMF (not including), and 100 mm or less in the PMF.

As per the figure below, there are no wetlands within the site boundary.

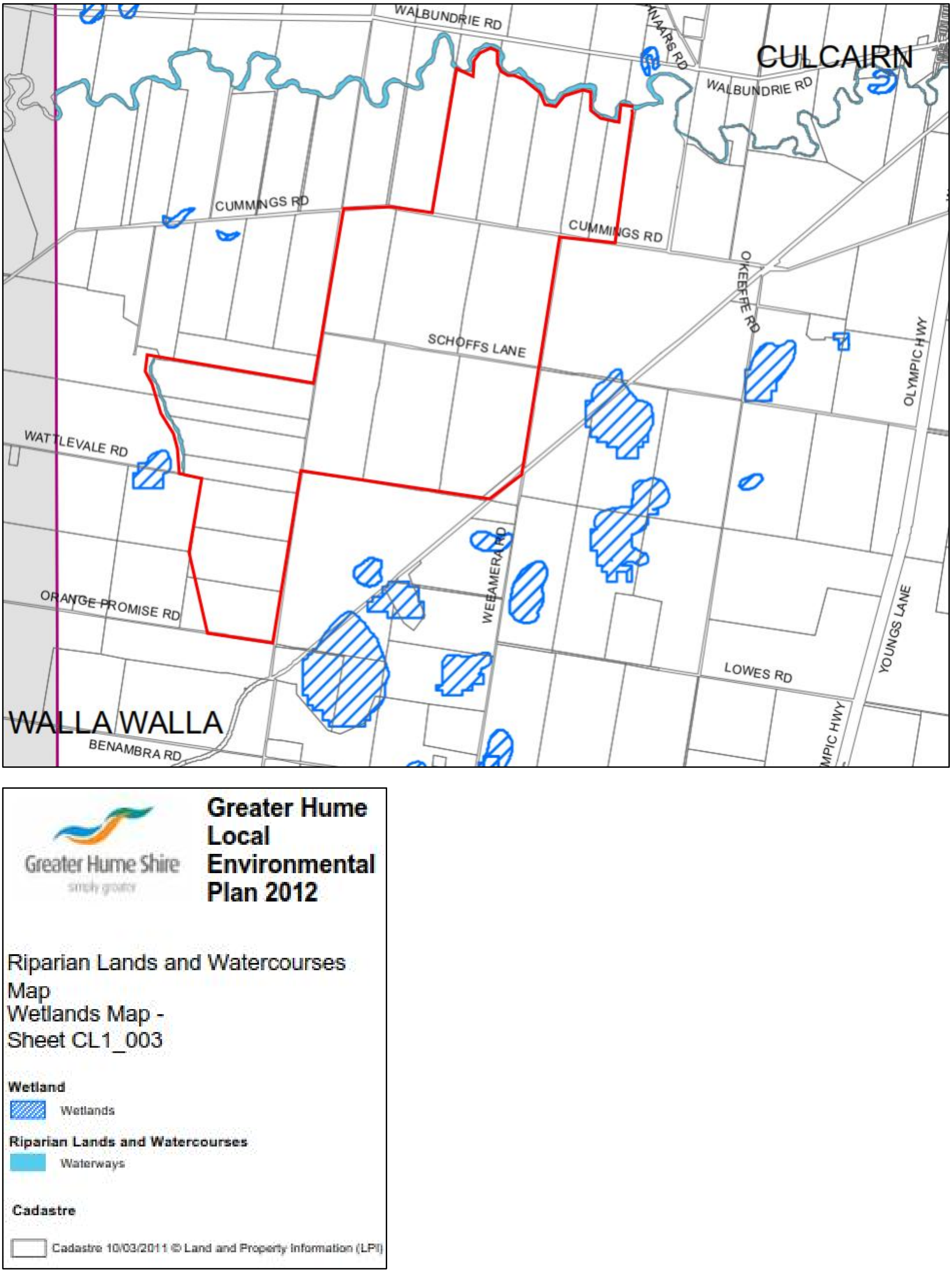


Figure 7.1 Site boundary overlaid onto *Riparian Lands and Watercourses Map*

7.2 GREATER HUME DEVELOPMENT CONTROL PLAN 2013

Reference is made to Section 8.0 of the DCP 'Flood Liable Land' and is reproduced in Appendix D.

The DCP lists objectives for development on land that is flood liable. The DCP defines flood liable land as 'land which is mapped by Council as being subject to inundation up to a 1 in 100 AEP flood event' (the "flood planning level" or FPL).

The LEP defines the flood planning level as the 'level of a 1:100 AEP (annual exceedance probability) flood event plus 0.5 metre freeboard'. The 5% and 1% AEP flood levels are shown in Appendix F and Appendix G. Local flood impacts of the proposed development are shown in the afflux maps for these events in Appendix G and discussed in Section 6.7.

Specific conditions in regards to solar arrays, solar array drivers or inverters relative to the flood planning level have not been identified in GHS documentation.

7.3 MANAGING URBAN STORMWATER: SOILS & CONSTRUCTION

Reference is made to *Soils and Construction Volume 1 4th Edition, March 2004* (Landcom, 2004).

Application of this document to the proposed solar farm development is dependent on the soil erodibility and dispersibility at the base of the solar array posts. The amount of erosion is also dependent on the amount of vegetation at the base of the array posts. Soil particle distribution results were not available at the time of preparation of this study.

It is recommended that the Development Application consent conditions the detailed design to respond to *Soils and Construction Volume 1* and other appropriate guidelines for mitigation of erosion.

Section 9 of this report provides some examples of mitigation measures that may be appropriate for erosion and sediment control.

7.4 STATE ENVIRONMENTAL ASSESSMENT REQUIREMENTS (SEARS)

The *Culcairn Solar (SSD 10288) Environmental Assessment Requirements* letter to Mr Antoine Lajouanie from Nicole Brewer (NSW Government Planning & Environment) dated 03/05/19 lists the requirements for ‘Water’. These are reproduced in the table below and a response has been provided regarding each requirement.

Table 7.1 Responses to Environmental Assessment Requirements

CULCAIRN SOLAR (SSD 10288) ENVIRONMENTAL ASSESSMENT REQUIREMENTS (‘WATER’)	RESPONSE
An assessment of the likely impacts of the development (including flood) on surface water and groundwater resources (including Back Creek, Billabong Creek, drainage channels, wetlands, riparian land, farm dams, floodplains, key fish habitat, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts.	An assessment of the likely impacts of the development (including flood) on surface water has been based on the proposed solar array layout to assess in the flood study. Local flood impacts of the proposed development are shown in the afflux maps for these events in Appendix G and discussed in Section 6.7 An increase in vegetation roughness of the site was applied to the flood modelling to reduce and mitigate the impacts the development. of the increased imperviousness of the site due to the development. Treatment of solar panels as 10% impervious increased the rate of runoff from the panel areas. It was assumed that grazing of the site would cease. Increase in site roughness due to the cessation of grazing, reduced the rate of runoff across the site. Other mitigation measures have not been investigated, however, a VMP is now proposed to be implemented at the site to maintain existing vegetation levels throughout the site. It is expected that the minor flood impacts predicted by the hydraulic modelling would to disappear due to the implementation of the VMP. It is recommended to investigate this further at detailed design phase. A groundwater assessment is not part of the scope of this concept stormwater management plan.
Details of water requirements and supply arrangements for construction and operation.	Not part of the scope of this concept stormwater management plan.
A description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with Managing Urban Stormwater: Soils & Construction (Landcom 2004).	Conceptual measures are presented in Section 9 of this report that may apply to access tracks.

8 WATER QUALITY

The proposed development will include solar panel arrays, inverter stations, transformer substation, lithium ion (or similar) battery storage and cabling (above or underground). Land over the site is currently zoned as primary production.

Development of land generally results in increased exports of suspended solids (SS) and nutrients, which are measured in terms of total nitrogen (TN) and total phosphorous (TP). The project and associated activities that may potentially cause an impact on water quality at the site are limited, as the solar panels themselves are not expected to increase pollutant or nutrient levels and the batteries will be sealed modules housed inside shipping containers and therefore not in direct contact with stormwater runoff. Sediment may be generated from the site, due to vehicle movements and from runoff from the gravel access tracks, in addition to localised material scour from around posts supporting the solar panels. Based on this assessment, the water quality mitigation measures associated with this SMP have focussed on sediment alone.

Access to the solar panel arrays, inverter stations, transformer substation, battery storage, administration and maintenance facilities will be via local roads, existing unsealed tracks on the site and newly constructed gravel access tracks. Erodibility of surface material surrounding the posts supporting the solar panel mounting racks, infrastructure areas, and access tracks will depend on the velocity of the flow across them, erodibility of the soil, vegetative cover quality and extents and finished quality of the construction of the access tracks. Control of sediment over these areas will be managed with localised sediment and erosion control measures installed adjacent to the infrastructure areas and access tracks as required. Possible mitigation measures for sediment control are identified in Section 9 of this report.

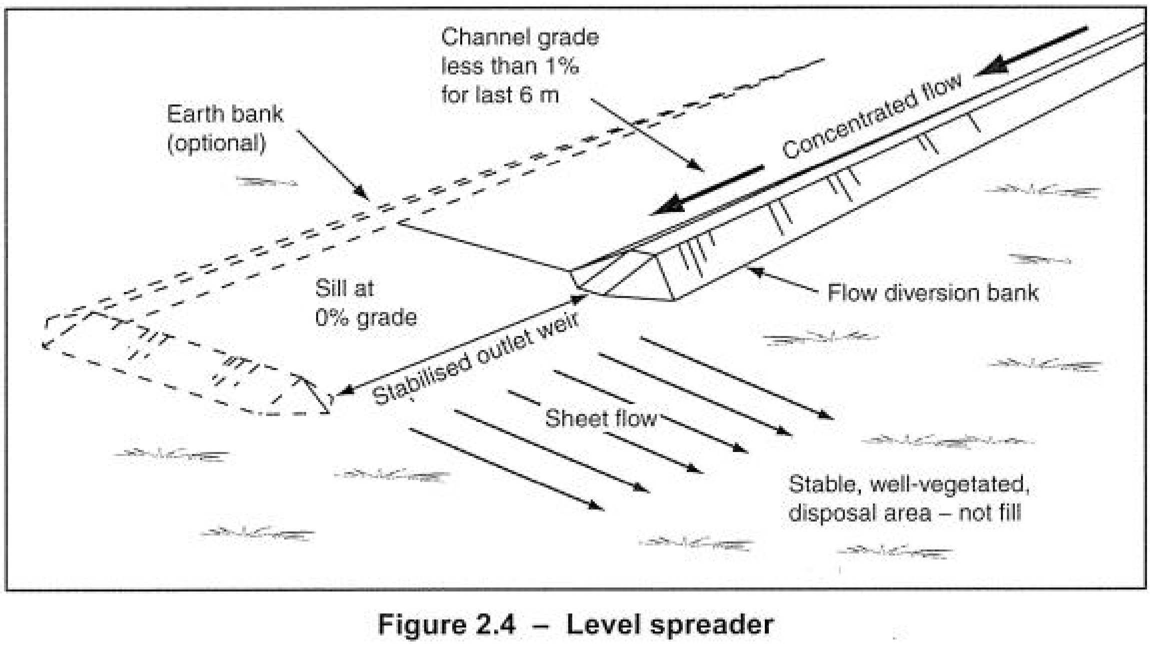
9 EROSION AND SEDIMENT CONTROL

Soil classification and erodibility testing should be undertaken prior to detail design to confirm the erodibility of the soil along the access track alignment and at also new infrastructure locations, including post sites, inverter stations and the transformer substation. This will assist in the design of appropriate targeted sediment and erosion control measures.

9.1 ACCESS TRACKS

Erosion and sediment control should be carried out in accordance with the International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control guideline or Managing Urban Stormwater: Soils and construction (Landcom, 2004).

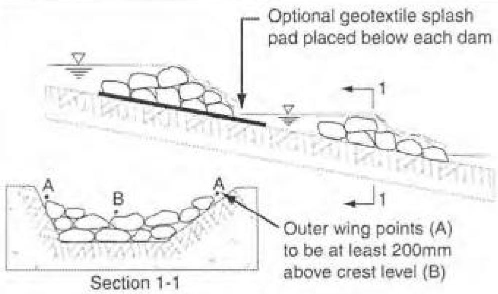
Concentration of runoff along the proposed access tracks should be avoided by providing regularly spaced drainage outlets to level spreaders. Regular transitioning of concentrated roadside flow back to sheet flow via level spreaders will also assist to reduce the sediment load, as flow velocities will be reduced, enabling sediment to fall. Figure 9.1 shows a typical level spreader arrangement.



Source: IECA, 2008, Page 2.24

Figure 9.1 Typical Level Spreader Arrangement

The velocities of any roadside table drains should be checked during detailed design and an appropriate channel lining will need to be adopted to prevent scour. Rock check dams may be adopted as a means of reducing velocities and trapping coarse sediment, however regular use of level spreaders is preferred. A typical rock check dam from IECA (2008) is shown in Figure 9.2.

Option	Advantages	Disadvantages
 **Rock Check Dam**	• Easy to place. • Rock size is 200mm to 300mm and thus can be placed by hand.	• May interfere with grass mowing. • Can lose their value when placed in drains steeper than 10% (1 in 10 fall).

Source: IECA, 2008, Appendix K – Access Tracks and Trails, Page K. 11

Figure 9.2 Rock Check Dam for unsealed table drain.

For low speed tracks, cross banks can be useful to ensure stormwater sheets off the track into the table drain and to discharge the table drains at appropriate locations. Outfall and infall cross banks for low speed tracks from the IECA (2008) guideline, are shown in Figure 9.3.

The locations of the stormwater infrastructure including table drains, check dams, level spreaders, causeways and culverts should be confirmed during detailed design.

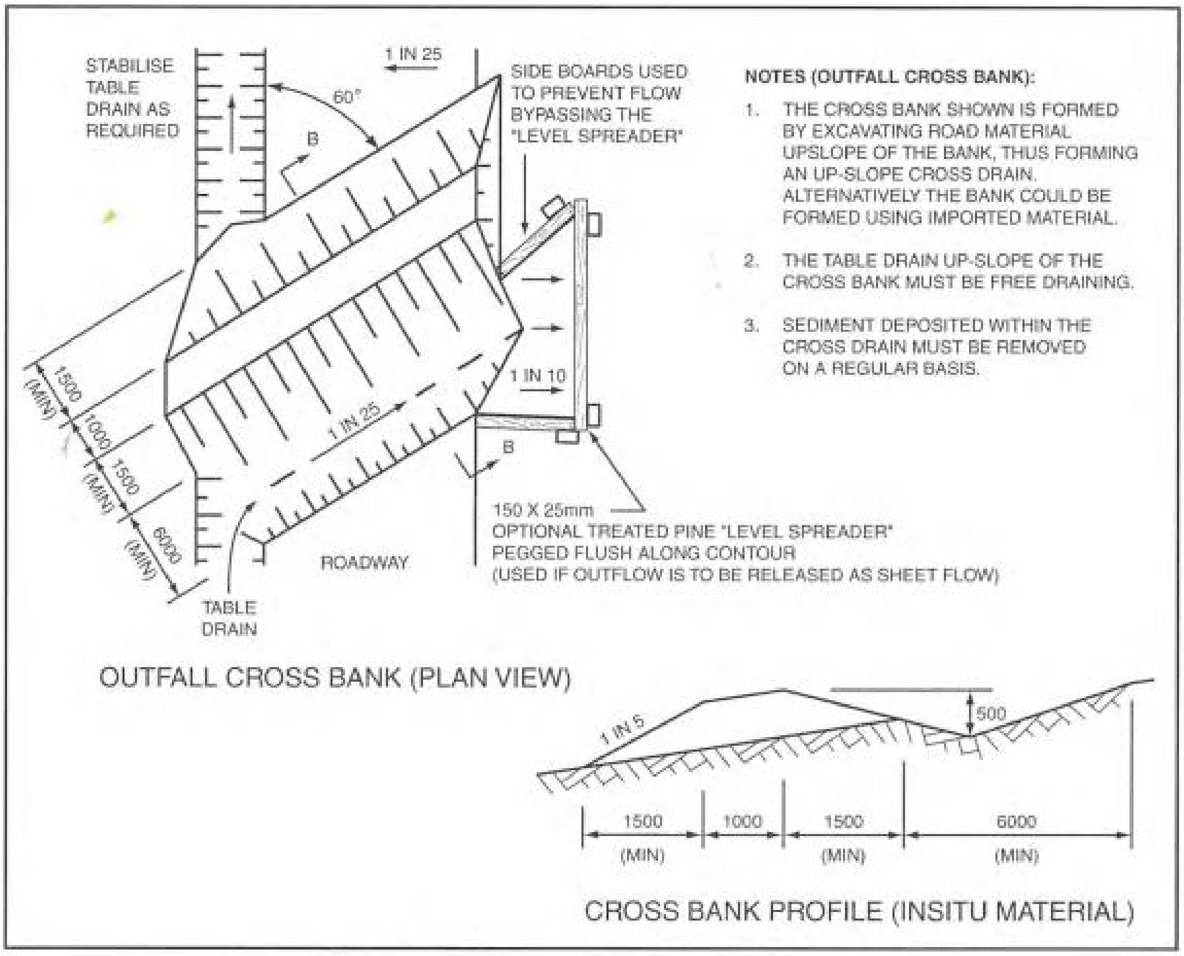


Figure K3 – Outfall cross bank for low speed tracks

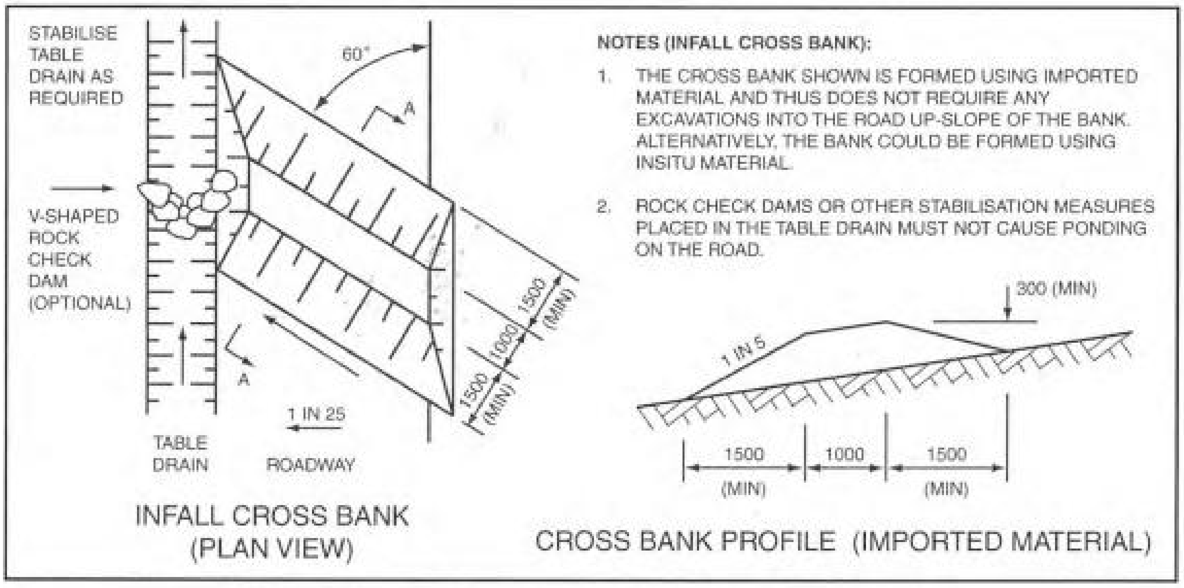


Figure K4 – Infall cross bank for low speed tracks

Source: IECA, 2008, Appendix K – Access Tracks and Trails. Page K.6

Figure 9.3 Outfall and infall Cross Banks and Level Spreaders for low speed tracks

9.2 OTHER SOLAR FARM INFRASTRUCTURE

It is recommended that support posts for the solar panel mounting racks be located outside the gullies that carry concentrated stormwater flows, thereby reducing the risk of scour around the columns. Velocities at the post locations should be confirmed during detailed design and can be output from the XP-SWMM 2D flood model. Where necessary, localised scour protection should be installed at the base of the posts.

Diversion drains may be installed upstream of the solar farm infrastructure to prevent uncontaminated external runoff from entering disturbed areas. Where drains are required within or about the solar farm infrastructure, outflows from these drains should be discharged via level spreaders onto grassed areas designed and maintained to trap any sediment load before it is discharged off site. The locations of the stormwater infrastructure associated with the solar farm will be confirmed during detailed design.

The locations and types of stormwater quality treatment measures, such as revegetation with appropriate grasses, selection of level spreaders, diversion channels, table drains, etc., will be determined during the detailed design phase.

10 CONCLUSIONS

The hydraulic modelling results indicated that the proposed installation of solar panels over the site would lead to small reductions in peak discharge at most site discharge locations. This was accompanied by increased flood depths across the site and into adjacent properties. These changes are expected to be the result of a slightly higher resistance to overland flow corresponding to the cessation of stock grazing and an increase in impervious area corresponding to the impervious solar panels themselves.

Afflux exceeds 50 mm within one watercourse through the property, for all modelled events. In the PMF afflux reaches 130 mm in the southern portion of the site and over parts of the adjacent property. For all other events, afflux is 50 mm or less, both within and external to the site. No major changes to flow paths or patterns has been predicted with the modelling (only some minor localised increases to water levels/depths on adjacent properties). The flood extents are not expected to measurably change due to the site development (refer afflux mapping).

Based on the hydraulic results; the change in runoff volume due to increased impervious area is considered minor in terms of flood impacts. The primary driver of flood impacts, both across the site and over adjacent properties, is the modelled change to surface roughness, which corresponds to the assumed cessation of stock grazing and the subsequent growth of well established vegetation coverage across the site.

Accordingly, it is expected that the implementation of a Vegetation Management Plan (VMP) over the site will effectively reduce any quoted adverse hydraulic impacts to negligible levels or levels that are within acceptable ranges. Accordingly, it is recommended that further hydraulic modelling be undertaken at detailed design phase to implement the recommendations of a VMP and incorporate any topographic changes associated with the development to confirm no offsite impacts.

The regional model was not simulated for the developed case scenario. Whilst an increase in hydraulic roughness (i.e. Manning's 'n' values) will likely result in an increase in predicted water levels, the proposed panels are located in low conveyance areas (typically flood depths less than 0.5 m), so will not be subjected to high flow conditions in the event of a regional flood. Accordingly, it is expected that the location of the panels, combined with the proposed VMP over the site, will not result in any adverse impacts to regional flood levels in the post developed state.

Sediment is the only potential pollutant expected to be associated with the proposed development. The site discharge water quality should not be impacted by the development, provided appropriate sediment and erosion control are measures are installed and maintained alongside all proposed access tracks and other infrastructure.

11 LIMITATIONS

This Report is provided by WSP Australia Pty Limited (*WSP*) for Neoen Australia Pty Ltd (*Client*) in response to specific instructions from the Client and in accordance with WSP's proposal dated 19 February 2019 and agreement with the Client dated 26 March 2019 (*Agreement*).

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11.5 PROJECT SPECIFIC

This developed case assessment is based on the client supplied layout. There were no changes to ground levels associated with the site. Impervious area of solar panels in assumed to be 10% of the overall panel area. It is assumed that Manning's roughness of the site will increase due to cessation of grazing (To be revised at detailed design with proposed VMP recommendations).

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APPENDIX A

INTENSITY FREQUENCY DURATION INFORMATION FROM THE BUREAU OF METEOROLOGY

Home | IFD Table | IFD Chart | Coefficients | ARI | Print IFD table | Help IFD table

Intensity-Frequency-Duration Table

Location: 35.675S 146.975E NEAR.. Culcairn, NSW Issued: 1/4/2019

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

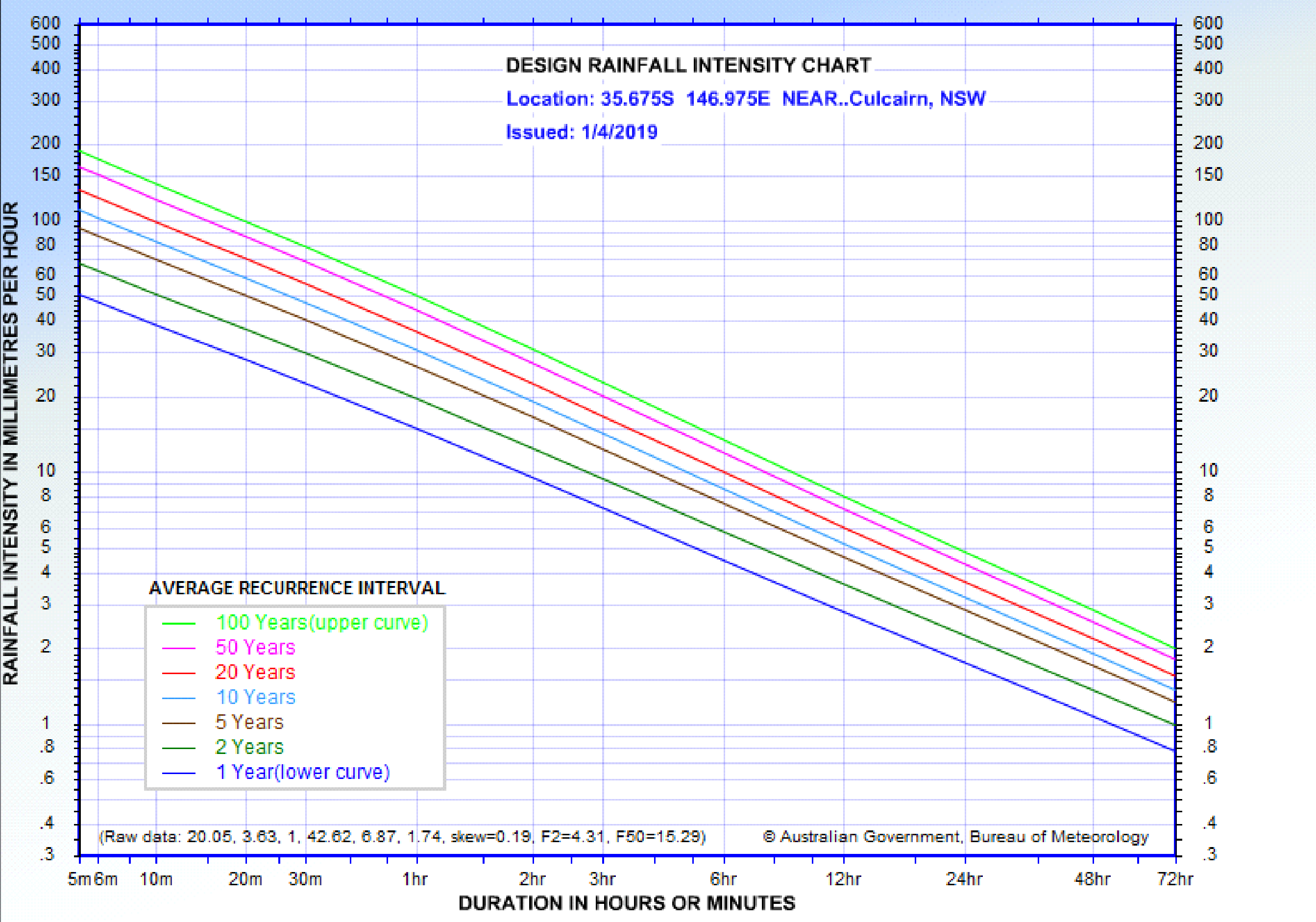
Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	50.8	67.5	93.3	110	132	163	189
6Mins	47.4	62.9	86.8	102	123	152	175
10Mins	38.5	51.0	70.1	82.4	98.6	121	140
20Mins	27.9	36.8	50.2	58.9	70.2	86.0	98.7
30Mins	22.5	29.7	40.2	47.0	56.0	68.4	78.4
1Hr	14.9	19.6	26.3	30.6	36.2	44.0	50.3
2Hrs	9.49	12.4	16.5	19.0	22.4	27.0	30.7
3Hrs	7.20	9.39	12.3	14.2	16.6	20.0	22.7
6Hrs	4.46	5.79	7.50	8.56	10.0	11.9	13.4
12Hrs	2.78	3.59	4.59	5.19	6.02	7.13	8.00
24Hrs	1.75	2.24	2.83	3.18	3.66	4.30	4.81
48Hrs	1.07	1.36	1.70	1.90	2.18	2.54	2.83
72Hrs	.779	.990	1.22	1.36	1.55	1.80	1.99

(Raw data: 20.05, 3.63, 1, 42.62, 6.87, 1.74, skew=0.19, F2=4.31, F50=15.29)

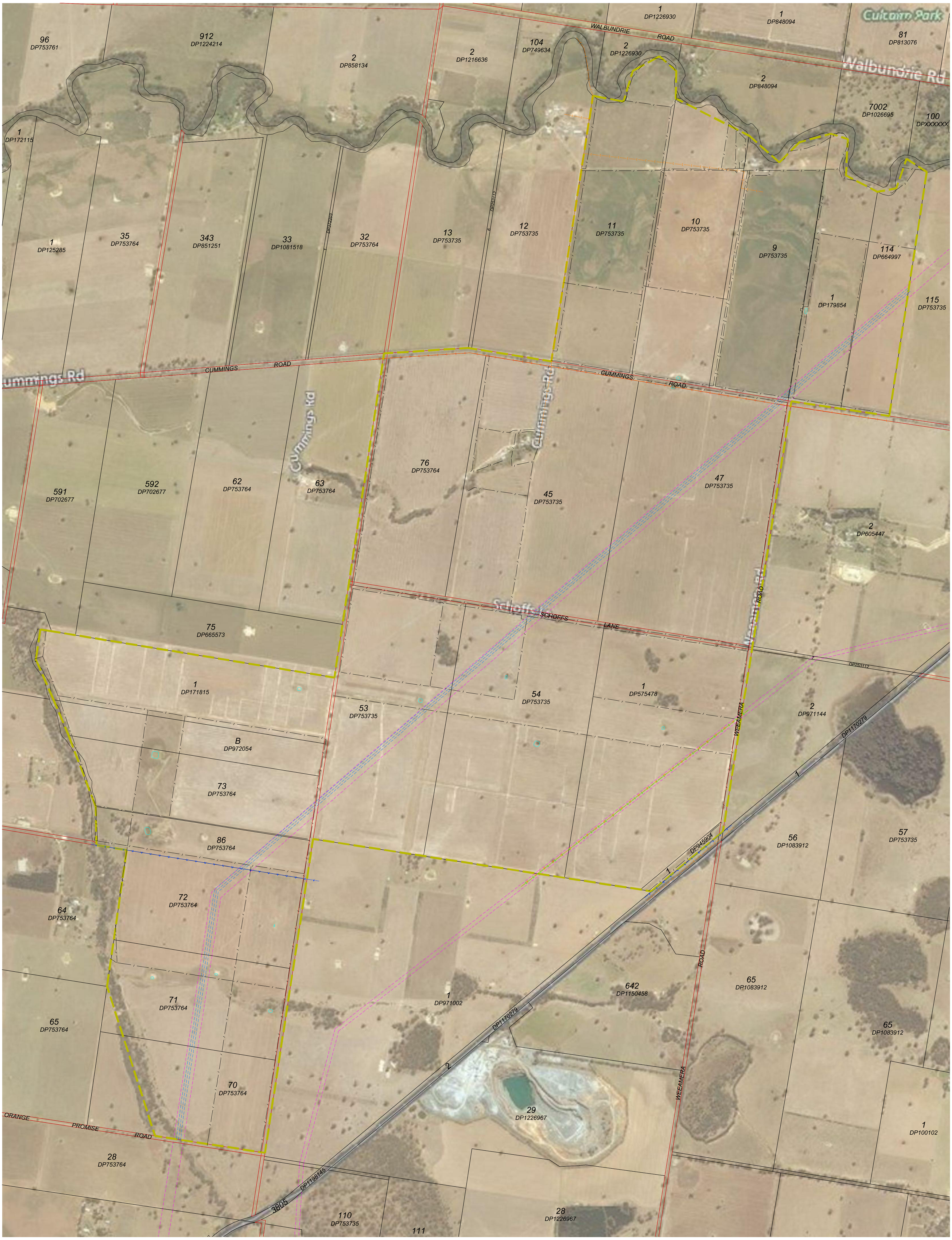
Copy Table

Home | IFD Table | IFD Chart | Coefficients | ARI | Print IFD chart | Help IFD chart



APPENDIX B

SURVEY



KEY FOR UNDERGROUND SERVICES

- Communications cable/pipe
- Comms optic fibre pipe
- Drainage pipe
- Electric cable/pipe
- Electric HV cable/pipe
- Gas pipe
- Sewer/Waste pipe
- Water pipe
- Scope extents

LEGEND

- Easement
- Fence
- Lot Boundary
- Road
- Road Corridor
- O/Head Power
- Edge of water

REV	DESCRIPTION	DRN	DATE	APP

Land Surveys
Unit 8, 3 Gibbes Street
Chatswood NSW 2067
T (02) 9439 6925
E sydney@landsurveys.net.au
www.landsurveys.net.au

SCALE @ A0: 1:7000

SURVEYED BY: N/A
SURVEYED ON: N/A
DRAWN BY: NN
DRAWN ON: 26/02/18
HOR DATUM: MGA-ZONE 55
VERT DATUM: AHD

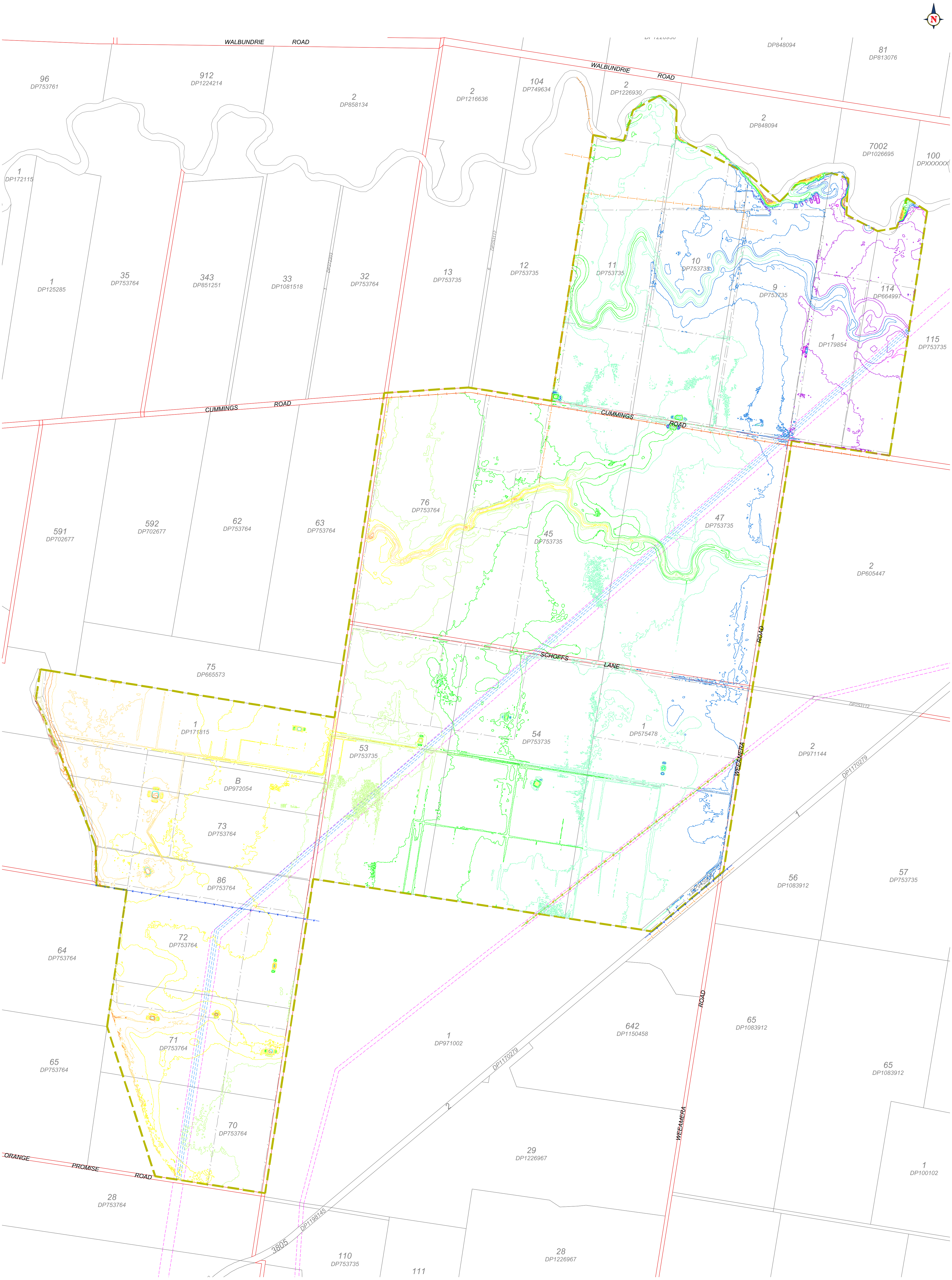
AERIAL SURVEY
CULCAIRN SOLAR FARM
NSW

CLIENT:
NEOEN AUSTRALIA

JOB No.	PLAN	DRG	REV	SHEET
1900056	AP	001	A	1 OF 2

\\lsapp01\Live_Projects\1900056 - Culcairn Solar Farm NSW\6. Deliverables\Drafting\1900056-AP-001-A.dwg

LS F 219



KEY FOR UNDERGROUND SERVICES

- C — C Communications cable/pipe
- OF — OF Comms optic fibre pipe
- D — > Drainage pipe
- E — E Electric cable/pipe
- HV — HV Electric HV cable/pipe
- G — G Gas pipe
- S — > Sewer/Waste pipe
- W — W Water pipe
- Scope extents

CONTOUR INTERVAL 0.5m

198	198.5
199	199.5
200	200.5
201	201.5
202	202.5
203	203.5
204	204.5
205	205.5
206	206.5
207	207.5
208	208.5
209	209.5
210	210.5

LEGEND

- Easement
- Fence
- Lot Boundary
- Road
- Road Corridor
- O/Head Power
- Edge of water

REV	DESCRIPTION	DRN	DATE	APP

Land Surveys
Unit 8, 3 Gibbes Street
Chatswood NSW 2067
T (02) 9439 6925
E sydney@landsurveys.net.au
www.landsurveys.net.au

SCALE @ A0: 1:7000

SURVEYED BY: N/A
SURVEYED ON: N/A
DRAWN BY: NN
DRAWN ON: 26/02/18
HOR DATUM: MGA-ZONE 55
VERT DATUM: AHD

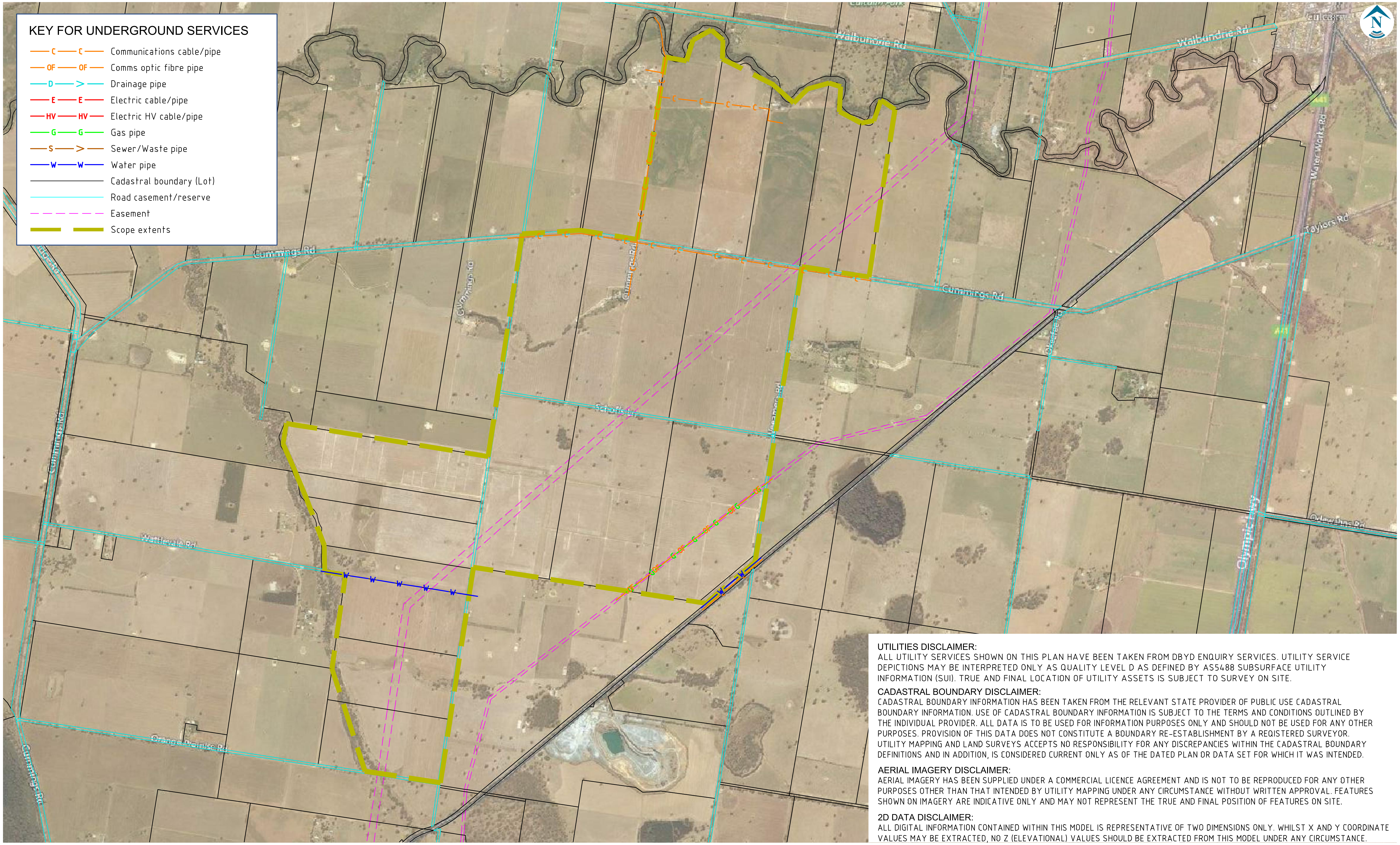
AERIAL SURVEY
CULCAIRN SOLAR FARM NSW

CLIENT:
NEOEN AUSTRALIA

JOB No.	PLAN	DRG	REV	SHEET
1900056	AP	001	A	2 OF 2

\\lsapp01\Live_Projects\1900056 - Culcairn Solar Farm NSW\6. Deliverables\Drafting\1900056-AP-001-A.dwg

LS F 219



UTILITIES DISCLAIMER:
ALL UTILITY SERVICES SHOWN ON THIS PLAN HAVE BEEN TAKEN FROM DBYD ENQUIRY SERVICES. UTILITY SERVICE DEPICTIONS MAY BE INTERPRETED ONLY AS QUALITY LEVEL D AS DEFINED BY AS5488 SUBSURFACE UTILITY INFORMATION (SUI). TRUE AND FINAL LOCATION OF UTILITY ASSETS IS SUBJECT TO SURVEY ON SITE.

CADASTRAL BOUNDARY DISCLAIMER:
CADASTRAL BOUNDARY INFORMATION HAS BEEN TAKEN FROM THE RELEVANT STATE PROVIDER OF PUBLIC USE CADASTRAL BOUNDARY INFORMATION. USE OF CADASTRAL BOUNDARY INFORMATION IS SUBJECT TO THE TERMS AND CONDITIONS OUTLINED BY THE INDIVIDUAL PROVIDER. ALL DATA IS TO BE USED FOR INFORMATION PURPOSES ONLY AND SHOULD NOT BE USED FOR ANY OTHER PURPOSES. PROVISION OF THIS DATA DOES NOT CONSTITUTE A BOUNDARY RE-ESTABLISHMENT BY A REGISTERED SURVEYOR. UTILITY MAPPING AND LAND SURVEYS ACCEPTS NO RESPONSIBILITY FOR ANY DISCREPANCIES WITHIN THE CADASTRAL BOUNDARY DEFINITIONS AND IN ADDITION, IS CONSIDERED CURRENT ONLY AS OF THE DATED PLAN OR DATA SET FOR WHICH IT WAS INTENDED.

AERIAL IMAGERY DISCLAIMER:
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2D DATA DISCLAIMER:
ALL DIGITAL INFORMATION CONTAINED WITHIN THIS MODEL IS REPRESENTATIVE OF TWO DIMENSIONS ONLY. WHILST X AND Y COORDINATE VALUES MAY BE EXTRACTED, NO Z (ELEVATIONAL) VALUES SHOULD BE EXTRACTED FROM THIS MODEL UNDER ANY CIRCUMSTANCE.

REV	REVISION DESCRIPTION	DATE	DRN	CHK

Land Surveys
HEAD OFFICE:
19 Brennan Way,
Belmont, WA 6104
T (08) 9477 4477
F (08) 9477 4499
admin@landsurveys.net.au www.landsurveys.net.au

Utility MAPPING
Suite 2, 85 Salmon Street
Port Melbourne
VIC 3207
Ph: 1300 62 77 46
Mail: melbourne@utilitymapping.com.au
Web: www.utilitymapping.com.au

NEOEN
UNDERGROUND UTILITY RECORDS
CULCAIRN SOLAR FARM
NSW

LOCATED:	n/a	CHECKED:	AMM	DATE:	22/01/19
SURVEYED:	n/a	SCALE AT A3:	1:30,000	DATUM:	none
DRAWN:	AMM	DBYD REF:	15617297	GRID:	MGA-55

STATE/YEAR	JOB No	DRG TYPE	DRG No	REV
NSW19 -	0037 -	MD -	01	R0

SHEET 1 OF 1

G:\Team Drives\00 Jobs\2019\NSW\NSW19-0037 Culcairn Solarfarm\06 Drafting\NSW19-0037-MD-01 R0.dwg CAD

APPENDIX C

EXTRACTS FROM GREATER HUME LOCAL ENVIRONMENT PLAN 2012

C1 EARTHWORKS

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

(2) Development consent is required for earthworks unless:

(a) the earthworks are exempt development under this Plan or another applicable environmental planning instrument, or

(b) the earthworks are ancillary to development that is permitted without consent under this Plan or to development for which development consent has been given.

(3) Before granting development consent for earthworks (or for development involving ancillary earthworks), the consent authority must consider the following matters:

(a) the likely disruption of, or any detrimental effect on, drainage patterns and soil stability in the locality of the development,

(b) the effect of the development on the likely future use or redevelopment of the land,

(c) the quality of the fill or the soil to be excavated, or both,

(d) the effect of the development on the existing and likely amenity of adjoining properties,

(e) the source of any fill material and the destination of any excavated material,

(f) the likelihood of disturbing relics,

(g) the proximity to, and potential for adverse impacts on, any waterway, drinking water catchment or environmentally sensitive area,

(h) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.

C2 FLOOD PLANNING

(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to land at or below the flood planning level.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

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

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005, unless it is otherwise defined in this clause.

(5) In this clause, flood planning level means the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard.

C3 RIPARIAN LAND AND WATERCOURSES

(1) The objective of this clause is to protect and maintain the following:

(a) water quality within watercourses,

(b) the stability of the bed and banks of watercourses,

(c) aquatic and riparian habitats,

(d) ecological processes within watercourses and riparian areas.

(2) This clause applies to all of the following:

(a) land identified as "Waterways" on the Riparian Lands and Watercourses Map,

(b) all land that is within 40 metres of the top of the bank of a watercourse on land identified as "Waterways" on that map.

(3) Before determining a development application for development on land to which this clause applies, the consent authority must consider:

(a) whether or not the development is likely to have any adverse impact on the following:

(i) the water quality and flows within the watercourse,

(ii) aquatic and riparian species, habitats and ecosystems of the watercourse,

(iii) the stability of the bed and banks of the watercourse,

(iv) the free passage of fish and other aquatic organisms within or along the watercourse,

(v) any future rehabilitation of the watercourse and riparian areas, and

(b) whether or not the development is likely to increase water extraction from the watercourse, and

(c) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.

(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or

(b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or

(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.

APPENDIX D

EXTRACT FROM GREATER HUME DEVELOPMENT CONTROL PLAN 2013

8.0 FLOOD LIABLE LAND

PURPOSE

This chapter applies to land use and development on flood liable land within the Shire. For the purposes of this chapter, "*flood liable land*" is land which is mapped by Council as being subject to inundation up to a 1 in 100 year ARI flood event (the "*flood planning level*" or FPL).

Council may deem other land to be flood liable (e.g. land that is poorly drained) where a flood history is known but the land is not included in any of the mapped flood areas.

OBJECTIVES

The objectives of this chapter are to:

(a) provide detailed controls and criteria for the assessment of development applications on land affected by flooding in Greater Hume Shire;

(b) consolidate existing flood planning principles and policies from relevant government agencies into a coherent framework for application at the development control level by Greater Hume Shire Council;

(c) reduce the impact of flooding and flood liability on individual property owners and occupiers;

(d) reduce private and public losses resulting from flooding;

(e) restrict the intensification of development below the FPL;

(f) limit development below the FPL to those activities and works considered to have an essential relationship with the river and its floodplain;

(g) provide specific measures for the control of caravan parks and associated development types within flood affected areas;

(h) provide for the consideration of the cumulative effects of any development on flood affected land, which in or of itself may be considered to be insignificant;

(i) provide for and protect the natural passage, storage and quality of flood waters;

(j) recognise and help sustain the natural ecosystems of floodplains and riparian zones including the protection of associated vegetation and wetlands;

(k) inform the community as to the extent and hazard of flood affected land in Greater Hume Shire;

(l) deal consistently with applications for development on flood affected land, generally in accordance with the *Floodplain Management Manual: The Management of Flood Liable Land* issued by the New South Wales Government 2005; and

(m) encourage the development and use of land which is compatible with the indicated flood hazard.

DECISION GUIDELINES

Proposed developments will be considered on their merits in terms of flooding impacts. Issues to be taken into consideration regarding the particular merits of development on flood liable land include the following:

- Whether the proposed development is reasonable having regard for the flood risk and resources available to the location. Applicants should place no reliance on the implementation of a condition specifying a private evacuation/flood management plan as a means to overcome an unacceptable flood risk.
- The need for a benefit/cost assessment that takes account of the full cost to the community of the flood response and flood damage likely to be incurred to the development and upon other development.
- Specific principles relating to flood liable land contained within *Murray Regional Environmental Plan No.2 - -Riverine Land* (MREP2) including:
  - the benefits to riverine ecosystems of periodic flooding;
  - the hazard risks involved in the development of that land;
  - the redistribution effect of the proposed development on floodwater;
  - the availability of other suitable land in the locality not liable to flooding;
  - the availability of flood free access for essential facilities and services;
  - the pollution threat represented by any development in the event of a flood;
  - the cumulative effect of the proposed development on the behaviour of floodwater;
  - the cost of providing emergency services and replacing infrastructure in the event of a flood; and
  - flood mitigation works constructed to protect new urban development should be designed and maintained to meet the technical specifications of the NSW government department responsible for such works.
- The *Floodplain Development Manual – the Management of Flood Liable Land (2005)*

NOTE:

Council is currently in the process of undertaking a Flood Study for parts of the Shire. Once this work is completed, additional controls may be included in this chapter of the GHDCP.

APPENDIX E

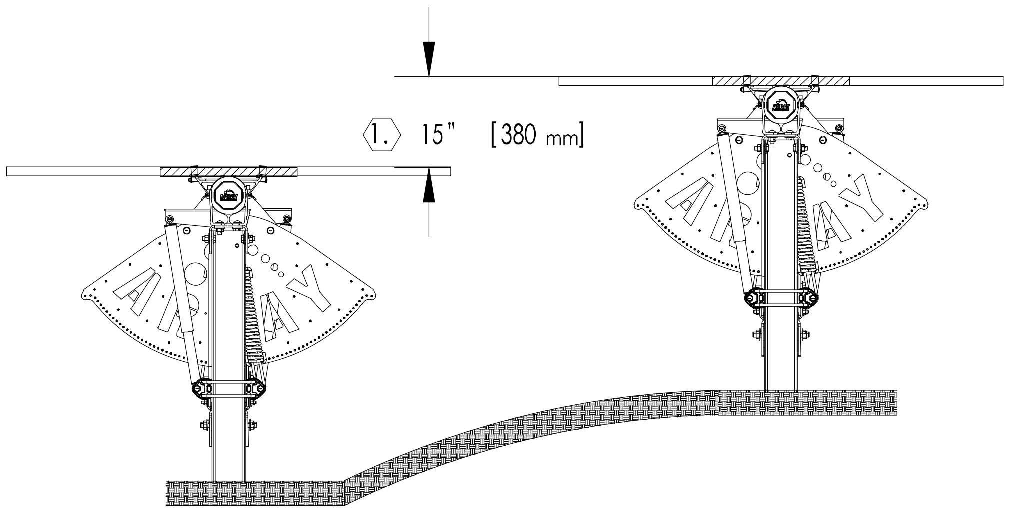
TYPICAL ARRAY POST DRAWING

TYPICAL DRAWING ONLY. NOT FOR CONSTRUCTION.

NOTE:

EXTERIOR ROW HEIGHT PARAMETER

1. IF HEIGHT DIFFERENCE EXCEEDS THE DISTANCE NOTED, ROW ON HIGHER PLANE IS AN EXTERIOR ROW.

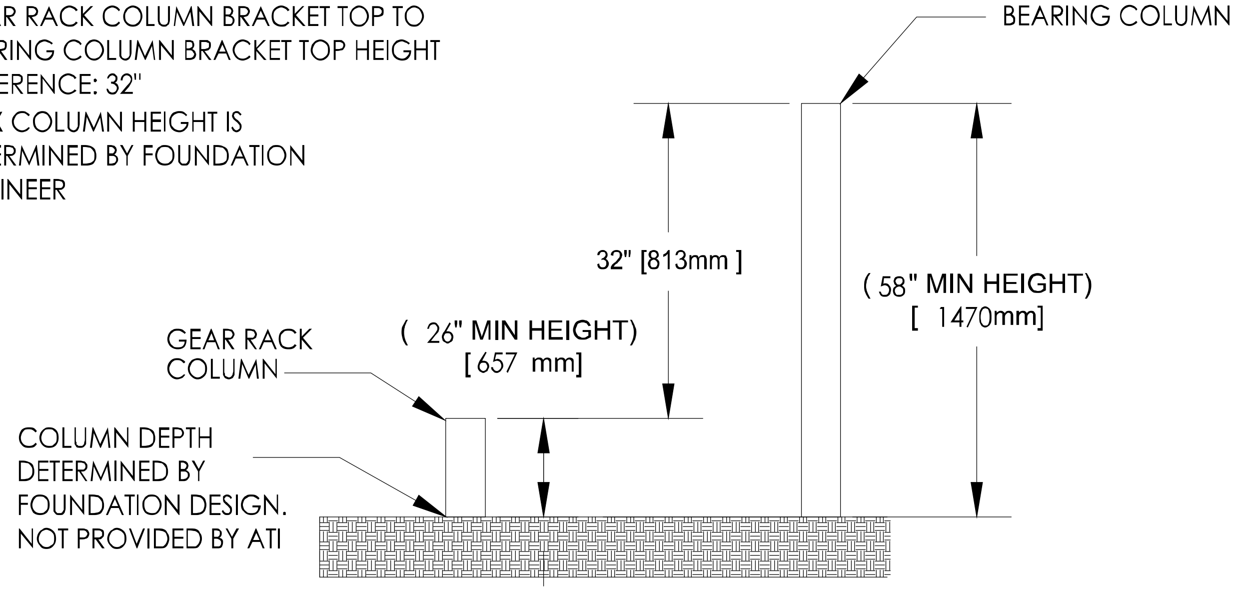


DETAIL A

NOTES:

COLUMN HEIGHT REQUIREMENTS

1. GEAR RACK COLUMN TOP TO BEARING COLUMN TOP HEIGHT DIFFERENCE: 32"
2. GEAR RACK COLUMN BRACKET TOP TO BEARING COLUMN BRACKET TOP HEIGHT DIFFERENCE: 32"
3. MAX COLUMN HEIGHT IS DETERMINED BY FOUNDATION ENGINEER



DETAIL B

NOTE:

MINIMUM DISTANCES AND MODULE DATA

1. REFERENCE INDIVIDUAL FIELD ASSEMBLY DRAWINGS FOR DETAILS.
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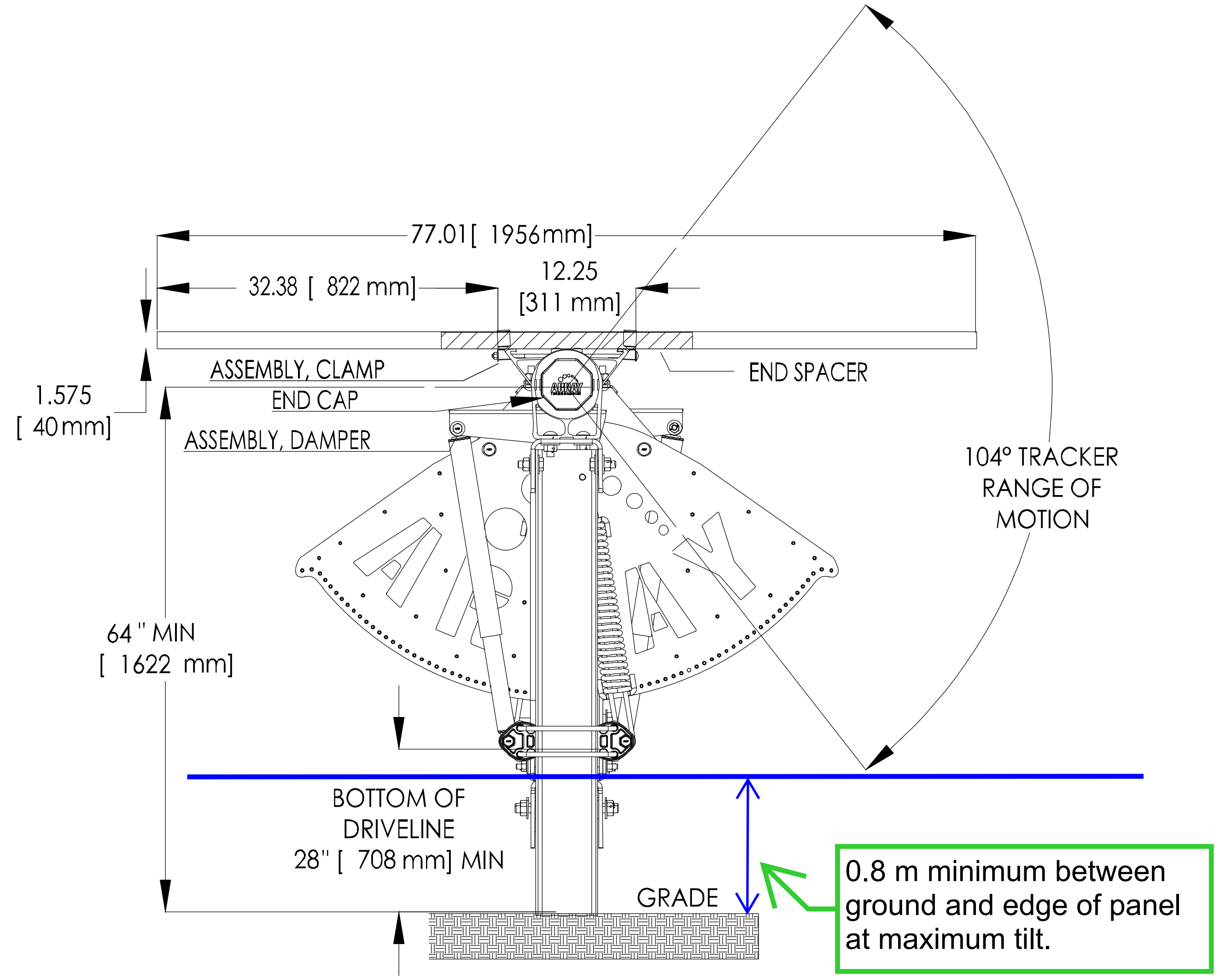
   INSTALL END CAP AT END OF BEAM.



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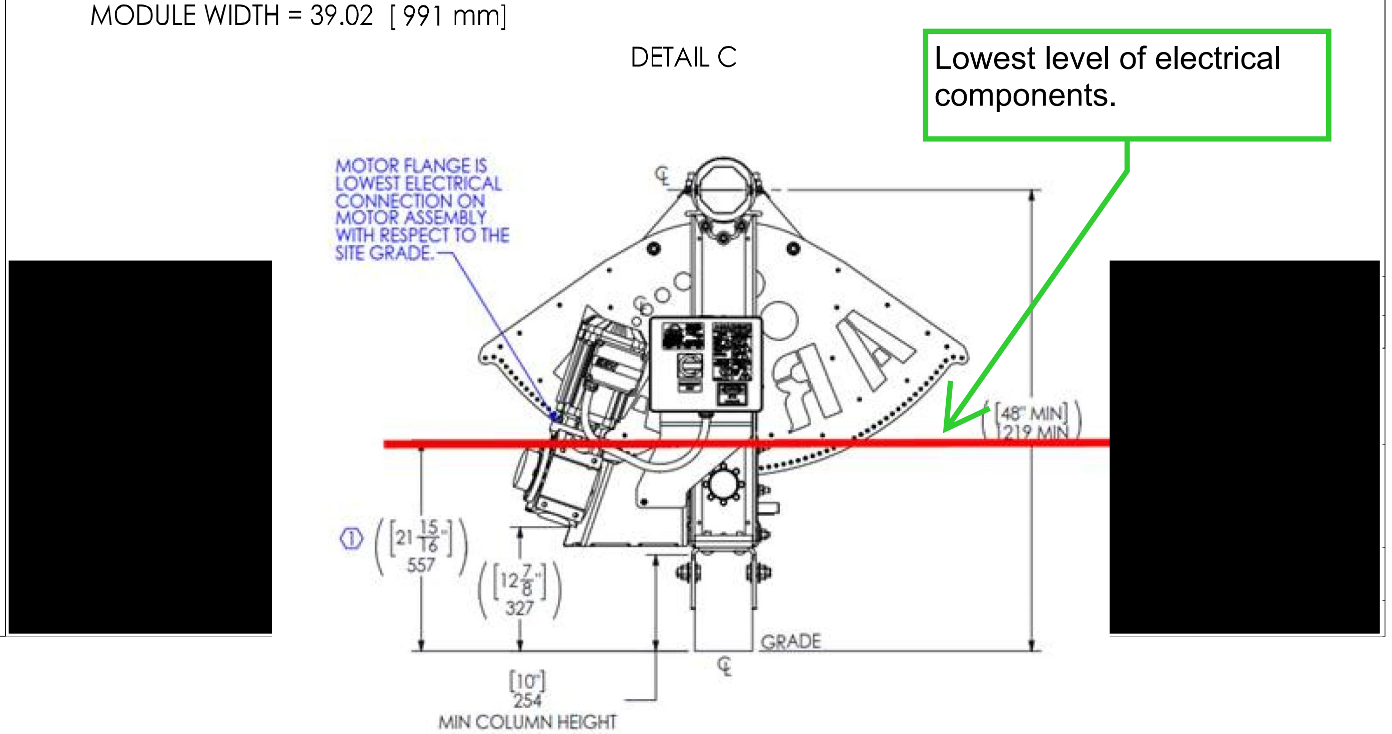
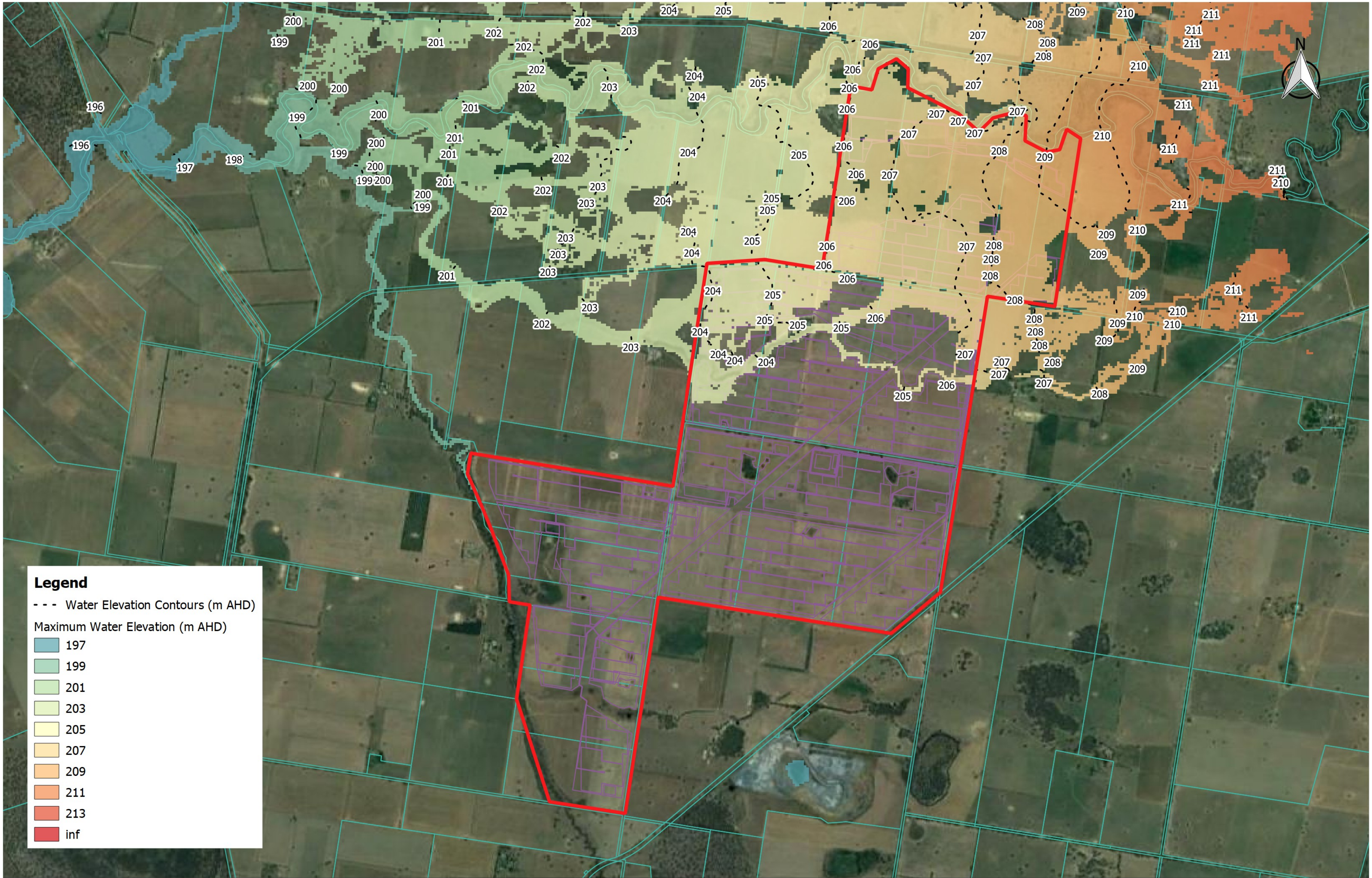
DETAIL C



APPENDIX F

REGIONAL MODEL FLOOD MAPS



Revision	Amendment	Approved	Approved Date					
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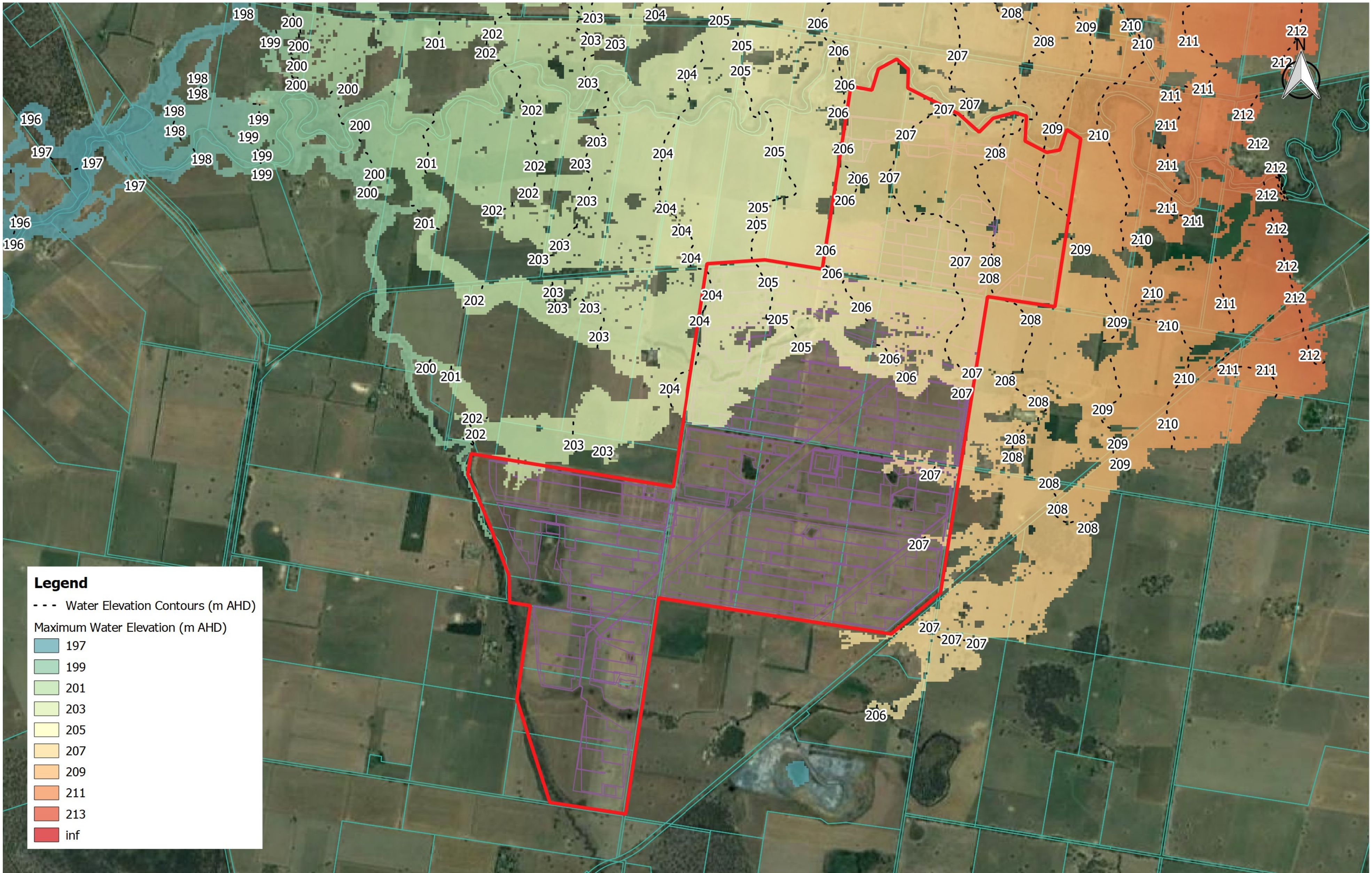
					Project No: Culcairn Proposed Solar Farm	Map: F01	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
					Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

wsp

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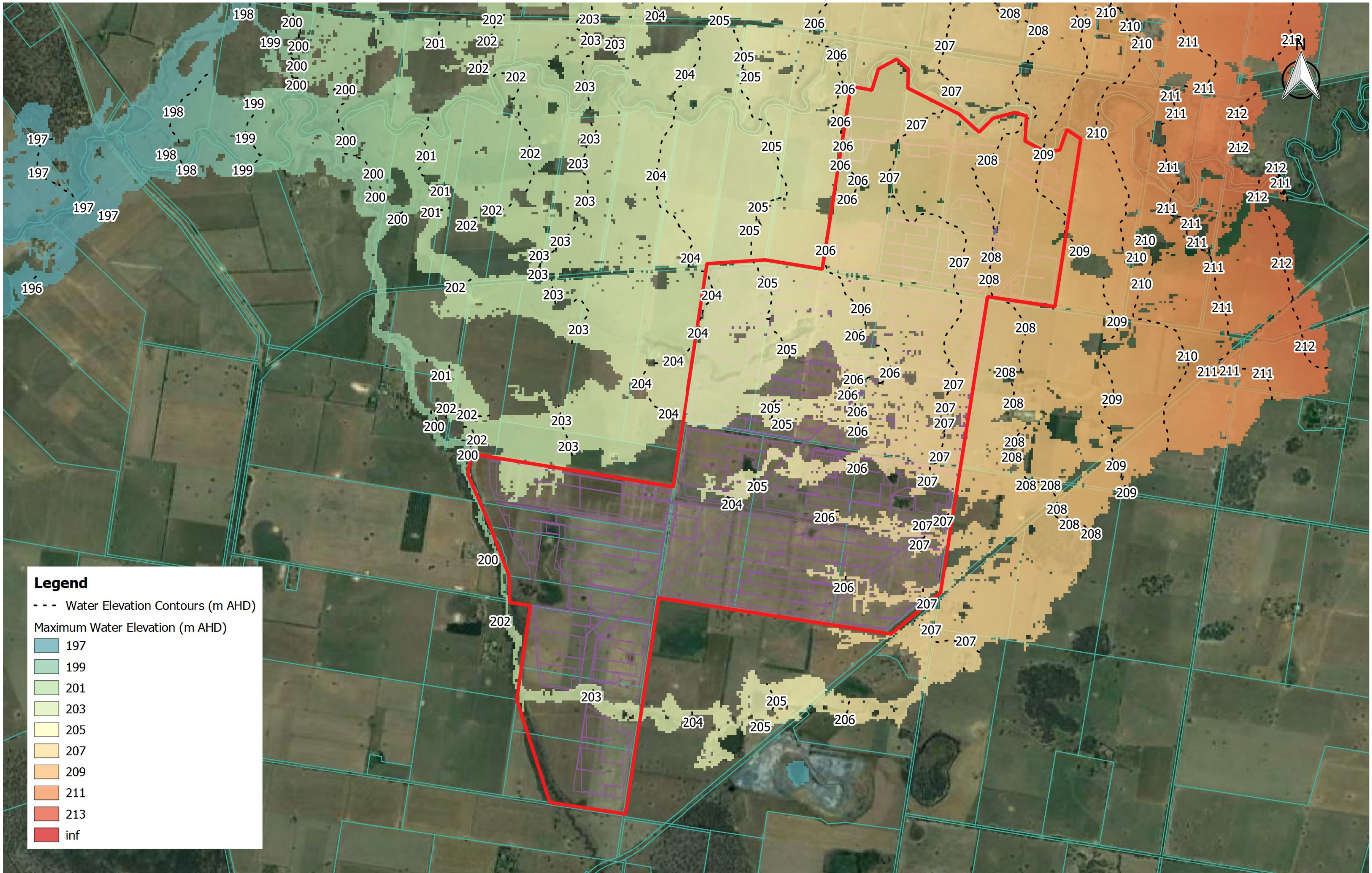
Project No: Culcairn Proposed Solar Farm	Map: F02	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 0.5% AEP 24 hour storm. Maximum Water Level Map		Scale: 1:30000	Original Size: A3
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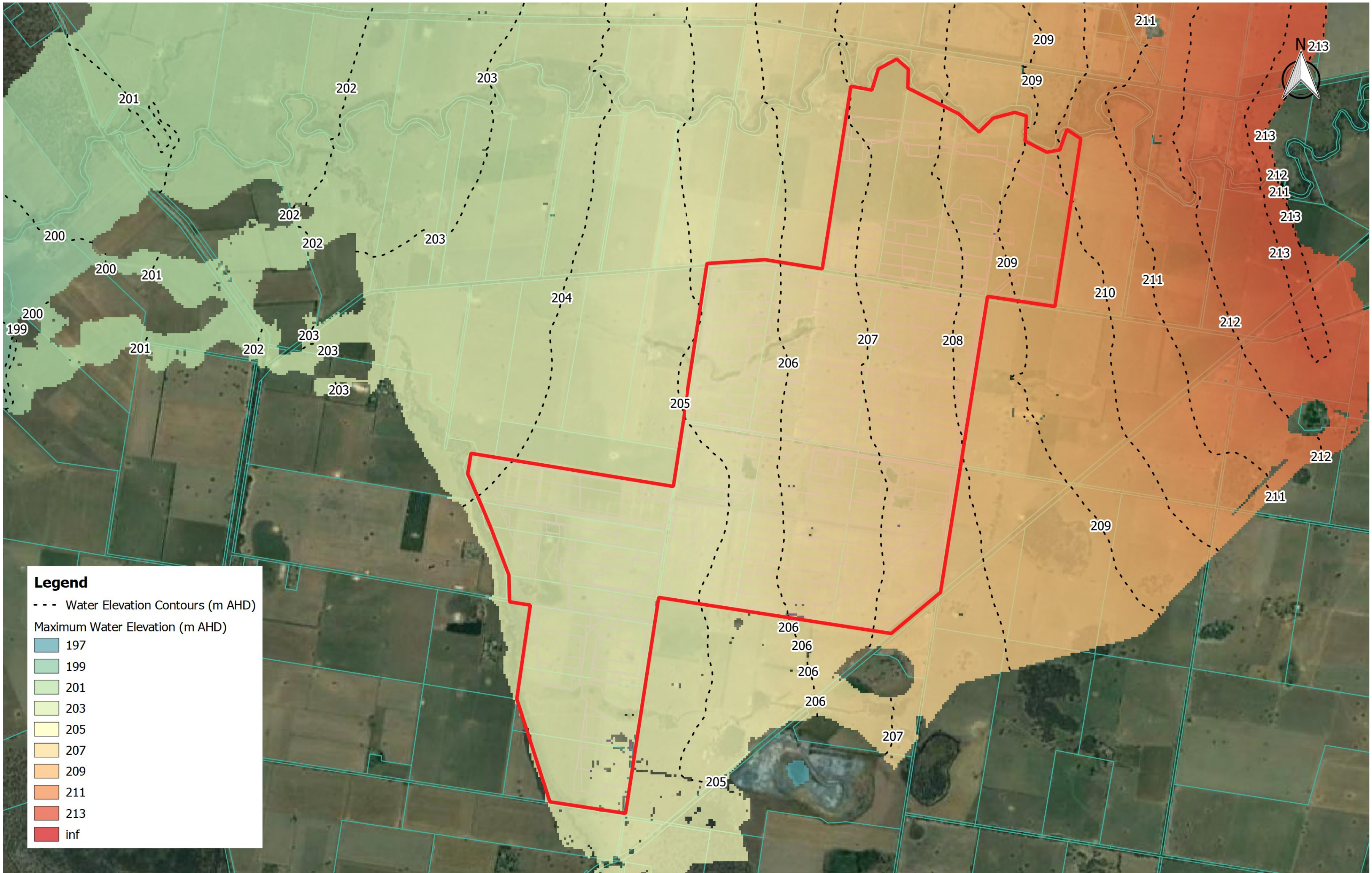
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

Title: Regional Flood Model. PMP 24 hour storm. Maximum Water Level Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F04

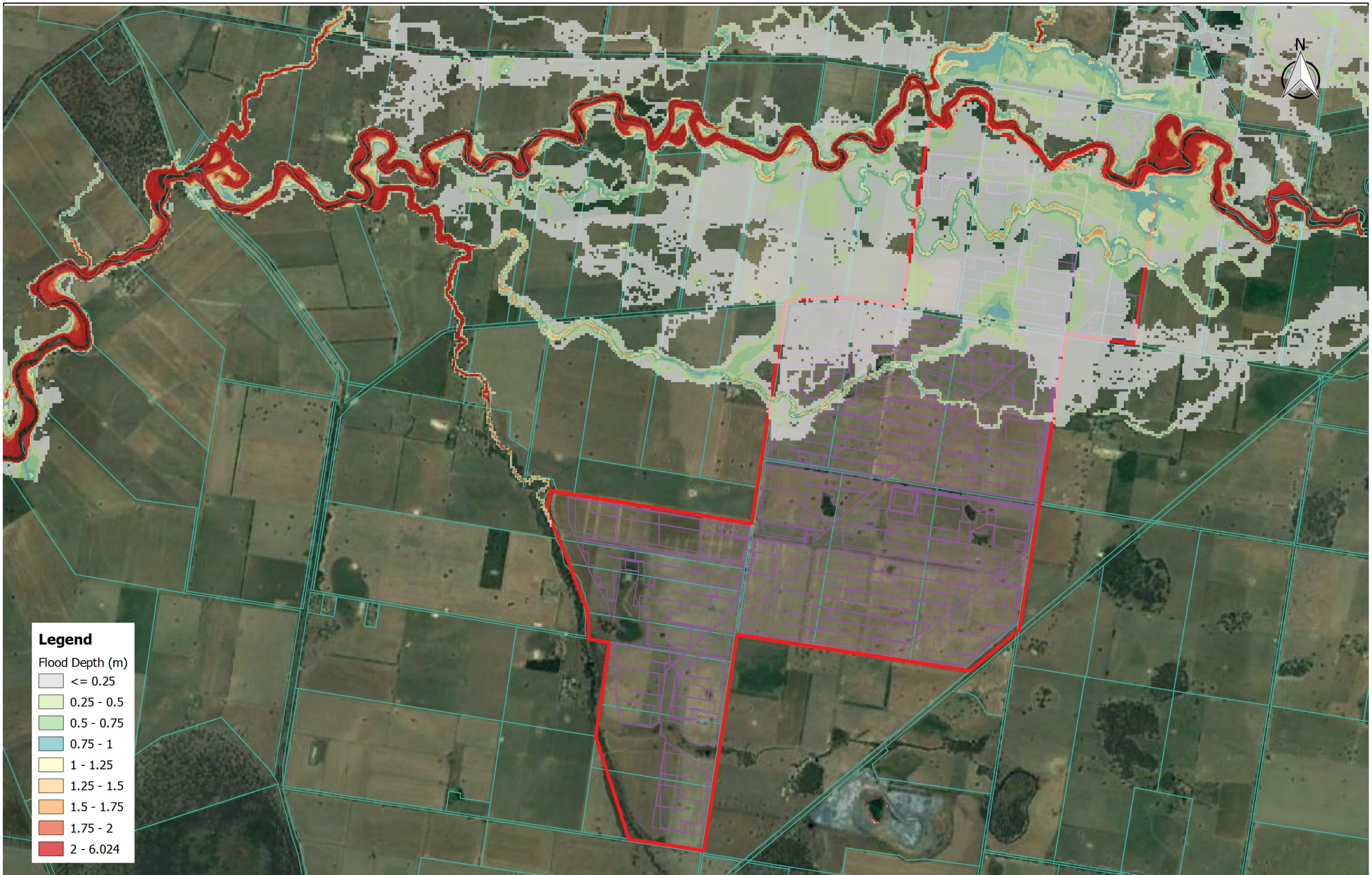
Sheet No: 001

Drawn:

Verified:

Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

Title: Regional Flood Model. 5% AEP 24 hour storm. Maximum Depth Map.

Project No: Culcairn Proposed Solar Farm

Map: F05

Sheet No: 001

Drawn:

Verified:

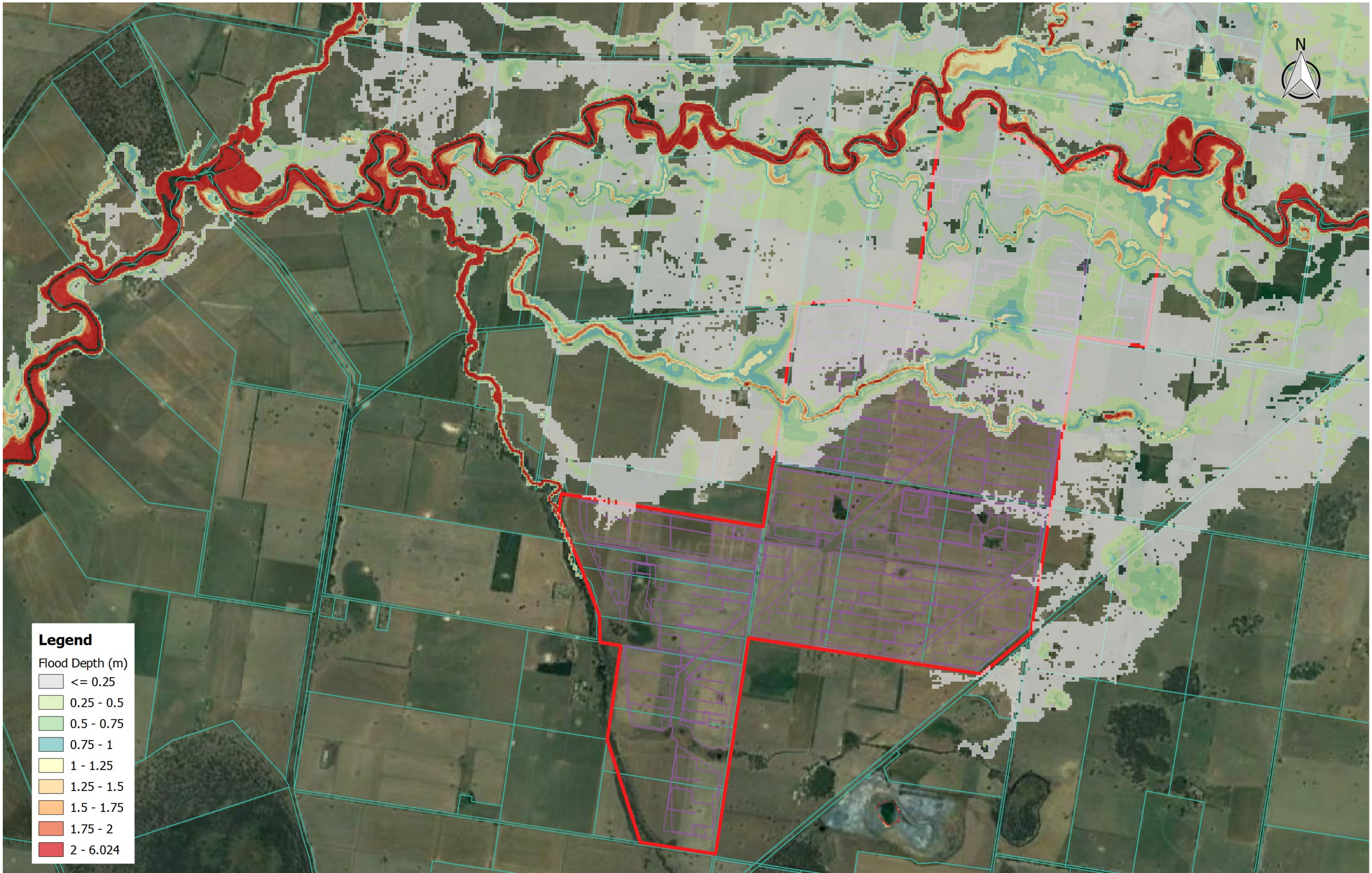
Approved Date:

Scale: 1:30000

Original Size: A3

Graphic Scale:

0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 1% AEP 24 hour storm. Maximum Depth Map.

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F06

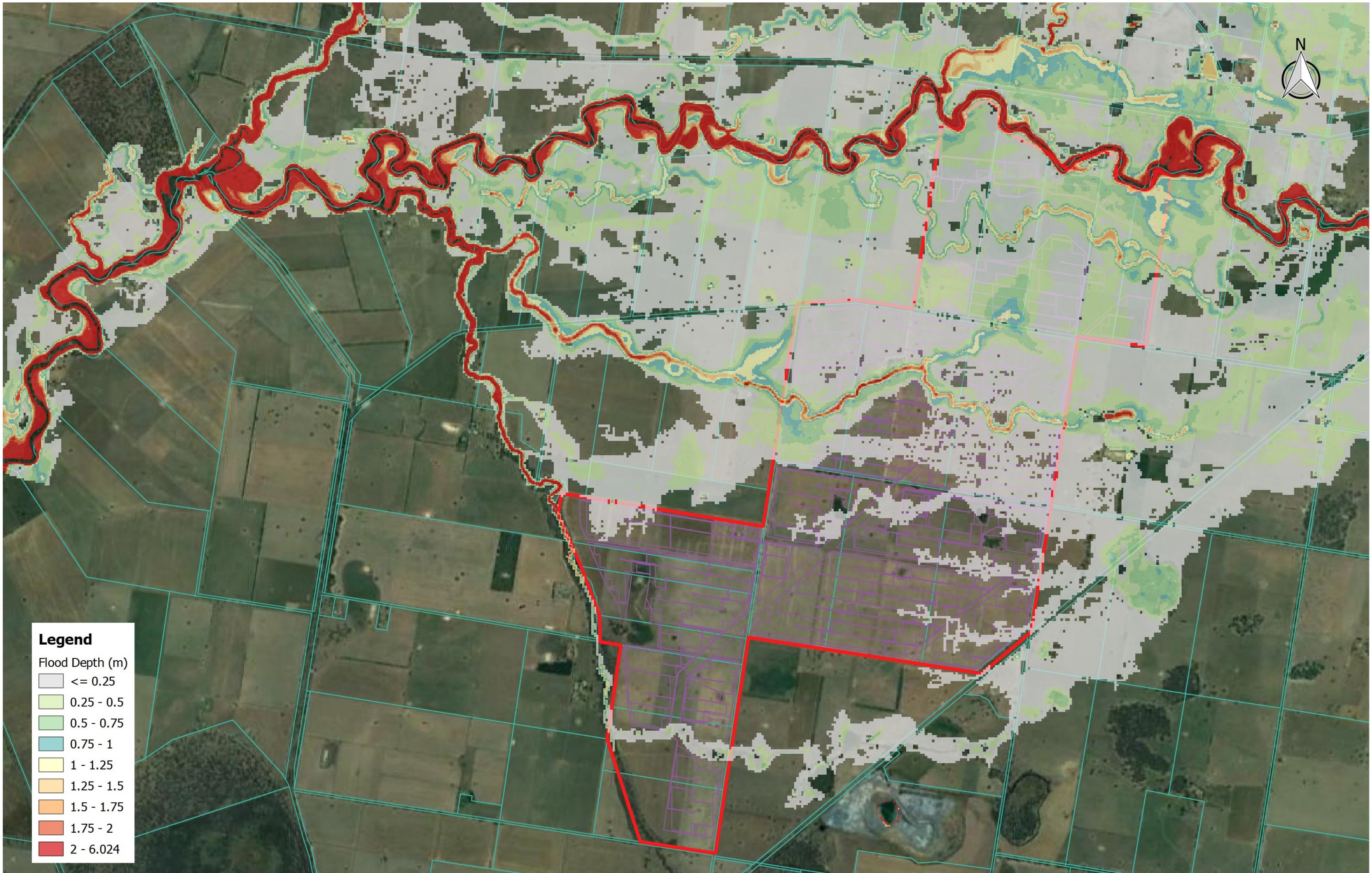
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

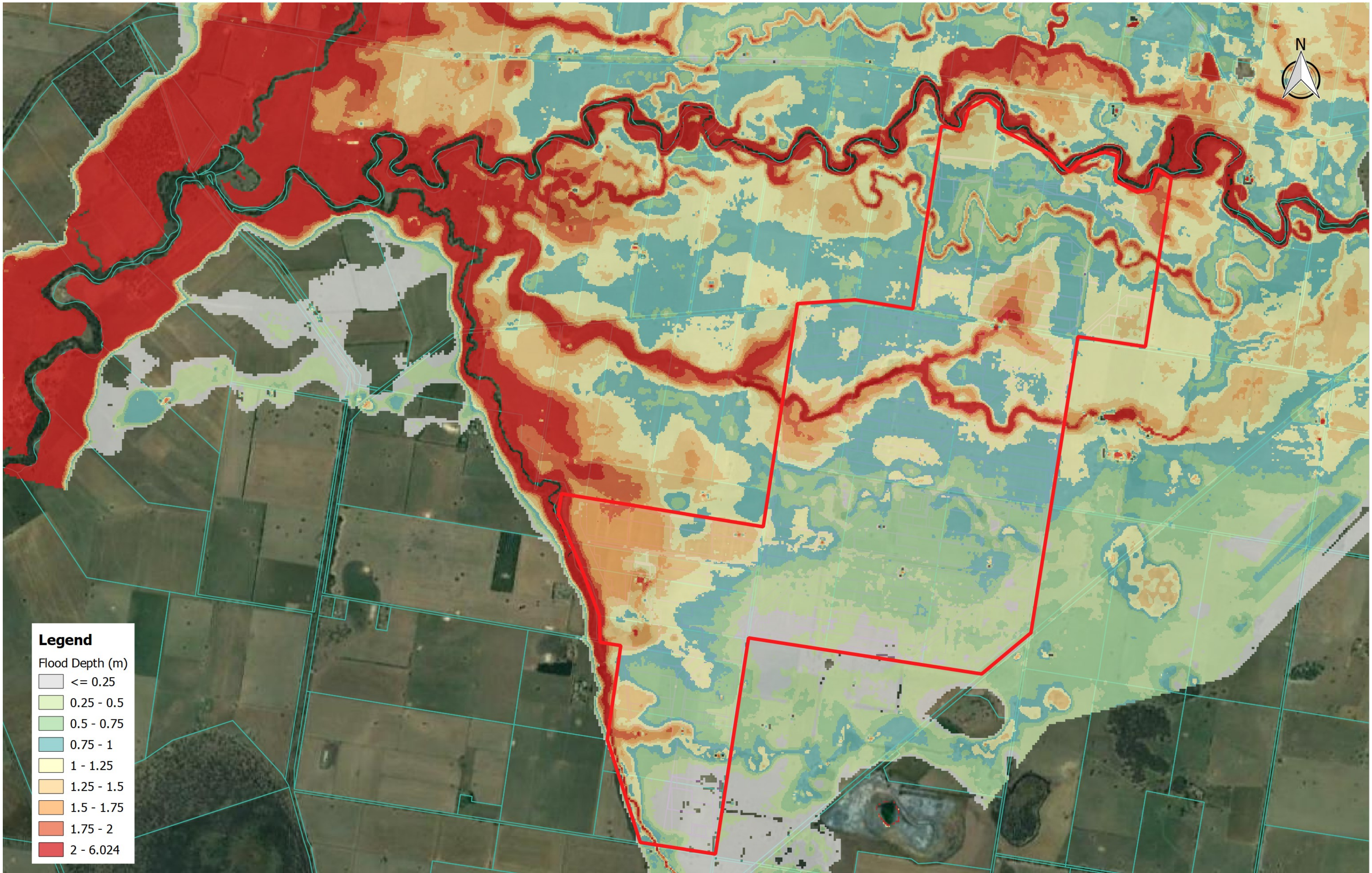
Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

Title: Regional Flood Model. 0.5% AEP 24 hour storm. Maximum Depth Map.		Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: F07	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

Title: Regional Flood Model. PMP 24 hour storm. Maximum Depth Map.

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F08

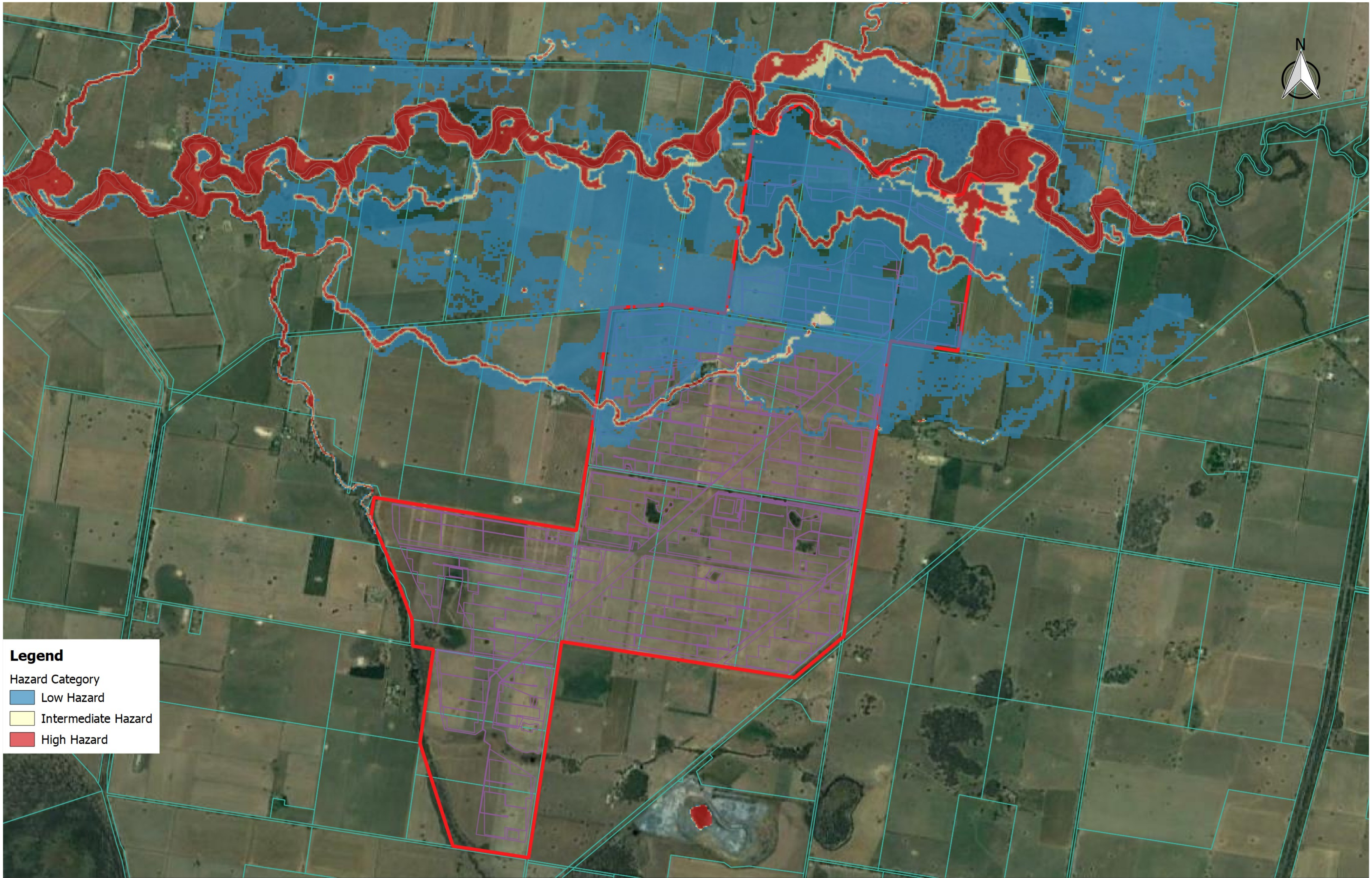
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 5% AEP 24 hour storm. Maximum Hazard Map (NSW Floodplain Management Manual)

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F09

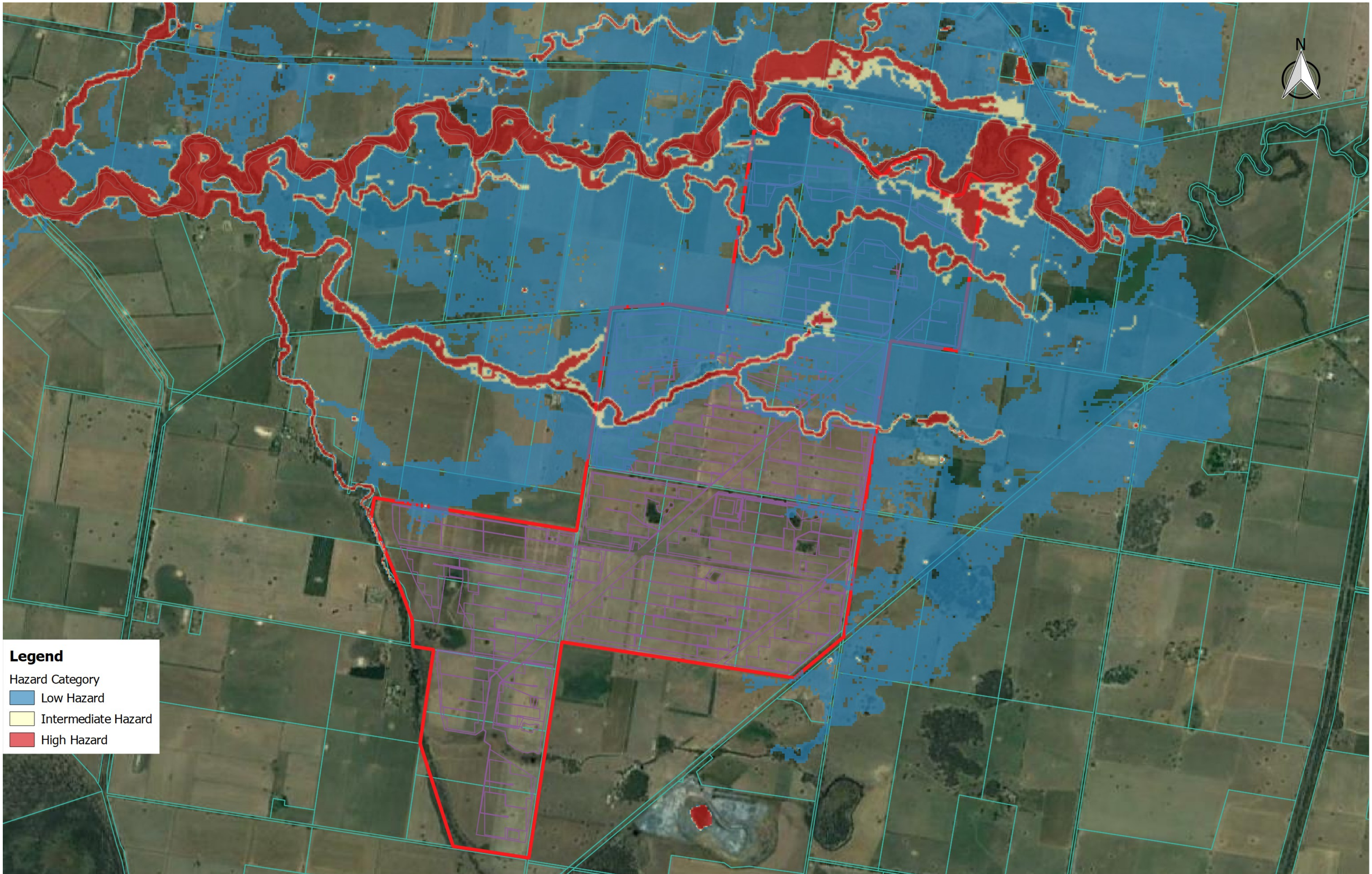
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 1% AEP 24 hour storm. Maximum Hazard Map (NSW Floodplain Management Manual)

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F10

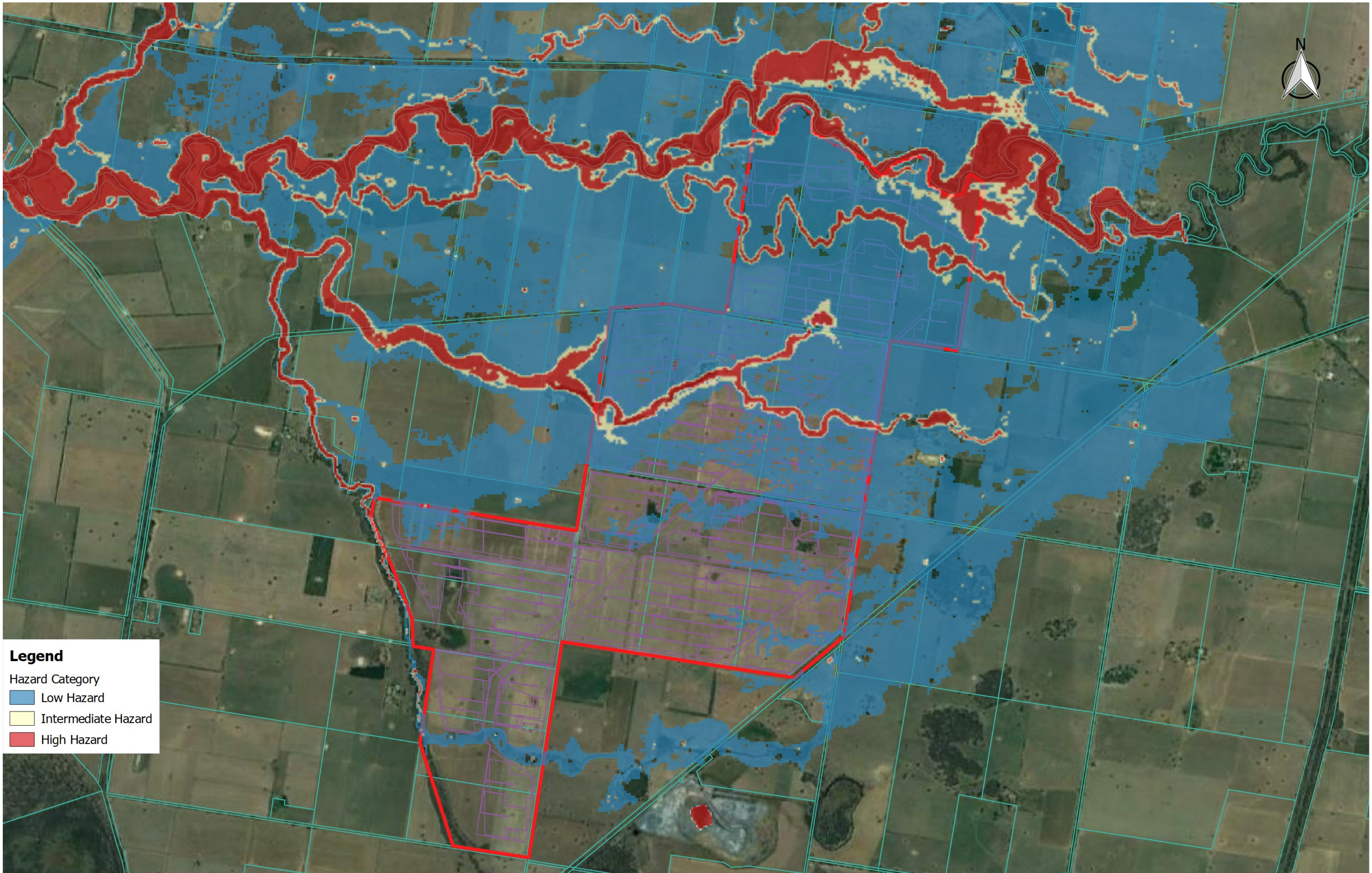
Sheet No: 001

Drawn:

Verified:

Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 0.5% AEP 24 hour storm. Maximum Hazard Map (NSW Floodplain Management Manual)

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F11

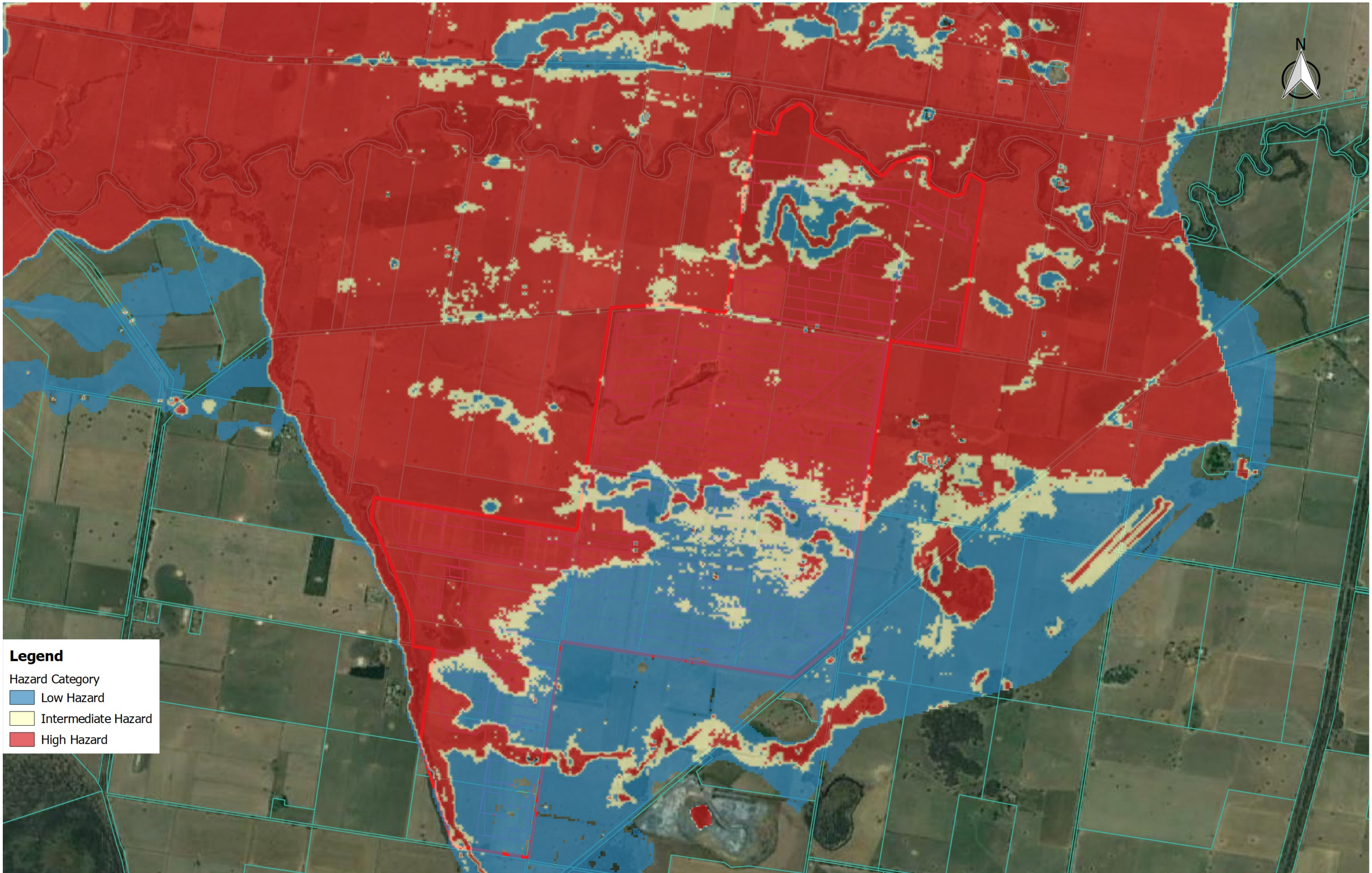
Sheet No: 001

Drawn:

Verified:

Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

wsp

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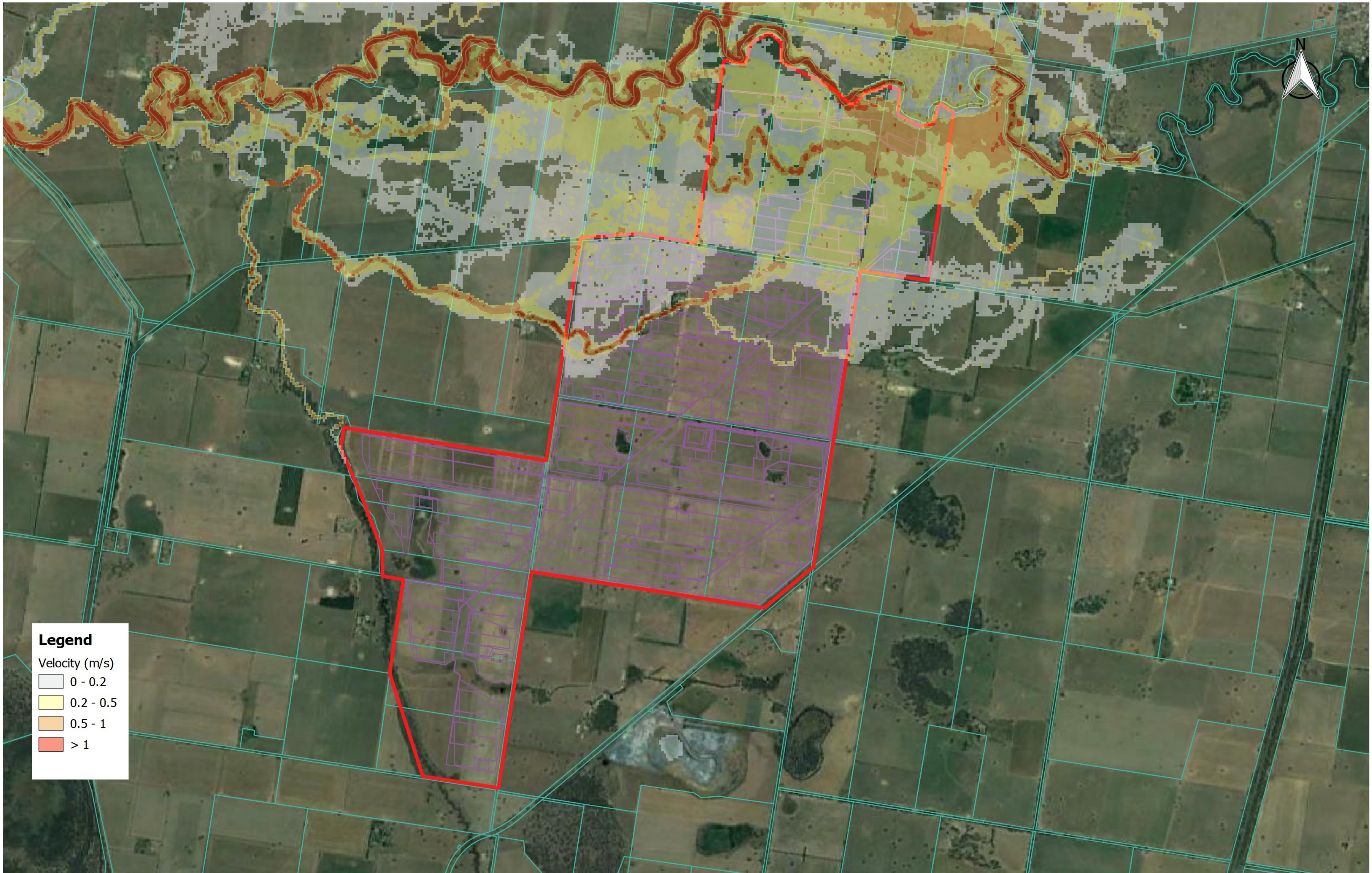


Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 5% AEP 24 hour storm. Maximum Velocity Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F13

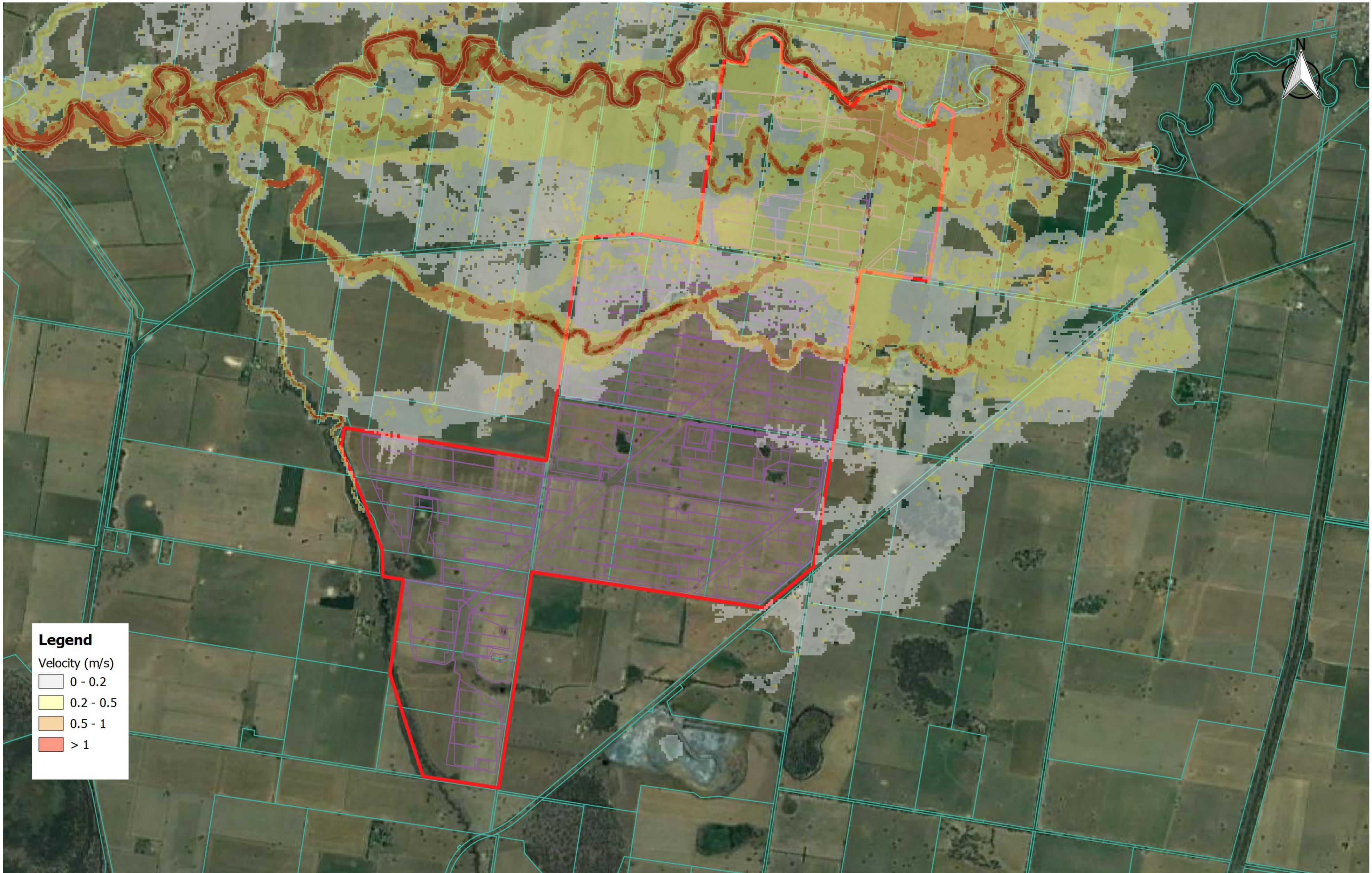
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. 1% AEP 24 hour storm. Maximum Velocity Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F14

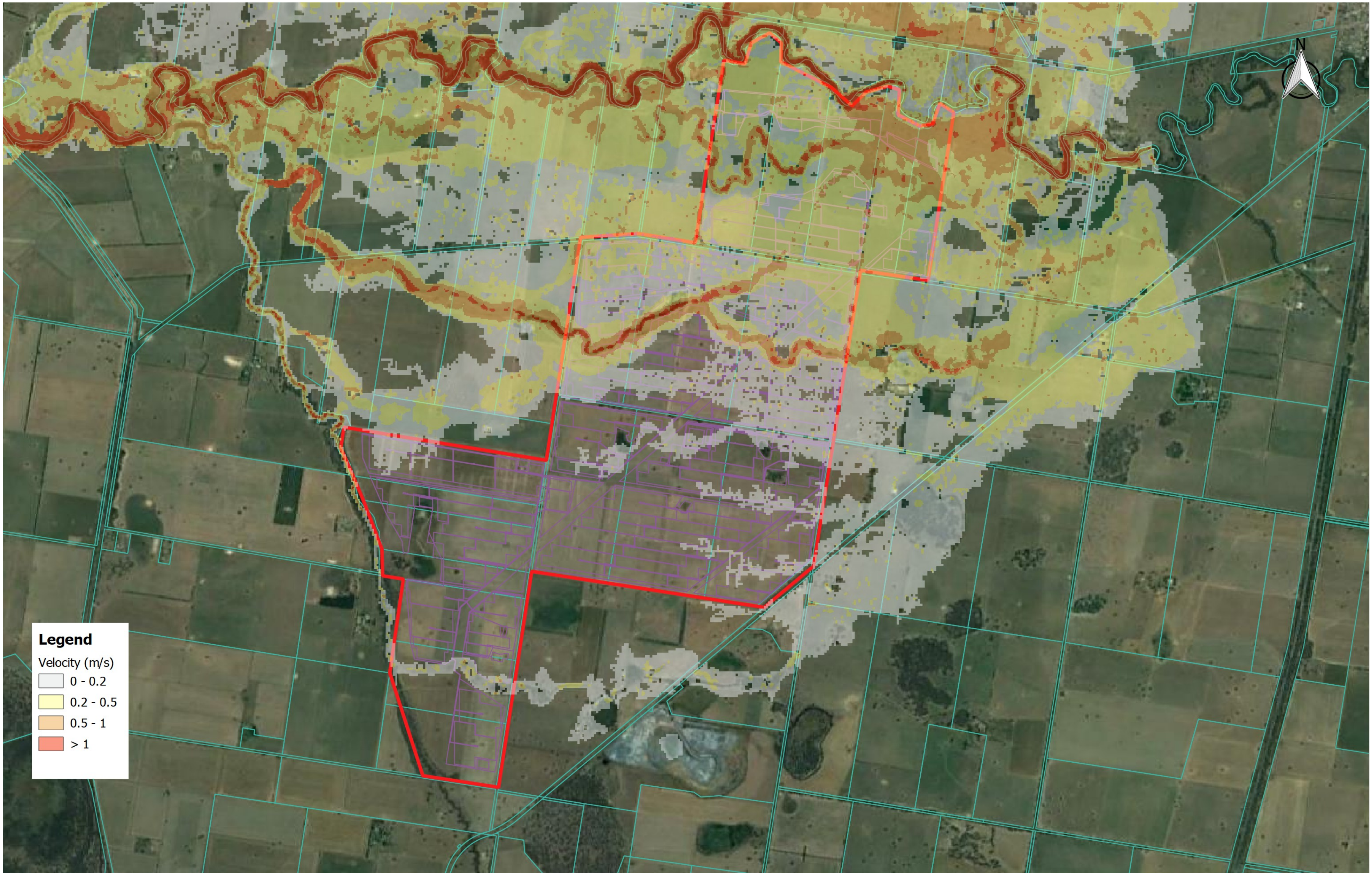
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

Title: Regional Flood Model. 0.5% AEP 24 hour storm. Maximum Velocity Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F15

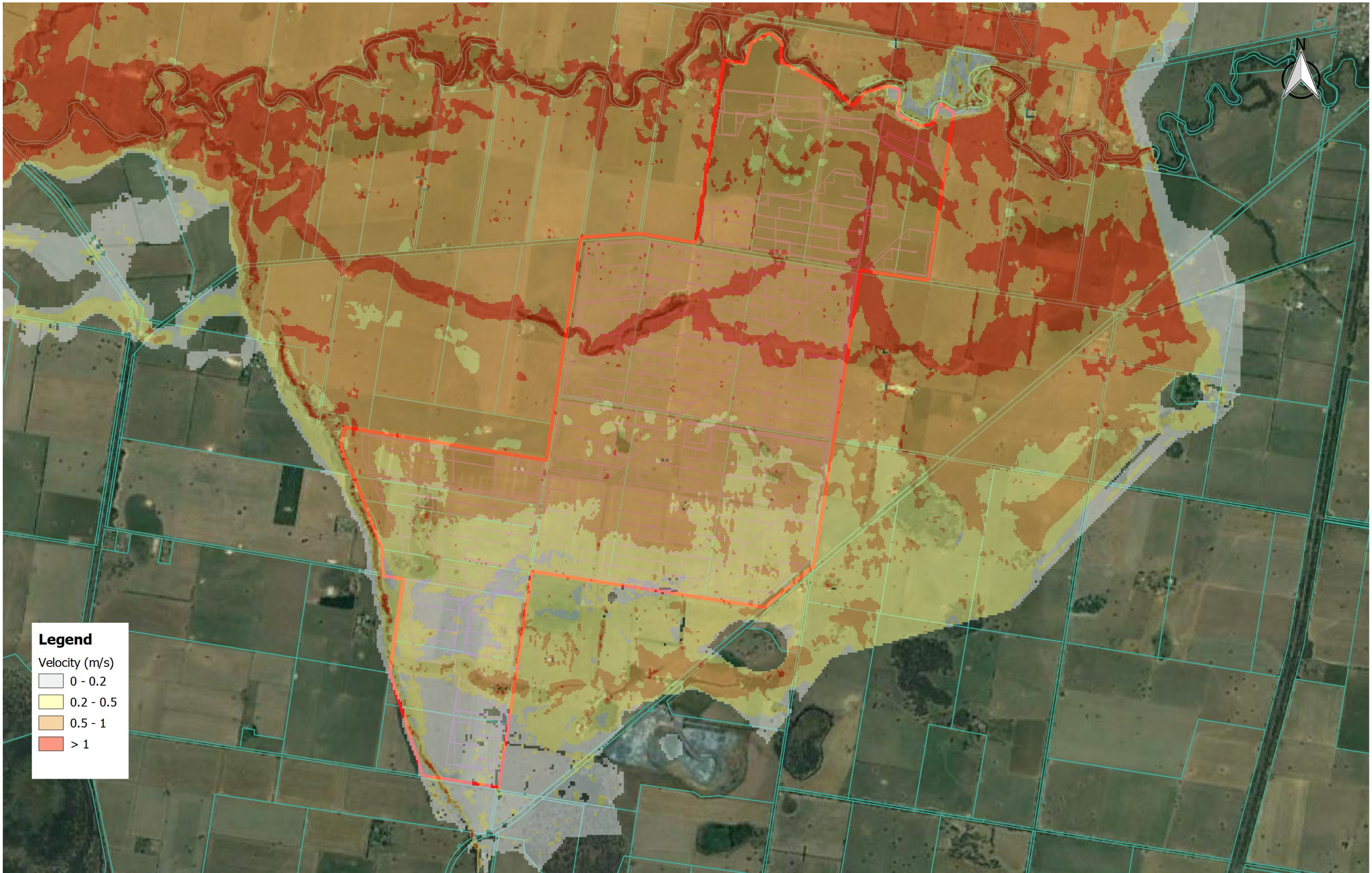
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

wsp

Title: Regional Flood Model. PMP 24 hour storm. Maximum Velocity Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: F16

Sheet No: 001

Drawn:

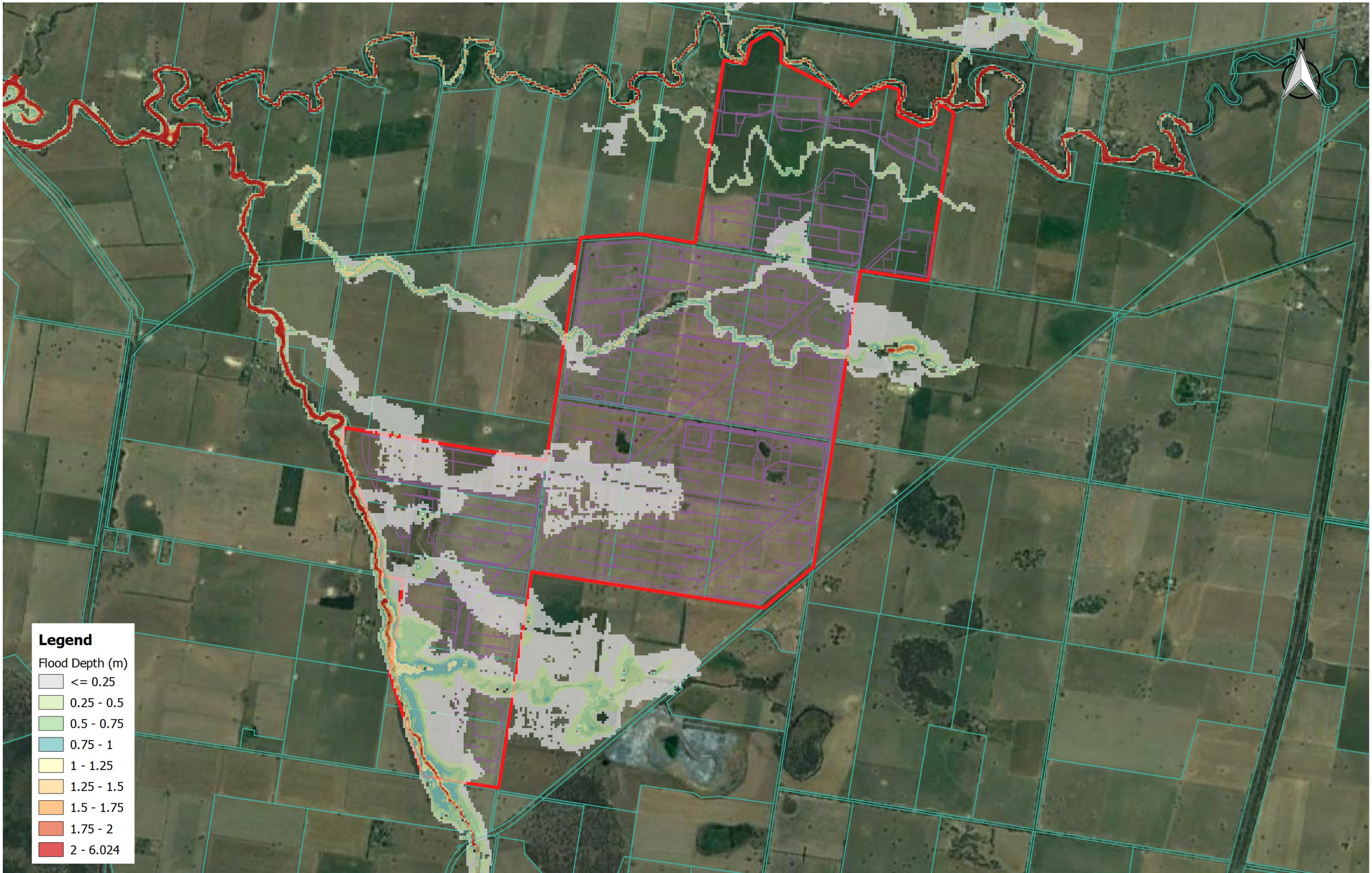
Verified:

Approved Date:

Graphic Scale: 0 250 500 750 1000 m

APPENDIX G

LOCAL MODEL FLOOD MAPS



Revision	Amendment	Approved	Approved Date

wsp

Title: Local Flood Model. Existing Case. 5% AEP 4.5 hour storm. Maximum Depth Map.

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G01

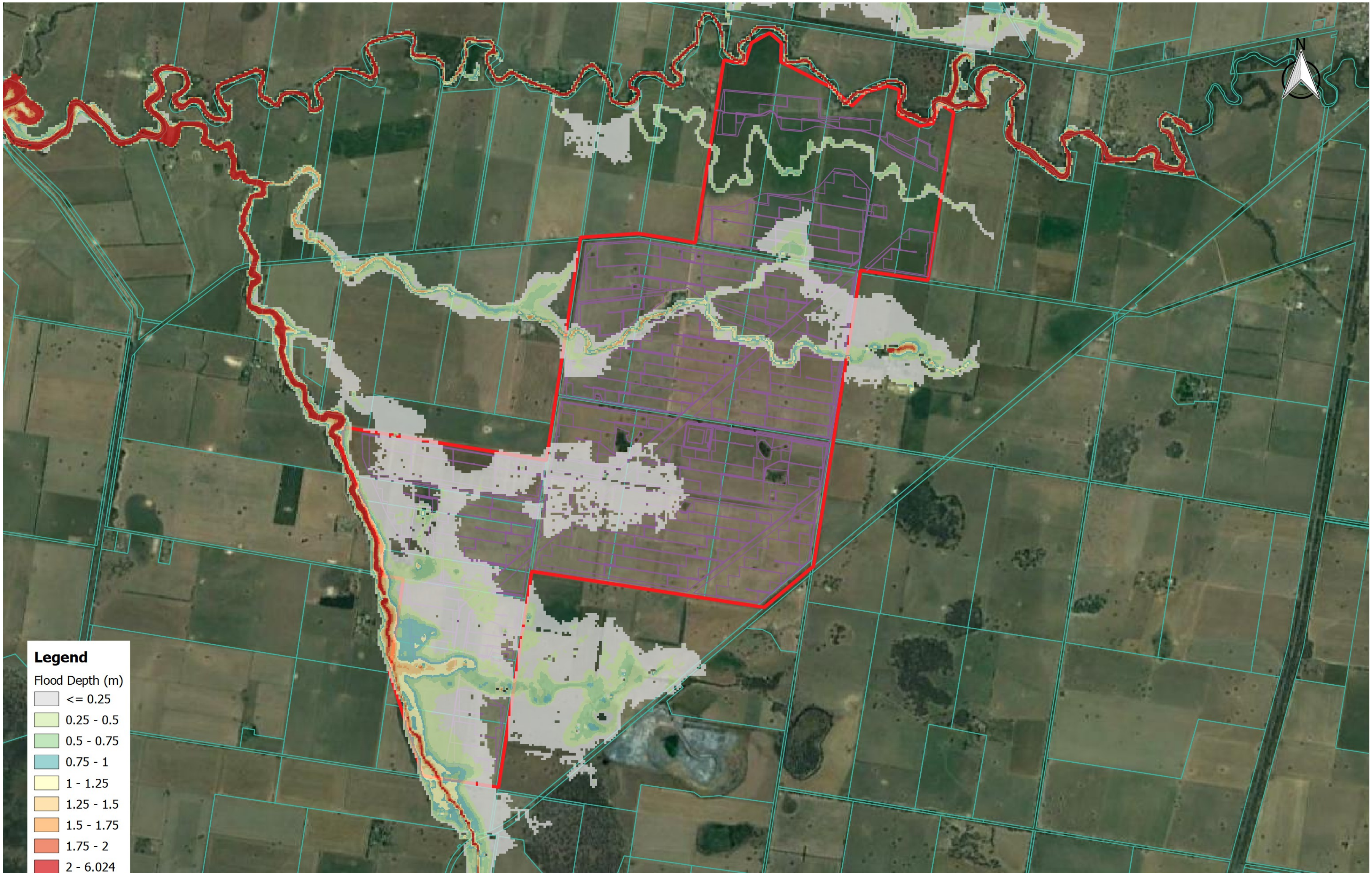
Sheet No: 001

Drawn:

Verified:

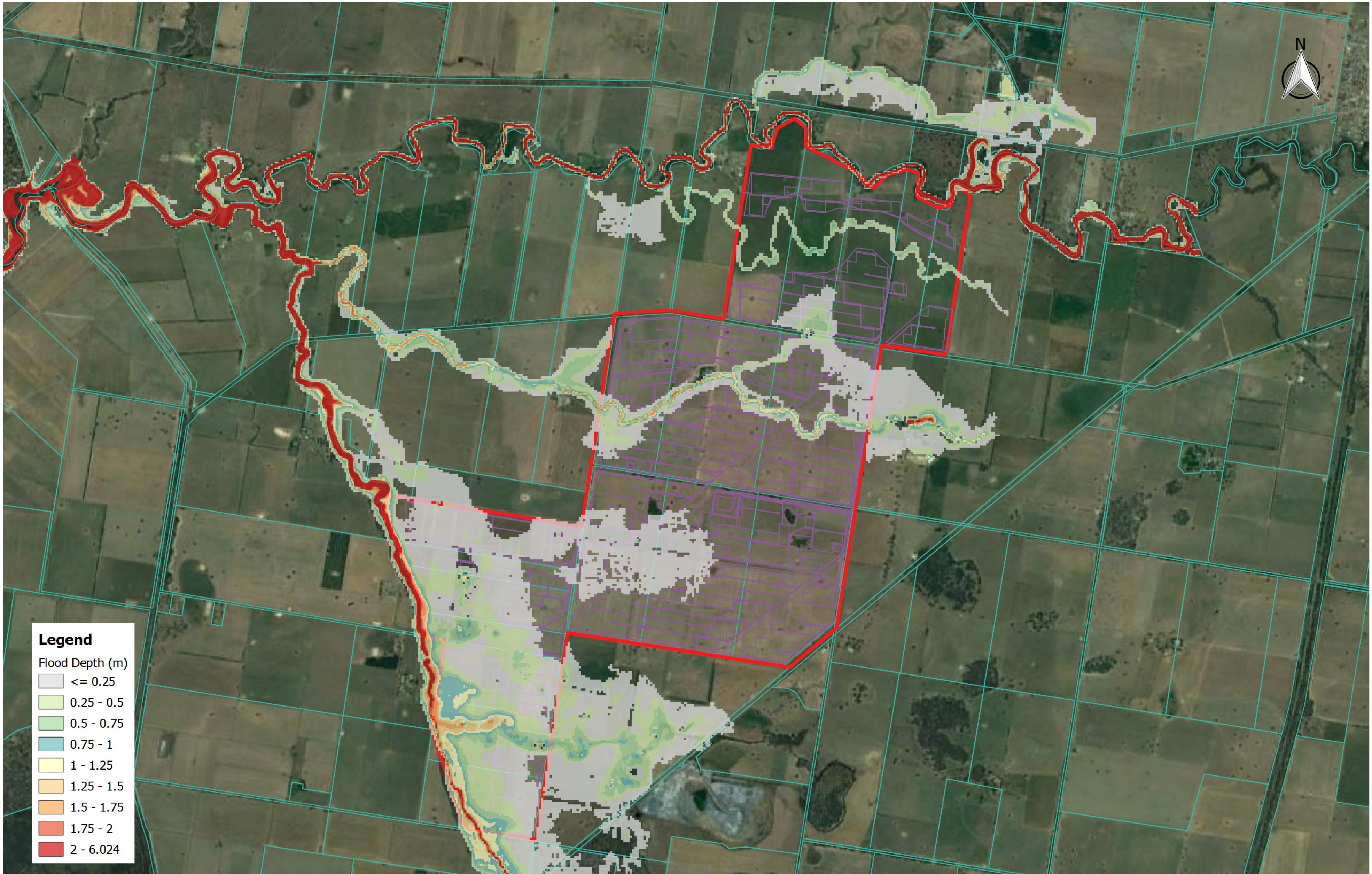
Approved Date:

Graphic Scale:
0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. Existing Case. 1% AEP 4.5 hour storm. Maximum Depth Map.			Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: G02	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m	
Drawn:	Verified:	Approved Date:		



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. Existing Case. 0.5% AEP 4.5 hour storm. Maximum Depth Map.

Scale: 1:31424

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G03

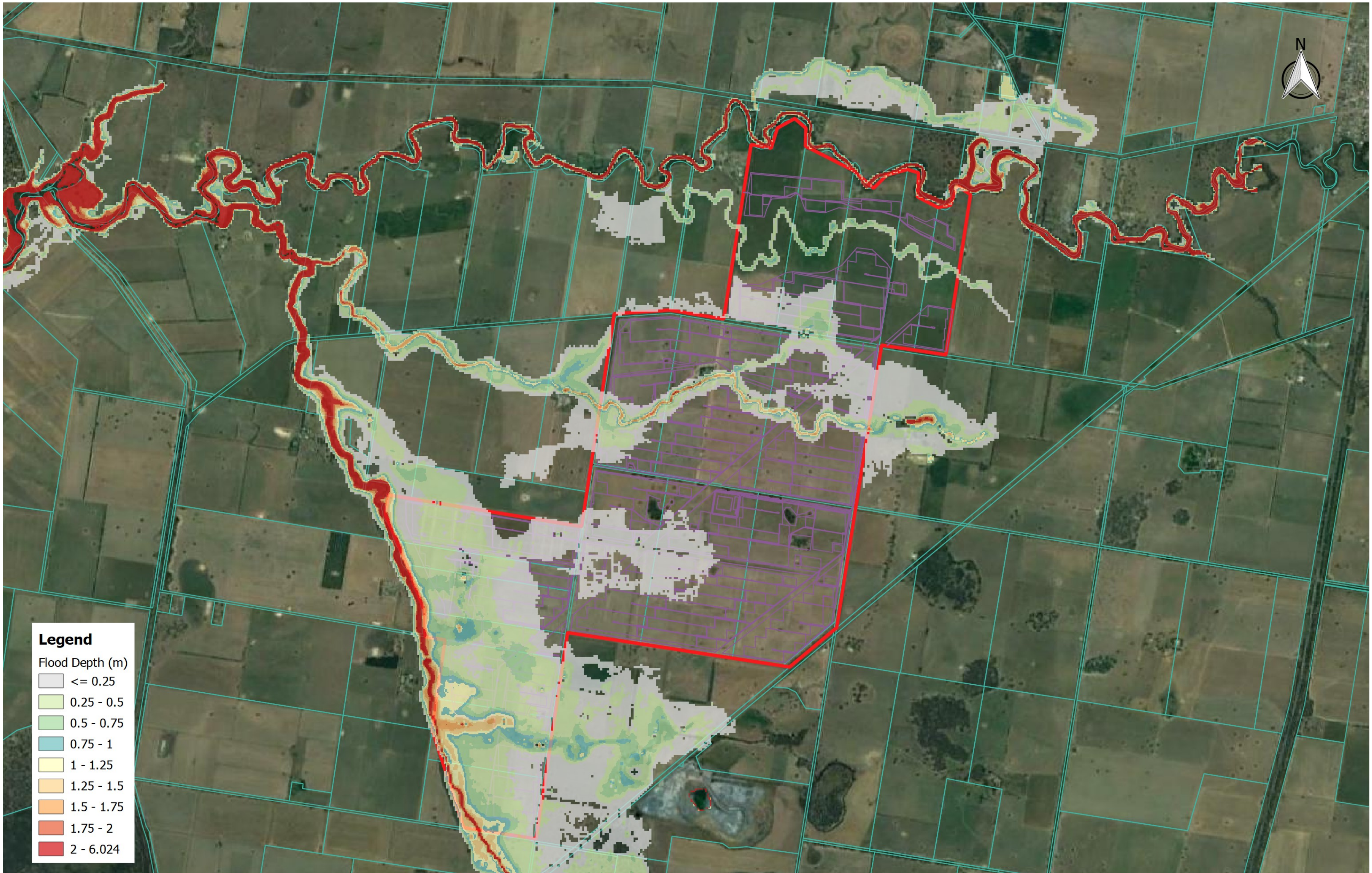
Sheet No: 001

Drawn:

Verified:

Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. Existing Case. 0.2% AEP 4.5 hour storm. Maximum Depth Map.

Scale: 1:31424

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G04

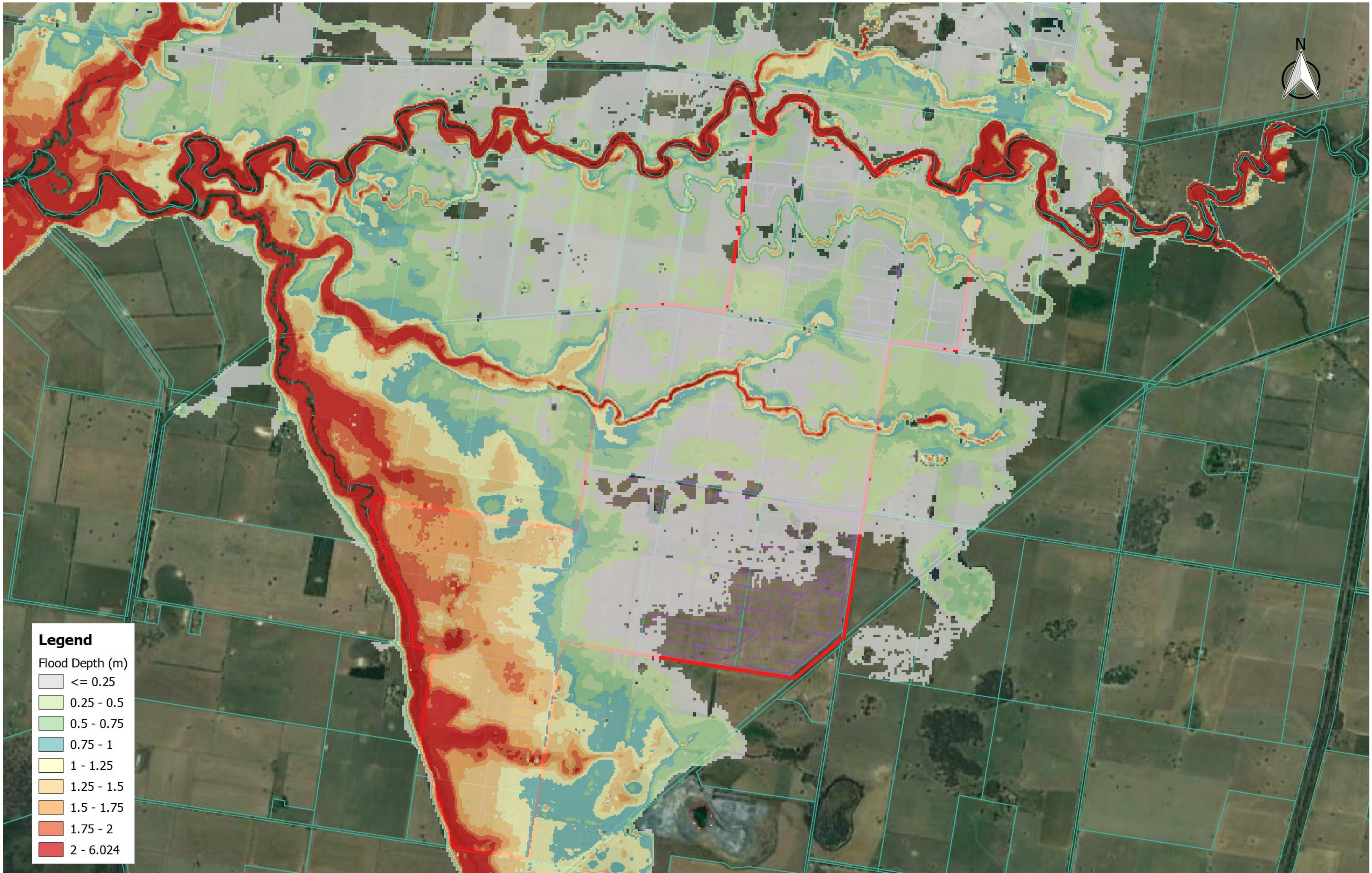
Sheet No: 001

Drawn:

Verified:

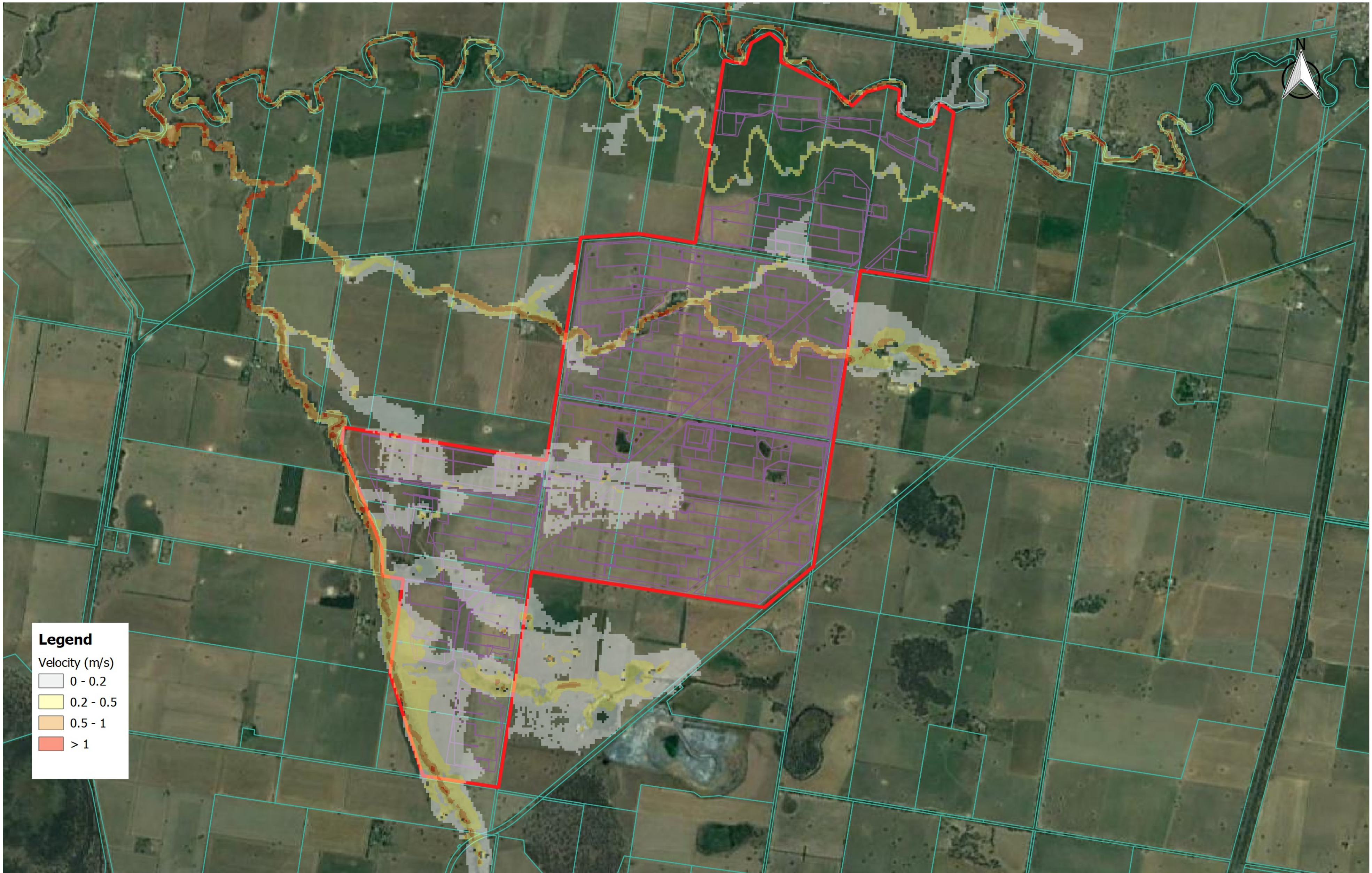
Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

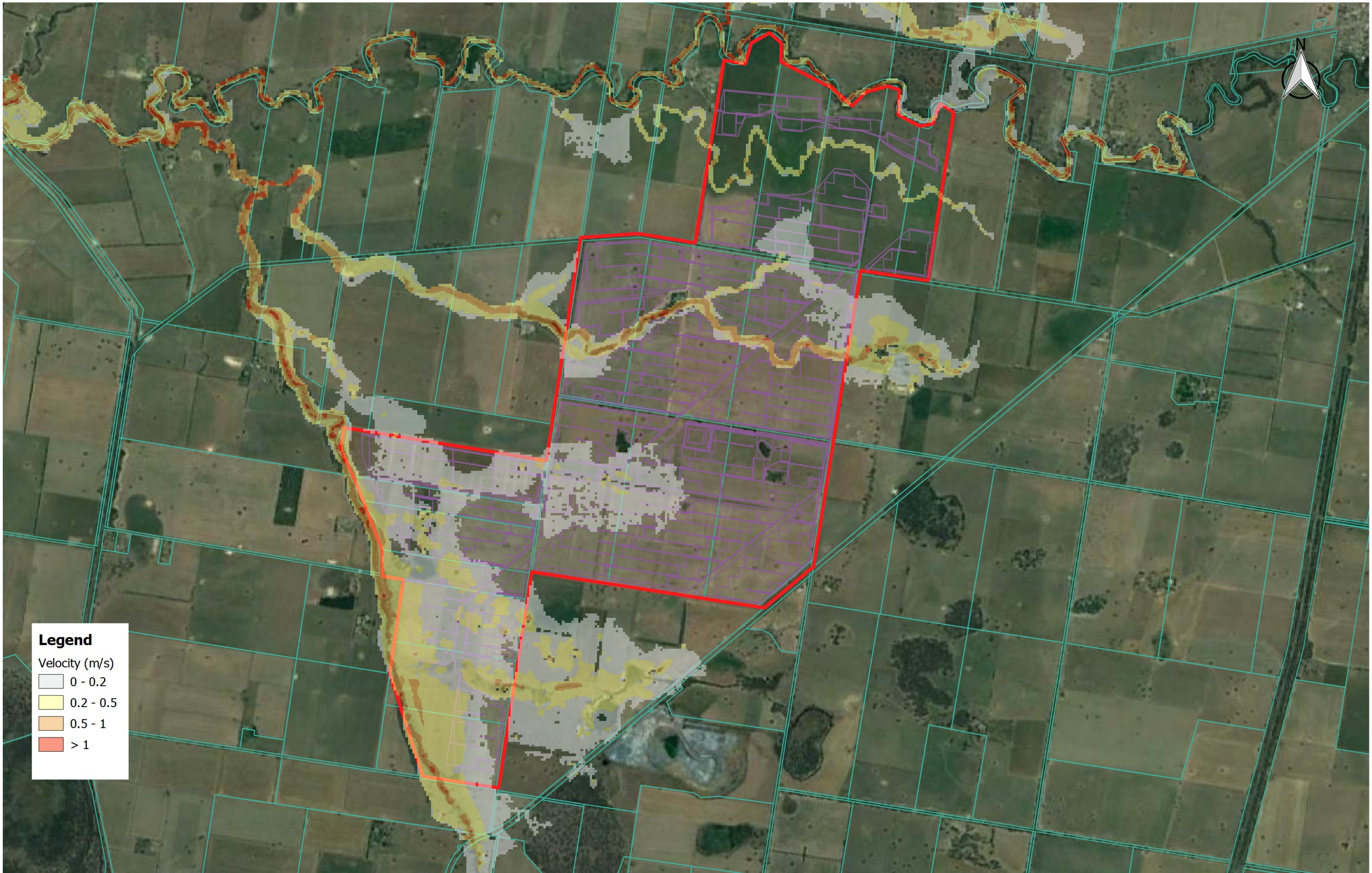
Title: Local Flood Model. Existing Case. PMP 3 hour storm. Maximum Depth Map.			Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: G05	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m	
Drawn:	Verified:	Approved Date:		



Revision	Amendment	Approved	Approved Date

wsp

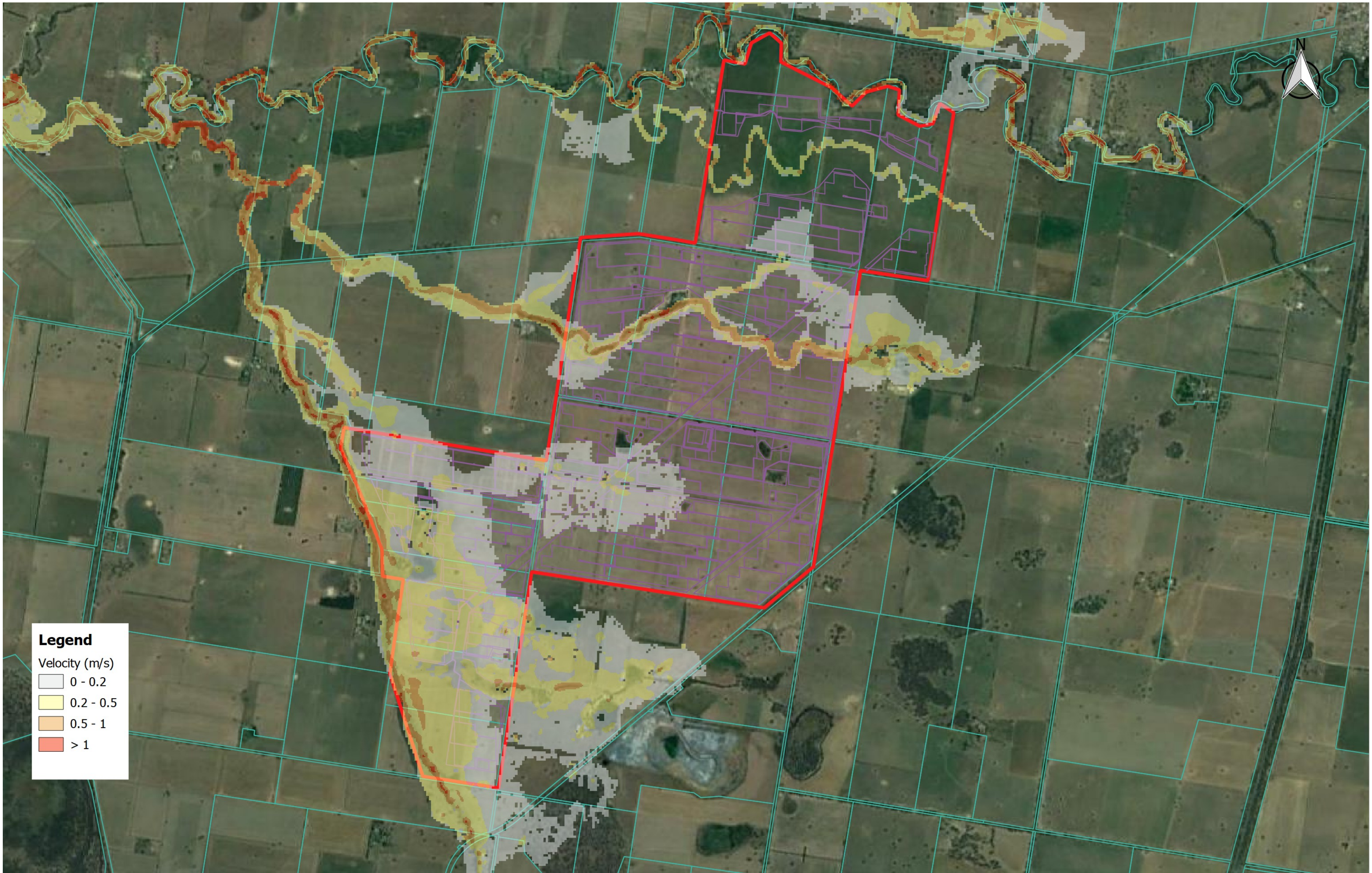
Title: Local Flood Model. Existing Case. 5% AEP 4.5 hour storm. Maximum Velocity Map		Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: G06	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

wsp

Title: Local Flood Model. Existing Case. 1% AEP 4.5 hour storm. Maximum Velocity Map		Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: G07	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

wsp

Title: Local Flood Model. Existing Case. 0.5% AEP 4.5 hour storm. Maximum Velocity Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G08

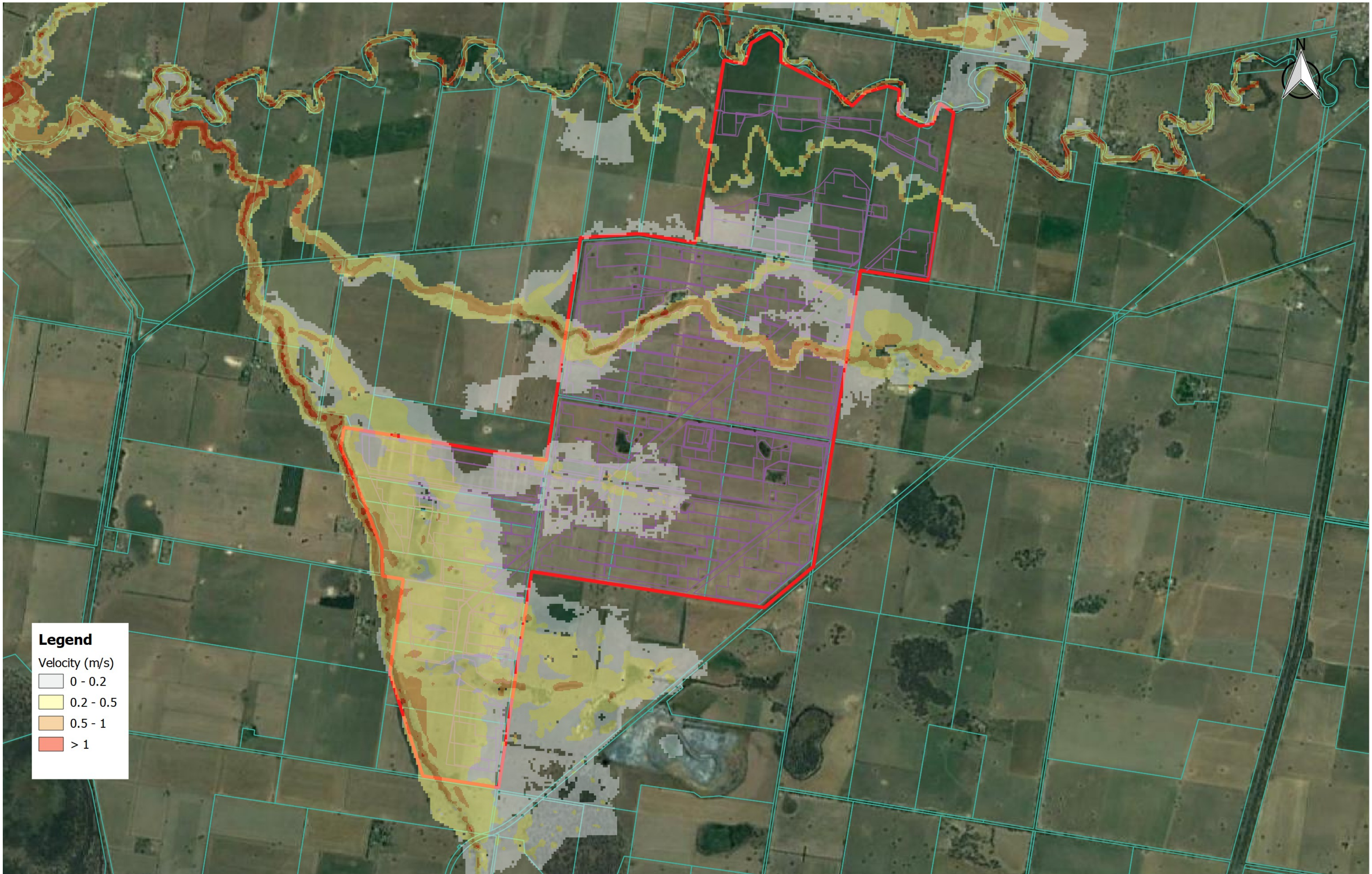
Sheet No: 001

Drawn:

Verified:

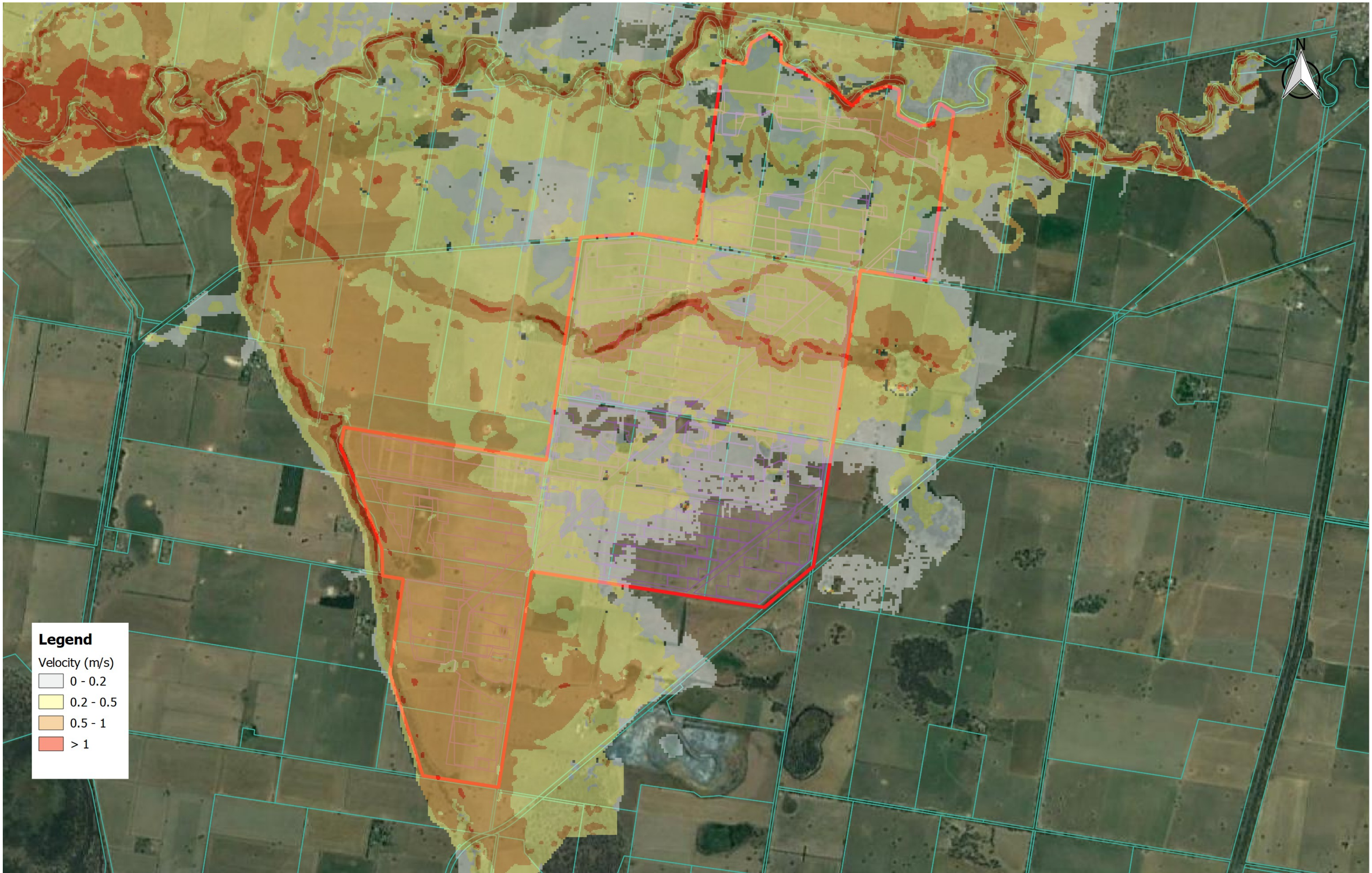
Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. Existing Case. 0.2% AEP 4.5 hour storm. Maximum Velocity Map		Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: G09	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. Existing Case. PMP 3 hour storm. Maximum Velocity Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G10

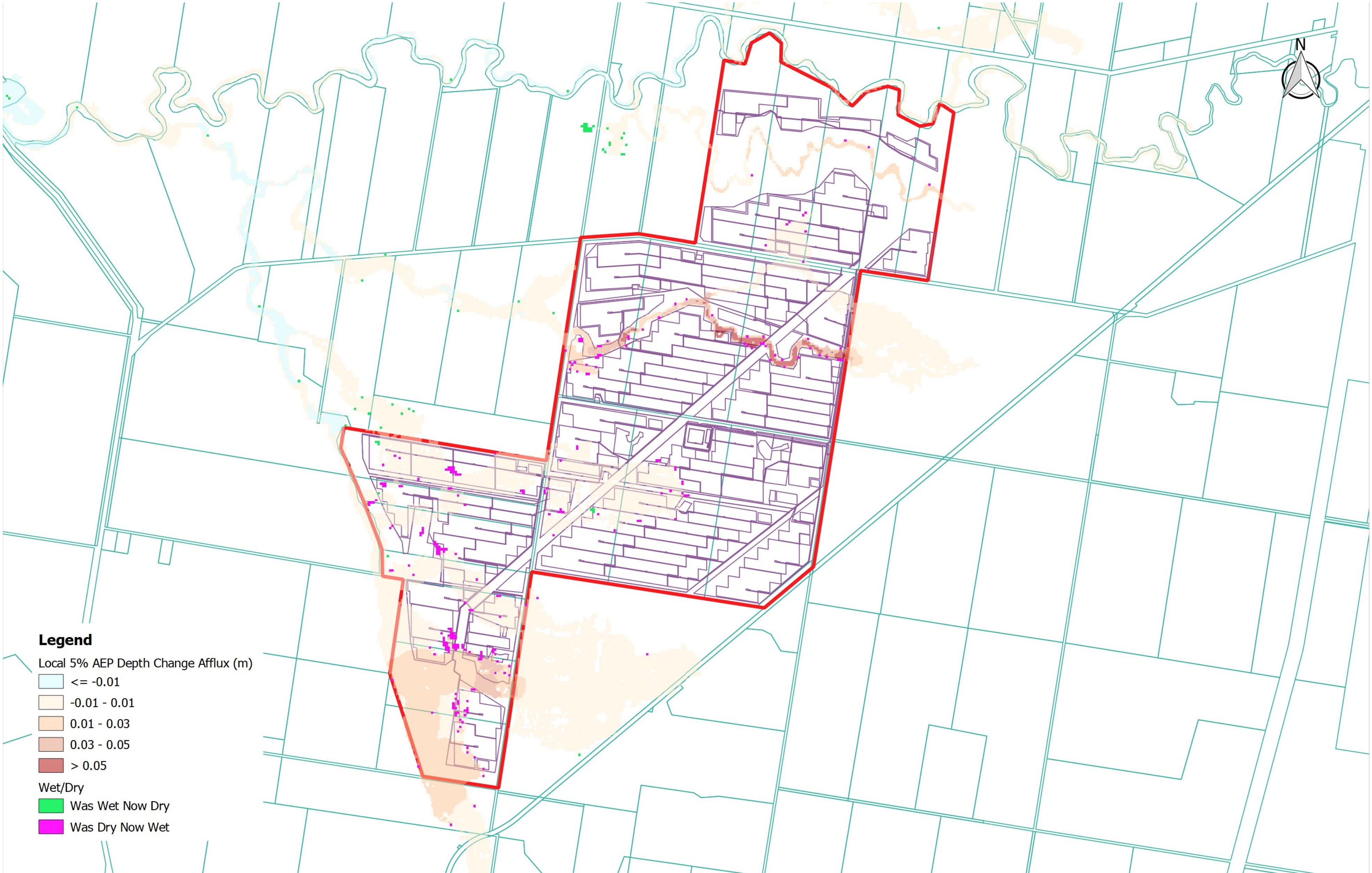
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

wsp

Title: Local Flood Model. 5% AEP 4.5 hour storm. Afflux & Wet/Dry Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G11

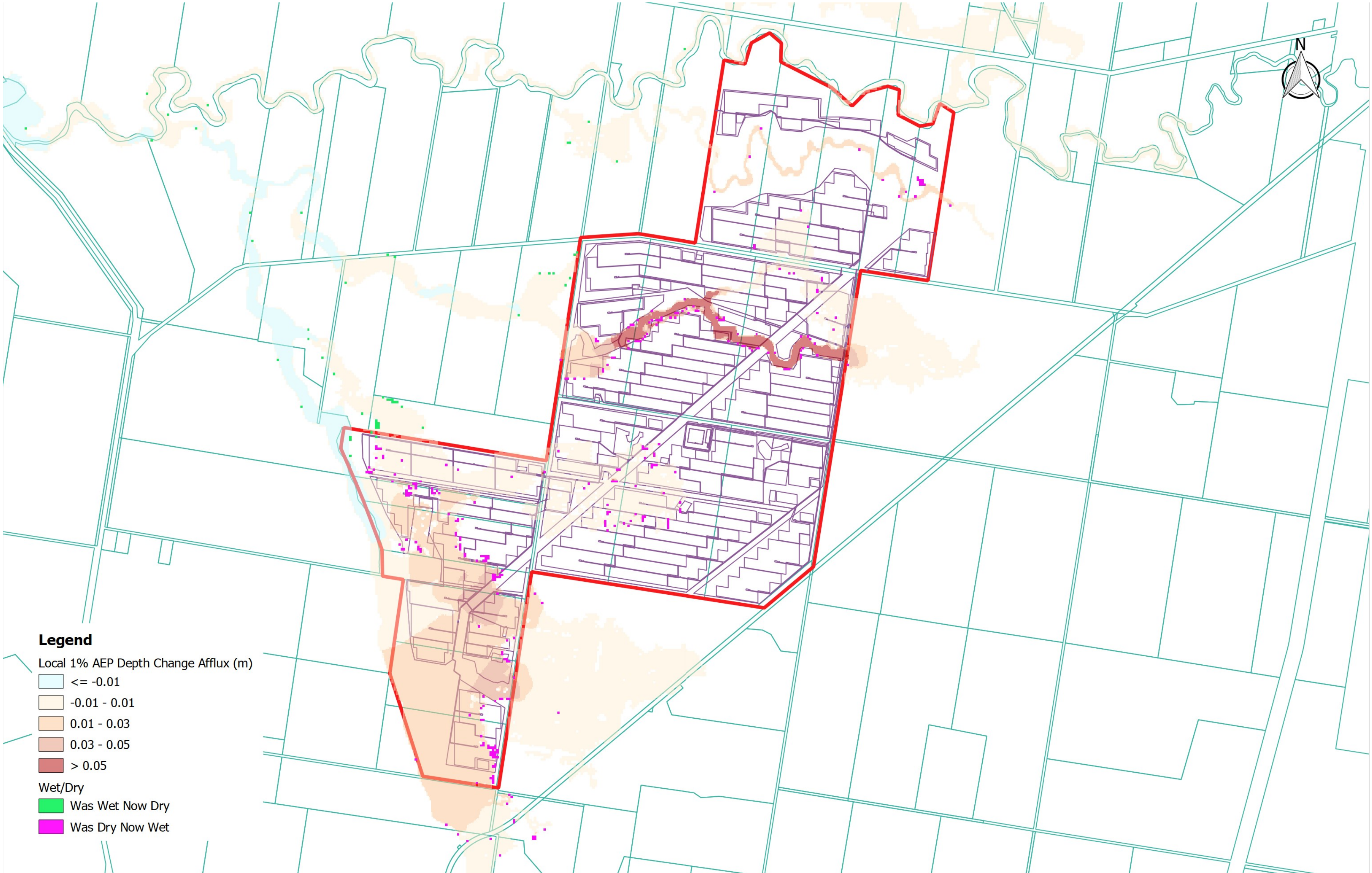
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. 1% AEP 4.5 hour storm. Afflux & Wet/Dry Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G12

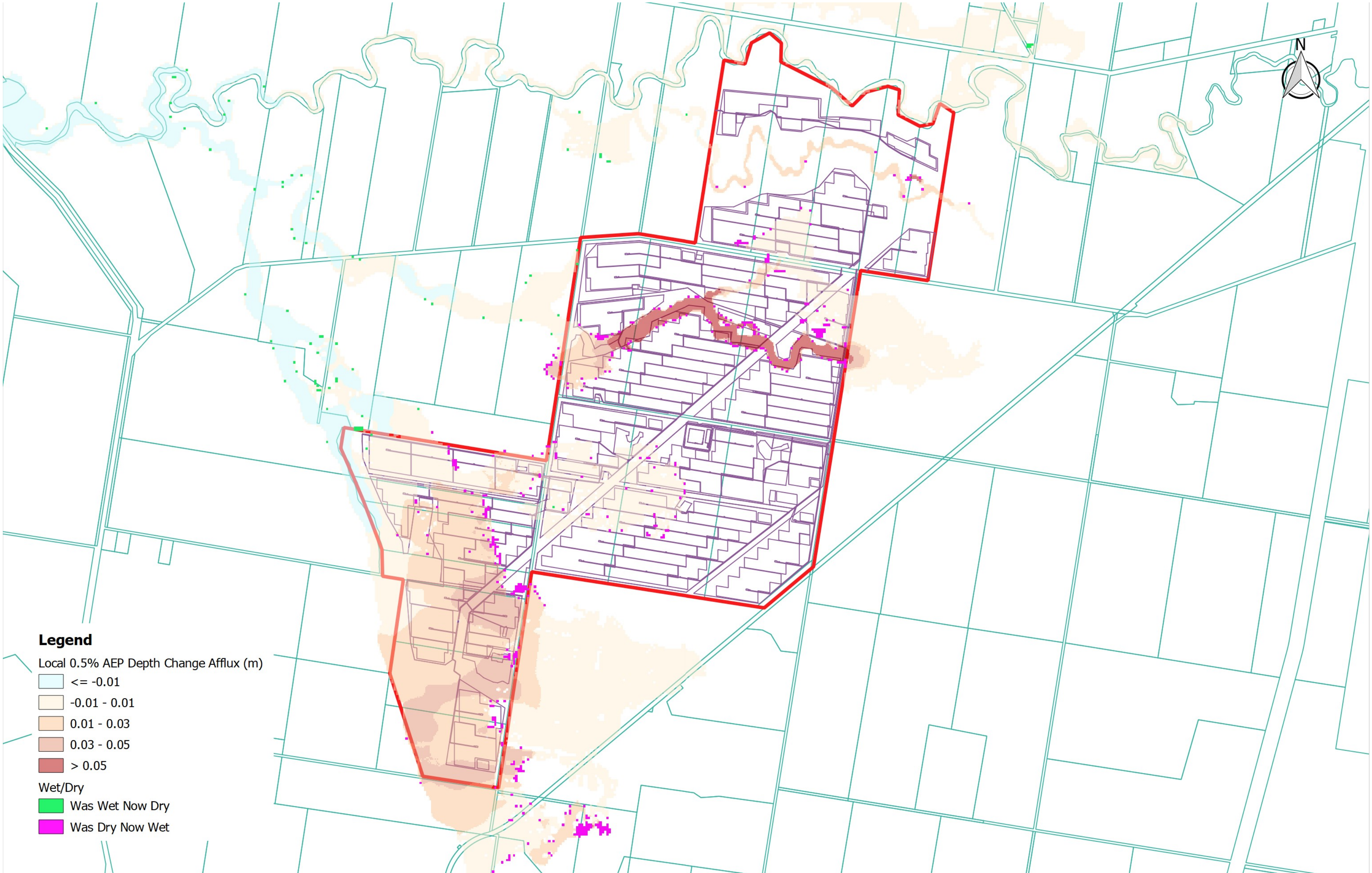
Sheet No: 001

Drawn:

Verified:

Approved Date:

Graphic Scale: 0 250 500 750 1000 m



Revision	Amendment	Approved	Approved Date

wsp

Title: Local Flood Model. 0.5% AEP 4.5 hour storm. Afflux & Wet/Dry Map

Scale: 1:30000

Original Size: A3

Project No: Culcairn Proposed Solar Farm

Map: G13

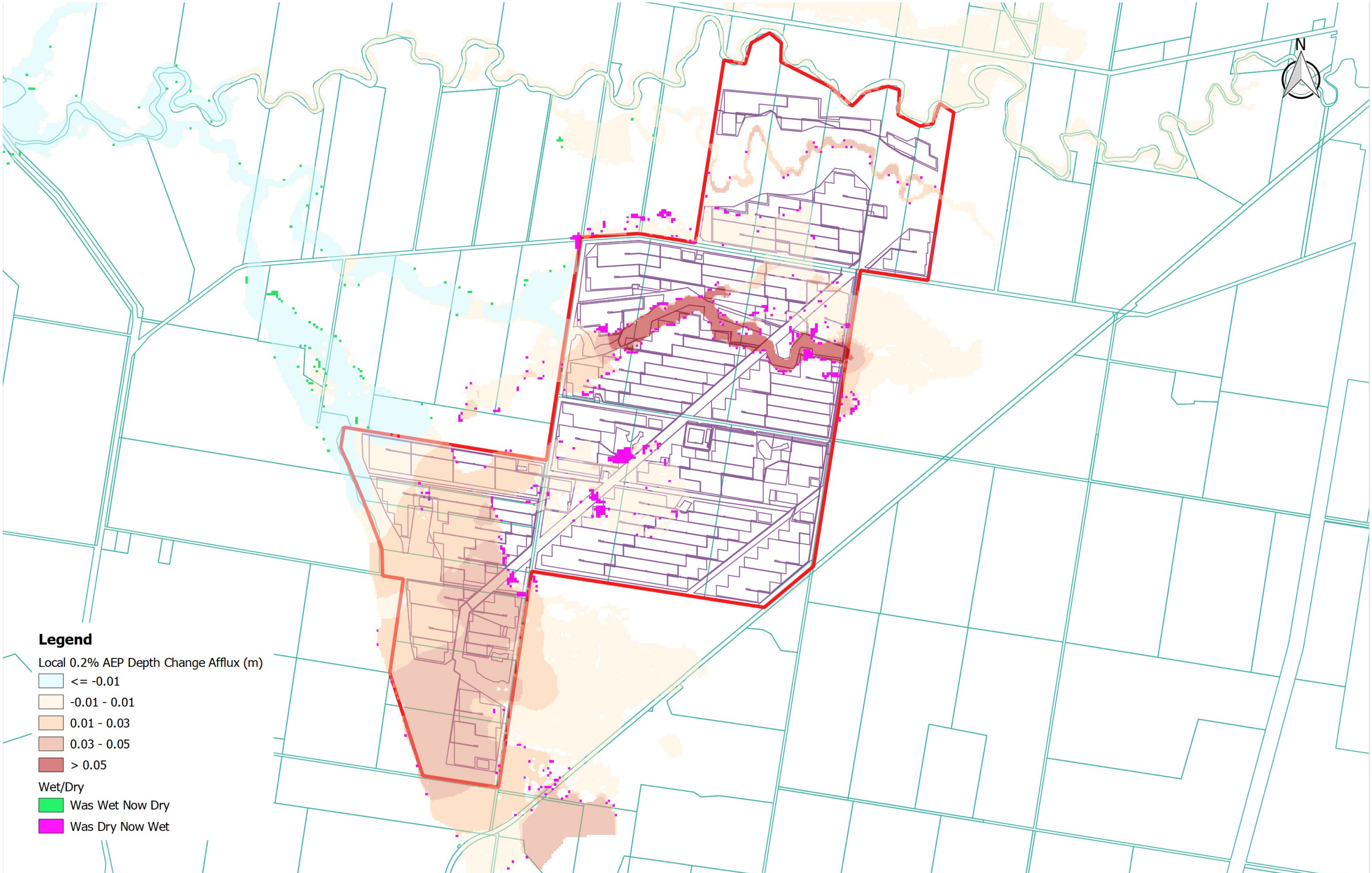
Sheet No: 001

Graphic Scale: 0 250 500 750 1000 m

Drawn:

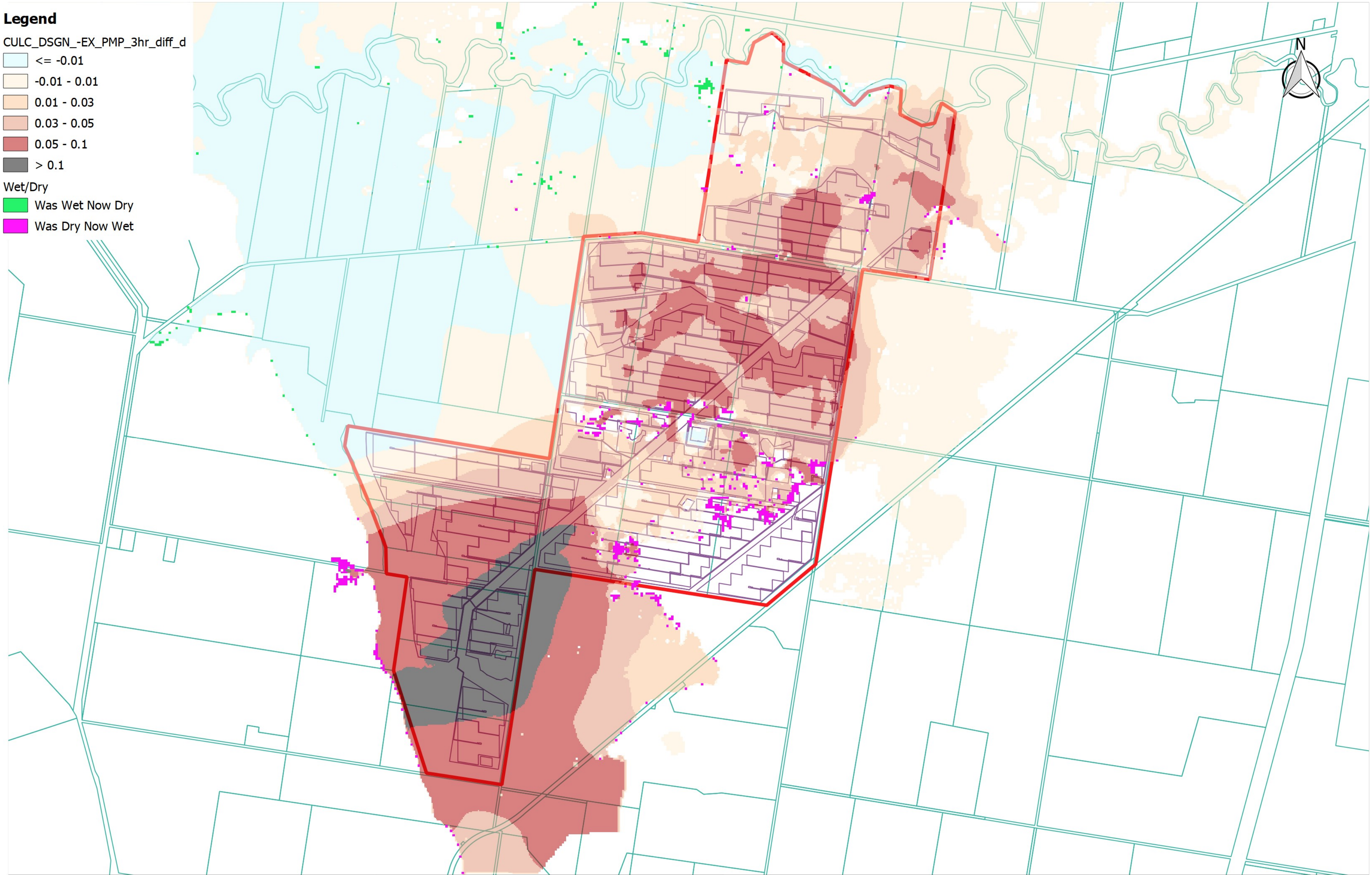
Verified:

Approved Date:



Revision	Amendment	Approved	Approved Date

Title: Local Flood Model. 0.2% AEP 4.5 hour storm. Afflux & Wet/Dry Map		Scale: 1:30000	Original Size: A3
Project No: Culcairn Proposed Solar Farm	Map: G14	Sheet No: 001	Graphic Scale: 0 250 500 750 1000 m
Drawn:	Verified:	Approved Date:	



Revision	Amendment	Approved	Approved Date

wsp

Title: Local Flood Model. PMP 4.5 hour storm. Afflux & Wet/Dry Map			
Project No: Culcairn Proposed Solar Farm	Map: G15	Sheet No: 001	
Drawn:	Verified:	Approved Date:	

Scale: 1:30000	Original Size: A3
Graphic Scale: 0 250 500 750 1000 m	