Marchant S & Higgins PJ 1993, Handbook of Australian, New Zealand and Antarctic birds, Volume 2: Raptors to Lapwings, Oxford University Press, Melbourne.

Menkhorst, P 1995, Mammals of Victoria, Oxford University Press, Melbourne.

Naarding JA 1983, Latham's Snipe in Southern Australia, Wildlife Division Technical Report 83/1, Tasmania National Parks and Wildlife Service, Tasmania.

Natural Resources and Environment Tasmania (NRE). *Threatened Native Vegetation Communities 2020*, Released February 2021. Tasmanian Vegetation Monitoring and Mapping Program, Environment Division.

Powell JM, Walsh NG & Brown EA 1996, Epacridaceae, in Walsh, NG & Entwisle, TJ (eds), Flora of Victoria, Volume 3: Dicotyledons Winteraceae to Myrtaceae, Inkata Press, Melbourne, pp. 494-497.

Saunders, DL & Tzaros, CL 2011, 'National recovery plan for Swift Parrot Lathamus discolor', Birds Australia, Melbourne

Threatened Species Section (2022). Species Management Profile for Tasmania's Threatened Species Link, www.threatenedspecieslink.tas.gov.au, Department of Natural Resources and Environment Tasmania (NRE).

Appendix 1: Flora species recorded in the study area

Origin	Common name	Scientific name
	Black Peppermint	*Eucalyptus amygdalina*
	Pink Beardheath	*Styphelia ericoides*
	Hairy Guineaflower	*Hibbertia hirsuta*
	Thyme Guineaflower	*Hibbertia serpyllifolia*
	Fan Sedge	*Lepidosperma inops*
	Necklace Sheoak	*Allocasuarina monilifera*
	Swamp Peppermint	*Eucalyptus rodwayi*
	Silver Wattle	*Acacia dealbata*
	Black Wattle	*Acacia mearnsii*
	Blackwood	*Acacia melanoxylon*
	Sheep's Burr	*Acaena echinata*
	Bidgee-widgee	*Acaena novae-zelandiae*
*	Sheep Sorrel	*Acetosella vulgaris*
*	Brown-top Bent	*Agrostis capillaris*
*	Hair Grass	*Aira spp.*
	Black Sheoak	*Allocasuarina littoralis*
*	Sweet Vernal-grass	*Anthoxanthum odoratum*
*	Cape weed	*Arctotheca calendula*
	Pale Vanilla-lily	*Arthropodium milleflorum s.l.*
	Chocolate Lily	*Arthropodium strictum s.l.*
	Supple Spear-grass	*Austrostipa mollis*
	Tall Spear-grass	*Austrostipa pubinodis*
	Spear Grass	*Austrostipa spp.*
	Quizzical Spear-grass	*Austrostipa stuposa*
*	Oat	*Avena sativa*
	Silver Banksia	*Banksia marginata*
	Creeping Bossiaea	*Bossiaea prostrata*
	Fringed Brachyloma	*Brachyloma ciliatum*
*	Lesser Quaking-grass	*Briza minor*
*	Soft Brome	*Bromus hordeaceus*
	Sweet Bursaria	*Bursaria spinosa*
	Blue Grass-lily	*Caesia calliantha*
*	Common Water-starwort	*Callitriche stagnalis*
	Curly Sedge	*Carex tasmanica*
	Common Cassinia	*Cassinia aculeata subsp. aculeata*
*	Common Mouse-ear Chickweed	*Cerastium glomeratum s.l.*
	Blue Stars	*Chamaescilla corymbosa var. corymbosa*
*	Spear Thistle	*Cirsium vulgare*

Origin	Common name	Scientific name
	Love Creeper	*Comesperma volubile*
	Blushing Bindweed	*Convolvulus angustissimus*
	Button Everlasting	*Coronidium scorpioides* s.s.
	Spreading Crassula	*Crassula decumbens var. decumbens*
	Sieber Crassula	*Crassula sieberiana* s.l.
*	Hawthorn	*Crataegus monogyna*
*	Cocksfoot	*Dactylis glomerata*
	Hop Bitter-pea	*Daviesia latifolia*
	Black-anther Flax-lily	*Dianella revoluta* s.l.
	Tasman Flax-lily	*Dianella tasmanica*
	Common Plume-grass	*Dichelachne rara*
	Kidney-weed	*Dichondra repens*
	Sticky Hop-bush	*Dodonaea viscosa* subsp. *spatulata*
	Branched Sundew	*Drosera hookeri*
	Pale Sundew	*Drosera peltata* s.l.
	Common Spike-sedge	*Eleocharis acuta*
	Mountain Gum	*Eucalyptus dalrympleana* subsp. *dalrympleana*
*	Shining Gum	*Eucalyptus nitens*
	Swamp Gum	*Eucalyptus ovata*
	White Sallee	*Eucalyptus pauciflora* subsp. *pauciflora*
	Cherry Ballart	*Exocarpos cupressiformis*
	Grassland Crane's-bill	*Geranium retrorsum* s.l.
	Crane's Bill	*Geranium* spp.
	Wax-lip Orchid	*Glossodia major*
	Shade Raspwort	*Gonocarpus humilis*
	Common Raspwort	*Gonocarpus tetragynus*
	Trailing Goodenia	*Goodenia lanata*
*	Ox-tongue	*Helminthotheca echioides*
	Guinea Flower	*Hibbertia* spp.
*	Yorkshire Fog	*Holcus lanatus*
	Small St John's Wort	*Hypericum gramineum*
*	St John's Wort	*Hypericum perforatum* subsp. *veronense*
*	Flatweed	*Hypochaeris radicata*
	Golden Weather-glass	*Hypoxis hygrometrica*
	Running Postman	*Kennedia prostrata*
	Common Bottle-daisy	*Lagenophora stipitata*
	Jersey Cudweed	*Laphangium luteoalbum*
	Variable Sword-sedge	*Lepidosperma laterale*
	Scaly Buttons	*Leptorhynchos squamatus* subsp. *squamatus*

Origin	Common name	Scientific name
	Peach Heath	*Lissanthe strigosa* subsp. *subulata*
*	Perennial Rye-grass	*Lolium perenne*
*	Wimmera Rye-grass	*Lolium rigidum*
*	Rye Grass	*Lolium* spp.
	Spiny-headed Mat-rush	*Lomandra longifolia*
	Dwarf Mat-rush	*Lomandra nana*
	Common Woodrush	*Luzula meridionalis*
*	Horehound	*Marrubium vulgare*
*	Medic	*Medicago* spp.
	Tree Violet	*Melicytus* spp.
	Weeping Grass	*Microlaena stipoides* var. *stipoides*
*	Creeping Wood-sorrel	*Oxalis corniculata* s.s.
	Grassland Wood-sorrel	*Oxalis perennans*
*	Toowoomba Canary-grass	*Phalaris aquatica*
	Smooth Rice-flower	*Pimelea glauca*
	Common Rice-flower	*Pimelea humilis*
*	Pine	*Pinus* spp.
*	Buck's-horn Plantain	*Plantago coronopus*
*	Ribwort	*Plantago lanceolata*
*	Annual Meadow-grass	*Poa annua* s.l.
	Common Tussock-grass	*Poa labillardierei*
	Velvet Tussock-grass	*Poa rodwayi*
	Grey Tussock-grass	*Poa sieberiana*
*	Four-leaved Allseed	*Polycarpon tetraphyllum*
	Thin Pondweed	*Potamogeton australiensis*
	Red Pondweed	*Potamogeton cheesemanii*
	Austral Bracken	*Pteridium esculentum* subsp. *esculentum*
	Greenhood	*Pterostylis* spp.
*	Onion Grass	*Romulea rosea*
*	Sweet Briar	*Rosa rubiginosa*
*	Blackberry	*Rubus fruticosus spp. agg.*
	Slender Dock	*Rumex brownii*
	Common Wallaby-grass	*Rytidosperma caespitosum*
	Bristly Wallaby-grass	*Rytidosperma setaceum*
	Wallaby Grass	*Rytidosperma* spp.
	Groundsel	*Senecio* spp.
*	Variegated Thistle	*Silybum marianum*
	Smooth Solenogyne	*Solenogyne dominii*
*	Common Sow-thistle	*Sonchus oleraceus*
*	Chickweed	*Stellaria media*

Origin	Common name	Scientific name
	Cranberry Heath	*Styphelia humifusa*
*	Garden Dandelion	*Taraxacum officinale* spp. agg.
	Sun Orchid	*Thelymitra* spp.
	Kangaroo Grass	*Themeda triandra*
*	Clover	*Trifolium* spp.
*	Subterranean Clover	*Trifolium subterraneum*
*	Gorse	*Ulex europaeus*
*	Nettle	*Urtica* spp.
	Slender Speedwell	*Veronica gracilis*
	Ivy-leaf Violet	*Viola hederacea*
*	Squirrel-tail Fescue	*Vulpia bromoides*
*	Rat's-tail Fescue	*Vulpia myuros*
	Bluebell	*Wahlenbergia* spp.
	Common Early Nancy	*Wurmbea dioica*

* = introduced to Tasmania

Appendix 2: Fauna species recorded in the study area

Common Name	Scientific Name
Birds	
Australian Hobby	*Falco longipennis*
Australian Magpie	*Gymnorhina tibicen*
Australian Pipit	*Anthus australis*
Australian Shelduck	*Tadorna tadornoides*
Australian Wood Duck	*Chenonetta jubata*
Black Currawong	*Strepera fuliginosa*
Black Swan	*Cygnus atratus*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Brown Falcon	*Falco berigora*
Brown Quail	*Synoicus ypsilophorus*
Brown Thornbill	*Acanthiza pusilla*
Chestnut Teal	*Anas castanea*
Common Blackbird*	*Turdus merula*
Common Bronzewing	*Phaps chalcoptera*
Common Starling*	*Sturnus vulgaris*
Dusky Robin	*Melanodryas vittata*
Dusky Woodswallow	*Artamus cyanopterus*
Eastern Rosella	*Platycercus eximius*
Eurasian Skylark*	*Alauda arvensis*
European Goldfinch*	*Carduelis carduelis*
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Galah	*Eolophus roseicapilla*
Golden Whistler	*Pachycephala pectoralis*
Grey Butcherbird	*Cracticus torquatus*
Grey Currawong	*Strepera versicolor*
Grey Fantail	*Rhipidura albiscapa*
Grey Shrike-thrush	*Colluricincla harmonica*
Laughing Kookaburra*	*Dacelo novaeguineae*
Little Corella	*Cacatua sanguinea*
Masked Lapwing	*Vanellus miles*
Noisy Miner	*Manorina melanocephala*
Pacific Black Duck	*Anas superciliosa*
Pallid Cuckoo	*Cacomantis pallidus*
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*
Silvereye	*Zosterops lateralis*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*

Common Name	Scientific Name
Tasmanian Native-hen	*Tribonyx mortierii*
Wedge-tailed Eagle	*Aquila audax*
Welcome Swallow	*Hirundo neoxena*
White-faced Heron	*Egretta novaehollandiae*
White-fronted Chat	*Epthianura albifrons*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Yellow-throated Honeyeater	*Nesoptilotis flavicollis*
Mammals	
Common Brush-tailed Possum	*Trichosurus vulpecula*
Common Wombat	*Vombatus ursinus* subsp. *Tasmaniensis*
European Brown Hare*	*Lepus europaeus*
European Rabbit*	*Oryctolagus cuniculus*
Fallow Deer*	*Dama dama*
Red-necked Wallaby	*Notamacropus rufogriseus*
Reptiles and Amphibians	
Banjo Frog	*Limnodynastes dumerilii*
Common Eastern Froglet	*Crinia signifera*
Skink	*Scincidae* sp.

*= introduced to Tasmania

Appendix 3: Photographs of native vegetation and fauna habitat recorded in the study area

All photographs were taken on 10-12 October 2022.

Photograph 4: Example of high quality flora and fauna habitat - woodland/forest

Photograph 5: Example of medium-quality flora and fauna habitat - grassland and scattered trees

Photograph 6: Example of low quality flora and fauna habitat - cleared pine plantation

pitt&sherry

Northern Midlands Solar Farm

Flooding Impact Assessment

Prepared for
Connorville Estates

Client representative
Emanuele Raffaele of Robert Luxmoore

Date
12 May 2023

Rev03

Table of Contents

List of figures

List of tables

Appendices

Prepared by — Hamish Waterston		**Date —** 12 May 2023
Reviewed by — Joshua Coates		**Date —** 12 May 2023
Authorised by — Joshua Coates		**Date —** 12 May 2023

Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
00	Issue to Client	HW	JC	JC	09/03/2023
01	Report with revisions	HW/OD	JC	JC	05/04/2023
02	Report with final revisions	HW/OD	JC	JC	05/05/2023

1. Introduction

Connorville Estates PTY Ltd are seeking to develop existing agricultural land into a medium-large scale Solar Farm. The proposal would involve the construction of solar panels and transmission infrastructure, from the site to existing TasNetworks infrastructure.

The development is being managed by Robert Luxmoore Project Management who have engaged pitt&sherry for advice on the Hydrology and Hydraulics aspects of the project during the development phase. This report will address stormwater and flooding criteria of the relevant planning code *Tasmanian Planning Scheme - Northern Midlands 2022*.

1.1 Site overview & climate

Located in Tasmania's Central Midlands, the site sits just to the east of the Western Tiers. The property is named Connorville Station and is located at 394 Connorville Rd, Cressy, TAS. The entire property is 17,600 Ha, in single ownership. Family has owned the land since 1823.

Given Tasmania's prevailing westerly weather patterns this means the development site is in a rain shadow. Some areas of the West coast of Tasmania receive in excess of 3 metres of rainfall a year. However, at the Cressy Research Station (Station ID 091022, Climate Data Online), which is situated ~11km away the mean annual rainfall is just 592mm.

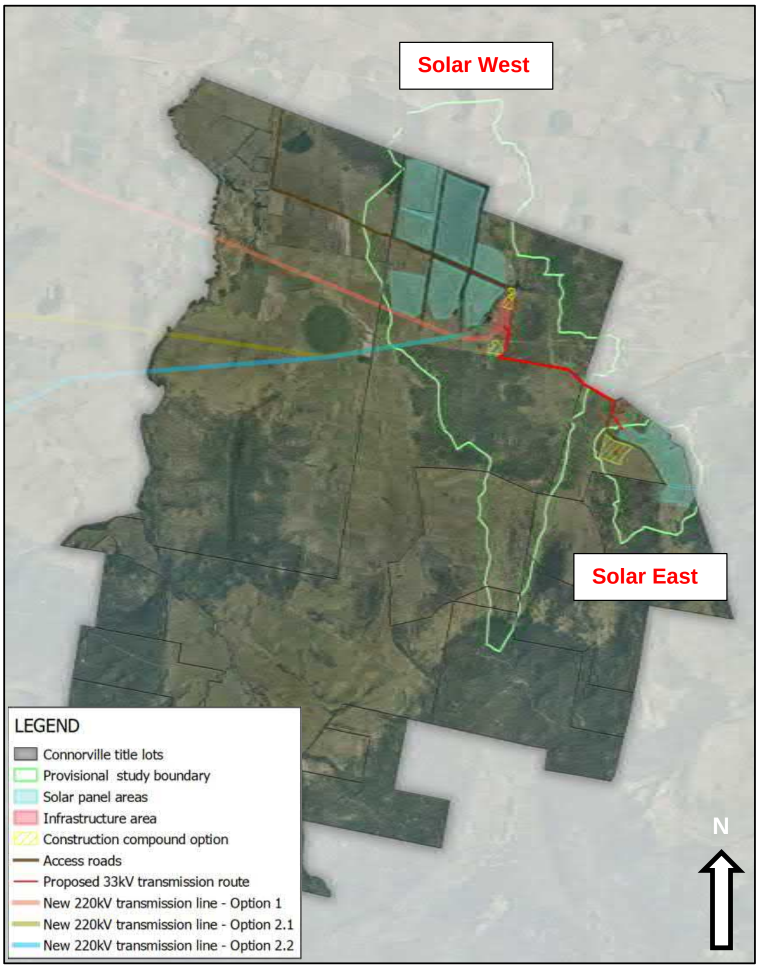


Figure 1: Site Overview – Connorville Station

The entire development area is 543 Ha, this area includes all the Proposal elements, i.e. Solar East & Solar West, access tracks, 220kV transmission line, main infrastructure area (including the switchyard, BESS1,and O&M compound), construction areas/car parking, and internal 33kV line).

The study area relevant for this flooding assessment is made up of two main areas, named Solar East and Solar West. Solar East comprises two panel regions, St Hildas and Old Barton, totalling 88 ha. Solar West is made up of seven panel regions as well as the infrastructure area, totalling a possible 379 ha of solar panel area.

There are three transmission line alignments that have been explored for this development. The chosen alignments cross several larger creeks as well as Lake River. Option 1 follows the existing transmission line easement across to the Palmerston Substation. Options 2.1 & 2.2 take a different alignment to join into an existing transmission line. Detailed flood modelling of these alignments and associated transmission towers has been excluded from this study. The proposed corridors are well mapped under the Waterway and Coastal Protection code in the *Tasmanian Planning Scheme – Northern Midlands 2022* and towers can easily be designed to be outside of these areas. Furthermore, it is unlikely these towers will have any impact on the upstream or downstream water level even if they are flood affected.

A masterplan detailed existing site features and elements of the proposed development has been included in Appendix B

2. Data collection & review

This assessment relies upon a variety of freely available data sources as well as client supplied items. A range of sources have been used to collate information from websites to on the ground site visits.

2.1 Topography

The digital surface has been extracted from the Australian Government service Elvis Elevation and Depth (https://elevation.fsdf.org.au/) and is a portion of a 5m Digital Elevation Model of Australia (DEM). The DEM is a collated from over 200 surveys taken between 2001 and 2015. Given the site is an agricultural area it is deemed unlikely that there would have been significant development and changes to the surface in that time period.

2.2 Drainage culverts

Information regarding diameter and location of culverts has been collected through a site visit carried out by Hamish Waterston on 04/11/2022. Invert levels have been approximated from the DEM.

Figure 2: DN1200 RCP Culvert

Figure 3: Twin DN600 RCP Culvert

Culverts on site range from large pipes with constructed headwalls to rudimentary cross drainage culverts. The culverts are located along the existing unsealed access road that traverses through the Solar West site off Connorville Road (see Figure 4).

Figure 4: Location of identified culverts from site visit

2.3 Rainfall data

Rainfall data was sourced from the Bureau of Meteorology using a rainfall extractor plugin in QGIS (https://qgis.org/en/site/) a special and mapping service. The rainfall data was extracted from the following location: Longitude: 147.1251, Latitude: -41.8483

2.4 Manning's 'n' Roughness values

Roughness values have been estimated based on aerial photography and assumed flow paths of water. The data displayed below in Table 1 has been utilised in this model. As a direct rainfall model has been adopted, much of the study area will be subject to shallow flow. It is important to account for the roughness at shallow depths as water will generally experience a greater impedance when shallow. As such a depth-varied Manning's roughness has been adopted.

Table 1: Manning's 'n' Roughness

Material ID	Manning's n	Rainfall Losses	Description
1	Depth < 0.03 m, n = 0.02, Depth > 0.1, n = 3	IL: 0, CL :0	Buildings
2	n = 0.025	IL: 0, CL :0	Roads
3	Depth < 0.1 m, n = 0.2, Depth > 0.4, n = 0.1	IL: 24, CL: 4.7	Heavy Vegetation
4	Depth < 0.1 m, n = 0.2, Depth > 0.6, n = 0.1	IL: 0, CL :0	Creek
5	Depth < 0.03 m, n = 0.1, Depth > 0.1, n = 0.06	IL: 24, CL: 4.7	Paddocks/Grass

2.5 Data review

The topography has been checked in various key locations (flow paths etc) to confirm that it is a reasonable fit for modelling. Roughness values have been adopted from industry norms.

3. Flood assessment

3.1 Flood modelling approach

The subject sites, Solar East and Solar West, are situated in locations that may be affected by overland flow or small distributed streams. As good terrain data is available, this assessment adopts a 'direct rainfall' modelling approach. This model applies rain directly to the 2D domain and allows the model to identify where flow is directed. Other methods require a degree of human input to make a decision where flow should be applied. This can introduce bias, particularly if the study area is flat or has many streams.

The 'direct rainfall' can be data intensive, as such, a traditional hydrologic model has been used to identify the critical storms to assess in the hydraulic model.

3.2 Hydrology

The proposed solar farm site is located within two main catchments, one 1559ha catchment (through Solar West) and a smaller 335ha catchment (through Solar East). For the 2-dimensional modelling, adjacent sub-catchments have been included with the 1559ha catchment model bringing the total area to 2317ha. The two sites are outlined below in Figure 5 overlaid on the Connorville Estate property boundary. The catchments have been extended downstream as required to ensure hydraulically relevant features are included in the 2-dimensional model.

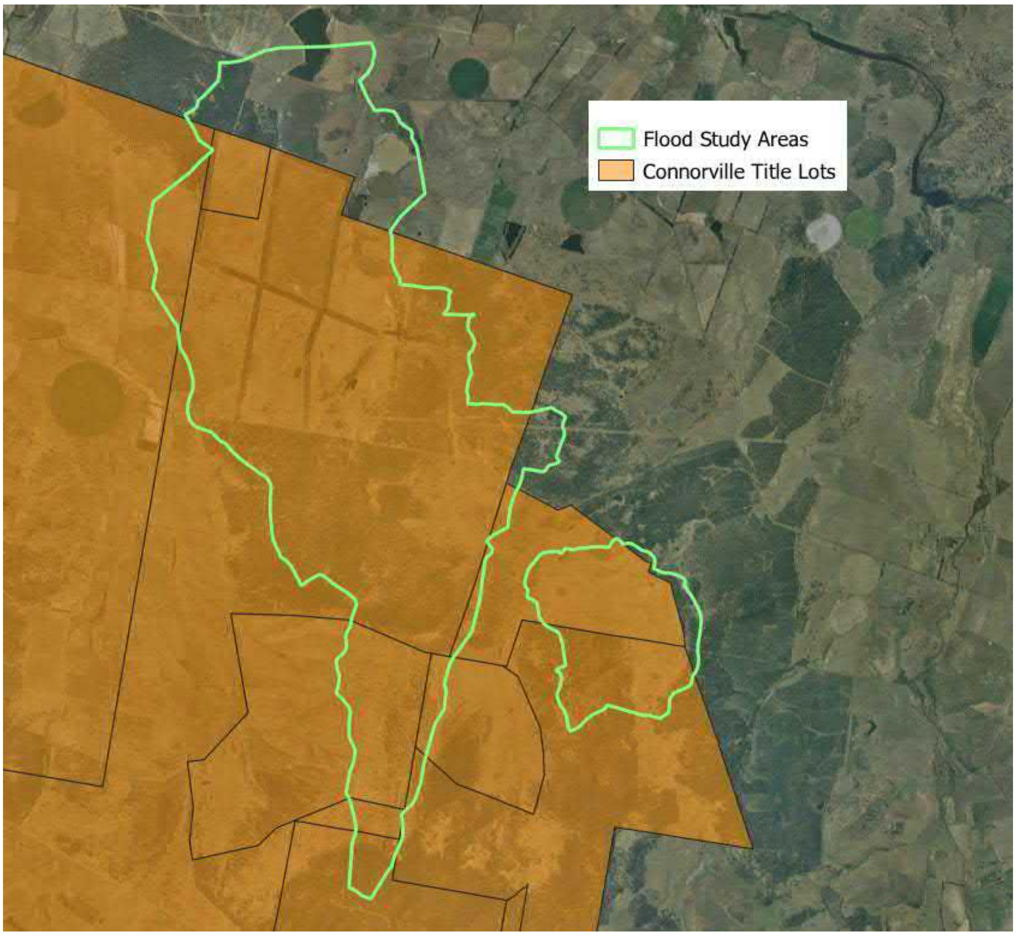


Figure 5: Site Catchments

Using the modelling package DRAINS, an Initial Loss/Continuing Loss model was utilised to calculate Critical Duration for the two different catchments. Input Data was collected from the ARR Data Hub (Australian Rainfall & Runoff, 2022) (https://data.arr-software.org/)

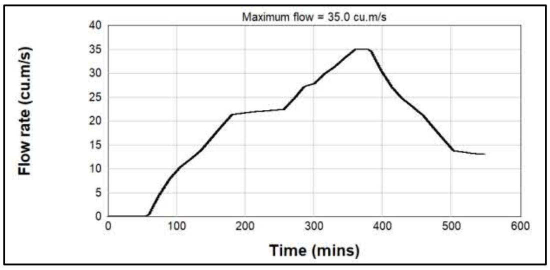
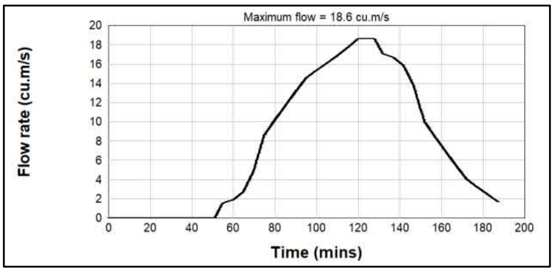
- Latitude: -41.858
- Longitude: 147.094
- Initial Loss: 24mm and a Continuing Loss: 4.7mm/hr
- Temporal Patterns: Southern Slopes Tasmania
- Pre-burst Depths: Median; and
- Climate Change: RCP 8.5 - 2090 – 16.3%.

Time of Concentration has been estimated using the Brandsby Williams Equation.

3.3 Hydrologic model results

Results for both of the catchments are presented below in Table 2. This presented a flow hydrograph at the downstream location of both catchments.

Table 2: IL/CL Results

1,559 Ha Site (Solar West)	**335 Ha Site (Solar East)**
	
Critical Storm: 1% AEP 6hr Storm 7	**Critical Storm:** 1% AEP 2hr Storm 8
Peak Flow Rate: 35.0m3/s	**Peak Flow Rate:** 18.6m3/s

The critical duration and median temporal pattern from the hydrologic modelling have been adopted to inform the 2-dimensional modelling.

4. Hydrologic model verification

To ensure the results of the hydrologic modelling (with the adopted of the IL/CL loss model) are reasonable, the model has to be validated against several alternate methods. The outcome of the verification is detailed below.

4.1.1 Regional Flood Frequency Estimate

Developed by Australian Rainfall & Runoff, a Regional Flood Frequency Estimate (RFFE) utilises nearby gauged catchments to approximate the response times and losses of the area to estimate peak flows. This method is more suitable to larger catchments, as such the 1,559 Ha catchment through Solar West will be used to validate.

Location and other input data for RFFE:

Table 3: RFFE Catchment Inputs

Latitude (Outlet)	-41.828
Longitude (Outlet)	147.119
Latitude (Centroid)	-41.864
Longitude (Centroid)	147.125
Catchment Area	15.59km2

4.1.2 RFFE results

After entering the above data, the model produced the following results:

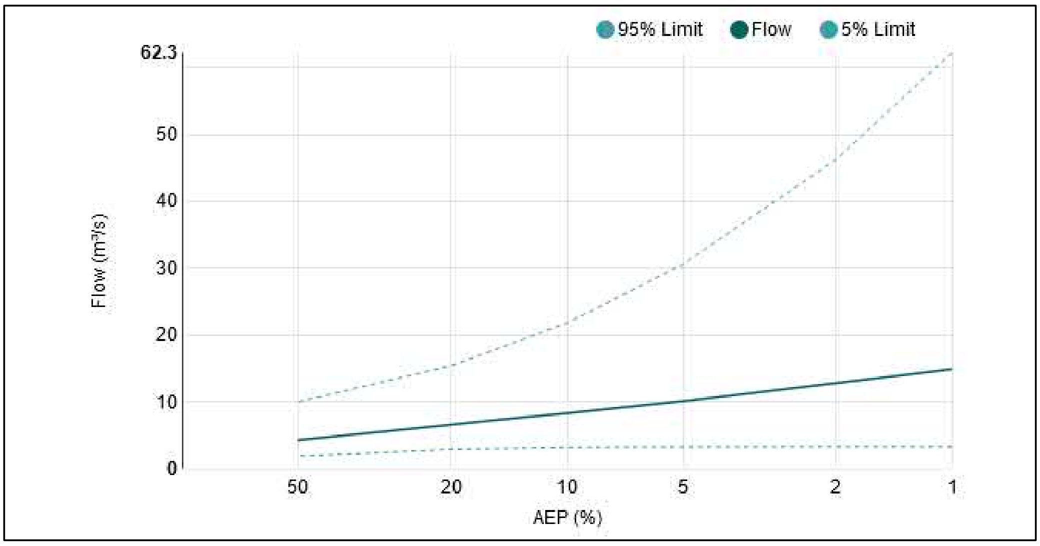


Figure 6: RFFE Peak Flow Chart

Table 4: RFFE Confidence Limits - 1,559 ha Solar West Catchment

AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	4.28	1.88	10.0
20	6.58	2.87	15.4
10	8.32	3.16	21.8
5	10.1	3.25	30.6
2	12.8	3.27	46.3
1	14.9	3.26	62.3

RFFE results presented in Table 4 show a 1% AEP peak discharge of 14.9m^3/s substantially lower than what was estimated from the IL/CL loss model. Further review of the RFFE data showed the chart in Figure 7.

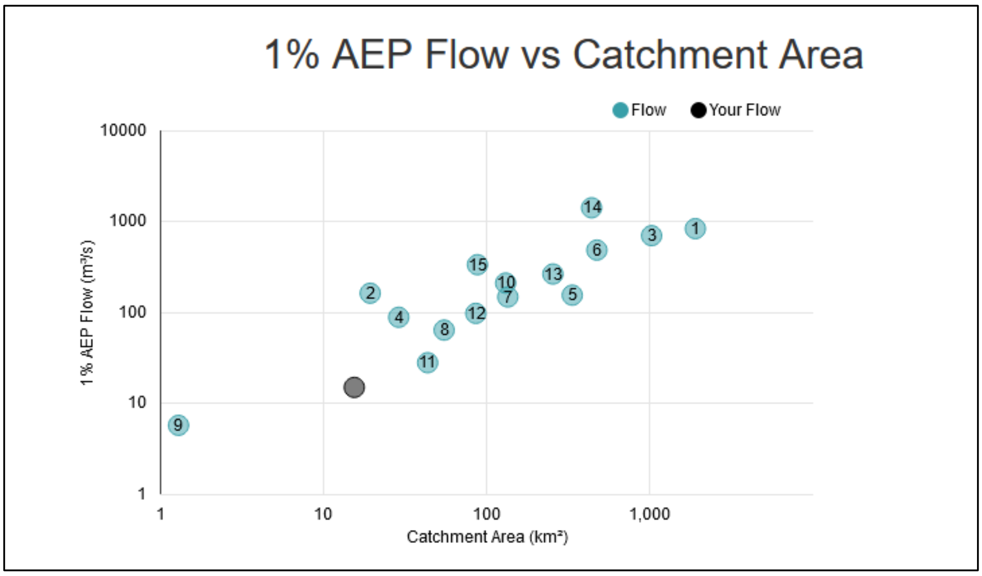


Figure 7: Flow Vs. Catchment Area Comparison

From Figure 7, the flow rates for two catchments (labelled 2 and 4) show much higher flows than the flow calculated for the subject site, both with similar sized catchments areas. The gauge locations are shown below in Figure 8 with the labels C and O being the study area's catchment centroid and outlet respectively.

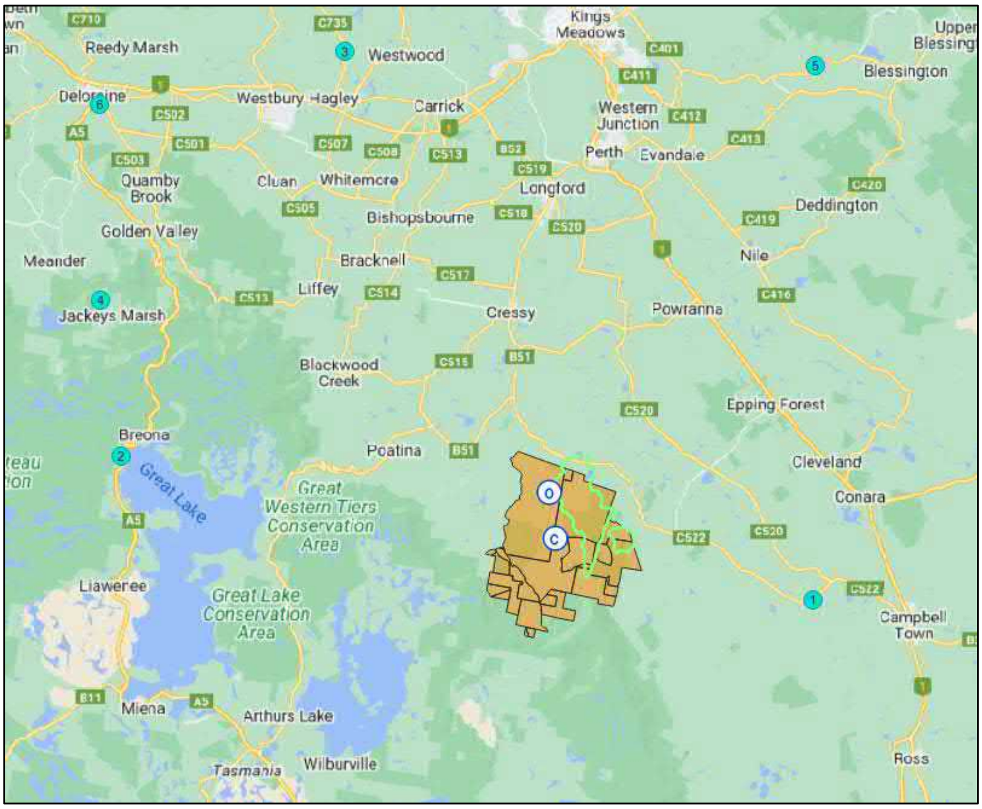


Figure 8: RFFE Gauge Locations

Given the proximity of these gauged sites to the study area and their relative position in the central midlands rain shadow, it is fair to assume that these gauged results represent a reasonable estimate for the project site.

4.1.3 RFFE model shortcomings

There is a lack of confidence in the results as seen in the wide upper and lower confidence ranges in Table 4. Due to this lack of convergence the results are used merely as a guide to confirm the IL/CL modelling is appropriate. The RFFE method appears to be underestimating the peak flow for the study area.

4.1.4 RORB model

In addition to the above assessment, a RORB model has been developed. RORB is a runoff routing model with relatively limited information available on catchments not on the West Coast of Tasmania, equation 7.6.29 has been utilised as per the advice in ARR2019 shown below in Figure 9 (Australian Rainfall and Runoff 2019).

6.2.1.8. Tasmania

Morris (1982) developed the following relation for 17 catchments (63 to 1780 km^2) using m = 0.75:

$$K_c = 4.86A^{0.32} \qquad (7.6.28)$$

Australian Rainfall and Runoff (Pilgrim, 1987) presents a relation developed by the Tasmanian Hydro Electric Commission for western Tasmania, with m = 0.75:

$$K_c = 0.86A^{0.57} \qquad (7.6.29)$$

Equation (7.6.28) and Equation (7.6.29) are in good agreement for catchments near to 1000 km^2 but Equation (7.6.28) predicts larger K_c values for smaller catchments.

> In the absence of further data, equation Equation (7.6.29) is recommended for Tasmania.

Figure 9: ARR Book 7 Chapter 6 - Tasmania Runoff Routing Model Parameters

Adopted RORB parameters are as follows:

- Kc: 5.16; and
- M: 0.75.

As noted in Figure 9 these equations have been developed by the Hydro Electric Commission for use around their dam infrastructure. Due to the previously mentioned rain shadow the results are potentially not suitable for the climate in the subject site.

4.1.5 RORB model setup

The RORB model was developed withinthe software package DRAINS. A schematic of the model is shown in Figure 10. The site consists of one main flow paith with several sub catchments draining into the main path from the West. Note that the smaller 335ha catchment through Solar East hasn't been modelled in this method and will be wholly captured by the 2-dimensional modelling due to its topography.

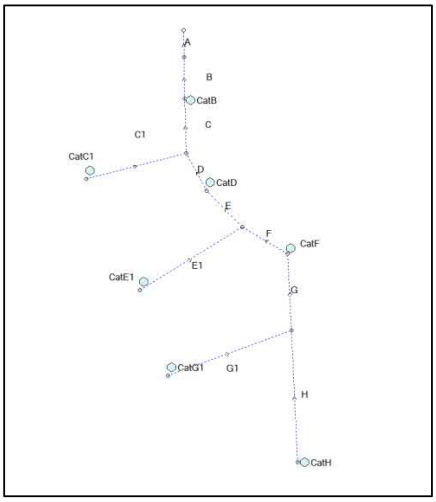


Figure 10: RORB Model Layout

The flow reporting location for the production of Hydrographs is channel segment A in the above figure.

4.1.6 RORB model results

Results from the modelling are shown in Table 5.

Table 5: RORB Results – 1,559 ha Solar West Catchment

Parameter	Value
Critical Duration	3hr
Peak Flow	41.2m3/s
Median Temporal Pattern	Storm 3

The corresponding Hydrograph is shown in Figure 11.

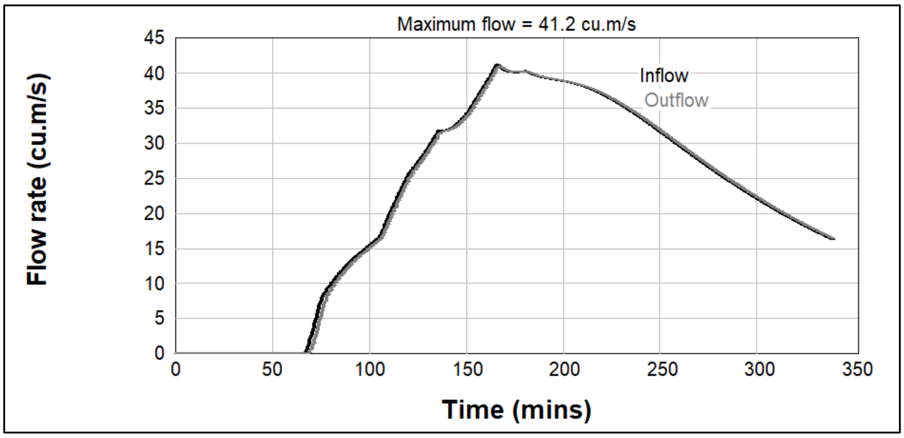


Figure 11: 1559ha Solar West Peak Flow Hydrograph

As observed, the RORB model estimates a much shorter Critical Duration than the IL/CL model (3 hours rather than 6 hours) but having similar peak flows recorded.

4.1.7 RORB model shortcomings

RORB models are best used when there is a gauged catchment to compare design events back to real world observed data. This model is then calibrated to fit the gauged results. Notwithstanding, the peak flow rate is within a reasonable bound of what had been calculated using the IL/CL Loss model, hence confirming the model is fit for purpose.

4.2 Hydrology conclusion

Summarising the section, the modelling and subsequent verification process has yielded reasonable peak flow convergence. However, convergence varies when considering the critical duration for the two subject sites. Given the 2-dimensional Rain-on-Grid approach that will be adopted for the Hydraulic modelling, this variance is somewhat inconsequential. In the hydraulic model a range of durations will be simulated, the Rain-on-Grid model results reviewed, and the critical result will then be analysed.

5. Hydraulic modelling

Using the information from the hydrologic investigation, a 2-dimensional Rain-on-Grid model was developed to assess the impacts to the site from flooding. The software package TUFLOW has been used to model the flood behaviour in the catchment. Modelling has been carried out in accordance with the Australian Rainfall and Runoff 2019 guidelines. The same climate change modifier from the hydrologic analysis has been adopted in the TUFLOW model (RCP 8.5, 2090).

5.1 Rain-on-Grid

Rain-on-Grid models apply rainfall directly to each cell of the grid in line with the rainfall intensity data. They also vary the intensity via ten temporal patterns to simulate variations in real storms. Pre-burst rainfall has been applied to the front end of the rainfall inflow file in TUFLOW.

5.2 Model extent

The model has been delineated in QGIS using the DEM into two separated areas. The two sites are independent of each other and can be represented as sperate model domains. One larger 2317ha site (representing Solar West and smaller contributing catchments) and a smaller 335ha site (representing Solar East). The larger area consists of the 1559ha catchment through Solar West discussed in the hydrology as well as several smaller adjacent catchments.

5.3 2D computational grid size

The two different catchments have been modelled using different grid sizes. A 3m grid has been used for the 335ha Solar East site and a 5m grid for the 2317ha Solar West site.

5.4 Boundary conditions

TUFLOW can model a variety of different conditions to simulate water flowing in the site. For this model our inflow boundary condition is a 2d_rf layer, an inflow rainfall area applied to the area of the study, in our case the whole of the site. The outflow conditions have been modelled as 2d_bc layer and using a normal slope boundary which automatically calculates flow exiting the model based on a user determined slope. This slope was estimated by cutting a slope in the DEM and averaging the slope downhill of the boundary.

5.5 Design event durations

The 1% Annual Exceedance Probability (AEP) has been requested to be modelled by the client, including the impacts of climate change. As previously discussed, a range of durations have been assessed to determine the critical duration. The following have been modelled for each catchment, shown in Table 6.

Table 6: Design Event Durations

2317 ha Catchment (Solar West)	335 ha Catchment (Solar East)
180 min	60 min
270 min	90 min
360 min	120 min
540 min	180 min

5.6 Critical duration analysis

An analysis of the peak hydrographs recorded towards the bottom of the Solar West 2317 ha catchment area is shown below in Figure 12.

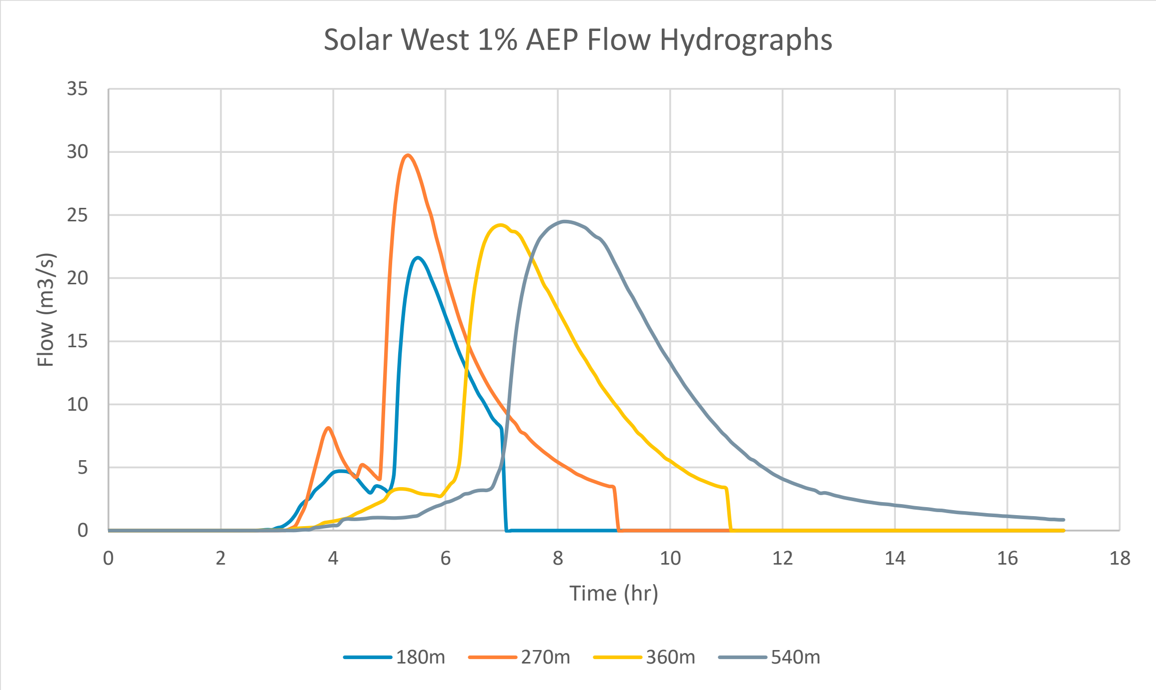


Figure 12: 2317ha Solar West Site 1% AEP Hydrographs

It is likely that the dams and depression storage throughout the catchment is affecting the timing of the peaks for the shorter events, delaying them to be at the same time as the peak in the 270 min event. The peak flow recorded in the 270 min event is 29.74 m^3/s which was recorded 5 and a half hours into the simulation.

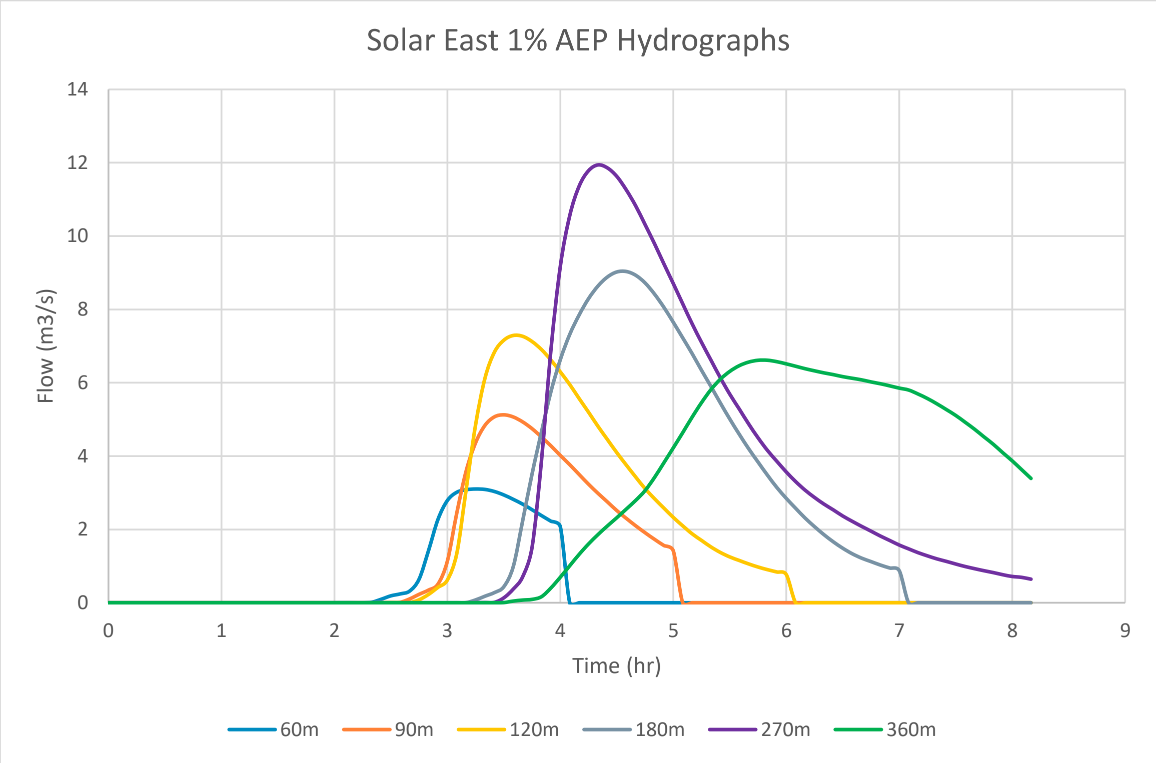


Figure 13: 335ha Solar East Site 1% AEP Hydrographs

The results from the Solar East 335ha catchment follow a more standard pattern with the critical duration being the 270m event. Review of the 2d results shows that there is a significant constriction on the flow leaving the catchment which isn't captured by the hydrology. This constriction has delayed the peak causing the critical duration to be much longer that first estimated.

As can be seen above in Figure 12 and Figure 13, the critical duration is the 270 min event for the 2317 ha Solar West site and the 270 min event for the 335 ha Solar East site.

5.7 Critical duration model results

Results for all the prepared flood maps for both modelled areas are shown in Appendix A.

5.7.1 2317 ha Solar West Site results discussion

There are several significant flow paths through the site that could be detrimental to the solar panels. Construction of solar panels in these concentrated flow paths should be avoided. Construction in areas downstream of dams and other water retention infrastructure should consider flood hazard ratings and appropriate level of risk associated with dam outflows/spillways. Flows are concentrated in these locations and will be of greater hazard than elsewhere on the site. Figure 14 illustrates the location of these flow concentrations across the typology of the Solar West's landscape.

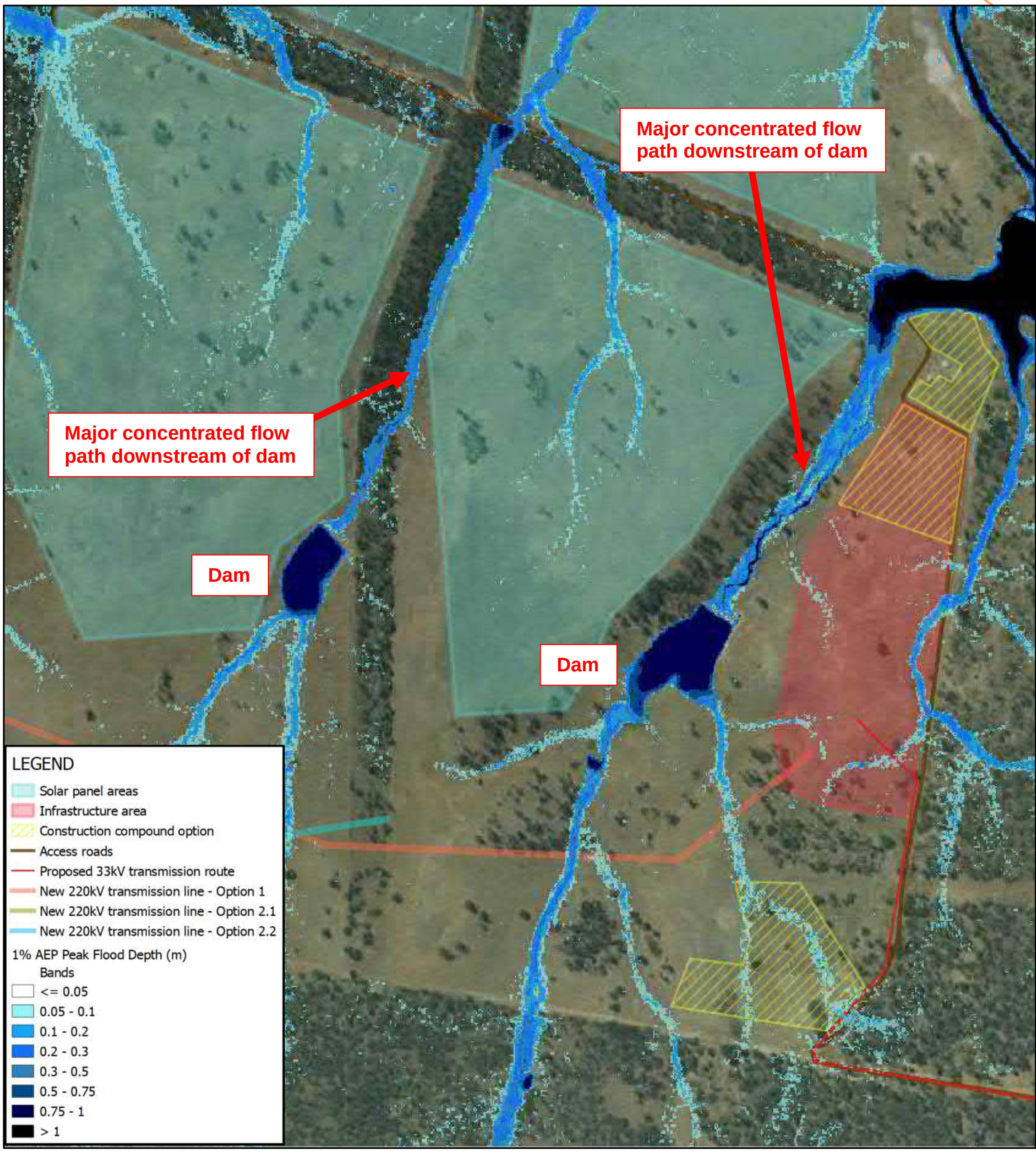


Figure 14: Dams and Flow Paths

The western section of Solar West has a significant flow through shown in the modelling (see Figure 15). Water should be safely conveyed through the area along these existing flow paths requiring minimal improvements (if any) to drainage infrastructure.

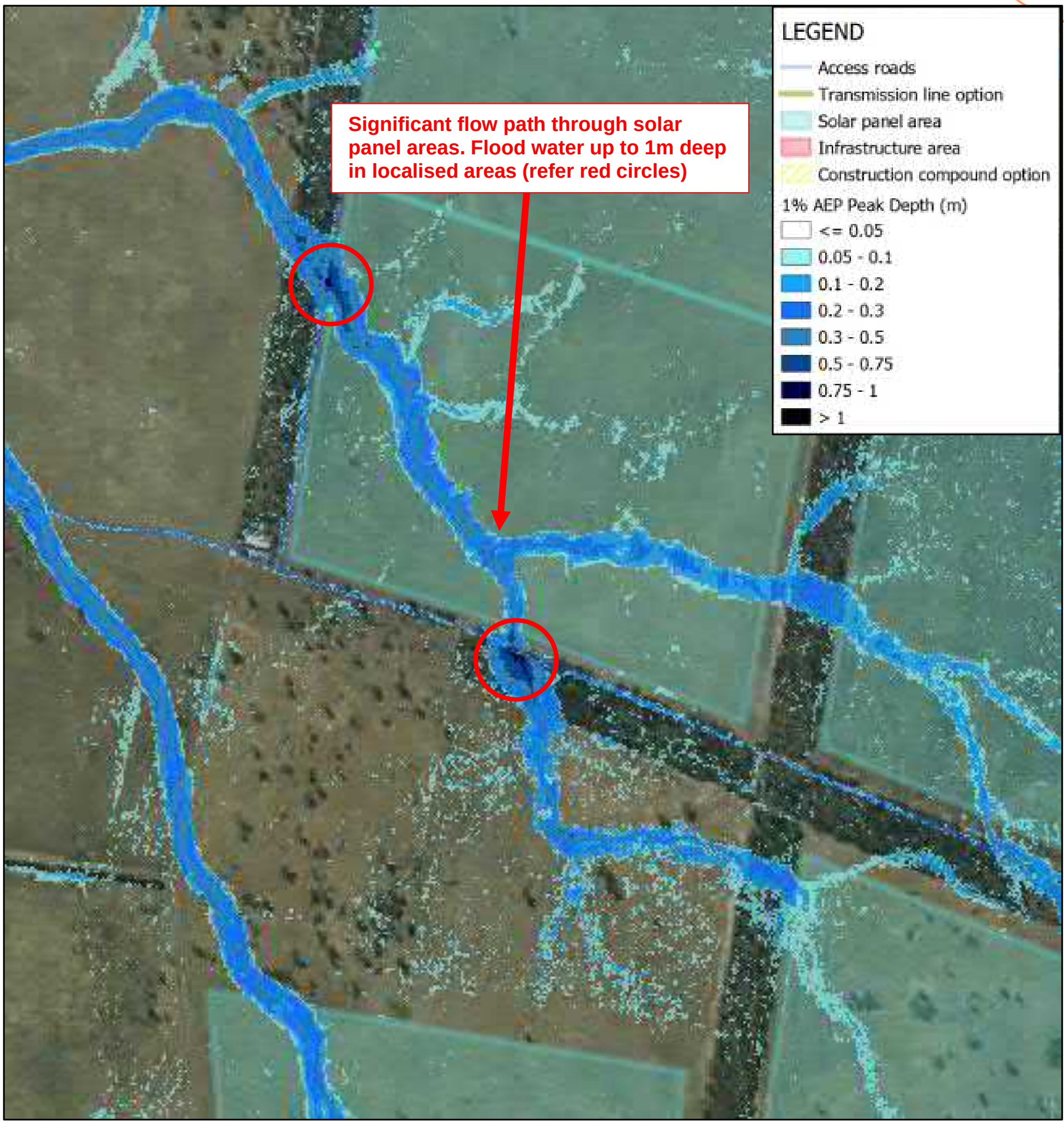


Figure 15: Solar West western section – 1% AEP flood extent

The infrastructure zone shown below in Figure 16 has one larger flow through towards the eastern end of the site. Other minor flows in the area can be accommodated with surface drainage to allow for the location of critical infrastructure. Open drainage channels and/or bunding around critical assets will protect the area from the 1% AEP flows. Further study should be carried out when location of assets is finalised to size the critical drainage infrastructure (pits, pipes, cut off drains etc).

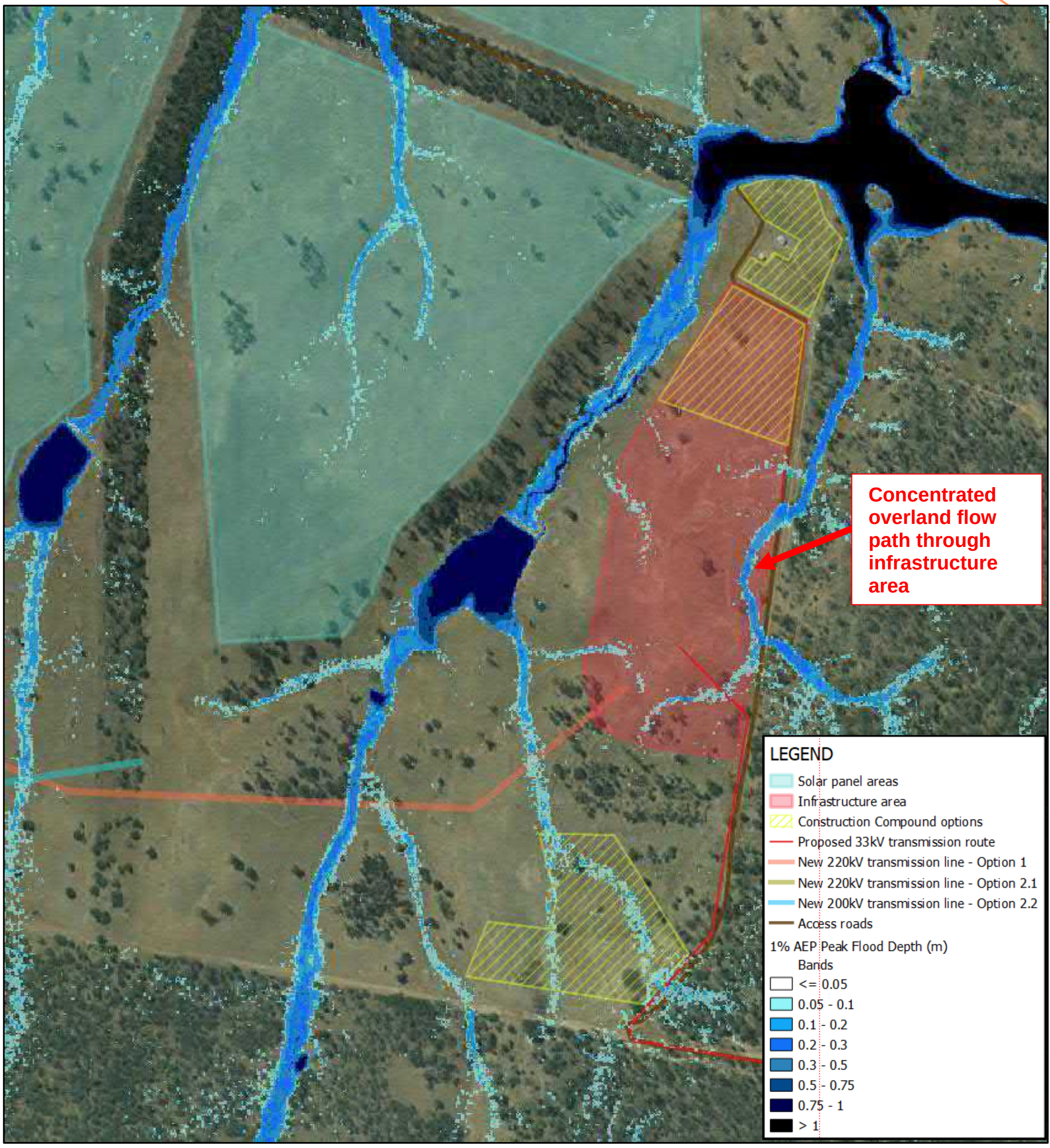


Figure 16: Infrastructure Study Area – Flooding

Broadly across the entire Solar West site, velocity of water ranges low to medium. Velocities are generally below 2m/s and only exceed this in the more defined flow paths. Constraints in relation to solar panel placement are covered in other sections. An overview of the site velocity can be seen in Figure 17 and more detailed mapping is shown in Appendix A.

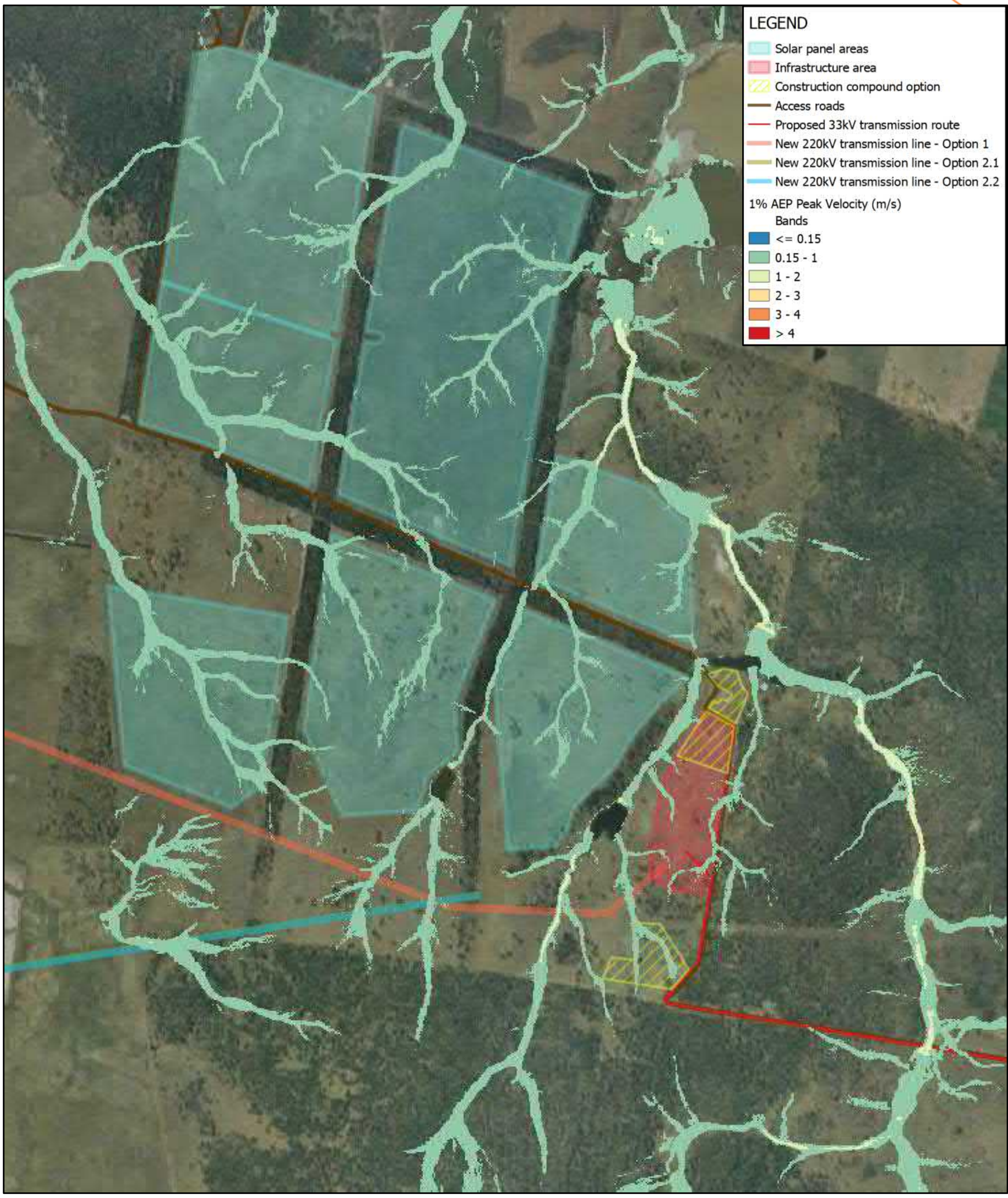


Figure 17: 1% AEP Peak Velocity – Solar West Site

5.7.2 335ha Solar East Site results discussion

The smaller Solar East site is within a large bowl that has a significant flow restriction on the outlet which causes water to back up and pond in the proposed panel sites. Towards the bottom of the site, water depths reach roughly 1m and back up, filling the bowl. The extent of inundation in the 1% AEP event is presented in Figure 18.

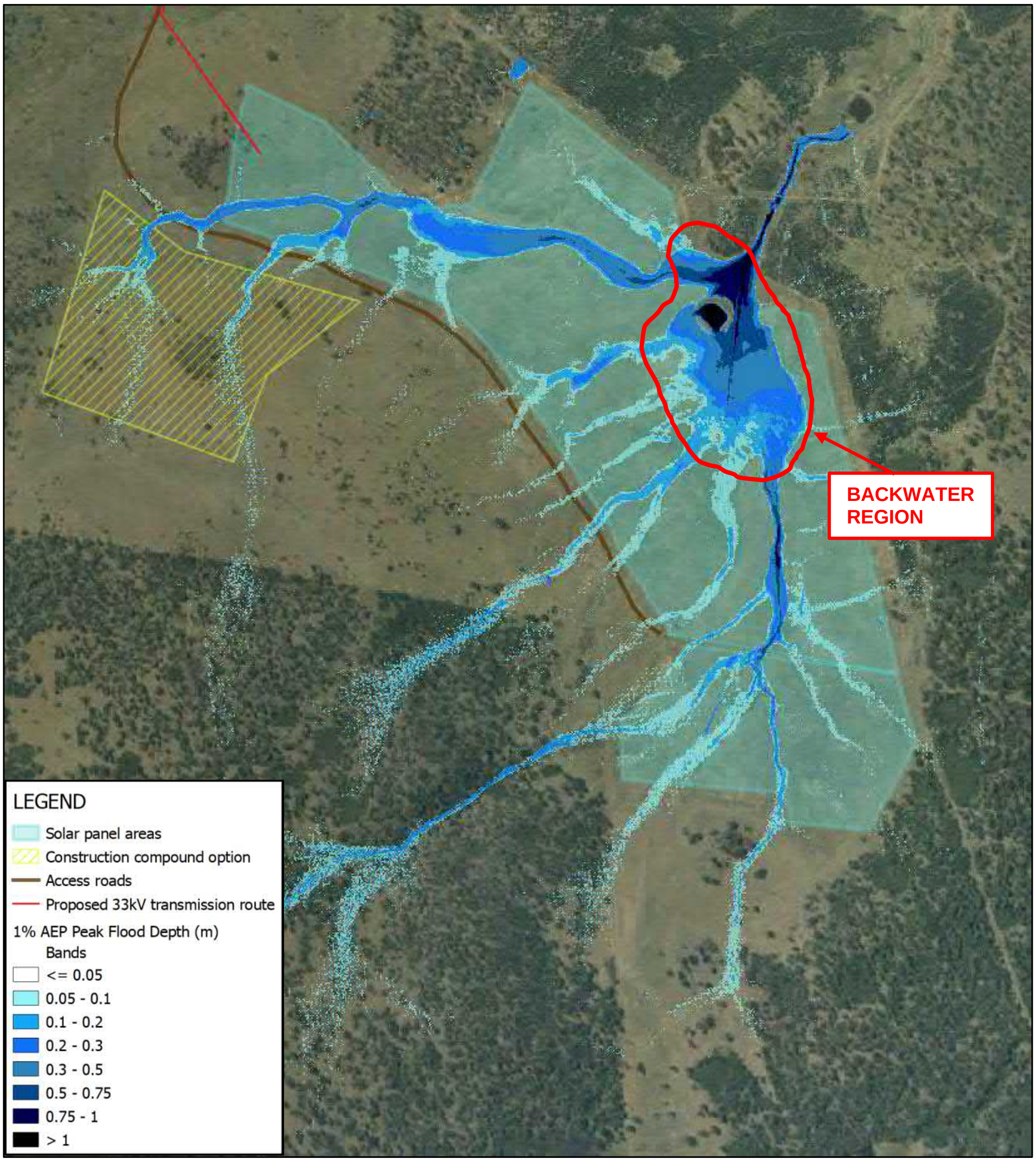


Figure 18: 1% AEP Flood Extent – Solar East Site

Portions of the two panel regions may be unsuitable for the placement of panels due to water levels. Water velocities in this area are low, however this is due to the backwater affect. Locating panels within the backwater region is unlikely to have an impact on flood behaviour. If panels are to be installed in these regions, it is recommended to review the flood depth maps against the height of solar panel infrastructure to ensure infrastructure is not adversely impacted. Figure 19 depicts the typical concept solar panel section at maximum tilt for the proposal (ref: Robert Luxmoore Project

Management). Ground clearance to bottom of panel face is minimum 300mm, at sunrise and sunset. Solar panels placed in the backwater region will experience 1% AEP flood depths in excess of this clearance, meaning a portion of the panel face could be submerged if the panel is at or near maximum tilt during a 1% AEP flood event.

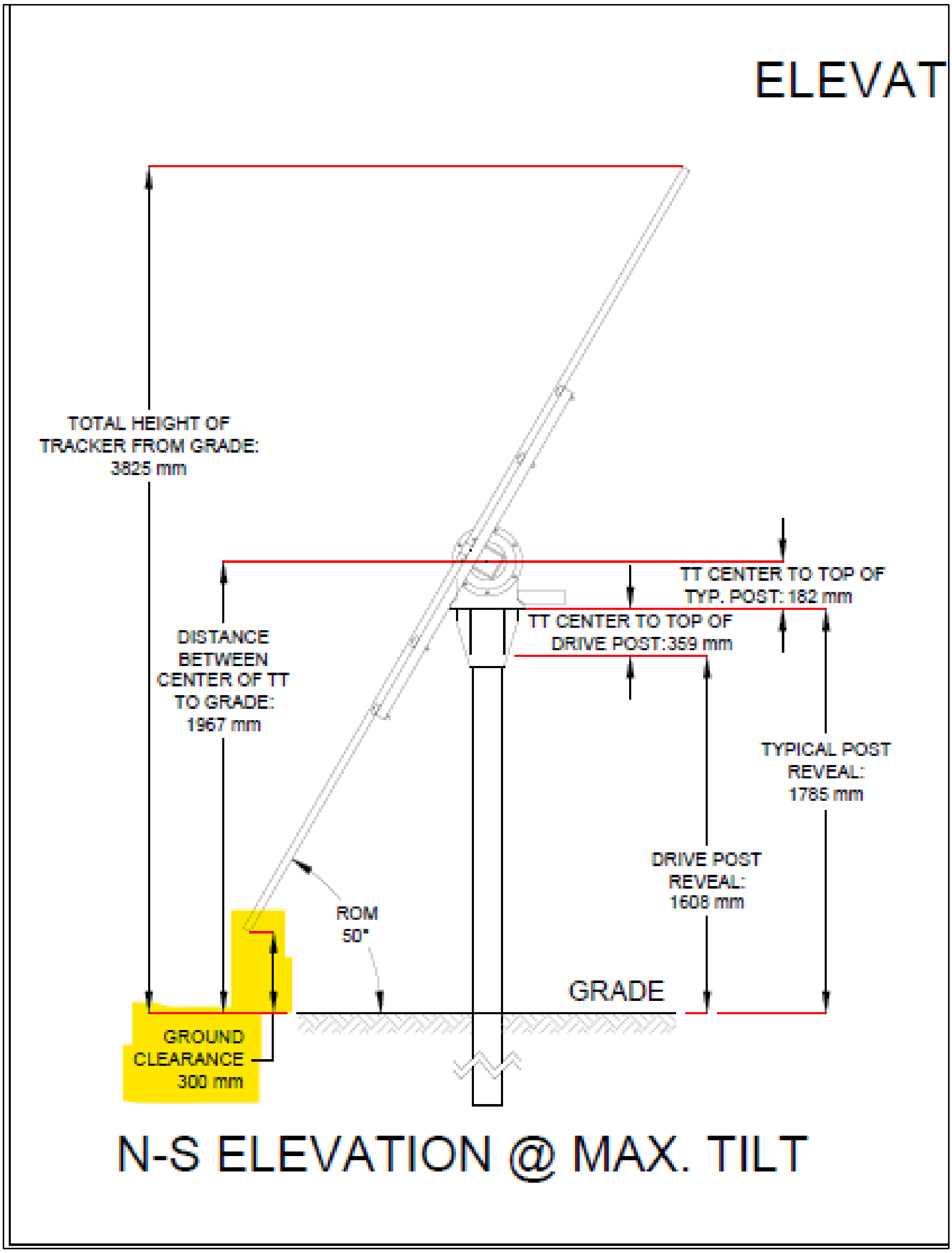


Figure 19: Solar panel – concept typical section

5.7.3 Peak hazard discussion

The mapping of depth and velocity across the site allows for the generation of hazard mapping. The Australian Guide to Rainfall and Runoff 2019 sets out hazard banding by the following chart, Figure 20.

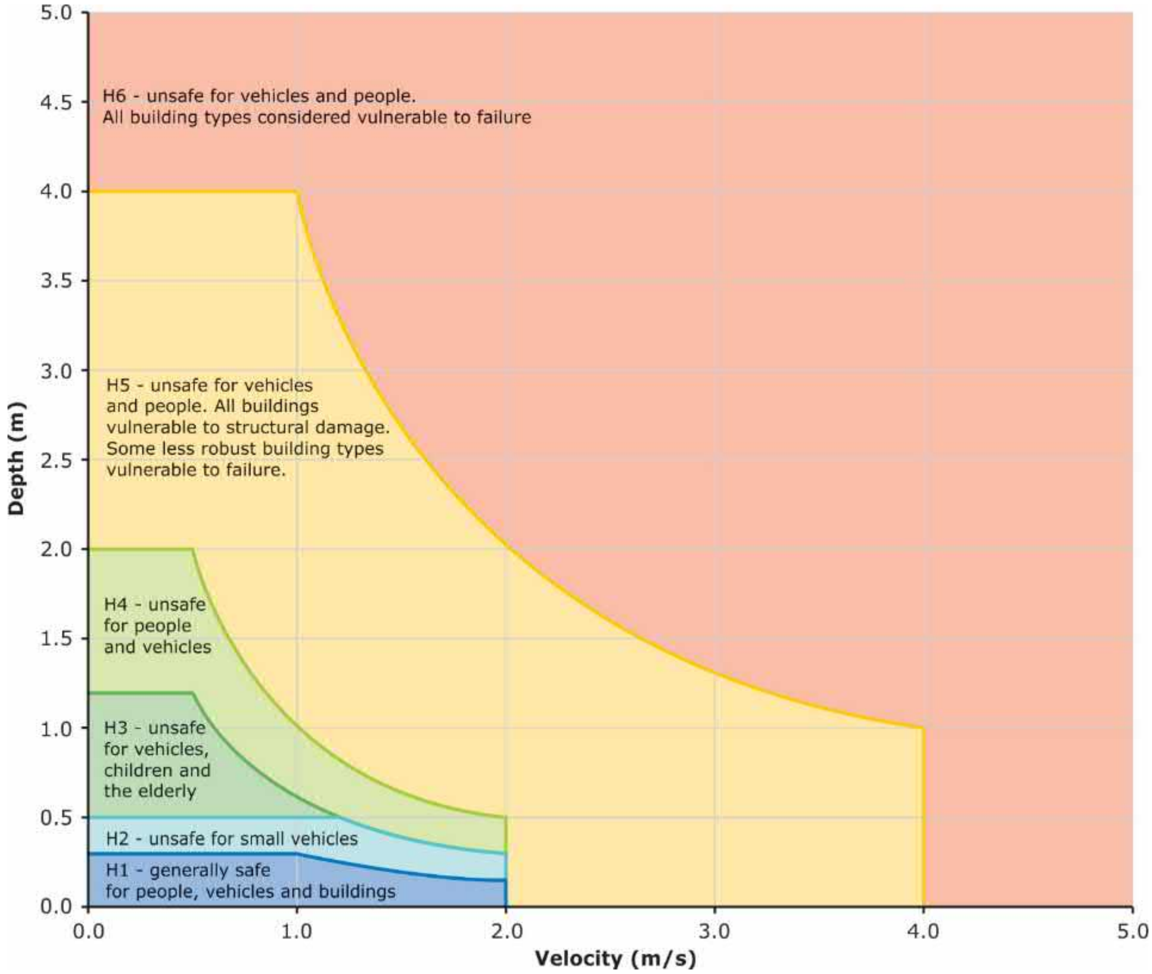


Figure 20: Combined Flood Hazard Curves - ARR2019

The hazard is a product of the water depth and velocity. While it doesn't strictly dictate where buildings can and cannot be placed, it is a useful guide given that people will be operating in and around the structures.

Some of the key hazardous areas around the site are as follows:

Roads and culverts

Access roads and the culverts that drain them are a typical risk on all flooded sites. Water levels back up around the inlet and velocities are higher on at the outlets. This can lead to significant hazard ratings around these structures. Two examples are shown in Figure 21 and Figure 22. Road culverts are also prone to blockage and failure during intense rainfall events which can lead to wash outs, further increasing the hazard rating. Mitigation measures such as scour (rock) protection, maintenance and clearing, headwall/wingwall optimisation, and potential for larger culverts are recommended to be explored during detailed design.

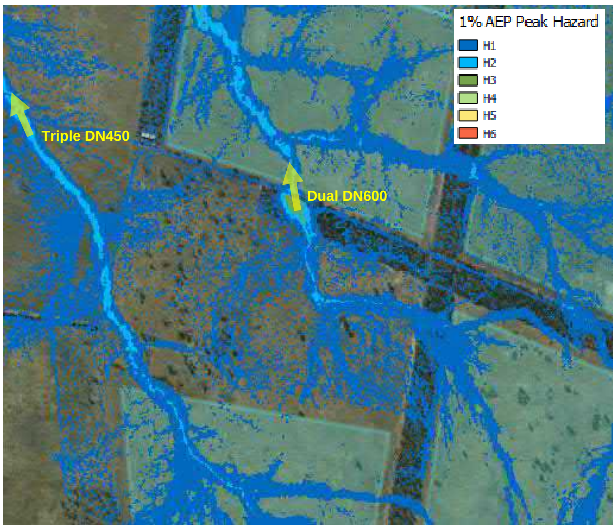


Figure 21: Solar West Drainage Culvert Hazard Site 1

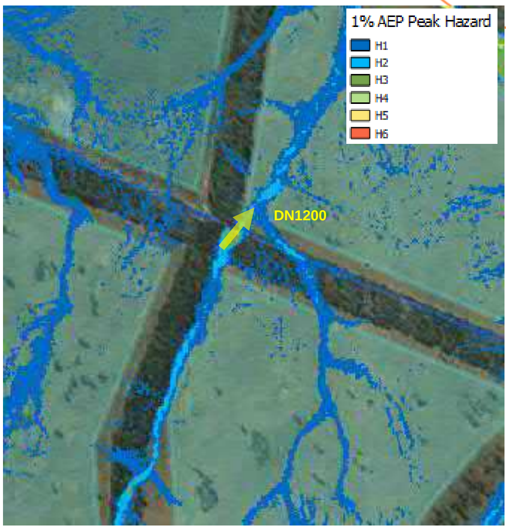


Figure 22: Solar West Drainage Culvert Hazard Site 2

Dams and spillways

There are several dams throughout the site, during flood they fill and present a risk both due to the deep water in the dam and due to the fast-flowing water leaving the dam via spillways and other infrastructure. The majority of the dams in this study area sit below the proposed panel locations so won't impact the proposed development. A total of six (6) dams are located within the Solar West site (shown in Figure 23) and one (1) dam within the South East site (shown in Figure 24). These dams present a H3 – H4 hazard being unsafe for people and vehicles. All dams within Solar West are situated outside the development footprint. Outflow from Dam 1 spillway appears to migrate through a portion of solar panel regions downstream and ultimately discharges to the H4 – H5 high hazard watercourse further to the north. The single Solar East dam is situated within the development footprint and spillway outflows contribute to H3 – H4 flooding of surrounding solar panel areas in the 1% AEP event. A flood emergency response plan is recommended to be explored at detailed design phase for this dam.

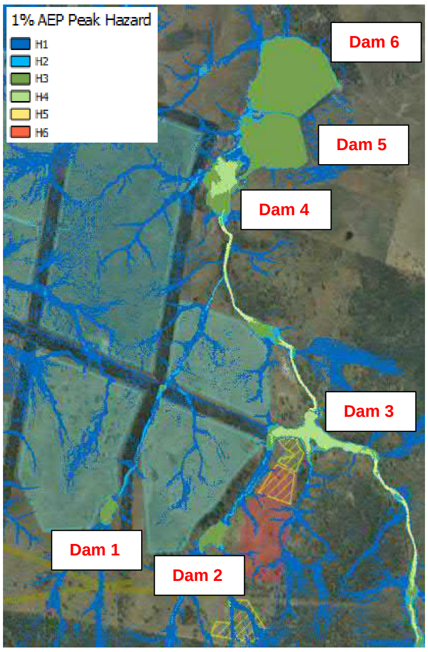


Figure 23: Solar West Site Dams

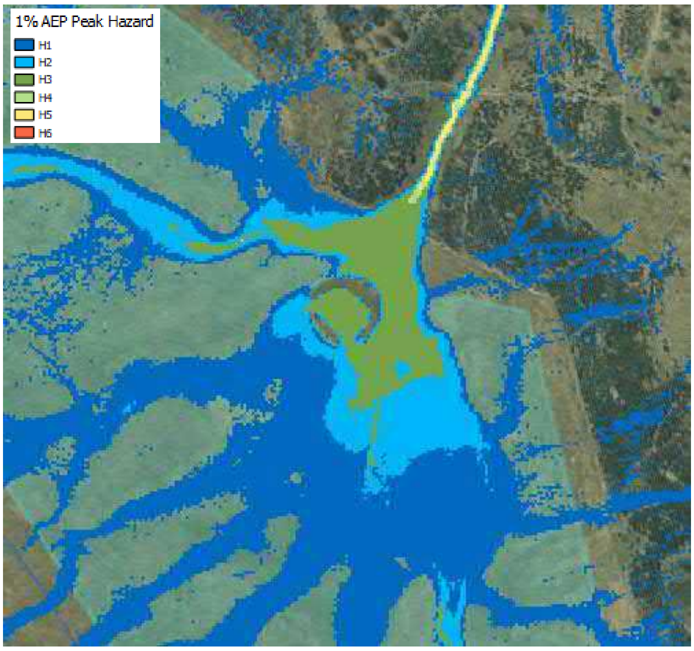


Figure 24: Solar East Site Dam

Watercourses

Flow paths concentrate at existing watercourses within both the Solar West and Solar East sites. Water along these flow paths is generally deep with high velocity. Hazard categories in these flow paths can reach up to H5 level. It is recommended to avoid developing these areas as infrastructure will be vulnerable to structural damage and potential failure. Figure 25 and Figure 26 depict these high flood hazard zones.

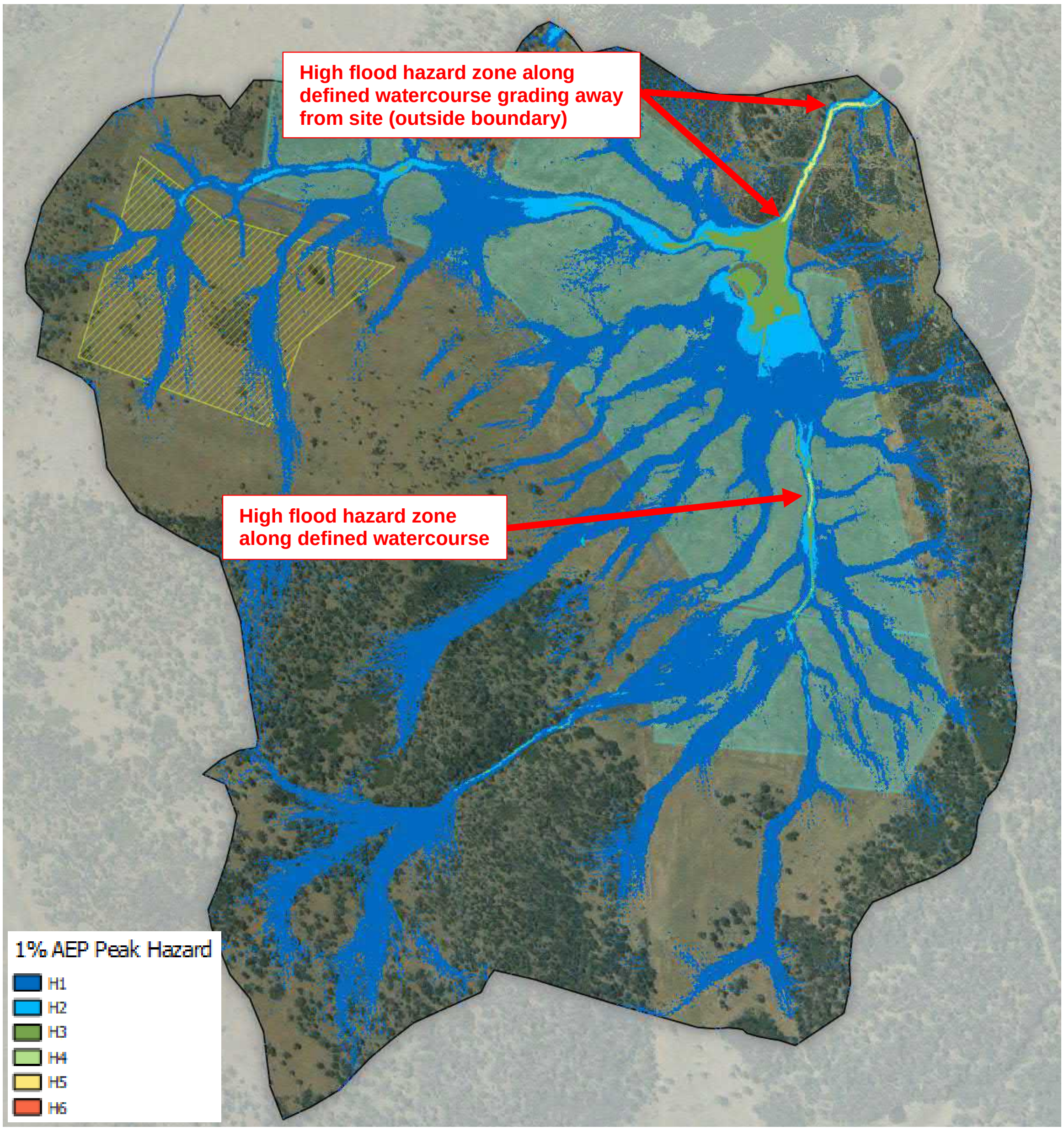


Figure 25: Solar East high hazard zones (between arrows) along existing watercourses

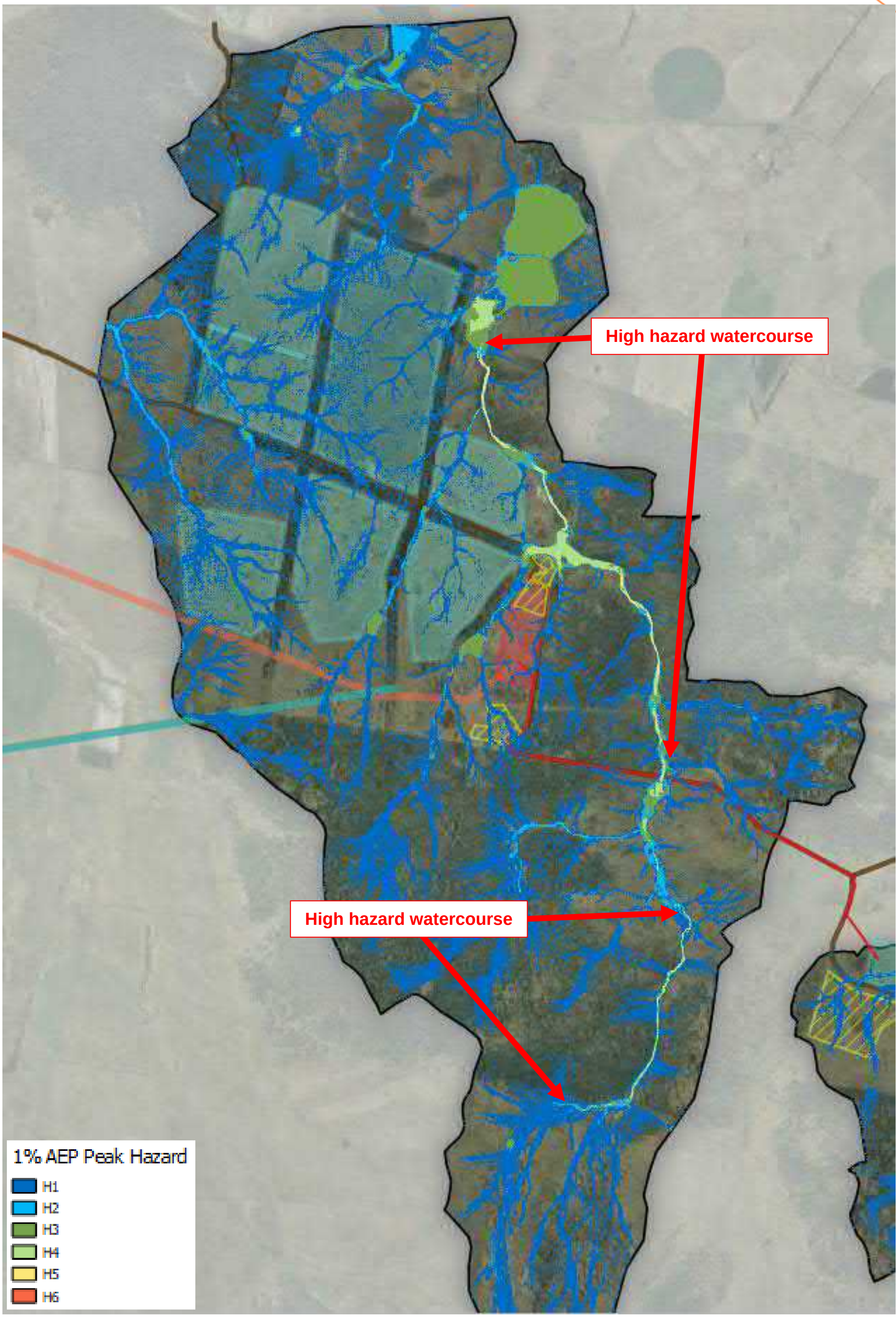


Figure 26: Solar West high hazard zones (between arrows) along existing watercourses

Infrastructure zone

Additional rigour should be given to the location of assets in the infrastructure zone. Locations of items such as Battery Energy Storage Systems (BESS) and/or substations will need to have immunity flooding impact. Shown below in Figure 27 is the Hazard map for this area. For the most part the site is H1 hazard. The northern extent of the construction compound area is situated on the fringe of the H4 flood hazard zone. It is recommended to ensure at least 1 m lateral clearance from the flood extent and a minimum Finished Flood Level (FFL) of 183.2 m AHD, representing the 1% AEP flood level + 300mm freeboard. Construction in these areas should consider these flow paths, but standard items such as open drains or pit and pipe drainage will mitigate the risks associated. Risks can be mitigated by either relocating the batteries or by raising the areas with earthworks to above the flood level.

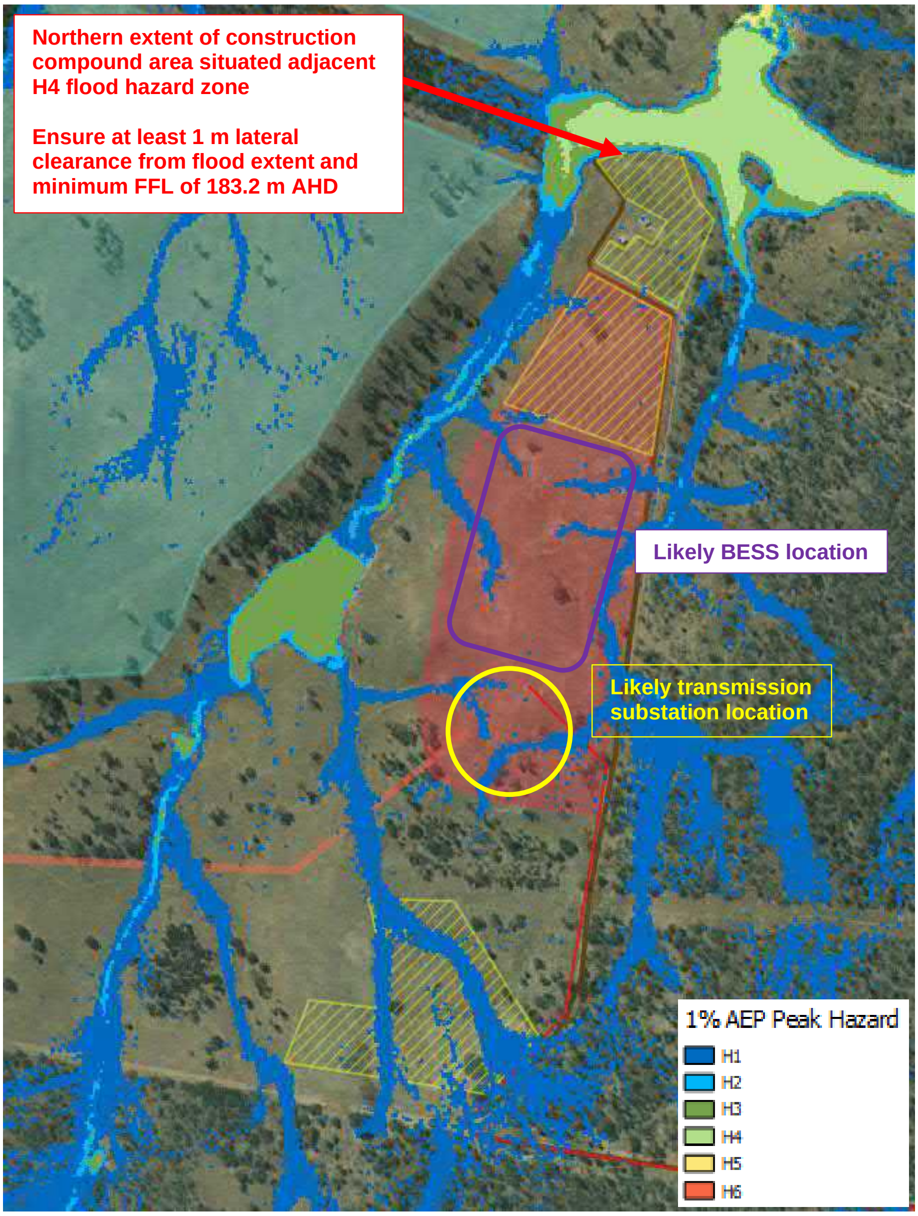


Figure 27: Infrastructure Zone Hazard

It is recommended that once the location of infrastructure items is finalised that further hydraulic investigation be conducted to inform the detailed drainage design.

6. Planning assessment

The development will be assessed against the *Tasmanian Planning Scheme – Northern Midlands 2022* and the *Northern Midlands Local Schedules 2022*. The proposal will need to demonstrate compliance with, amongst other things, the Natural Assets Code – Waterway and Coastal Protection Area (C7.0) and the Flood-Prone Areas Hazard Code (C12.0). Figure 28 depicts the Planning Scheme Code Overlay for these two Codes in the vicinity of Solar East and Solar West. Areas within both sites are impacted by the Waterway and Coastal Protection Area Overlay. No Flood-Prone Areas are located within Solar East or Solar West. However, the proposal will need to consider this Code for development of the proposed 220kV transmission lines.

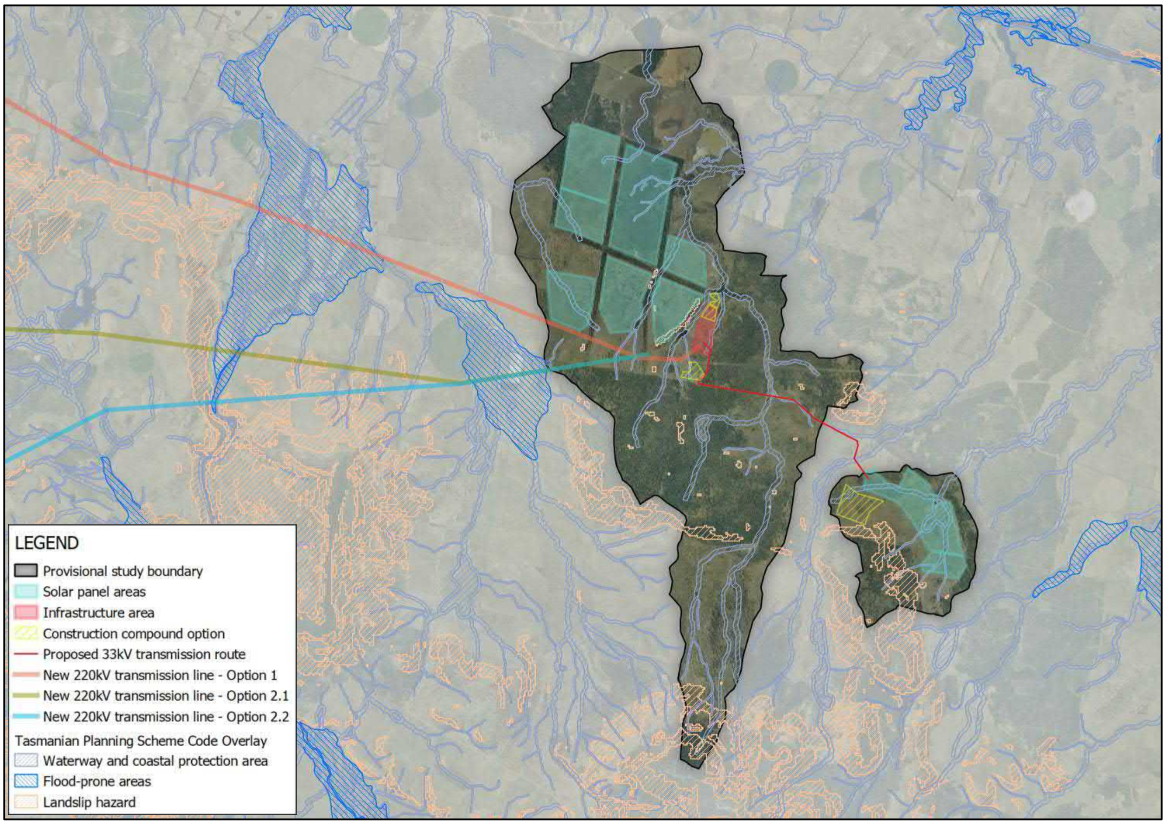


Figure 28: Tasmanian Planning Scheme - Code Overlay

Also shown in orange hatching are the low to medium hazard landslip zones as identified in the landslip code of the Tasmanian Planning Scheme.

Table 7 and Table 8 present the relevant planning criteria and responses to either the acceptable solution or performance criteria.

Table 7: C7.6.1 Buildings and works within a waterway and coastal protection area or a future coastal refugia area

Objective: That buildings and works within a waterway and coastal protection area or future coastal refugia area will not have an unnecessary or unacceptable impact on natural assets.	
Acceptable Solution	**Performance Criteria**
A1 Buildings and works within a waterway and coastal protection area must: a) Be within a building area on a sealed plan approved under this planning scheme b) In relation to a class 4 watercourse, be for a crossing or bridge not more than 5m in width; or c) If within the spatial extent of tidal waters, be an extension to an existing boat ramp, car park, jetty, marina, marine farming shore facility or slipway that is not more than 20% of the area of the facility existing at the effective date.	**P1.1** Buildings and works within a waterway and coastal protection area must avoid or minimise adverse impacts on natural assets, having regard to: a) Impacts caused by erosion, siltation, sedimentation and runoff b) Impacts on riparian or littoral vegetation c) Maintaining natural streambank and streambed condition, where it exists d) Impacts on in-stream natural habitat, such as fallen logs, bank overhangs, rocks and trailing vegetation e) The need to avoid significantly impeding natural flow and drainage f) The need to maintain fish passage, where known to exist g) The need to avoid land filling of wetlands h) The need to group new facilities with existing facilities, where reasonably practical i) Minimising cut and fill j) Building design that responds to the particular size, shape, contours or slope of the land k) Minimising impacts on coastal processes, including sand movement and wave action l) Minimising the need for future works for the protection of natural assets, infrastructure and property m) The environmental best practice guidelines in the Wetlands and Waterways Works Manual; and n) The guidelines in the Tasmanian Coastal Works Manual.

Objective: That buildings and works within a waterway and coastal protection area or future coastal refugia area will not have an unnecessary or unacceptable impact on natural assets.	
	P1.2 Buildings and works within the spatial extent of tidal waters must be for a use that relies upon a coastal location to fulfil its purpose, having regard to: a) The need to access a specific resource in a coastal location b) The need to operate a marine farming shore facility c) The need to access infrastructure available in a coastal location d) The need to service a marine or coastal related activity e) Provision of essential utility or marine infrastructure; or f) Provisions of open space or for marine-related educational, research, or recreational facilities.

Response

The proposed development will comply with A1. Buildings and other key infrastructure will be located outside of the waterways marked in the Code and those defined in the modelling.

Table 8: C12.6.1 Buildings and works within a flood-prone hazard area

Objective: That:

(a) building and works within a flood-prone hazard area can achieve and maintain a tolerable risk from flood; and

(b) buildings and works do not increase the risk from flood to adjacent land and public infrastructure.

Acceptable Solution	Performance Criteria
A1 No Acceptable Solution	**P1.1** Buildings and works within a flood-prone hazard area must achieve and maintain a tolerable risk from a flood, having regard to: (a) The type, form, scale and intended duration of the development (b) Whether any increase in the level of risk from flood requires any specific hazard reduction or protection measures (c) Any advice from a State authority, regulated entity or a council; and (d) The advice contained in a flood hazard report. **P1.2** A flood hazard report also demonstrates that the building and works: (a) Do not cause or contribute to flood on the site, on adjacent land or public infrastructure; and (b) Can achieve and maintain a tolerable risk from a 1% annual exceedance probability flood event for the intended life of the use without requiring any flood protection measures.

Response

P1.1(a) – The form and scale of the development will be minimised by locating assets outside of the flow paths outlined in the modelling.

P1.1(b) – The detailed design phase will address the specific hazard protection measures (such as cut off drains and bunding of critical infrastructure). It is noted that the primary approach is to locate solar panels outside of flow paths. Where additional measures are required to manage overland flow, these will be identified at a detailed design phase to ensure that as infrastructure design develops the flood related controls are appropriate.

P1.1(c) – Relevant authorities' advice will be adhered to when received. This assessment has not identified any specific advice

P.1.1(d) –The development will comply with the recommendations in this report. Primarily to locate infrastructure outside of flow path location.

P1.2(a) – The proposed development will not contribute to flooding on this site or adjacent land. Flows will be contained to existing flow paths and directed to existing dams and waterways.

P1.2(b) –Peak hazard ratings are in acceptable ranges and construction is proposed to be avoided. See Appendix A for site hazard mapping.

7. Recommendations

A Hydrologic and Hydraulic assessment of the proposed solar farm development has been undertaken to identify and demonstrate the flood risks posed in the study area. The analysis follows the guiding principles outlined in the Australian Rainfall and Runoff 2019 for flood estimation. The key recommendations for the site are:

- The proposal demonstrates compliance with the Natural Assets Code (C7.6.1) and the Flood-Prone Hazard Area Code (C12.6.1) requirements outlined in Tasmanian Planning Scheme – Northern Midlands 2022. Development within the proposed Solar East and Solar West sites is not located within a flood-prone area based on the TPS Code overlay. The proposed 220kV transmission line alignment options (Options 1, 2.1 and 2.2) will traverse flood-prone areas on route to the sites. It is anticipated transmission towers associated with the alignment options can be located outside these overlay areas. Buildings and works will be located outside of the waterway protection areas marked in the Code and those waterways defined in the flood modelling. The form and scale of the development will be minimised by locating assets outside of the flow paths determined from the modelling. The proposal will not contribute to flooding on site or adjacent land. Flows will be contained to existing flow paths and directed to existing dams and waterways. Peak flood hazard ratings are in acceptable ranges and high-hazard areas have been identified to inform and/or avoid construction. Specific flood hazard protection/reduction measures (such as bunding/fill earthworks, scour protection, maintenance and clearing, and drainage infrastructure improvements) will be addressed in detailed design phase.
- 1% AEP outflow from a dam spillway within Solar West (Dam 1) appears to migrate through a portion of solar panel regions downstream. The single Solar East dam is situated within the development footprint and spillway outflows contribute to H3 – H4 flooding of surrounding solar panel areas in the 1% AEP event. A flood emergency response plan may be required for these dams and is recommended to be explored at detailed design phase.
- The northern extent of the construction compound area in Solar West is situated adjacent a H4 flood hazard zone. It is recommended to ensure a minimum FFL of 183.2 m AHD for the constructed compound level, with a minimum horizontal clearance of 1 m from the flood extent.
- Building works and solar panel placement are recommended to avoid the H2 and above hazard areas in addition to the defined flow paths and planning code areas as a conservative approach. The extent of the H2 and above hazard areas can be located from the flood hazard maps contained in Appendix A. Solar farm development may be able to occur within H2 areas provided that appropriate flood mitigation measures involving earthworks/fill are implemented as part of detailed design in accordance with further detailed hydrological studies. Solar panels can operate in flood-prone areas but should avoid high flood hazard flow paths due to the risk of structural damage and failure. The structural integrity/robustness of the proposed solar panels has not been considered as part of this current assessment and construction/operation in higher flood hazard areas may also be possible if panels can withstand forces owing to deeper and faster flow than the H2 categorisation (refer Figure 20). In any such instances, a hazard/risk management plan for vehicles and persons is recommended; and
- Critical infrastructure (transformers, batteries etc) shall be subject to additional hydraulic study when the building layout and bulk earthworks are confirmed. It is noted that a draft earthworks model and infrastructure layout have been developed. Terrain in the present flood model is based on LIDAR and excludes the draft bulk earthworks model. The additional hydraulic study will allow for the detailed design of additional drainage infrastructure to protect proposed assets.

Important information about your report

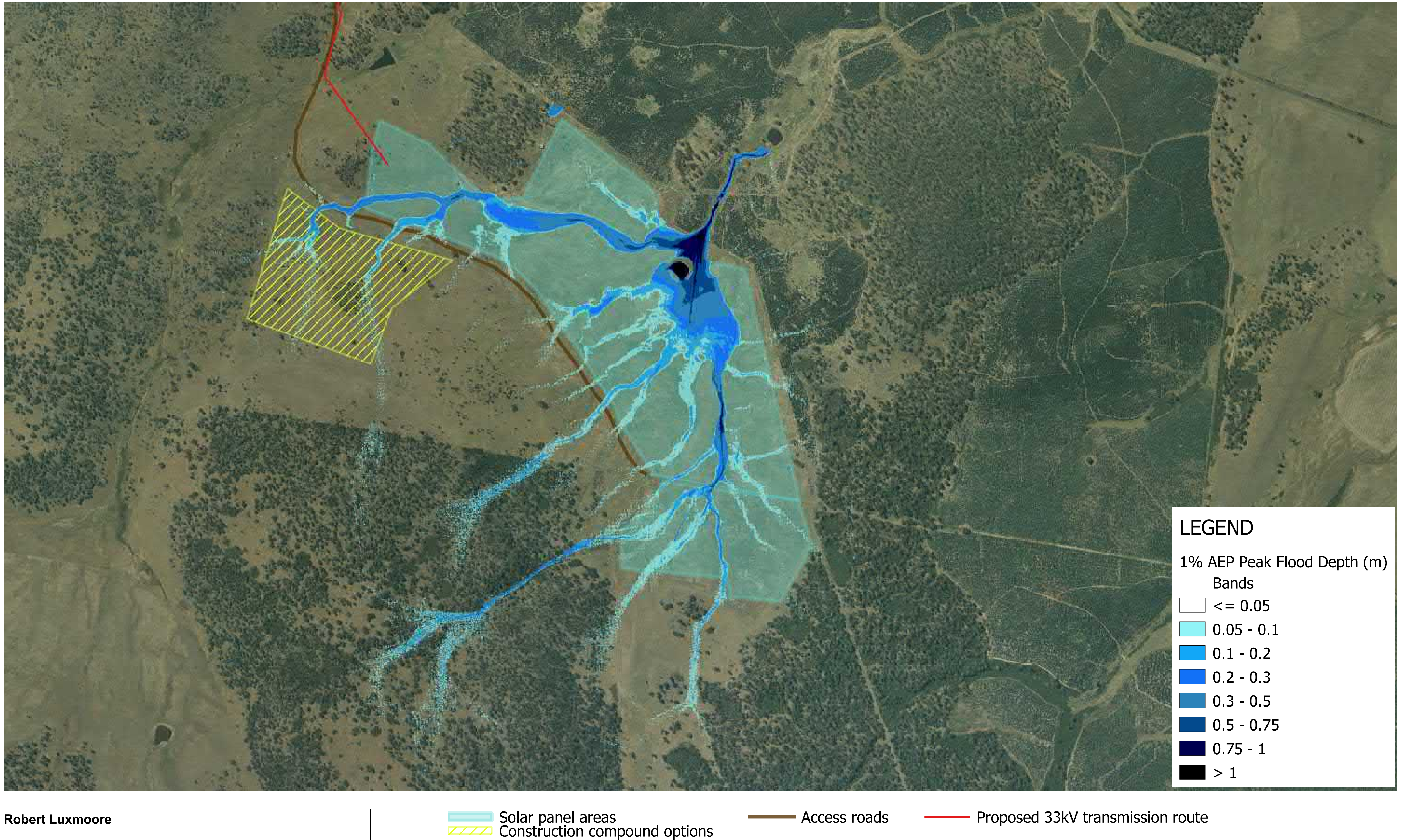
In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints. The Report may only be used and relied on by the Client for the purpose set out in the Report. Any use which a third party makes of this document, or any reliance on or decisions to be made based on it, is the responsibility of the Client or such third parties.

The services undertaken by pitt&sherry in connection with preparing the Report were limited to those specifically detailed in the report and are subject to the restrictions, limitations and exclusions set out in the Report. The Report's accuracy is limited to the time period and circumstances existing at the time the Report was prepared. The opinions, conclusions and any recommendations in the Report are based on conditions encountered and information reviewed at the date of preparation of the Report. pitt&sherry has no responsibility or obligation to update the Report to account for events or changes occurring after the date that the report was prepared. If such events or changes occurred after the date that the report was prepared render the Report inaccurate, in whole or in part, pitt&sherry accepts no responsibility, and disclaims any liability whatsoever for any injury, loss or damage suffered by anyone arising from or in connection with their use of, reliance upon, or decisions or actions based on the Report, in whole or in part, for whatever purpose.

1% AEP Flood Mapping

Appendix A

pitt&sherry



Robert Luxmoore

Figure 01 - Solar East 1% AEP Peak Flood Depth

pitt&sherry

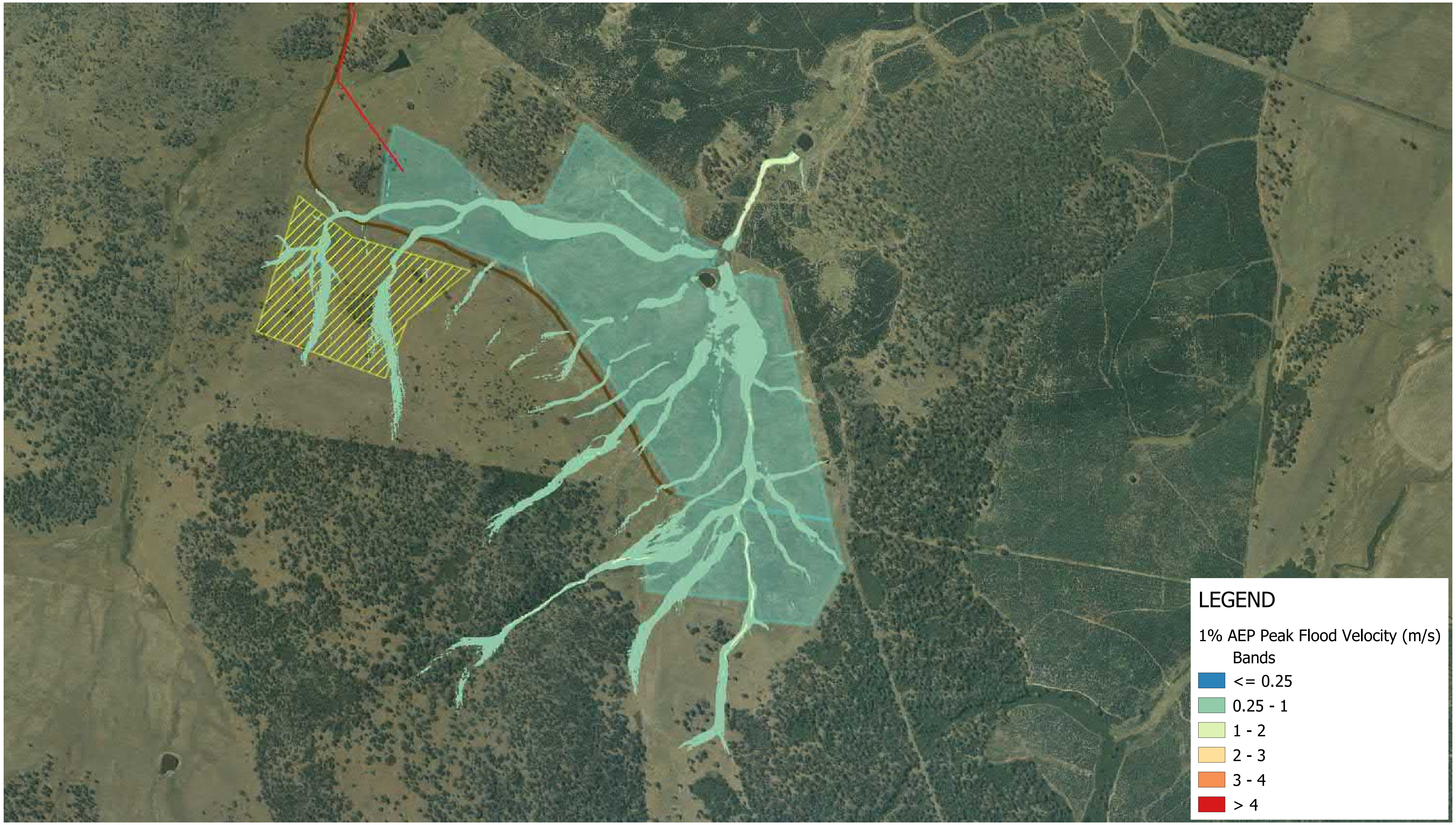
MAP REF:	P221382_Workspace.qgz
AUTHOR:	Oliver Davies
REVISION:	01
DATE:	19/Apr/2023

DATA SOURCES: TheLIST Orthophoto

N

0 200 400 600 800 m

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:12000



Solar panel areas
Construction compound options
Access roads
Proposed 33kV transmission route

Robert Luxmoore

Figure 02 - Solar East 1% AEP Peak Flood Velocity

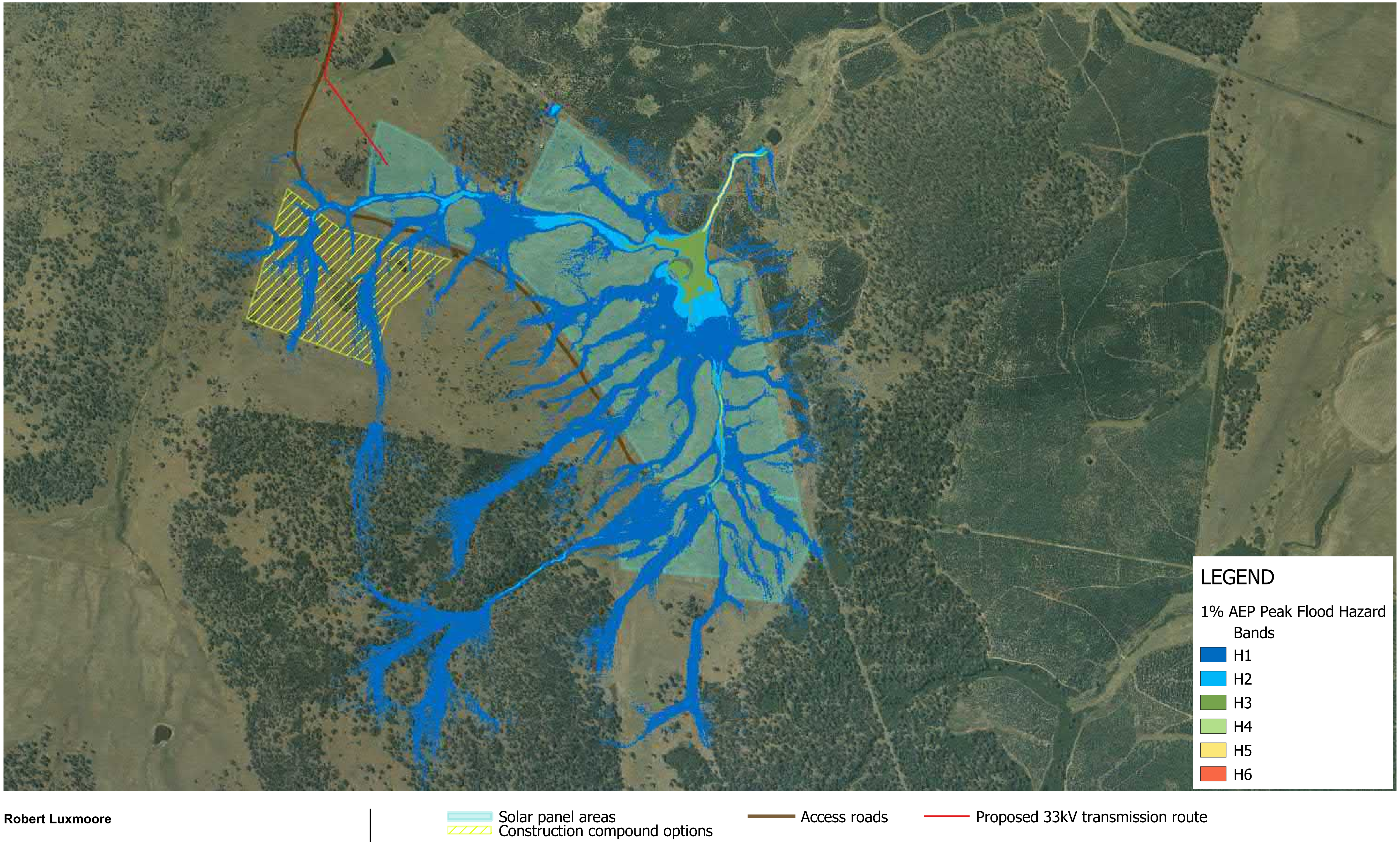
pitt&sherry

MAP REF:	P221382_Workspace.qgz	**DATA SOURCES:**	TheLIST Orthophoto
AUTHOR:	Oliver Davies		
REVISION:	01		
DATE:	19/Apr/2023		

N

0 200 400 600 800 m

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:12000



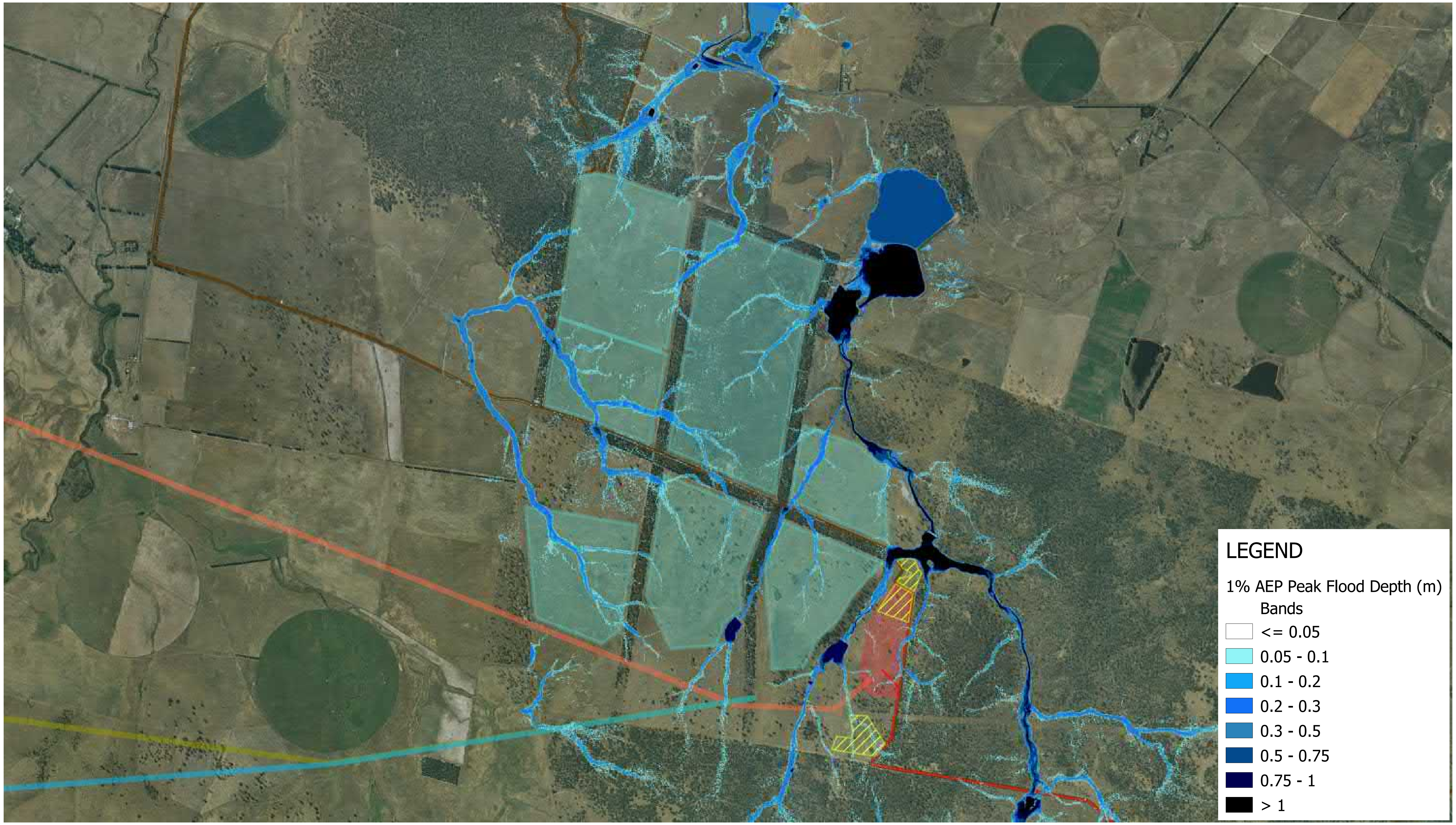
Robert Luxmoore

Figure 03 - Solar East 1% AEP Peak Flood Hazard

MAP REF:	P221382_Workspace.qgz	**DATA SOURCES:**	TheLIST Orthophoto
AUTHOR:	Oliver Davies		
REVISION:	01		
DATE:	19/Apr/2023		

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:12000

pitt&sherry



Robert Luxmoore

Figure 04 - Solar West 1% AEP Peak Flood Depth - Sheet 1

Solar panel areas
Construction compound options
Infrastructure area
Access roads
Proposed 33kV transmission route
New 220kV transmission line - Option 1
New 220kV transmission line - Option 2.1
New 200kV transmission line - Option 2.2

pitt&sherry

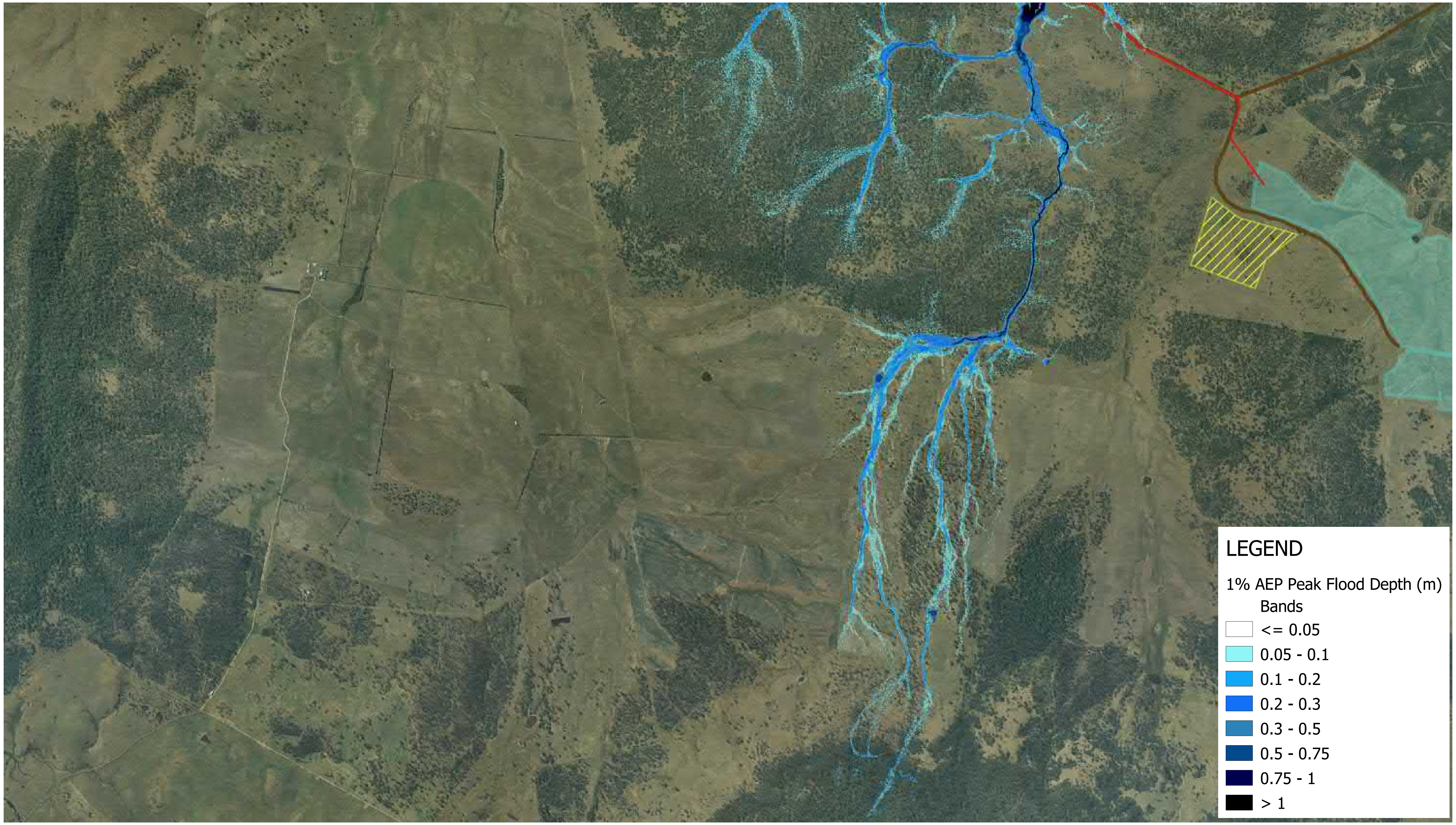
MAP REF:	P221382_Workspace.qgz
AUTHOR:	Oliver Davies
REVISION:	01
DATE:	19/Apr/2023

DATA SOURCES: TheLIST Orthophoto

N

0 500 1,000 1,500 2,000 m

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:24000



Robert Luxmoore

Solar panel areas
Construction compound options
Access roads
Proposed 33kV transmission route

Figure 05 - Solar West 1% AEP Peak Flood Depth - Sheet 2

pitt&sherry

MAP REF: P221382_Workspace.qgz
AUTHOR: Oliver Davies
REVISION: 01
DATE: 19/Apr/2023

DATA SOURCES: TheLIST Orthophoto

N

0 500 1,000 1,500 2,000 m

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:24000

Solar panel areas
Construction compound options
Infrastructure area
Access roads
Proposed 33kV transmission route
New 220kV transmission line - Option 1
New 220kV transmission line - Option 2.1
New 200kV transmission line - Option 2.2

Robert Luxmoore

Figure 06 - Solar West 1% AEP Peak Flood Velocity - Sheet 1

pitt&sherry

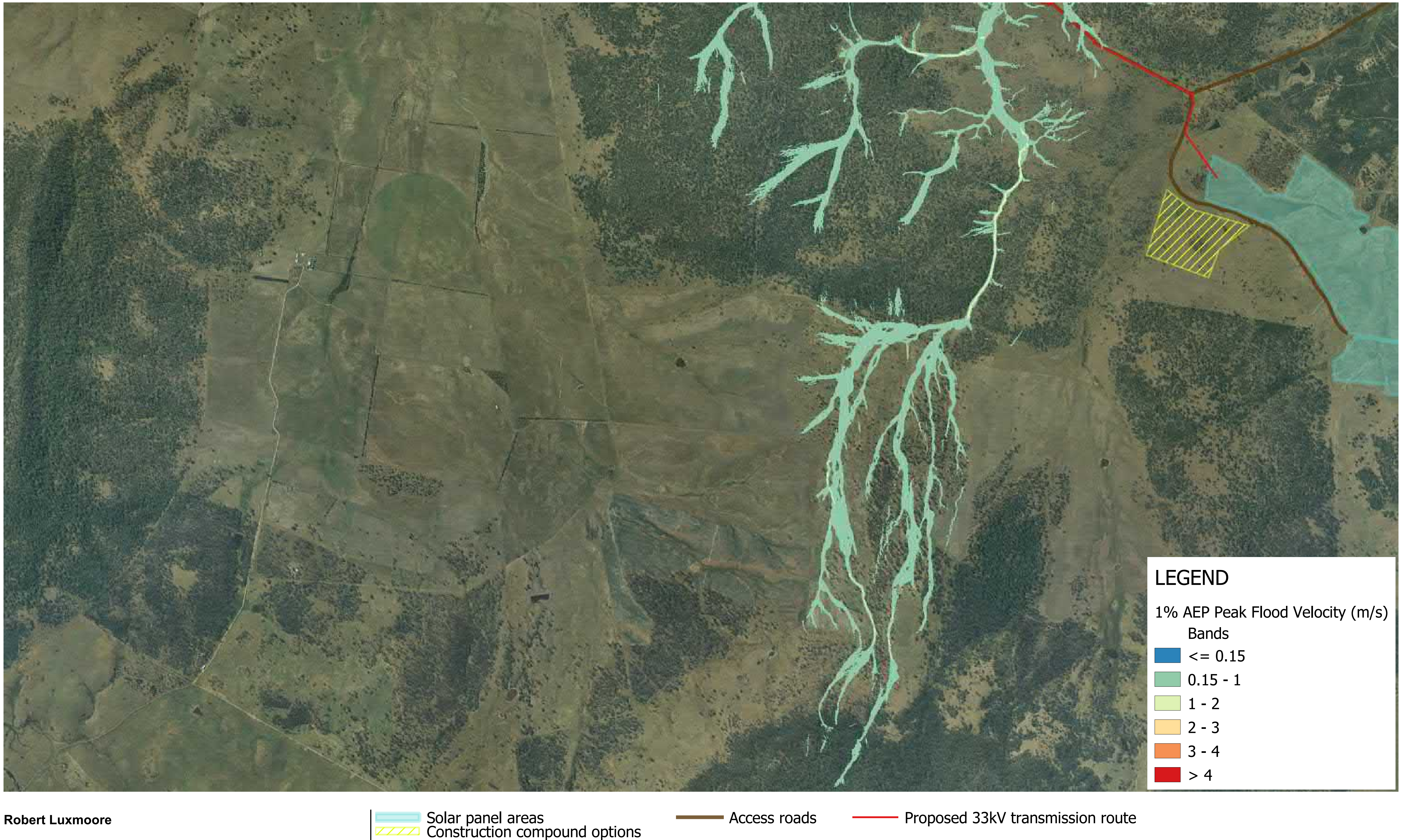
MAP REF: P221382_Workspace.qgz
AUTHOR: Oliver Davies
REVISION: 01
DATE: 19/Apr/2023

DATA SOURCES: TheLIST Orthophoto

N

0 500 1,000 1,500 2,000 m

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:24000



Robert Luxmoore

Figure 07 - Solar West 1% AEP Peak Flood Velocity - Sheet 2

pitt&sherry

MAP REF:	P221382_Workspace.qgz
AUTHOR:	Oliver Davies
REVISION:	01
DATE:	19/Apr/2023

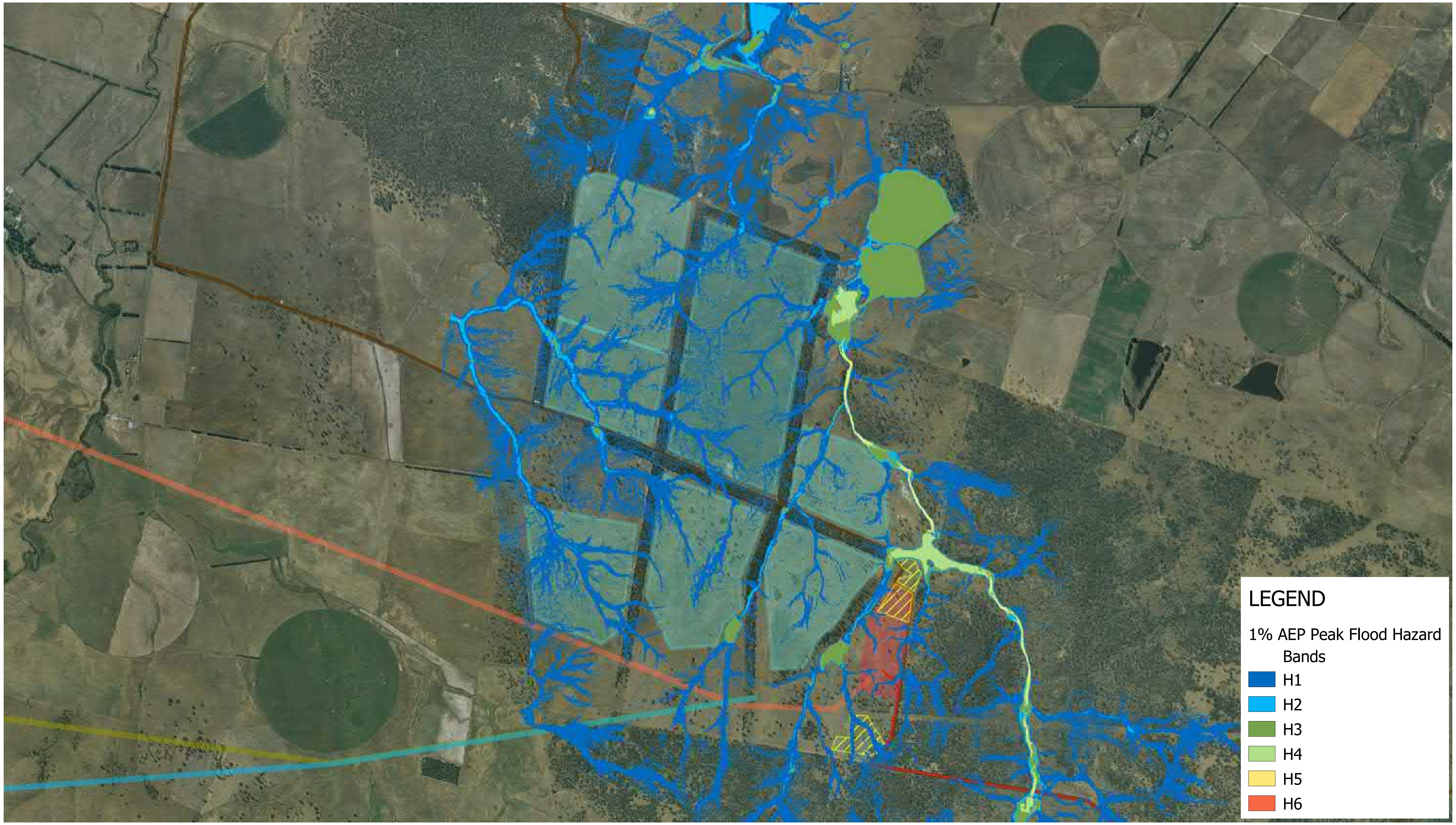
DATA SOURCES: TheLIST Orthophoto

N

0 500 1,000 1,500 2,000 m

COORDINATE SYSTEM: EPSG:7855

SCALE @ A3: 1:24000



Robert Luxmoore

Figure 08 - Solar West 1% AEP Peak Flood Hazard - Sheet 1

Solar panel areas
Construction compound options
Infrastructure area
Access roads
Proposed 33kV transmission route
New 220kV transmission line - Option 1
New 220kV transmission line - Option 2.1
New 200kV transmission line - Option 2.2

pitt&sherry

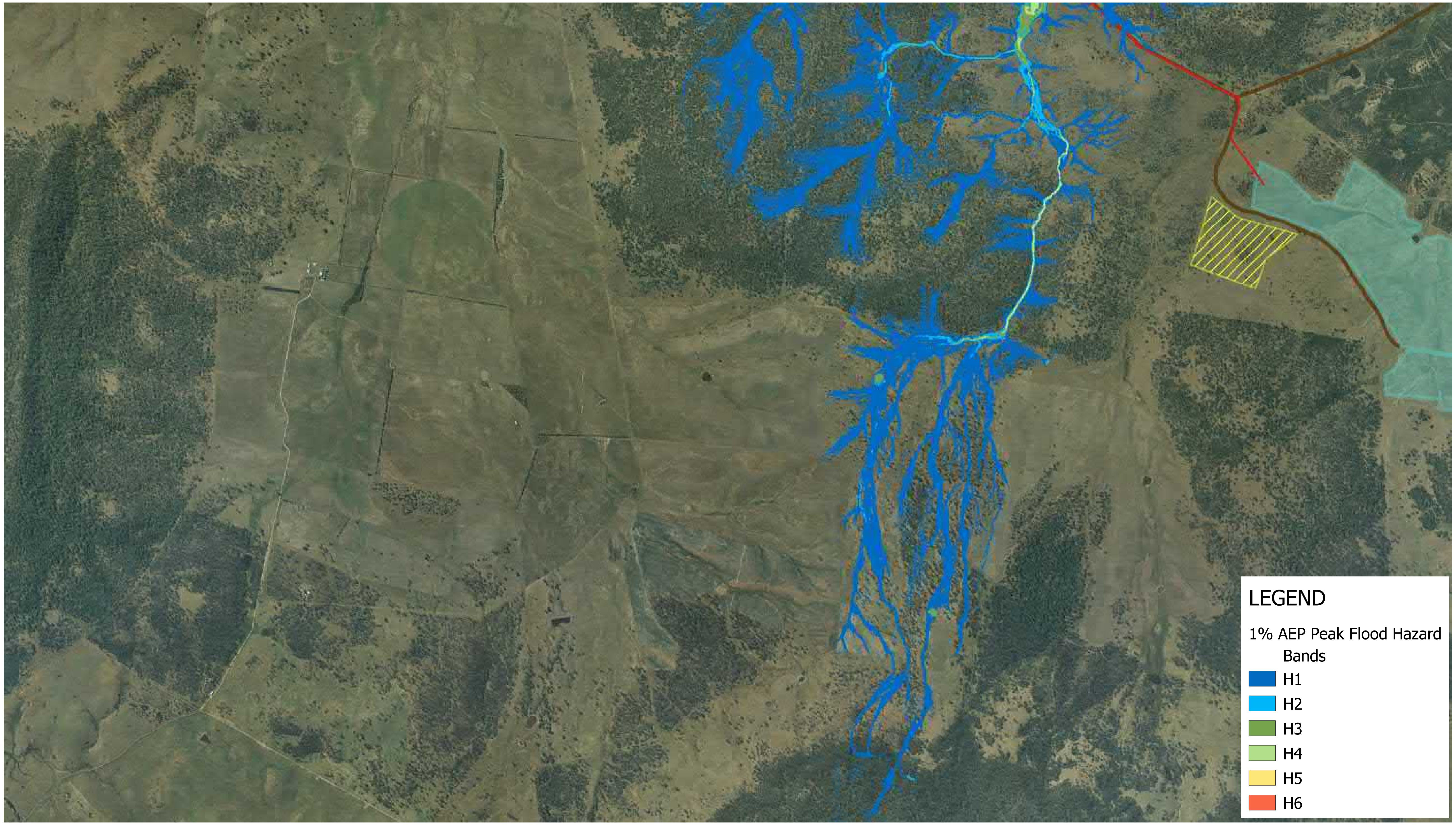
MAP REF: P221382_Workspace.qgz
AUTHOR: Oliver Davies
REVISION: 01
DATE: 19/Apr/2023

DATA SOURCES: TheLIST Orthophoto

N

0 500 1,000 1,500 2,000 m

COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:24000



Robert Luxmoore

Solar panel areas
Construction compound options
Access roads
Proposed 33kV transmission route

Figure 09 - Solar West 1% AEP Peak Flood Hazard - Sheet 2

MAP REF:	P221382_Workspace.qgz	**DATA SOURCES:**	TheLIST Orthophoto
AUTHOR:	Oliver Davies		
REVISION:	01		
DATE:	19/Apr/2023		

N

0 500 1,000 1,500 2,000 m

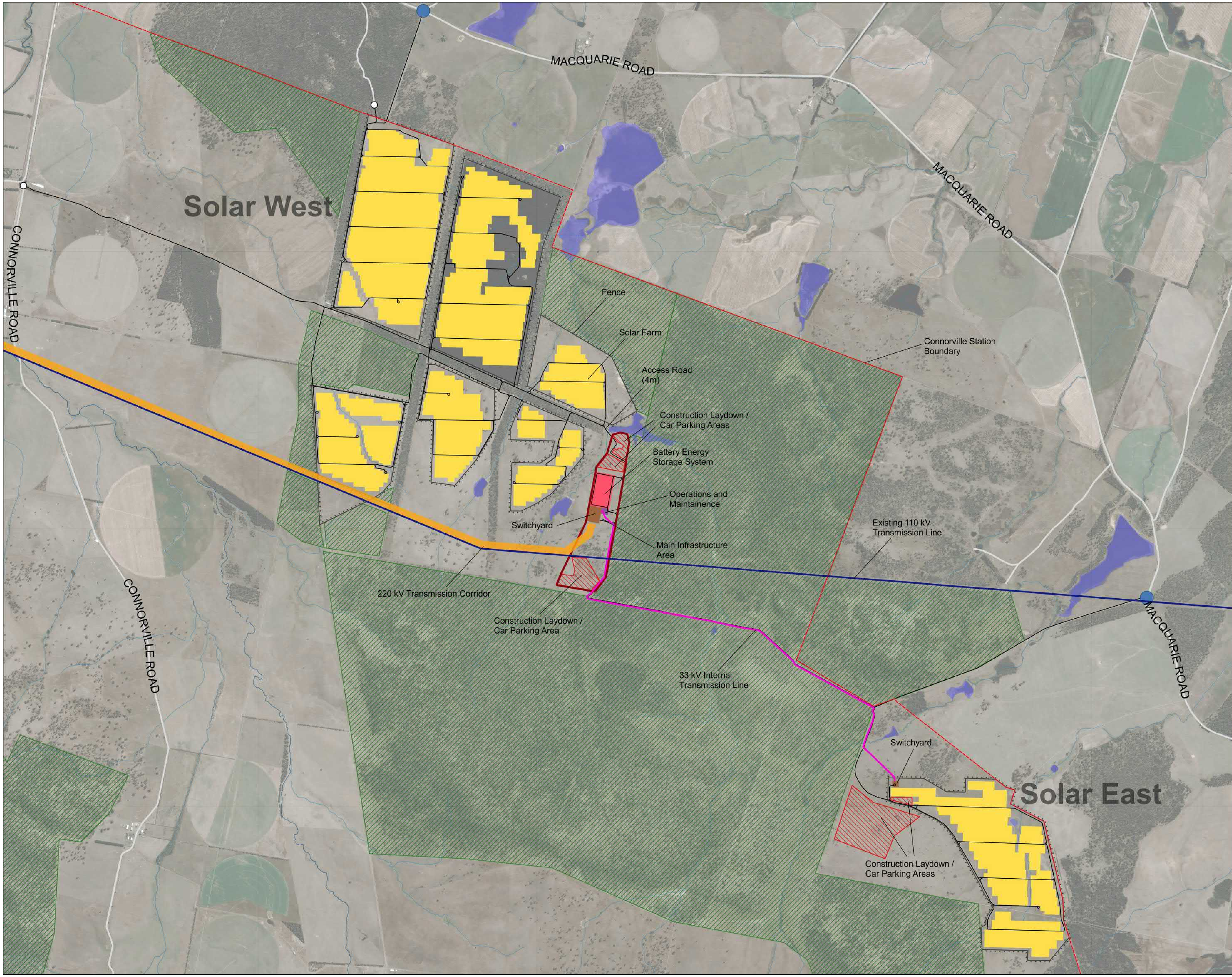
COORDINATE SYSTEM: EPSG:7855
SCALE @ A3: 1:24000

pitt&sherry

Masterplan

Appendix B

pitt&sherry



cogency

ROBERT LUXMOORE Project Management

Masterplan Page 1 Overall Area

2210 - Northern Midlands Solar Farm

Existing Features
- Parcels
- Existing Roads
- Conservation Covenant and Greening Australia Reserves
- Dams
- Watercourse
- 110 kV Existing Transmission Line

Proposed Development
- Connorville Station
- Access Roads
- Solar Farm
- Main Infrastructure Area
- Battery Energy Storage System
- Operations and Maintainence
- Swtichyard
- Construction Laydown / Car Parking Area
- 220 kV Transmission Corridor
- 33 kV Internal Tranmission Line
- Fence
- Main Access Points
- Secondary/Emergency Access Points

Version: 5

Date: 21/04/2023

0 250 500 m

1:13,000 at A1

cogency
Robert Luxmoore Project Management

Masterplan Page 2
Transmission Line

2210 - Northern Midlands Solar Farm

Existing Features
- Parcels
- Existing Roads
- Conservation Covenant and Greening Australia Reserves
- Dams
- Watercourse
- Palmerston Substation
- Exsting Transmission Line

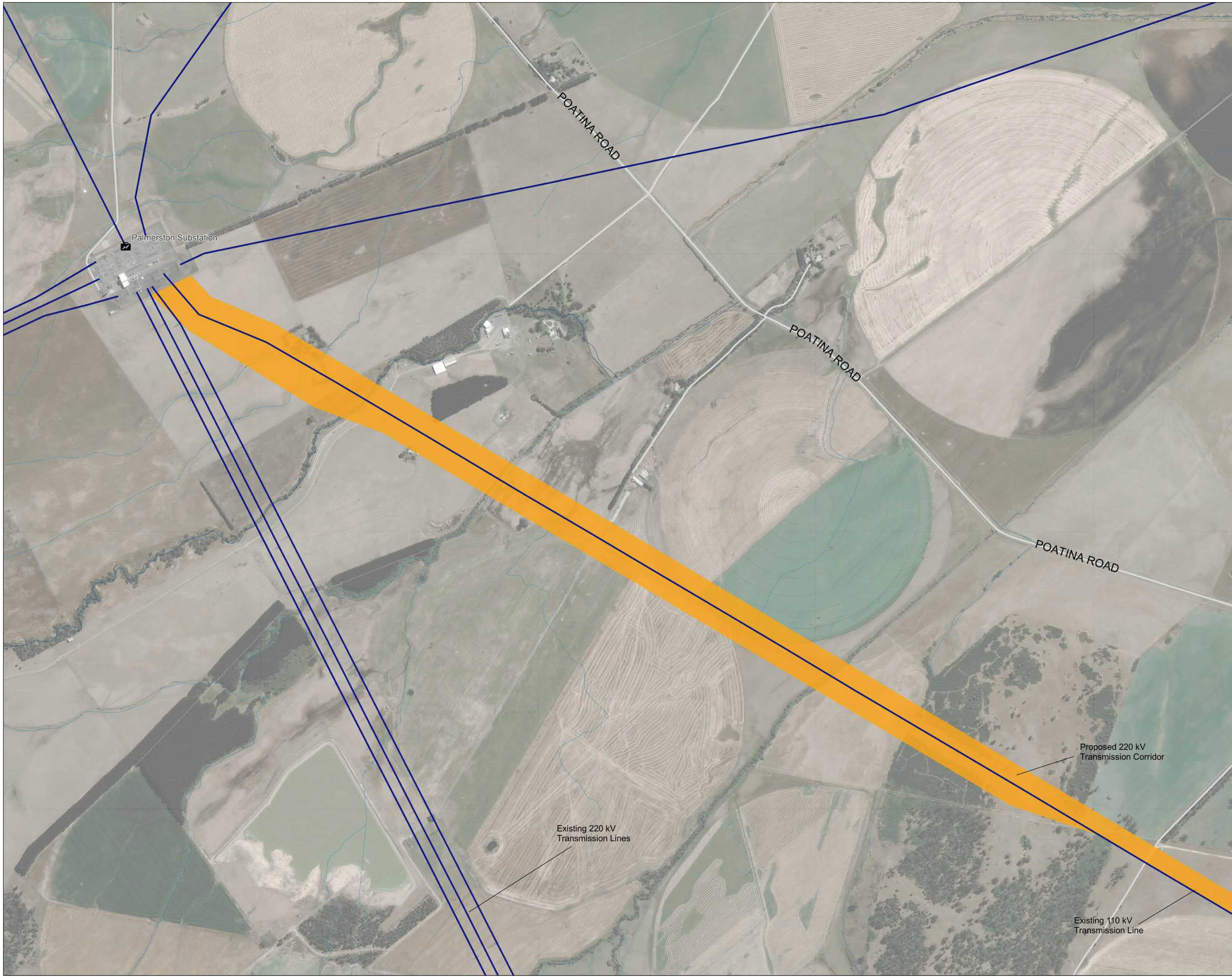
Proposed Development
- Connorville Station
- Access Roads
- Solar Farm
- Main Infrastructure Area
- Battery Energy Storage System
- Operations and Maintainence
- Swtichyard
- Construction Laydown / Car Parking Area
- 220 kV Transmission Corridor
- 33 kV Internal Tranmission Line
- Fence
- Main Access Points
- Secondary/Emergency Access Points

Version: 5

Date: 21/04/2023

0 250 500 m

1:25,000 at A1



cogency

ROBERT LUXMOORE Project Management

Masterplan Page 3
Transmission Line -
Palmerston Substation

2210 - Northern Midlands Solar Farm

Existing Features
- Parcels
- Existing Roads
- Dams
- Watercourse
- Palmerston Substation
- Exsting Transmission Line

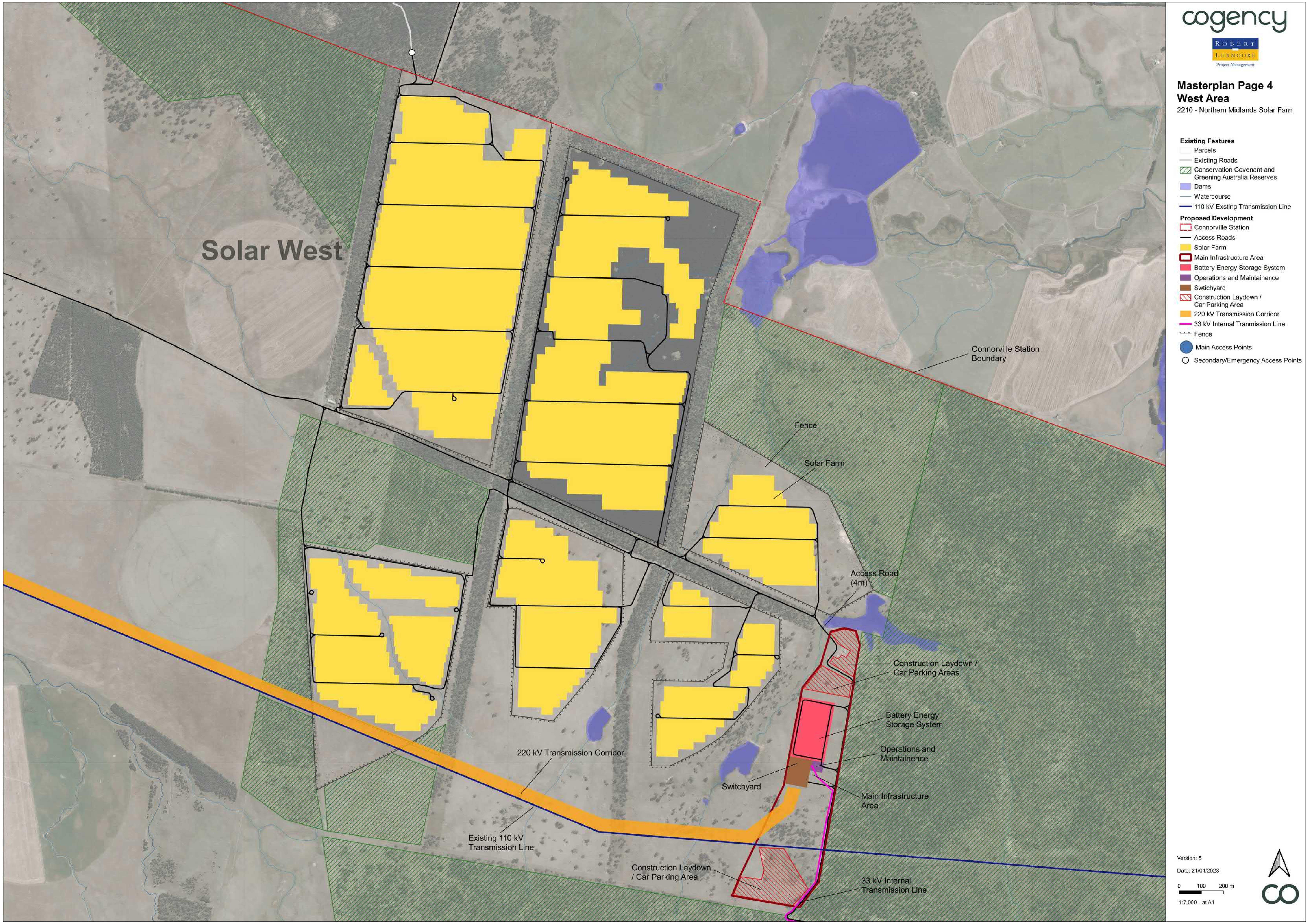
Proposed Development
- 220 kV Transmission Corridor

Version: 5

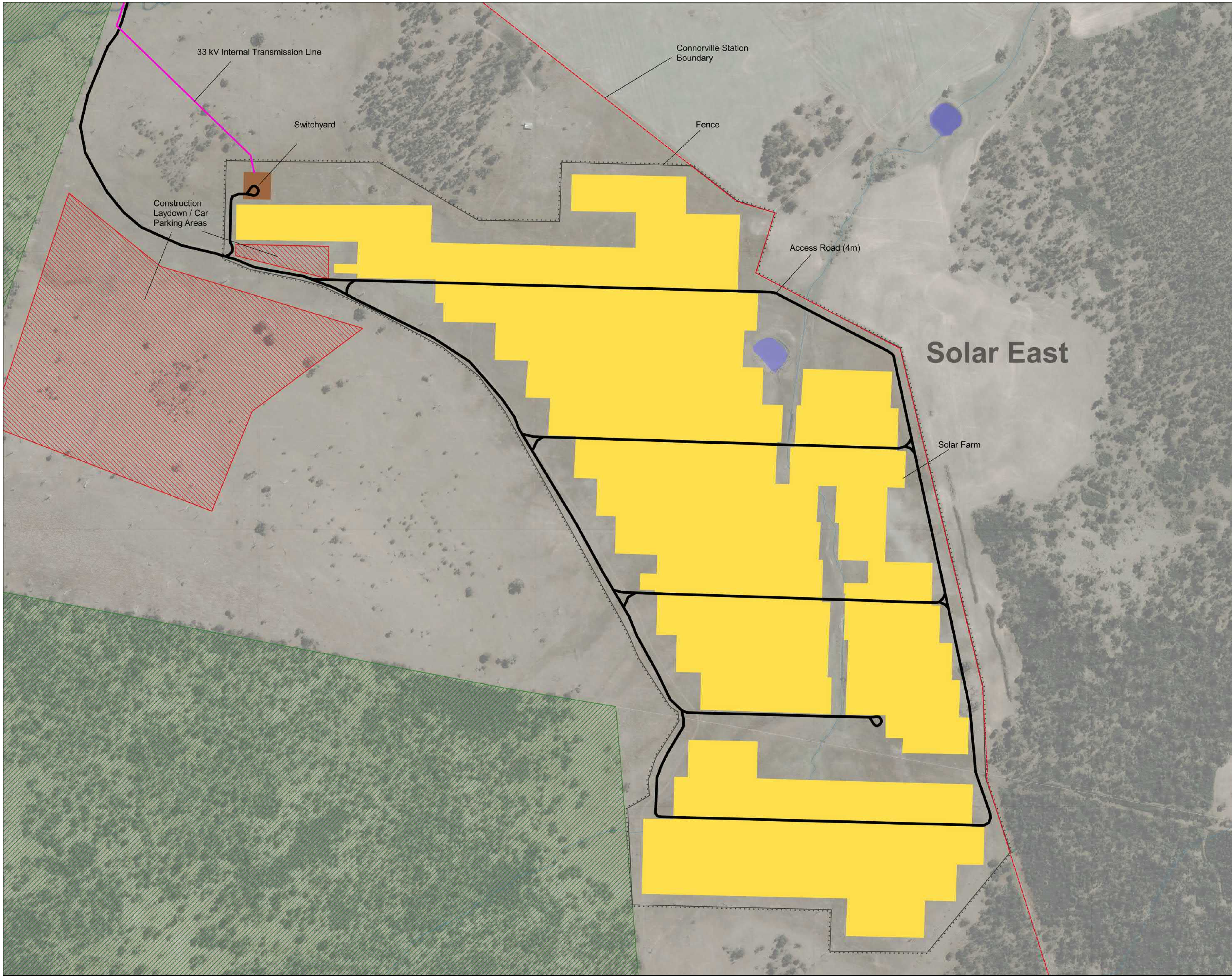
Date: 21/04/2023

0 50 100 m

1:5,000 at A1



Solar West
Connorville Station Boundary
Fence
Solar Farm
Access Road (4m)
Construction Laydown / Car Parking Areas
Battery Energy Storage System
Operations and Maintainence
Main Infrastructure Area
Switchyard
220 kV Transmission Corridor
Existing 110 kV Transmission Line
Construction Laydown / Car Parking Area
33 kV Internal Transmission Line
cogency
Robert Luxmoore Project Management
Masterplan Page 4
West Area
2210 - Northern Midlands Solar Farm
Existing Features
Parcels
Existing Roads
Conservation Covenant and Greening Australia Reserves
Dams
Watercourse
110 kV Exsting Transmission Line
Proposed Development
Connorville Station
Access Roads
Solar Farm
Main Infrastructure Area
Battery Energy Storage System
Operations and Maintainence
Swtichyard
Construction Laydown / Car Parking Area
220 kV Transmission Corridor
33 kV Internal Tranmission Line
Fence
Main Access Points
Secondary/Emergency Access Points
Version: 5
Date: 21/04/2023
0 100 200 m
1:7,000 at A1



cogency

ROBERT LUXMOORE Project Management

Masterplan Page 5
East Area

2210 - Northern Midlands Solar Farm

Existing Features
- Parcels
- Existing Roads
- Conservation Covenant and Greening Australia Reserves
- Dams
- Watercourse

Proposed Development
- Connorville Station
- Access Roads
- Solar Farm
- Swtichyard
- 33 kV Internal Tranmission Line
- Construction Laydown / Car Parking Area
- Fence
- Main Access Points
- Secondary/Emergency Access Points

Version: 5

Date: 21/04/2023

0 50 100 m

1:3,000 at A1

pitt&sherry

Northern Midlands Solar Farm – Flooding Impact Assessment

Pitt & Sherry (Operations) Pty Ltd
ABN 67 140 184 309

Phone 1300 748 874
info@pittsh.com.au
pittsh.com.au

Located nationally —
Melbourne
Sydney
Brisbane
Hobart
Launceston
Newcastle
Devonport

pitt&sherry | ref: T-P.22.1382-DRN-REP-NMSF-Flood-001-Rev03/HGW/aw

pitt&sherry

Specialist Knowledge.
Practical Solutions.

P.22.1382 – Northern Midlands Solar Farm – Acid Sulfate Soil Investigation

To	Emanuele Raffaele, Robert Luxmoore Project Management
From	Millicent Probert, pitt&sherry
Date	16 May 2023
Revision	Rev00
RE	**P.22.1382 – Northern Midlands Solar Farm – Acid Sulfate Soil Investigation**

1. Background

A large-scale solar farm to be located in Cressy, Tasmania will comprise two main areas, Solar East and Solar West (the Site) as illustrated on Figure 1. A new 220 kilivolt (kV) transmission line will be constructed to connect the solar farm to the existing Tasmanian Networks Pty Ltd (TasNetworks) infrastructure and the possibility of storing batteries for back-up power supply will be investigated. As a component of the approvals pathway, the Environmental Protection Authority Tasmania (EPA) has requested Connorville Estates (the proponent) investigate the potential presence of acid sulfate soils (ASS) at the Site.

ASS is a collective term for natural, waterlogged soils that contain sulfides formed by underwater bacterial activity. Once exposed to air through disturbances such as excavation or drainage, oxidation can produce sulfuric acid in large quantities. Undisturbed and unoxidized, these soils are known as potential acid sulphate soils (PASS), and soils that have been disturbed and oxidized are known as actual acid sulphate soils (AASS). ASS has the potential to cause the release of heavy metals and other toxins damaging sensitive ecosystems and water catchments (DPIPWE, 2009).[1]

This memorandum provides a brief desktop assessment of ASS risk factors to determine the likelihood of ASS being present on the Site and is structured as follows:

- Section 1 – Background (this section)
- Section 2 – Topography and hydrology
- Section 3 – Northern Midlands soil mapping
- Section 4 – Acid sulfate soil risk mapping
- Section 5 – Discussion
- Section 6 – Recommendations; and
- Section 7 – References.

[1] Department of Primary Industries and Water (DPIPWE), 2009, *Tasmanian Acid Sulfate Soils Guidelines*.

pitt&sherry

Specialist Knowledge.
Practical Solutions.

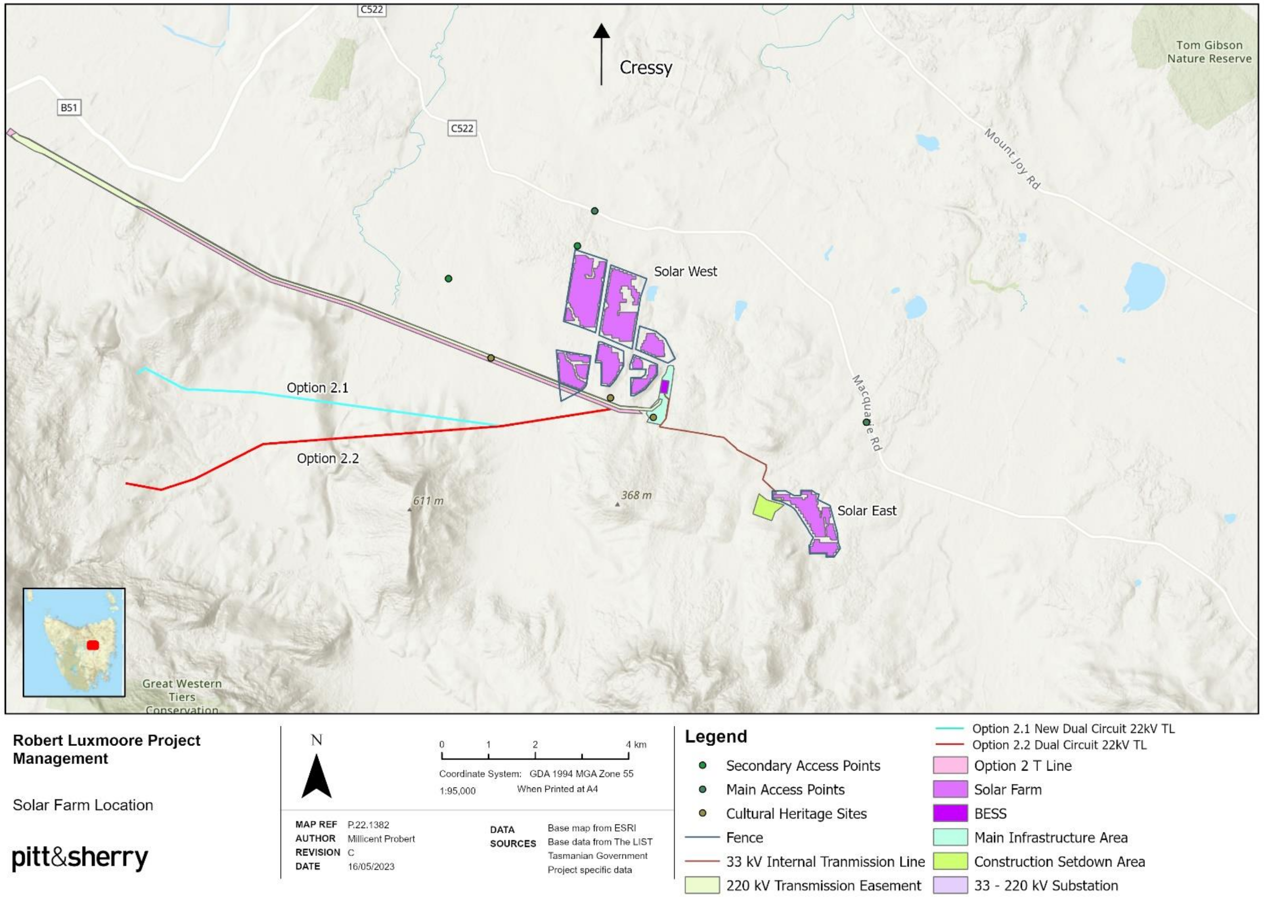


Figure 1. Location of the proposed solar farm

pitt&sherry

Specialist Knowledge.
Practical Solutions.

2. Topography and hydrology

The Site is situated in Cressy, within the Northern Midlands region of Tasmania. The Site is located at an elevation of approximately 190 to 200 metres above sea level (m ASL) and is surrounded by a combination of agricultural farmland and natural vegetation. The Solar East site is situated south-east of the Solar West site and is separated by a small ridge with a maximum elevation of 250 m ASL.

There are two dams (natural or agricultural) to the north-east of the Solar West site, two dams in the south and numerous small tributaries traverse this site draining into the dams and nearby Macquarie River.The Solar West site is slightly elevated in contrast to the Macquarie River and dams, and any surface runoff is likely to drain into these catchments.

The Solar East site has a small dam on the north-eastern perimeter and an onsite wetland. With a slight depression in contrast to the surrounding land, surface water runoff is likely to drain into this dam and wetland.

Regional topographic contours and hydrological features are illustrated on Figure 2.

Elevation profiles for the Solar East site and the wetland are illustrated on Figure 3.

pitt&sherry

Specialist Knowledge.
Practical Solutions.

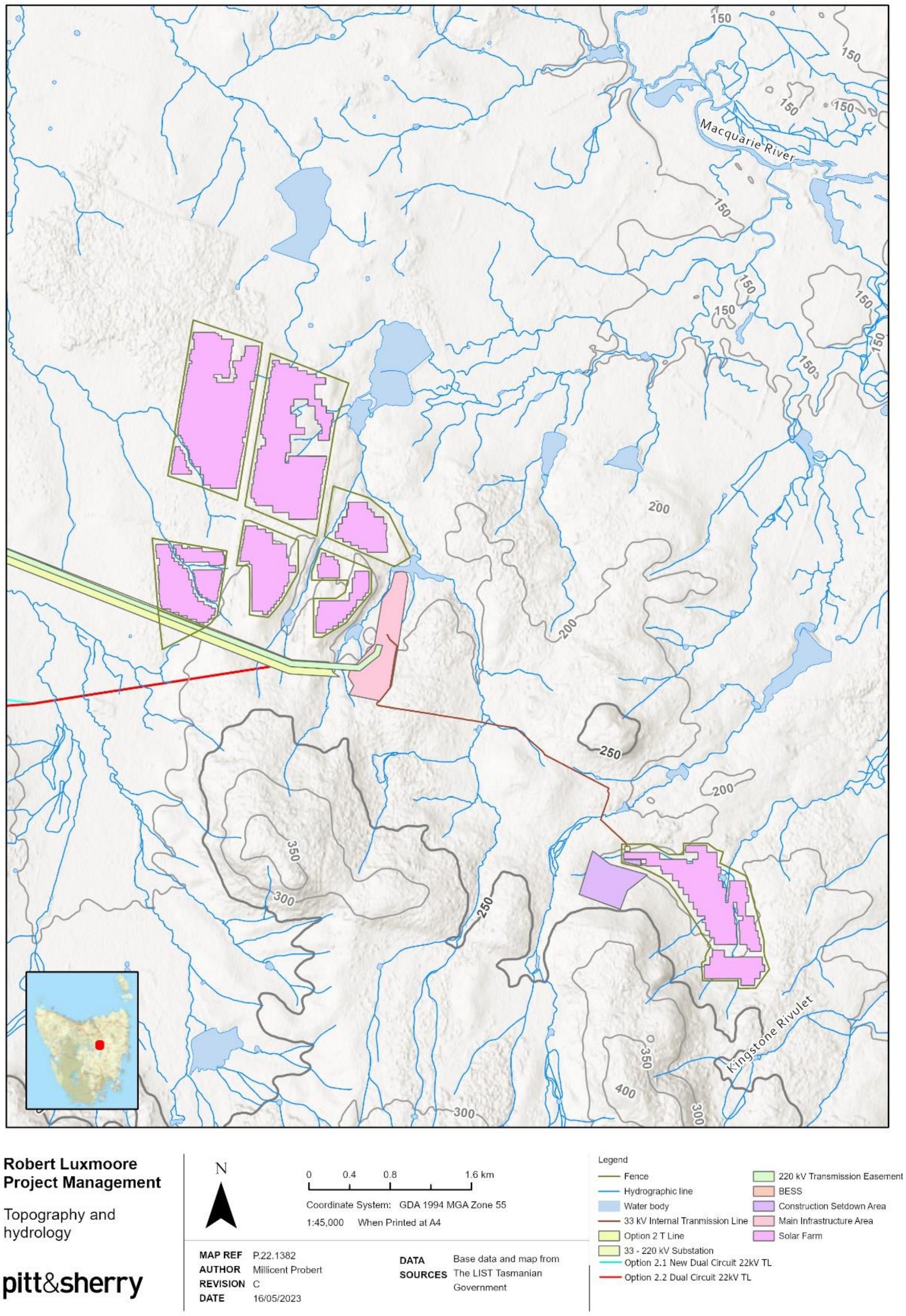


Figure 2 Regional topography and hydrology

pitt&sherry

Specialist Knowledge.
Practical Solutions.

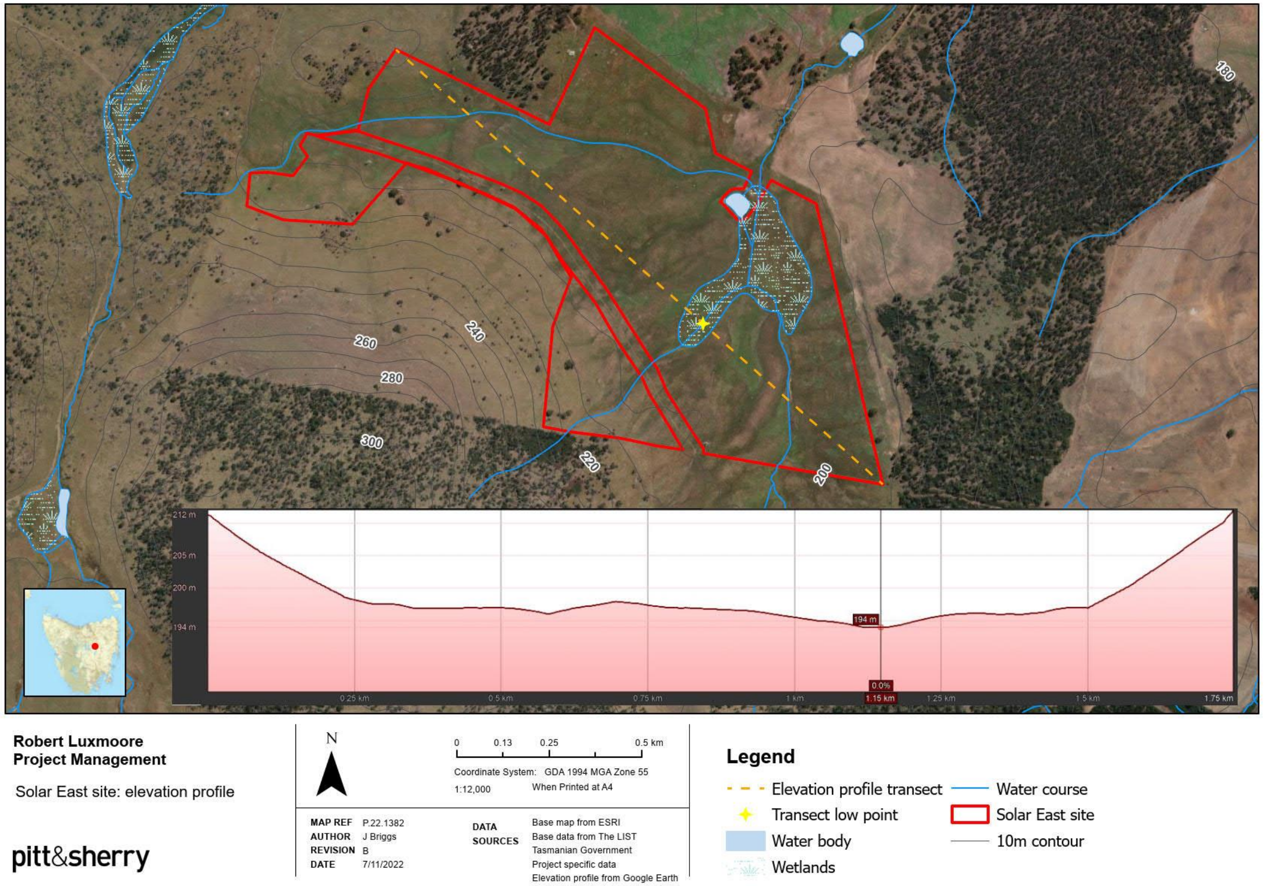


Figure 3 Solar East site elevation profile and wetlands

pitt&sherry

Specialist Knowledge.
Practical Solutions.

3. Northern Midlands soil mapping

The soil mapping provided by the Land Information Systems of Tasmania interactive mapping tool (LISTmap) is derived from *Soils of the South Esk Sheet Tasmania* (Doyle, 1993)[2]. Mapped soil types by Site are provided in Table 1 and illustrated on Figure 4.

Doyle, 1993 describes:

- Kurosols, Chromosols and Sodosols as soils with slow permeability and restricted drainage due to heavy clay subsoils; and

Tenosols as sandy soils with rapid drainage, summer dryness and low moisture holding capacity.

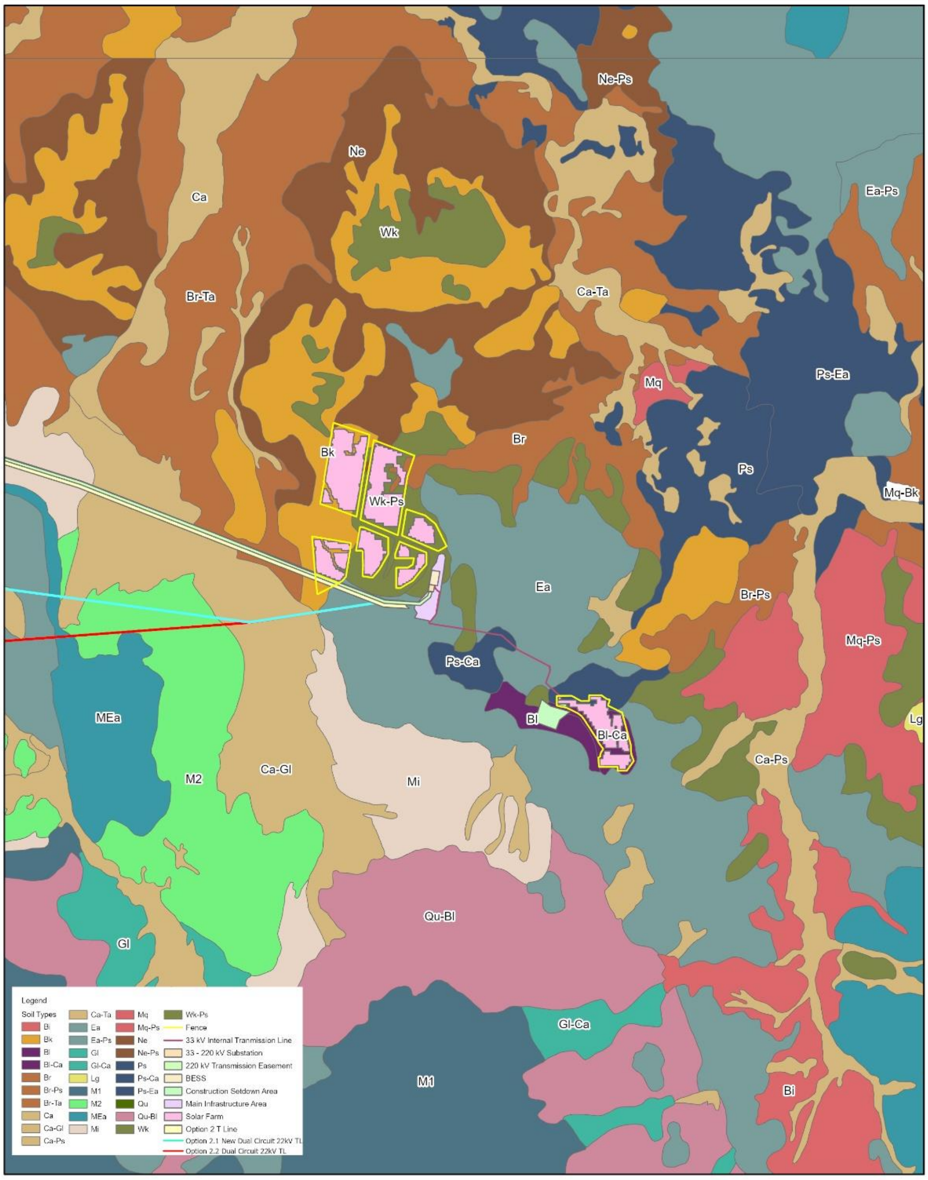
Table 1: Mapped soil types by site

Site	Soil Code and Name	Soil Description
Solar West	**Wk-Ps** – Kurosol, Tensol	Soils above Tertiary sediments on flat to undulating (0-10%) relic lake beds or terraces, with sandy rises.
	Wk – Kurosol	Soils above Tertiary sediments on flat to undulating (0-10%) relic lake beds or terraces.
	Bk – Chromosol	Soils developed on flat to gently undulating (0-3%) river terraces.
	Ne - Chromosol	Soils on undulating and rolling (3-32%) drop-off slopes or terrace scarps.
	Br – Sodosol	Soils developed on alluvium overlying Tertiary clays on flat to gently undulating (0-3%) river terraces.
Solar East	**Bl** – Sodosol	Soils developed on Triassic sandstone on rolling and steep (10-56%) land.
	Bl-Ca – Sodosol, Vertosol	Soils developed on Triassic sandstone on rolling and steep (10-56%) land, with black cracking clays in depressions.
	Ps-Ea – Tenosol, Chromosol, Sodosol	Soils on loose, windblown sand on gently undulating to rolling (3-32%) dunes and flanks of dolerite hill slopes, with texture contrast soils on dolerite rises.
	Ea – Chromosol, Ferrosol	Imperfectly drained texture contrast soils developed from Jurassic dolerite on rugged hilly land with frequent rock outcrops.

[2] Doyle R.B. 1993, *Soils of the South Esk Sheet*, Tasmania (southern halt) Soil Survey Series of Tasmania, No. 1 Department of Primary Industry and Fisheries, Tasmania (Doyle, 1993)

pitt&sherry

Specialist Knowledge.
Practical Solutions.



Robert Luxmoore Project Management

Soil Types

pitt&sherry

N

0 0.75 1.5 3 km

Coordinate System: GDA 1994 MGA Zone 55

1:90,000 When Printed at A4

MAP REF P.22.1382
AUTHOR Millicent Probert
REVISION C
DATE 16/05/2023

DATA SOURCES Base data and map from The LIST Tasmanian Government and project specific data

Figure 4 Mapped soil type

pitt&sherry

Specialist Knowledge.
Practical Solutions.

4. Acid sulfate soil risk mapping

ASS are mapped on the LISTmap (Figure 5) as:

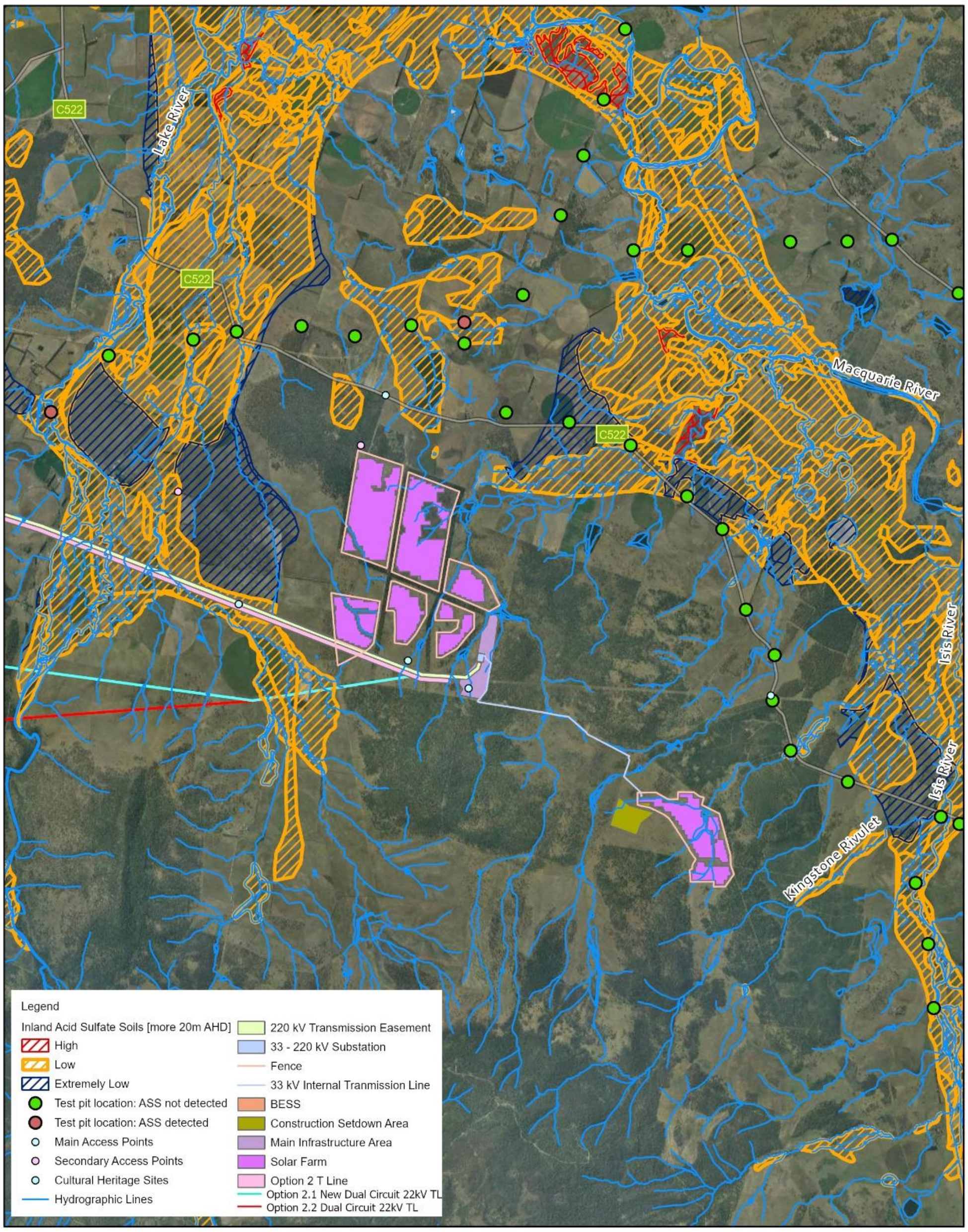
- High probability of occurrence (>70% change of encountering ASS)
- Low probability of occurrence (5 to 70% chance of encountering ASS); or
- Extremely low probability of occurrence (<5% chance of encountering ASS).

Most of the land surrounding the Site is mapped as low probability of occurrence, with no ASS risk mapping extending within the Site. ASS risk mapping is indicative only and generally needs to be ground truthed.

Pitt & Sherry (Operations) Pty Ltd (pitt&sherry) has previously conducted geotechnical investigations in the Northern Midlands including ASS sampling and laboratory analysis for areas mapped as low and high probability of encountering ASS. ASS was confirmed by laboratory testing at two locations, mapped as low probability of encountering ASS, within a 5 km radius of the Site. The soil within the test pit north of the Solar West site comprised Chromosol (Bk) soil, which is mapped (Figure 4) to extend into the western half of the Solar West site.

pitt&sherry

Specialist Knowledge.
Practical Solutions.



Robert Luxmoore Project Management

Acid Sulfate Soils

pitt&sherry

N

0 0.5 1 2 km

Coordinate System: GDA 1994 MGA Zone 55
1:75,000 When Printed at A4

MAP REF P.22.1382
AUTHOR Millicent Probert
REVISION C
DATE 16/05/2023

DATA SOURCES Base data and map from The LIST Tasmanian Government and project specific data

Figure 5 Acid sulfate soil risk mapping

pitt&sherry

Specialist Knowledge.
Practical Solutions.

5. Discussion

Considering the sandy-clay soil profile at the Solar West site and the slight elevation compared to surrounding landscape, surface water is likely to readily drain to nearby dams and streams, and the soils are unlikely to become waterlogged. There are however a number of waterways traversing this Site that are mapped as low risk for ASS further upstream. If these waterways remain undisturbed, further investigation for ASS is not warranted.

ASS mapping is indicative only. pitt&sherry has previously confirmed the presence of ASS (by laboratory testing) at two locations, mapped as low probability of encountering ASS, within a 5 km radius of the Site (within the same soil type as that mapped beneath the Solar West site). The absence of any ASS risk mapping at the Site does not preclude its presence.

The Solar East site has a similar sandy-clay soil profile however the onsite wetland provides a catchment for water from the mountains to the south-west and other small tributaries on a similar elevation. Wetlands contain waterlogged soils and therefore there is the potential for ASS soils to be present at this location.

6. Recommendations

Based on the findings from this desktop ASS assessment, preliminary intrusive investigations are recommended:

- Conduct a walkover to assess the size and significance of the waterways at the Solar West site, allowing for collection of up to 5 samples if necessary (as per below methodology for the Solar East site)
- Conduct a field-testing investigation of the Solar East site targeting the various soil types present in the area to gauge their potential to be ASS, including:
  - Preparing for sampling including development of a Project Safety Assessment (PSA)
  - Travelling and borehole excavation using a hand auger (assume 1 day)
  - Field testing for ASS indicators at 6 to 8 sites, targeting low-lying, poorly drained soils at depths of 0.6 to 1 m bgl
  - Taking photographs
- Laboratory testing of up to 3 samples for ASS (where field testing is inconclusive)
- Provide a brief report of the findings, including:
  - Field logs of the boreholes
  - Field ASS indicator results
  - Laboratory testing results and comparison of results against relevant criteria given in the Tasmanian ASS Management Guidelines (DPIPWE, 2009); criteria are dependent on the volume of soils to be disturbed at any one time
  - Photographs
  - Figures; and
  - Commentary on the potential for ASS to be present within the Site based on the outcomes of the preliminary intrusive investigations.

Yours sincerely,
Millicent Probert

pitt&sherry

Specialist Knowledge.
Practical Solutions.

7. References

Doyle R.B. 1993, *Soils of the South Esk Sheet*, Tasmania (southern halt) Soil Survey Series of Tasmania, No. 1 Department of Primary Industry and Fisheries, Tasmania.

Department of Primary Industries and Water (DPIPWE), 2009, *Tasmanian Acid Sulfate Soils Guidelines*.

LISTmap, 2022, www.thelist.tas.gov.au

NORTHERN MIDLANDS SOLAR FARM

Noise Impact Assessment

Prepared for:

Connorville Estates c/- Robert Luxmoore Pty Ltd
11A Newton Street,
Richmond, 3121, VIC

SLR Ref: 640.30536.00000-R01
Version No: -v1.2
February 2023

SLR

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 11, 176 Wellington Parade
East Melbourne VIC 3002 Australia
T: +61 3 9249 9400
E: melbourne@slrconsulting.com   www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Connorville Estates c/- Robert Luxmoore Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
640.30536.00000-R01-v1.2	February 2023	Benjamin French	Gustaf Reutersward	Gustaf Reutersward
640.30536.00000-R01-v1.1	February 2023	Benjamin French	Gustaf Reutersward	Gustaf Reutersward
640.30536.00000-R01-v1.0	February 2023	Benjamin French	Gustaf Reutersward	Gustaf Reutersward
640.30536.00000-R01-v0.2	January 2023	Benjamin French	Gustaf Reutersward	Gustaf Reutersward
640.30536.00000-R01-v0.1	December 2022	Benjamin French	Gustaf Reutersward	Gustaf Reutersward

EXECUTIVE SUMMARY

This technical report is an attachment to the Northern Midlands Solar Farm Development Application submission on behalf of Connorville Estates.

SLR Consulting Pty Ltd (SLR) was engaged by Robert Luxmoore Pty Ltd on behalf of Connorville Estates to conduct a noise assessment of a proposed 288 MW DC / 370 MWp AC solar farm located at 394 Connorville Rd to support a Development Application submission to the Northern Midlands Council under the *Land Use Planning & Approvals Act 1993*.

The project is located on rural farmland approximately 16 km south-southeast of Cressy, Tasmania.

Evaluation of noise impacts on sensitive receptors has been undertaken in accordance with the *Environmental Management and Pollution Control Act 1994*, *Environmental Management and Pollution Control (Noise) Regulations 2016* and the *Environment Protection Policy (Noise) 2009.*

Unattended noise monitoring was conducted between 19 September and 26 September 2022 at two locations representative of the existing ambient environment. These measurements were used to determine appropriate noise goals in general accordance with the *Noise Measurement Procedures Manual*, borrowing elements from the NSW *Noise Policy for Industry, 2017*.

The key project impacts in relation to noise is as follows:

- **Noise from construction activities:** All construction works will be completed under a Construction Environmental Management Plan (CEMP). Due to the distances between the proposed site and the closest receptors construction noise impacts are relatively minimal. However, scheduling construction activities in accordance with the Prohibited Hours as defined in the Regulations[1], community engagement and best practice noise management controls, regular maintenance, broadband reversing beepers etc. will further minimise residual risk of harm to nearby receptors.
- **Noise from operational activities:** The closest receptor is located approximately 1,250 m north of Solar West. Night-time compliance is achieved at this receptor with the current modelling with no additional mitigation. Some receptors close to the existing transmission line corridor may experience some corona ('buzzing') noise during periods of heavy rain or high humidity, the installation of any additional transmission lines to cater for this project is not expected to increase corona noise at these receptors significantly.

It is recommended to update the noise model during detailed design to ensure compliance is maintained. Confirmation of compliance will be verified by post commissioning noise measurements.

[1] Refer to Item 2 of Schedule 1 in the *Environmental Management and Pollution Control (Noise) Regulations 2016*. Reproduced in **Table 3** in this report.

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

Connorville Estates is proposing to develop a 288 MW DC / 370 MWp AC solar farm and 345.9 MW / 691.7 MWh battery energy storage system (BESS), located at 394 Connorville Rd, Cressy, Tasmania.

SLR Consulting Pty Ltd (SLR) has been engaged by Robert Luxmoore on behalf of Connerville Estates to conduct a noise assessment to support the development application of the proposed Northern Midlands Solar Farm under the *Land Use Planning & Approvals Act 1993*.

2 Project Area

The proposed site is located on rural farmland approximately 16 km SSE of the township of Cressy. The farm is divided into two areas with the infrastructure area consisting of a Battery Energy Storage System (BESS), (capacity TBD) and a substation and solar farm in Solar West and a smaller solar farm located approximately 2.5 km south east of Solar West as shown in **Table 1**.

The infrastructure study area is sited so that the substation can utilise an existing transmission easement to feed power to the Palmerston substation located 13 km to the west.

54 noise sensitive receptors were identified within a 5 km radius of the site boundary and 500 m from the transmission line easement. See **Figure 1** for receptor locations and **Table 1** for their GDA 2020 Zone 55 coordinates.

Figure 1 Project area and close sensitive receptors

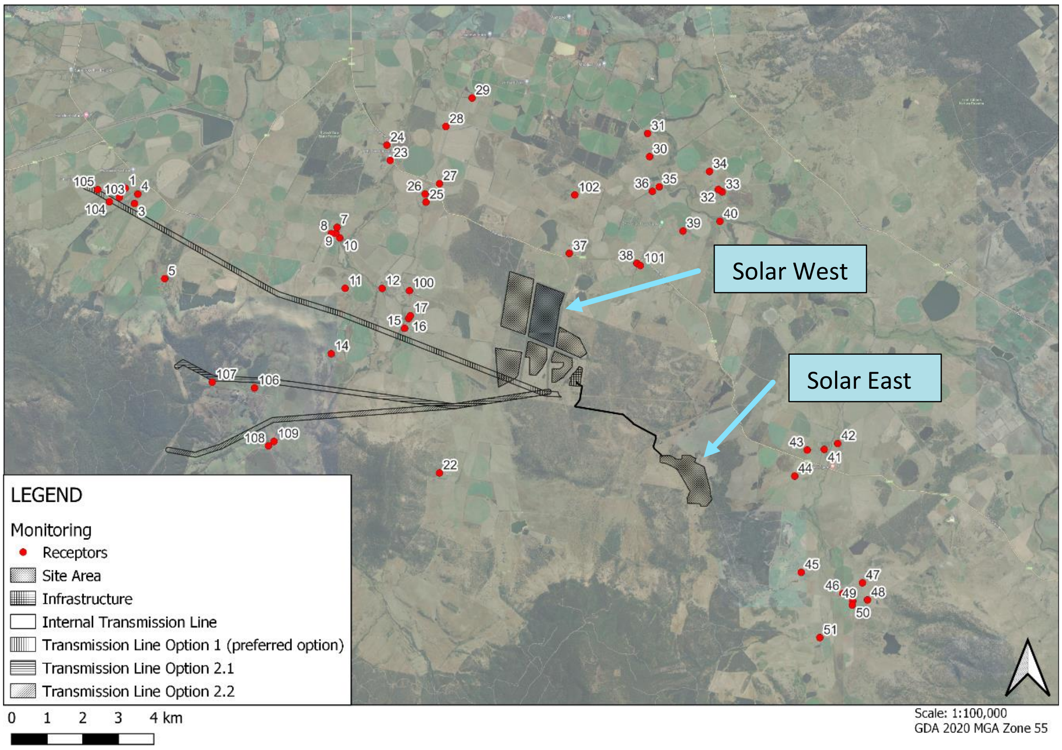


Table 1 Noise sensitive receptors

ID	Easting	Northing	ID	Easting	Northing
1	500488	5373658	35	515507	5373700
3	500747	5373230	36	515315	5373573
4	500840	5373494	37	512979	5371829
5	501597	5371117	38	514879	5371546
7	506446	5372560	39	516177	5372455
8	506281	5372383	40	517216	5372728
9	506415	5372395	41	520149	5366315
10	506521	5372263	42	520528	5366480
11	506673	5370846	43	519671	5366299
12	507714	5370843	44	519320	5365565
14	506281	5369006	45	519502	5362857
15	508345	5369720	46	520675	5362264
16	508459	5369996	47	521225	5362563
17	508506	5370075	48	521365	5362082
22	509327	5365652	49	520951	5362049
23	507940	5374442	50	520939	5361939
24	507846	5374874	51	520025	5361024
25	508947	5373270	100	508481	5370778
26	508924	5373496	101	514978	5371483
27	509328	5373789	102	513133	5373471
28	509507	5375396	103	500325	5373403
29	510243	5376197	104	500041	5373280
30	515238	5374548	105	499713	5373622
31	515183	5375198	106	504125	5368044
32	517171	5373624	107	502935	5368207
33	517279	5373556	108	504516	5366417
34	516922	5374130	109	504671	5366540

3 Project Criteria

In Tasmania, the *Environmental Management and Pollution Control Act 1994* (Act), *Environmental Management and Pollution Control (Noise) Regulations 2016* (Regulations) and the *Environment Protection Policy (Noise) 2009* (EPP Noise) regulates noise from industry. The objectives of the EPP Noise are to implement the Act and to protect the acoustic environment that are conductive to:

- The wellbeing of the community including its social and economic amenity, or
- The wellbeing of an individual, including the individual's
  - Health and
  - Opportunity to work and study and to have sleep, relaxation and conversation without unreasonable interference from noise.

The EPP Noise provides acoustic environment indicator levels, adopted from the World Health Organisation publication *Guidelines for Community Noise, 1999*. A selection of project relevant indicator levels is shown in **Table 2**. Note that these environment indicator levels are indicative, and not mandatory noise levels.

Table 2 Acoustic environment indicator levels

Specific Criteria	Critical Health Effect(s)	L_{eq} [dBA]	Time base [hours]	L_{max} fast [dBA]
Outdoor Living Area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, Indoors	Speech intelligibility & moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
Industrial, commercial, shopping and traffic area, indoors and outdoors	Hearing impairment	70	24	110

The Northern Midlands Council has published general guidelines on noise but does not have specific noise criteria for industry.

Although the acoustic indicator levels in **Table 2** are not mandatory noise limits, they can be used to form a basis for design targets.

It is noted that the background determination methodology in the Tasmanian Environment Division's document *Noise Measurement Procedures Manual* is very similar to the Rating Background Level prescribed in the NSW's *Noise Policy for Industry, 2017 (NPfI)* [2]. It is proposed to adopt the NSW procedure for defining noise targets as it is more conservative than the WHO Acoustic Environment Indicator levels.

[2] The main difference between procedures is the NSW procedure uses a 15 min assessment period, the Tasmanian procedures uses 10 minute periods. For the purposes for assessment, the Tasmanian Background Noise Level procedure detailed Part B Section 14 of the *Noise Measurement Procedures Manual* and the NSW *Noise Policy for Industry* RBL procedure are interchangeable. The 10 minute period was used for this assessment.

According to the NSW NPfI, project noise targets are the minimum of:

- Recommended Amenity Noise Levels:
  - 50/45/40 dBA for day/evening/night respectively, and
- Project Intrusiveness Noise Levels:
  - Which is the maximum of:
    - Rating Background Level + 5 dB, or
    - 40/35/35 dBA for day/evening/night respectively (rural residential settings)

For example, when background levels are low, i.e. RBL + 5 < 35 dBA, the night time noise targets are set to 35 dBA according to the minimum Project Intrusiveness Noise Levels. When background levels are high (RBL + 5 > 40 dBA), the noise targets are limited to 40 dBA according to the Amenity Noise Level.

For sleep disturbance assessments, the NSW Noise Policy for Industry recommends noise targets of:

- L_{AFmax} = 52 dBA or
- L_{AFmax} = RBL + 15 dBA, whichever is greater.

3.1 Construction Noise

The aforementioned Act, Regulations and EPP Policy also control construction noise. Part 2, Section 6 of the Regulations specifies:

1) *A person must not operate equipment, or a machine specified in Schedule 1 on -*

   a. *Any residential premises; or*

   b. *Any site where construction, or demolition, that is not the construction or demolition of a public street, is taking place –*

If the noise emitted by the equipment, or machine, when so operated is, or likely to be, audible in a habitable room in any residential premises, other than the residential premises referred to in paragraph a. whether or not the doors and windows of that habitable room are opened or closed.

Table 3 presents the prohibited hours of use for mobile machinery, forklift trucks and portable equipment, operation of such equipment is prohibited within these periods if it is likely to be audible in a habitable room. Operation of construction equipment outside of the prohibited hours of use is unlimited, provided the EPP Noise is upheld, i.e. best practice environmental management to reduce noise emissions to the greatest extent that is reasonably practical, dominant or intrusive noise characteristics of an activity should be reduced to the greatest extent that is reasonably practical etc.

Table 3 Schedule 1 – Prohibited hours of use: Mobile machinery, forklift truck or portable equipment

Day of Operation	Prohibited hours of use
Monday to Friday	Before 7 am and after 6 pm
Saturday	Before 8 am and after 6 pm
Sunday or public holiday	Before 10 am and after 6 pm

4 Existing Noise Environment

Unattended noise monitoring was conducted at the two closest identified dwellings, located approximately 4 km from the proposed solar farm, as shown in **Figure 2**. Monitoring was conducted from Monday 19 September until Monday 26 September 2022. The monitoring equipment was located outdoors and in acoustic free field conditions. Photos of the installed equipment are shown **Appendix A**. Details of the equipment are provided in **Table 4**.

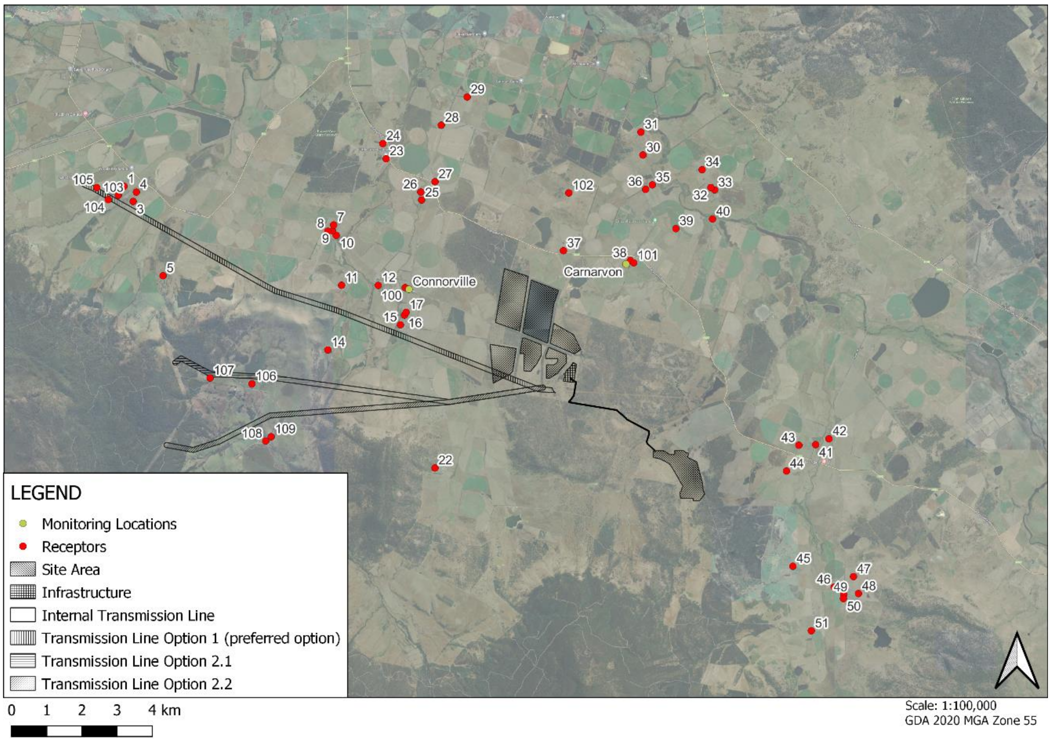
Table 4 Measurement equipment details

Location	Measurement Equipment	Calibration status
Connorville	Ngara noise monitor Serial No 8780DB	Current (calibration due 14 May 2023)
Carnarvon	Ngara noise monitor Serial No 8781BE	Current (calibration due 1 April 2023)

Noise monitoring was conducted in accordance with AS 1055:2018 *Acoustics- Description and measurement of environmental noise*. Background levels were determined in general accordance with the *Noise Measurement Procedures Manual, Second Edition July 2008*.

Weather data was obtained from the nearest Bureau of Meteorology weather station at Cressy, approximately 15 km NNW of the monitoring locations. Data potentially affected by rain or wind has been excluded from the analysis.

Figure 2 Monitoring locations



4.1 Results

Table 5 and **Table 6** presents the measured representative daily background levels for day, evening and night periods at Connorville and Carnarvon respectively. Day periods are defined in the Tasmanian Environment Division of the Department of Environment, Parks, Heritage and the Arts *Noise Measurement Procedures Manual, 2nd Edition July 2008.* The background noise levels are taken as the median of all 10 percentile $L_{90,\ 10\ min}$ values calculated over the monitoring period. The background noise levels for both locations are summarised in **Table 7.** Detailed graphs showing hourly L_{10}, L_{90} and L_{eq} levels with observations from the Cressy weather station are presented in **Appendix A**.

Table 5 Connorville background noise results

Date	10th percentile of $L_{90,\ 10\ min}$ dBA		
	Day (7am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Mon 19 Sep	26	27	23
Tue20 Sep	25	27	25
Wed 21 Sep	25	31	28
Thurs 22 Sep	26	29	29
Fri 23 Sep	24	*	30
Sat 24 Sep	35	32	24
Sun 25 Sep	23	31	25
Mon 26 Sep	25	-	-
Median	**25**	**30**	**25**

* The entire evening period of Friday 23 Sep was excluded due to wind.

Table 6 Carnarvon background noise results

Date	10th percentile of $L_{90,\ 10\ min}$ dBA		
	Day (7am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Mon 19 Sep	30	25	24
Tue20 Sep	31	26	24
Wed 21 Sep	32	29	26
Thurs 22 Sep	32	30	28
Fri 23 Sep	32	*	31
Sat 24 Sep	36	27	24
Sun 25 Sep	29	25	23
Mon 26 Sep	29	-	-
Median	**31**	**27**	**24**

* The entire evening period of Friday 23 Sep was excluded due to wind.

Table 7 Summary of background noise levels, L_{90} dBA

Location	Day	Evening	Night
Connorville	**25**	**30**	**25**
Carnarvon	**31**	**27**	**24**

4.2 Discussion

SLR Consulting completed unattended background noise monitoring for the proposed Northern Midlands Solar Farm project from 19 September to 26 September 2022.

The Environment Division adopts the World Health Organisation acoustic environment indicator levels in the EPP Noise as an indicator of environments conductive to health and wellbeing. The indicator levels are 50 dBA (L_{eq}) for day and 45 dBA (L_{eq}) for night, with an additional 60 dBA (L_{max}) criterion for sleep disturbance. These levels are significantly higher than the measured backgrounds; adopting these as targets would allow the project to drastically alter the existing ambient environment.

Therefore, it is proposed to apply the NSW Noise Policy for Industry minimum assumed rating background noise level (RBL). The minimum rating background level noise levels is applied when the measured backgrounds are very low, this is common for rural situations, as is the case here.

Project intrusiveness noise levels are defined as RBL + 5 dB. Similar to the WHO environment indicator levels, these are not directly used as regulatory limits but are used to assess potential noise impacts.

The NSW minimum Project Intrusiveness Noise Level are shown in **Table 8** along with the minimum measured background levels + 5 dB, the minimum intrusiveness levels, recommended amenity noise levels and the derived project noise targets.

Table 8 Project noise targets

Time of Day	Measured Background Level + 5 dB, dBA	Minimum Intrusiveness Noise Levels, dBA	Recommended Amenity Noise Levels (rural residential), dBA	Project Noise Targets, $L_{Aeq, 10 min}$ dBA
Day	30	40	50	**40**
Evening	32	35	45	**35**
Night	29	35	40	**35**

In order to protect existing ambient environment, it is proposed to adopt the more stringent noise targets of **40/35/35 dBA ($L_{eq, 10 min}$) for day/evening/night** respectively.

For sleep disturbance, it is also proposed to adopt the more stringent NSW Noise Policy for Industry noise target of **52 dBA (L_{AFmax})**.

5 Acoustic Investigation

This acoustic investigation assesses construction and operational noise impacts to the closest receptors. The following six construction scenarios were modelled:

- BESS Earthworks & Hardstand – involving bulk earthworks and hardstand construction of the BESS infrastructure and substation site
- BESS Infrastructure installation – construction of the BESS facility substation and auxiliary buildings
- Solar farm construction - construction of the solar arrays
- Transmission line construction – construction of transmission towers and lines, three options were assessed:
    - Option 1 (preferred option)
    - Option 2.1
    - Option 2.2

One operational scenario was modelled. All inverters in the solar array and BESS are assumed to be operating at 100% capacity and for the entire duration of the assessment period. Noise levels are also assessed against the night time noise criterion. This is considered the most conservative noise scenario.

5.1 Noise Modelling

A 3D noise model was constructed within the modelling software SoundPLAN 8.2 to predict noise levels at the nearby sensitive receivers.

Noise modelling was conducted using the ISO 9613-2[3] algorithms incorporated in the noise modelling software. The ISO 9613-2 algorithm predicts the A-weighted sound pressure levels under meteorological conditions favourable to propagation from sources of known sound power levels. This enhanced propagation is equivalent to downwind propagation or a moderate ground-based temperature inversion. The model also includes attenuation due to air absorption, ground attenuation and shielding.

5.2 General Modelling Assumptions

The following general assumptions are made based on best-practice modelling method to suit the project:

- The reflection-order of other buildings was set to three (3), indicating that the noise model allowed for three (3) reflections off façades.
- Source heights were set according to the source item.
- Receivers were set 1.5 m above ground level.
- All equipment is assumed to be in operation for the entire 1 hour assessment period.
- Ground topography within 5 km of the proposed site was sourced from publicly available 1 m elevation data published by the Tasmanian Government.

[3] ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*

- Ground absorption is modelled by a single number parameter between 0 (hard – reflective) and 1 (soft – absorptive). The infrastructure was modelled as hard ground, all other ground surfaces were modelled with a ground absorption parameter of 0.6, suitable for rural farmland.

5.3 Construction Noise Assessment

Construction activities are proposed to be undertaken during daytime hours only. Stages of the construction includes:

1. Earthworks, including compaction and drainage and construction of hardstand pads for the solar farm infrastructure.
2. Infrastructure deliveries and installation, installation of transformers and construction of onsite buildings.
3. Construction of solar panel array.
4. Construction of a 220 kV double circuit overhead transmission line between the solar farm and the Palmerston TasNetworks Sub Station located at 4554 Poatina Road, Cressy. Three transmission line options were assessed, Option 1 follows the existing transmission line easement. A parallel transmission line will be constructed adjacent to the existing 110 kV line. Options 2.1 and 2.2 involve linking up with an existing easement approximately 9 km west of the project site (as shown in **Figure 2**).

5.3.1 Sound Power Levels

Sound power levels of typical mobile plant and equipment, taken from SLR's noise database of field measurements and BS 5228-1:2009[4] are summarised in **Table 9**. For a worst-case assessment it is assumed that all equipment is operating continuously over the assessment period, due to sequencing of equipment usage that often occurs on site, this is expected to represent a conservative approach.

The loudest construction activity is anticipated to be the piling of the steel columns that support the solar panel arrays, which is completed by a specialist piece of equipment. These units are typically track mounted and diesel powered with the high-speed piling achieved hydraulically. The full sequence for completing a pile, (which includes: traversing to next pile position, lifting and loading the pile into position, hammering in the pile, releasing the hammered pile), would typically take approximately 2 minutes of which half of that interval includes the hammering phase.

It is anticipated to have six solar farm pile driver operating with the solar farm area at one time, the Solar Array installation scenario was modelled as an area source with all sound power located at one point. The levels calculated at each receptor with this method represents the worst case exposure to piling noise.

The transmission line construction is assumed to be of a steel post/truss construction. The dominant noise sources will be concentrated around the construction of the post footing, i.e. excavation, hammering and piling.

[4] *Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise*

The contour maps presented in **Section 6** show the resulting noise levels if construction of each footing was carried out in sequence. Noise emissions from one footing is not combined with emissions from the next. Similarly to the solar farm construction scenario, this analysis shows the worst case situation. Impacts to any one receptor during the construction activity will be relatively short term as the work front progresses to other footings.

The earthworks + hardstands and infrastructure delivery and instalment scenarios were modelled as area sources covering the infrastructure study area. The overall sound power level is distributed over this area.

Table 9 Construction equipment sound power levels

Scenario	Equipment	Quantity	SWL, per item, $L_{Aeq, 15 min}$	Overall, $L_{Aeq, 15 min}$
Solar Array Install	Solar Farm Pile Driver	6	117[1]	125
Earthworks + Hardstand	Excavator	2	104	123
	Dozer	1	108	
	Grader	1	104	
	Dump Truck	2	102	
	Vibratory Roller	1	105	
	Concrete Truck	4	104	
	Concrete Pump	4	102	
	Concrete Poker	4	97	
	Rock Breaker	1	121	
	Chain Trencher	1	102	
	Rock Saw	1	113	
	Water Truck	1	111	
	Diesel Generator	4	94	
	Diesel Pump	2	97	
Infrastructure Delivery and Construction	Trucks	2	102	115
	Powered Hand Tools	4	102	
	Forklift or Telehandler	1	102	
	20 t Franna crane	1	98	
	Diesel Generator	4	94	
	Diesel Pumps=	2	97	
	Elevated Working Platform (EWP)	3	95[2]	
Transmission Line Construction	Trucks	1	102	122
	Powered Hand Tools	2	102	
	Crane	1	98	
	Rotary Piling Rig	1	112	
	Concrete Truck	2	104	
	Concrete Pump	2	102	
	Rock Hammer	1	121	

Scenario	Equipment	Quantity	SWL, per item, $L_{Aeq, 15 min}$	Overall, $L_{Aeq, 15 min}$
	EWP	3	95[2]	

1 A 5 dB penalty has been applied to the solar farm pile driver due to impulsive noise characteristics

2 A 5 dB penalty has been applied to the EWP due to tonality noise characteristics

5.4 Operational Noise Assessment

5.4.1 Sound Power Levels

Sound power levels of noise producing equipment shown in **Table 10** are typical of currently available equipment. All items are assumed to be in operation for the entire 1 hour assessment period, thus 15-minute and 1-hour noise data are identical. The medium voltage power station inverters are also assumed to operate at 100% capacity (i.e. maximum fan speed) 24 hours each day.

Since only overall sound pressure levels were provided for some equipment, the spectrum for the transformers were adopted from refence data by Bies and Hanson (11.16). These spectra are shown in **Table 11**.

Table 10 Equipment sound power levels

Qty	Item	Sound Pressure Level (SPL), $L_{eq\ 15\ min}$, dBA	Overall Sound Power Level (SWL), $L_{eq\ 15\ min}$, dBA
71	Inverter	62 dBA at 10 m	90 per unit
96	Battery enclosures	63 dBA at 1 m per unit	71 dBA per unit
2	HV Transformer	N/A	92 dBA per unit
4	Auxiliary transformers	56 dBA at 1 m	65 dBA per unit

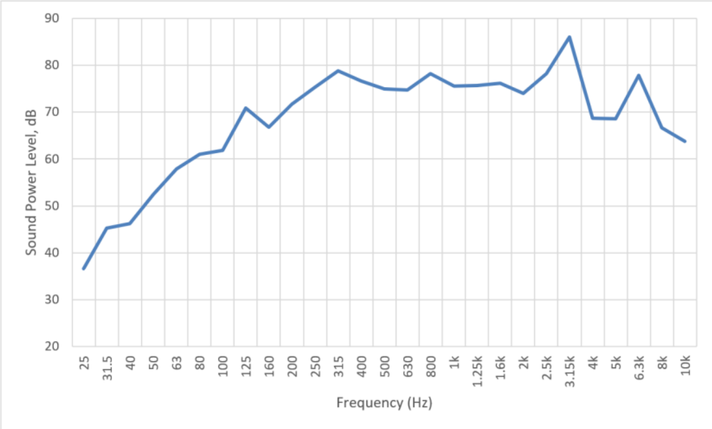
Table 11 Nominative noise spectra

Item	Octave Band Centre Frequency, Hz -linear weighting, dBZ								dBA
	63	125	250	500	1k	2k	4k	8k	
Inverter	63	73	81	80	81	81	86	78	**90**
BESS battery enclosure chiller & Combiner cabinet chiller	68	69	69	68	66	62	58	52	**71**
HV Transformer	94	96	92	92	86	81	76	69	**92**
Aux. Transformer	67	69	65	65	59	54	49	42	**65**

The 1/3 octave sound power spectrum for a typical inverter used in the assessment is shown in **Figure 3**. Note the tones at 125, 3.15k and 6.3k Hz. The inverters were modelled with the 1/3 octave data but are summarised in **Table 11** as octaves for convenience.

The inverter units were modelled as point sources within the solar farm areas according to the Entura PV Concept Layout. The BESS and substation equipment were summed and modelled as an area source encompassing the infrastructure study area.

Figure 3 Nominative inverter sound power level spectrum



6 Assessment Results

6.1 Construction Noise Results

Table 12 presents the construction noise results for the assessed scenarios. It is important to note the transient nature of construction noise, particularly over large areas with a moving work front, such as the solar array and transmission line construction. Receptors with predicted elevated noise levels will be impacted for a relatively short period of time i.e. less than a week, as the work front moves away from the receptor.

Noise contour plots for these scenarios are shown in **Figure 4** to **Figure 9**.

Table 12 Construction noise results

Scenario	Number of receptors				
	Less than 40 dBA	40 to 50 dBA	50 to 60 dBA	60 to 70 dBA	above 70 dBA
Earthworks & Hardstand	54	-	-	-	-
Infrastructure	54	-	-	-	-
Solar Array Construction	51	3	-	-	-
Transmission Line Option 1	40	4	5	4	1
Transmission Line Option 2.1	51	1	1	1	-
Transmission Line Option 2.2	51	2	1	-	-

Figure 4 Construction results – Earthworks and Hardstand

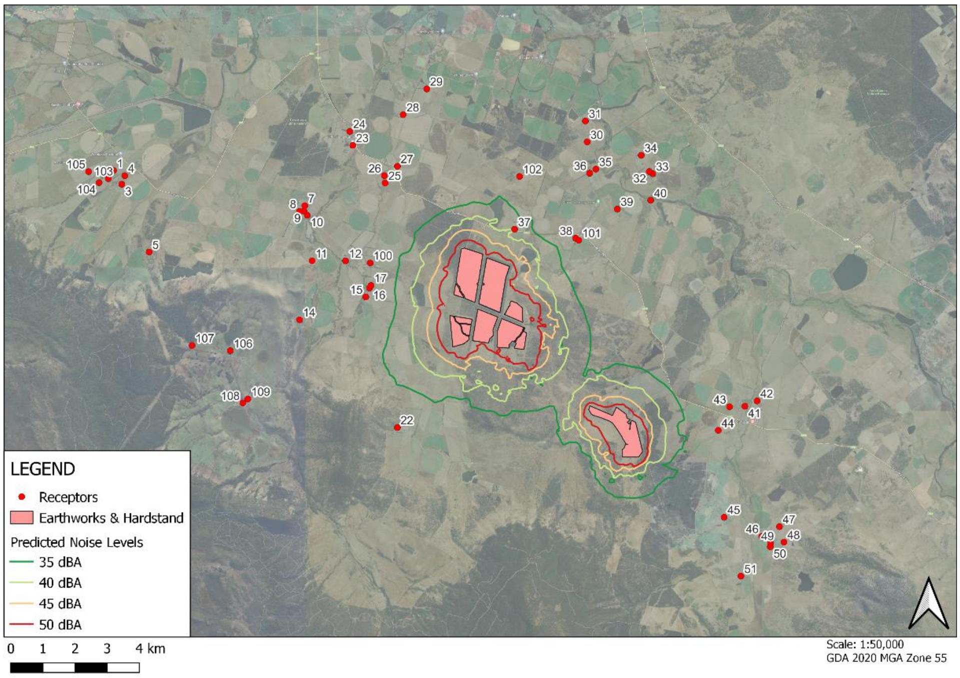


Figure 5 Construction results - Infrastructure

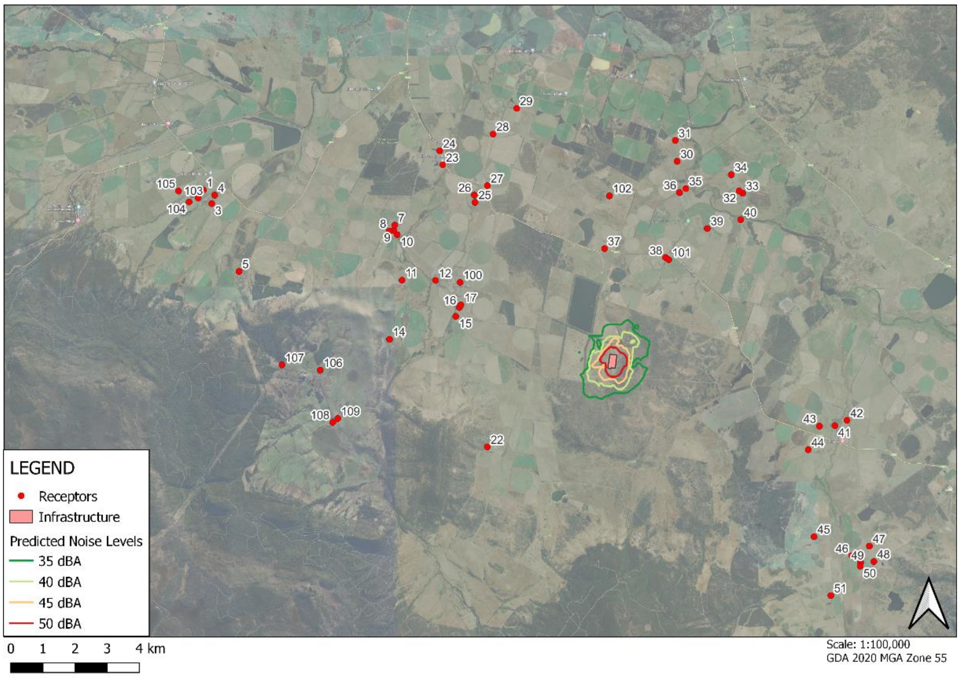


Figure 6 Construction results – Solar Array

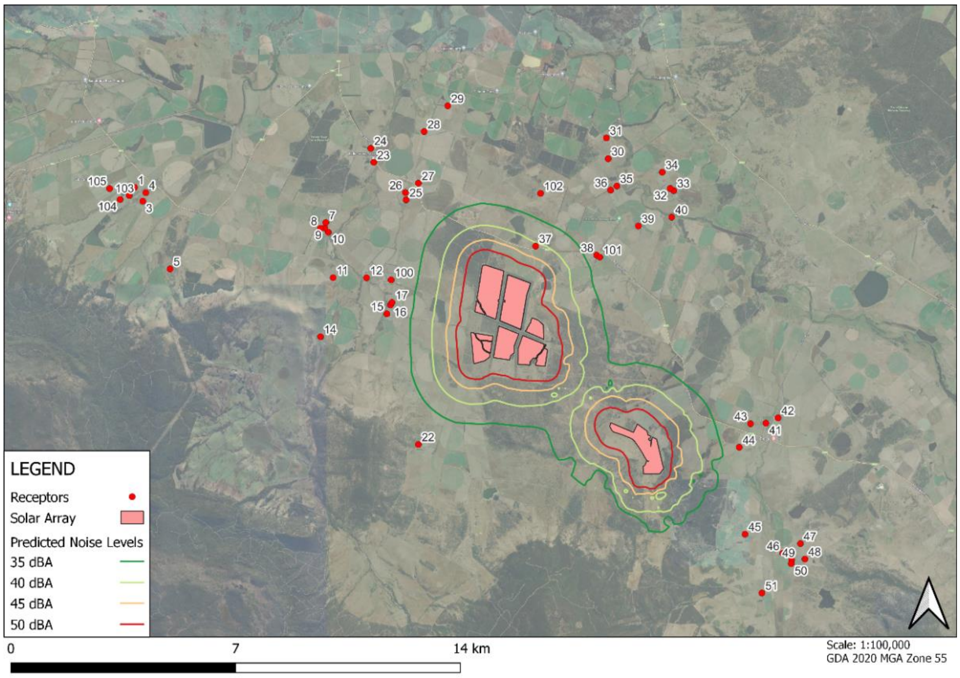


Figure 7 Construction results – Transmission Line Option 1

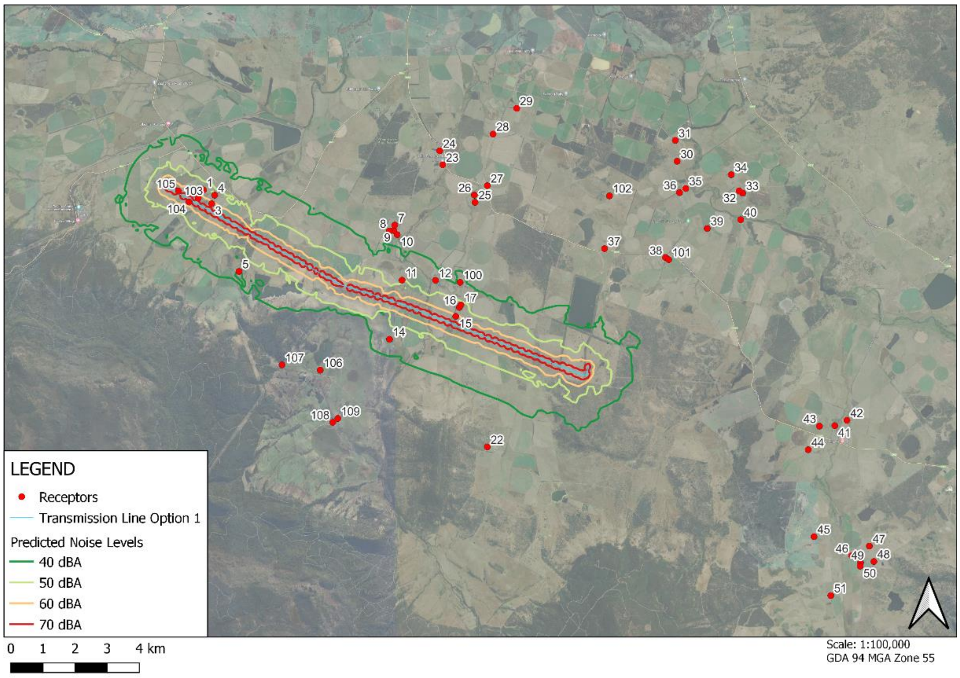


Figure 8 Construction results – Transmission Line Option 2.1

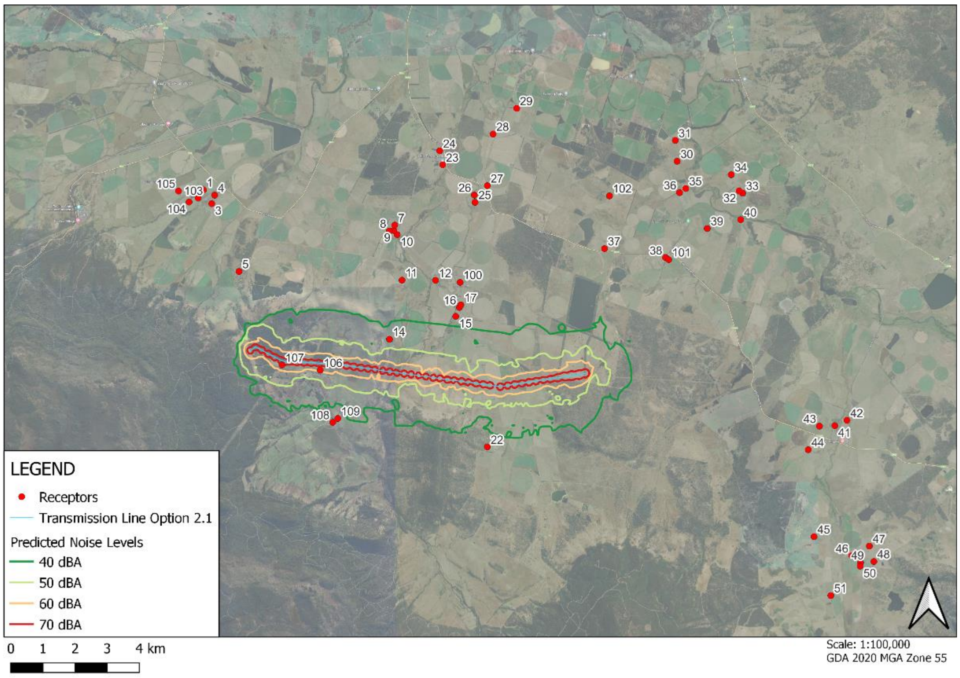
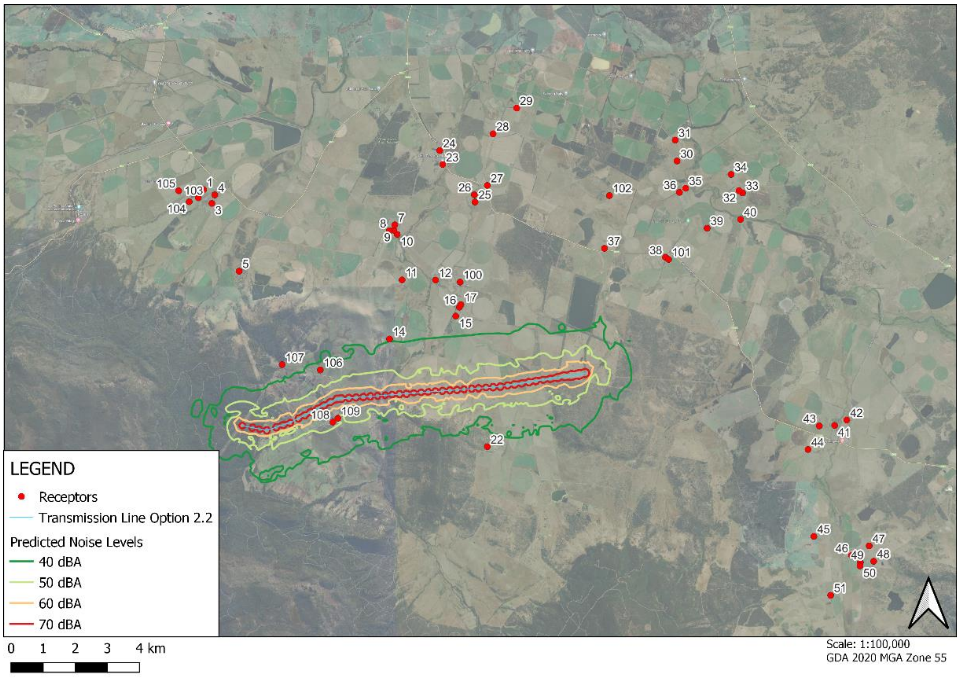


Figure 9 Construction results – Transmission Line Option 2.2



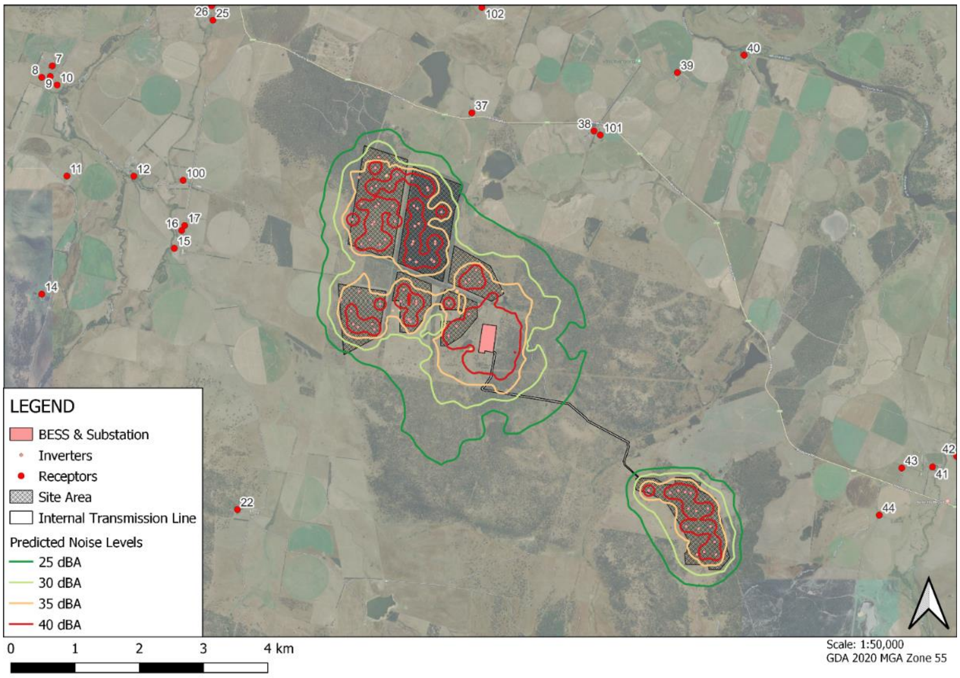
6.2 Operational Noise Results

Table 13 shows the predicted noise levels at the identified sensitive receptors compared with the night time noise goal of 35 dBA. Compliance can be achieved at all receptors without additional noise mitigation. **Figure 10** shows the predicted operational noise contours.

Table 13 Operational noise results

Scenario	Number of receptors					Noise Goal, dBA
	Less than 35 dBA	35 to 40 dBA	40 to 45 dBA	45 to 50 dBA	Above 50 dBA	
Operational noise	54	-	-	-	-	35

Figure 10 Operational noise



6.2.1 Transmission Lines – Corona Noise

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It generally only occurs in humid conditions, as provided by fog or rain. A minimum line potential of 70 kV or higher is required to generate corona noise depending on the electrical design. Corona noise does not occur on domestic distribution lines.

Corona noise has two major components, a low frequency tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing' and is generally only a feature during foggy or raining conditions.

SLR has previously measured corona noise at a site near Officer in outer Melbourne, Victoria. It was possible to measure corona noise at close distances, at high frequencies only, as other noise sources, namely traffic and birds, caused some interference at times. A 500 kV line was measured during damp foggy conditions.

At a distance of 30m along the ground from the line a L_{eq} noise level of approximately 44 dBA was measured. At a distance of 100m the corona noise was calculated to be approximately 39 dBA.

Based on these measurements it is noted that corona noise from the existing transmission line may be audible at the receptors in the vicinity of Palmerston Sub Station (receptors 3, 103, 104 and 105), as shown in **Figure 11**. The impact of running additional 220 kV lines (Option 1) will not significantly increase existing corona noise emissions.

Figure 11 Transmission line corona noise

The closest receptors to Option 2.1 are receptors 106 and 107, corona noise from the proposed transmission lines can potentially exceed 35 dB at those receptors under the correct conditions. Corona noise is not expected to be audible at any receptors in Option 2.2 is selected.

7 Discussion

7.1 Construction Noise

Construction of the solar farm is predicted to not adversely impact amenity of nearby sensitive receptors due to its remoteness. Piling of the solar array steel columns may be audible from the closest receptors i.e. Receptor 37 to the north, for a short period as the closest row of piles are driven.

Construction of the transmission lines will be audible from several receptors regardless of the option chosen. Option 2.2 is the least impactful as the closest no closer than 500 m to a sensitive receptor. Option 1 will impact the receptors near Palmerston substation, however the work is temporary and should be conducted outside of the prohibited hours as defined in the Act.

The Australian Standard AS2436-2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* sets out numerous practical recommendations to assist in taking all reasonable and practicable measures to prevent or minimise noise impacts.

All construction works will be completed under a Construction Environmental Management Plan (CEMP).

Noise control strategies to be considered are listed below:

- Ensure construction works to occur outside of the prohibited hours as defined in the Act (see **Table 3** for a summary of the prohibited hours)
- Notification of receptors of the proposed works schedule and potential noise impacts and relevant contacts for queries or complaints.
- Incorporate clear signage at the site including relevant contact numbers for community enquiries.
- The lowest noise emitting plant and equipment that can economically and efficiently undertake the work should be selected where possible.
- Maintain regular maintenance of equipment to keep it in good working order and operating at the lowest feasible noise level.
- Use less intrusive broadband reversing beepers on mobile plant where possible.
- Equipment operators are to be made aware of noise impacts and techniques to minimise emissions through training/instruction, examples include:
    - Avoid dropping materials from height into bins, trucks and receptacles.
    - Operate mobile plant and power tools in a quiet, efficient manner where possible.
    - Switch plant off when not in use
- Machines/tools found to produce excessing noise compared with industry best practice should be removed from service until repairs or modification can be made, or the machine/tool is replaced.
- Where possible avoid tonal reversing/movement alarms on machinery and replace with broadband (non-tonal) alarms or ambient noise-sensing alarms.
- Use dampened bits on impulsive tools (e.g. ratchet drivers) to avoid 'ringing' noise.

7.2 Operational Noise

Predicted operational noise levels at all sensitive receptors are less than the night time noise goal of 35 dBA, thus compliance with the *Environment Protection Policy (Noise) 2009* can be achieved.

The operational noise assessment presented in this report is to be considered a conservative approach, i.e., inverters and battery cooling systems and HV transformers operating at 100% capacity all the time combined with atmospheric conditions favourable to noise propagation.

All plant will be reviewed during detailed design to ensure that compliance with the noise goals can be maintained through the selection of equipment and site layout.

The potential of additional transmission lines along the existing transmission easement will likely not drastically alter the existing environment.

8 Conclusions

This Noise Impact Assessment was prepared to support a Development Application of the Northern Midlands Solar Farm project at 394 Connorville Rd. This report presents background noise measurement results, noise goals, assessment methodology, results and management strategies to minimise noise impacts to sensitive receptors as far as reasonably practicable.

Construction noise impacts are considered relatively minor due to distances to sensitive receptors. Impacts are further minimised by scheduling works to day periods and a combination of training/equipment maintenance and community engagement. Noise control strategies given in **Section 7.1** should be implemented in the Construction Environmental Management Plan (CEMP).

Compliance with the relevant noise legislation is achieved at all sensitive receptors with additional mitigation. All plant will be reviewed during the detailed design stage to ensure that compliance with the noise goals is maintained as the acoustic performance of plant and site layout is refined, followed by post commissioning noise measurements to confirm compliance.

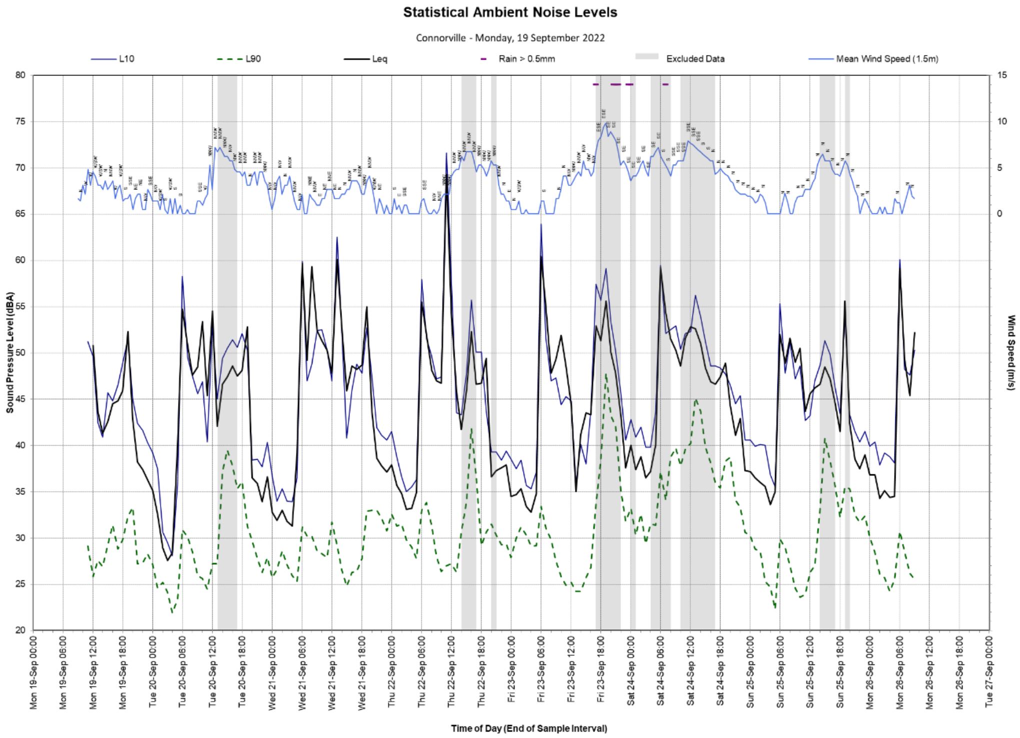
Appendix A:

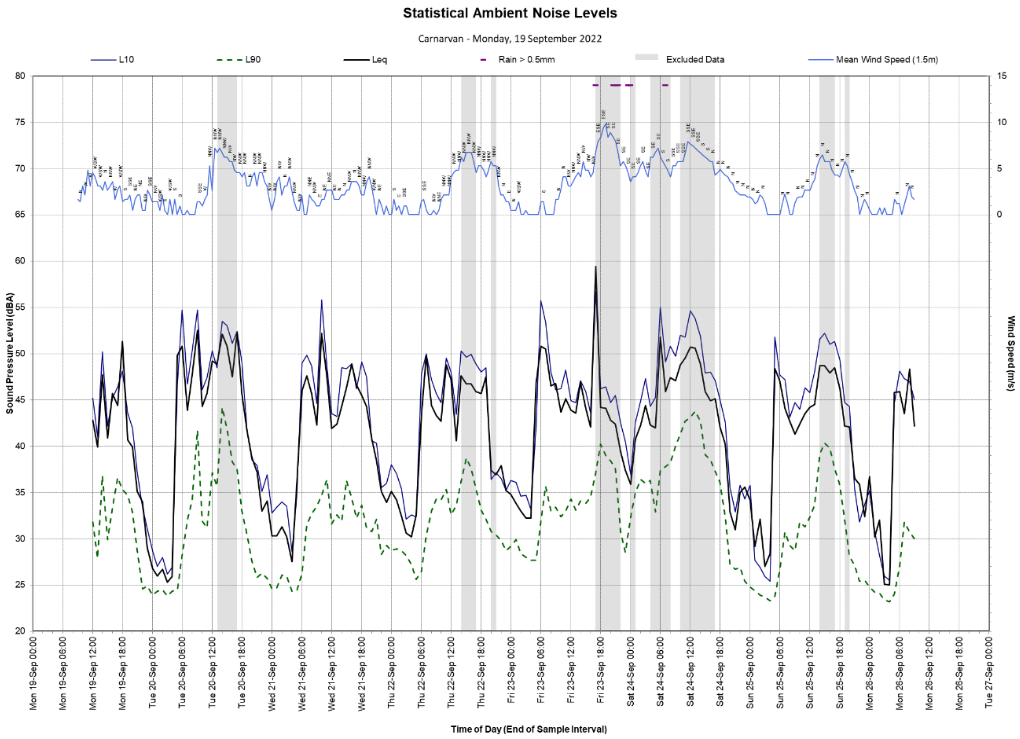
Monitoring Results

Figure 12 Connerville noise monitor

Figure 13 Carnarvon noise monitor

The following figures present detailed noise summaries showing hourly L_{Aeq}, L_{A90} and L_{A10} levels and with weather. Excluded data is highlighted with grey boxes.





ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CAIRNS
Level 1, Suite 1.06
Boland's Centre
14 Spence Street
Cairns QLD 4870
Australia
T: +61 7 4722 8090

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
1/25 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Level 1, 500 Hay Street
Subiaco WA 6008
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
201 Victoria Street West
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

www.slrconsulting.com