Appendix F – Flood Modelling Study

Appendix F - Flood Assessment

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Quality Information

Document Appendix F – Flood Assessment

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1.0 Introduction

In order to address the Secretary's Environmental Assessment Requirements (SEARs) for the proposed Springdale Solar Farm (SSF) (the project) being developed by Renew Estate Pty Ltd, a flood assessment has been undertaken to evaluate the existing flood risk across the site, provide input into the design of the project, and to develop mitigation measures where necessary.

1.1 Study area and project overview

The proposed project will be located in Sutton, NSW, within the Yass Valley Council area, approximately 3.5km northeast of the ACT border (see Figure 1 in Annexure A). The project site is approximately 370 hectares in size (the Site), of which approximately 190 hectares will be occupied by the solar farm and associated infrastructure (the development envelope).

The proposed project would include the following key components:

- Photovoltaic (PV) solar modules on a single-axis tracking system mounted on steel piles
- Approximately 22 containerised power conversion stations, containing electrical switchgear, inverters and transformers
- An electrical switchyard and substation that would be connected to the existing 132 kilovolt (kV) TransGrid transmission line that traverses the Site
- DC and AC cabling for electrical reticulation
- A control building including office, supervisory control and data acquisition (SCADA) systems, operation and maintenance (O&M) facilities, staff amenities, and associated carpark
- Two meteorological stations
- Internal all-weather access tracks
- Security fencing
- Landscaping
- Subject to the execution of a Voluntary Planning Agreement with the Yass Valley Council (YVC) and agreement on the relevant works, construction of a new public road connection between Tallagandra Lane and Tintinhull Road (referred to in this EIS as Tintinhull Road re-alignment)
- Subject to the execution of a Voluntary Planning Agreement with the YVC and agreement on the relevant works, subdivision of Lot 202 DP754908 to create a proposed new lot to be dedicated as a public road for the proposed Tintinhull Road re-alignment.

The single-axis tracking system would orient the solar modules to follow the sun from east to west throughout the day. The tracking structures would be mounted on piles, which would be screwed or pile driven depending on final geotechnical analysis. This eliminates the need for concrete and foundations which significantly reduces the impact of construction. In turn, this enables the retention of grasslands under the array.

This construction methodology also keeps ground disturbance to a minimum and allows the final design to follow the existing lie of the land. The intention of the project is to maintain the existing vegetation on-site as far as practicable. Ongoing vegetation management, in collaboration with the final bushfire management and environmental management plans, would be facilitated by grazing of sheep under and around the operational panels.

The on-site switchyard and substation would lie adjacent to the existing 132kV TransGrid Easement. Final design will be carried out in collaboration with TransGrid and the Australian Energy Market Operator (AEMO). Civil and earthworks would be carried out to meet the transmission substation design guidelines.

The operational lifetime of the solar farm is 30 years, at which time the Site would either be decommissioned or continue to operate subject to further approval and commercial considerations.

Decommissioning would remove all above ground infrastructure and rehabilitate the Site to return it to its predevelopment condition.

2.0 Method of assessment

The objective of this study was to assess the existing flood behaviour across the Site to inform project planning and design. The flood assessment for the Site was undertaken using a two dimensional (2D) TUFLOW hydraulic model, with inputs from a hydrologic model using WBNM software.

The 1% Annual Exceedance Probability (AEP) and 0.2% AEP design flood events were simulated. The 1% AEP is the standard flood planning level adopted for most infrastructure projects in NSW. The 0.2% AEP event was used as a proxy for potential future climate change, approximately representing a 1% AEP event with a 30% increase in rainfall intensities. A 30% increase in rainfall intensities is associated with a climate change horizon of 2100, based on current climate change predictions.

It should be noted that the assessment has been based on Australian Rainfall and Runoff (ARR) 1987, not the Draft ARR 2016. Due to its recent release for industry comment only, the latest version of ARR has yet to be formally released or widely implemented.

2.1.1 Data inputs

The flood assessment was based on the following key data sets:

- LiDAR data obtained in 2017 provided by Renew Estate. The LiDAR data was used to generate catchment boundaries, and to define the floodplain topography and watercourse bathymetry for the 2D hydraulic model.
- Site boundary and development envelope provided by Renew Estate.
- Intensity-Frequency-Duration (IFD) data, sourced from the Bureau of Meteorology (BoM).

2.2 Hydrologic model

A hydrologic model covering the catchment draining to the Site was developed using WBNM software. The total catchment draining to the Site is approximately 3460 hectares. The Back Creek catchment draining to the eastern part of the Site is approximately 2270 hectares and the unnamed creek draining to the western part of the Site about 1190 hectares. The critical duration for peak flows for both catchment areas was estimated to be 2 hours.

Key hydrologic modelling parameters adopted were:

- A catchment lag factor of 1.4.
- A stream lag factor of 1 for all catchments, representative of the natural channels.
- Initial Loss (IL) = 10mm and Continuing Loss (CL) = 3mm/h for all events.
- Impervious fractions of 3-5% were estimated for the rural landscape.
- Storage associated with farm dams was not included in the hydrologic model. The farm dams are relatively small and would not provide much attenuation for flows. Particularly assuming they may be full at the start of the critical storm event.

Peak flows from the WBNM model were compared against the Probabilistic Rational Method (PRM). The estimated peak flows from WBNM are slightly higher than those based on the PRM by approximately 20%, but considering the variability and uncertainty in input parameters, the peak flows estimated from WBNM are still considered to be appropriate for use in this assessment.

Table 1: Estimated peak discharges for the critical duration at the upstream inflow boundary (m^3/s)

Catchment	1% AEP		0.2% AEP	
	WBNM	PRM	WBNM	PRM
Unnamed Creek	50.6	43.9	96.8	N/A**
Back Creek	87.7	71.5	139.6	N/A**

*: The PRM does not cover events with magnitude greater than 1% AEP.

2.3 Hydraulic model

The hydraulic model was developed using the TUFLOW software package (Version 2016-03-AC-w64) and was used to estimate flood extents, depths and velocities within the Site.

The model covers the majority of the Site (350 hectares). Some areas on the edges of the Site boundary could not be included in the model due to the limits of the LiDAR coverage (see Figure 3 in Annexure A). The LiDAR covered the area within the Site boundary exactly, but did not extend beyond the Site boundary. Outside the LiDAR coverage there is limited high accuracy terrain data available. To allow for all inflow and outflow boundaries to be defined perpendicular to the flow direction, as is standard practice, the model extent had to be fitted within the Site boundary and could not extend much beyond it.

Key hydraulic model parameters adopted were:

- Grid size 5x5m using LiDAR to represent underlying topography. The grid size was selected to allow the features of the main creek channel and floodplain to be represented with sufficient accuracy while maintaining efficient model run times.
- Inflow hydrographs from the hydrologic model were applied at the upstream model boundaries.
- Direct rainfall (or 'rain-on-grid') was applied within the TUFLOW model extent, using the same IFD data as used in the hydrologic model.
- The downstream boundary was set as a stage-discharge curve, based on the average channel slope in the vicinity of the boundary. Ideally the downstream boundary would have been set further away from the Site, but the extent of available LiDAR was a constraint.
- Areas with similar land use and vegetation cover types were defined within the 2D domain and assigned appropriate roughness values (Manning's 'n' coefficients, see Table 2).

It should be noted that the culvert under Tallagandra Lane at the unnamed creek crossing has not been included in the model. The exact size and invert levels of the culvert are unknown, but judging by the low level of the road at the crossing (see Figure 2 in Annexure A), it is likely that the culvert (with relatively low capacity) only caters for smaller storm events and that the majority of flows would overtop the road in events such as the 1% AEP. It is also quite likely that the culvert would be blocked at least partially by debris during major storm events. The implications of these assumptions would only influence flood levels in the immediate vicinity of the crossing, but would not affect flood behaviour across the majority of the Site.

The critical duration for peak water levels was found to be 3 hours, which is slightly longer than the critical duration for peak flows from the hydrologic model.

Table 2 Adopted Manning's "n" Roughness Values

Land use category	Manning's "n"
Waterway	0.03
Trees	0.08

Land use category	Manning's "n"
Farm dams	0.03
Gravel road	0.04
Floodplains	0.05

3.0 Existing environment

The Site contains a number of creek/drainage lines and farm dams as illustrated in Figure 3 in Annexure A. The creek/drainage lines generally flow in a southwest to northeast direction across the Site, and drain towards the Yass River approximately 10km downstream.

As shown on Figure 3 in Annexure A, Spring Flat Creek runs west of the Site and Back Creek runs through the eastern portion of the Site. Another unnamed creek runs from south of Tallagandra Lane through the western portion of the Site. Back Creek and the unnamed creek join approximately 1km downstream of the Site. Several smaller drainage lines cross the Site and drain towards the creeks.

Within the Site the floodplain of the unnamed creek is between 150m to 250m wide, with 1% AEP flood depths of less than 0.5m on the floodplain areas (see Figure 4 in Annexure A). The floodplain along Back Creek is slightly more extensive, being about 200m to 350m wide within the Site. The flood depths on the Back Creek floodplain are generally less than 1m in the 1% AEP.

Velocities during a 1% AEP event are approximately 1 to 2m/s in both creeks, but less than 1m/s outside the main channels (see Figure 5).

3.1 Climate change

Under future climate change conditions the extent of flooding along the unnamed creek would not be significantly greater than under current conditions, but flood depths could be up to 0.5m higher along the floodplain. Along Back Creek the floodplain could be more extensive, as can be seen from Figure 6 in Annexure A, and flood depths would also be about 0.5m higher than under current conditions. This is a conservative estimate as the climate change scenario looked at a conservative horizon of 2100. The project life is estimated to be 30 years, which means that in that time frame impacts on flooding due to climate change are likely to be much less.

3.2 Potential impacts

3.2.1 Construction

During construction there is the potential for inundation of site compounds, construction equipment, stockpiles and storage areas if these are located close to or within the main floodplain areas. This could present a safety hazard to construction personnel, damage to equipment and could potentially lead to materials being washed into the creeks.

Flood impacts to surrounding properties would be negligible as the footprint of the temporary works compared to the wider floodplain area would be small.

3.2.2 Operation

During operation there is the potential for minor inundation of the solar field areas during a 1% AEP event. The proposed locations of the solar fields have been set outside 1% AEP flood depths of >0.4m, which is the maximum depth beyond which is deemed by the project owner as an unacceptable risk to the asset. During a storm event the modules can be stowed horizontally until flood levels subside.

The proposed location of the control building has been set outside 1% AEP flood depths of >0.25m, which is the maximum depth beyond which is deemed by Renew Estate as an unacceptable risk. The control building may be raised on a concrete slab to further reduce flood risk.

The proposed location of the substation has been set outside the 1% AEP flood extent.

Flood impacts to surrounding properties would be negligible as the solar panels are raised above the floodplain with only the supports potentially presenting an obstruction to flows. The installation of impervious solar arrays would not increase runoff from the Site, as they would allow rainwater to drain to the ground underneath the arrays and follow similar flow paths to those currently present on the Site.

Where practical, access roads would be built close to existing ground level similar to the construction of the existing Tallagandra Lane.

4.0 Mitigation measures

4.1 Construction

During construction flood impacts would be managed by locating temporary site compounds, stockpiles and storage areas outside the 1% AEP flood extent where possible.

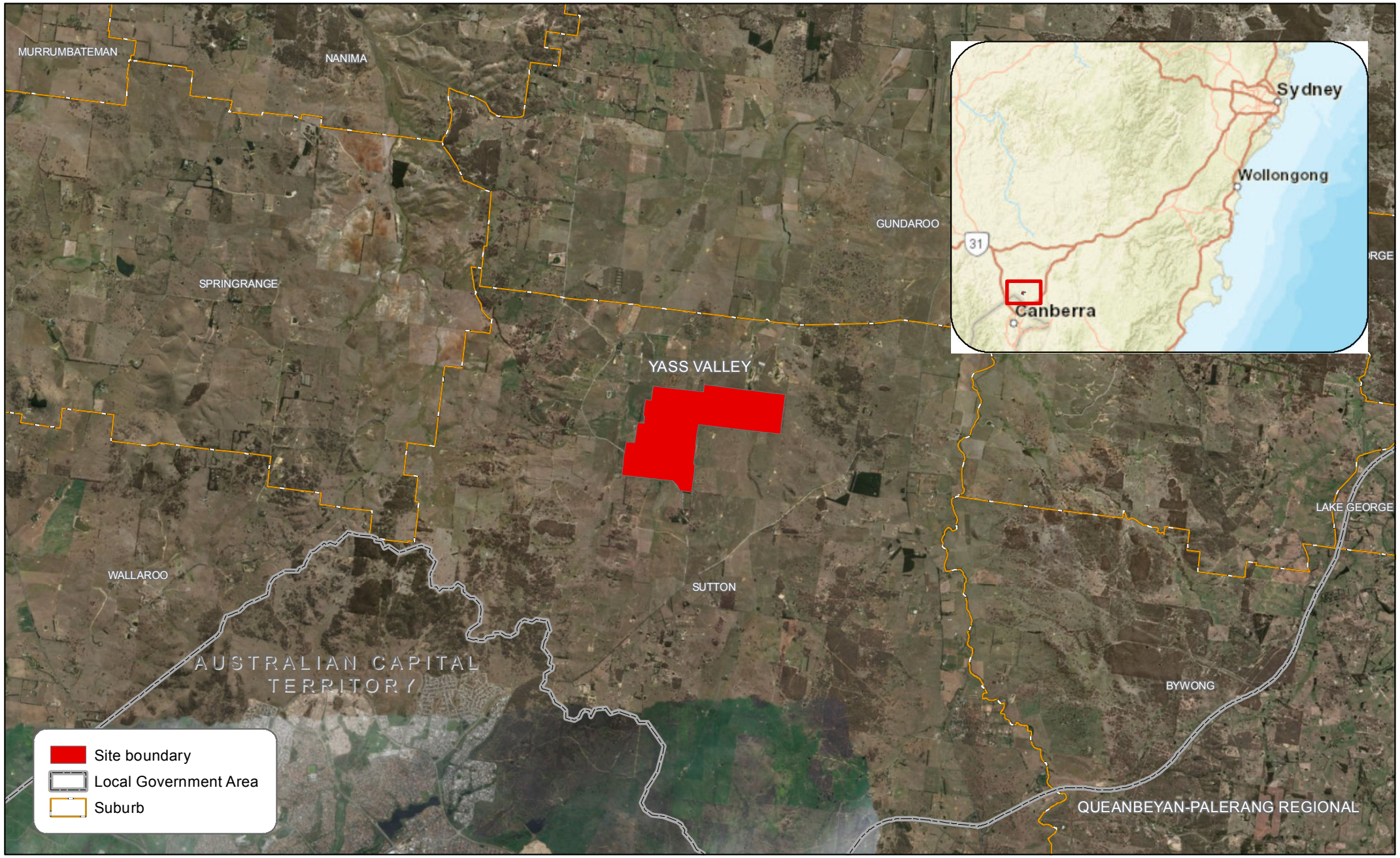
4.2 Operation

The flood modelling undertaken for the Site informed the layout of the project. The potential operational flood impacts associated with the project have been assessed based on the following measures implemented through the design:

- The substation would be located outside the 1% AEP flood extent.
- The control building would be set outside 1% AEP flood depths of >0.25m, which is the maximum depth beyond which is deemed by Renew Estate as an unacceptable risk. The control building will be raised on a concrete slab to further reduce flood risk.
- Solar field areas would be set outside 1% AEP flood depths of >0.4m, which is the maximum depth beyond which is deemed by Renew Estate as an unacceptable risk to the asset. Further, during a storm event the modules can be stowed horizontally until flood levels subside.
- Access roads required within the 1% AEP flood extent would be constructed close to existing ground levels where possible and practical.

Annexure A

Figures



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Renew estate.

NORTH

0 1.5 3 6 km

SPRINGDALE SOLAR FARM

SITE CONTEXT

DATE	12/03/2018
SCALE	1:100,000
PROJECT	60555008
DRAWN	PH

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2018. Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia,

Figure 2 Unnamed creek crossing at Tallagandra Lane

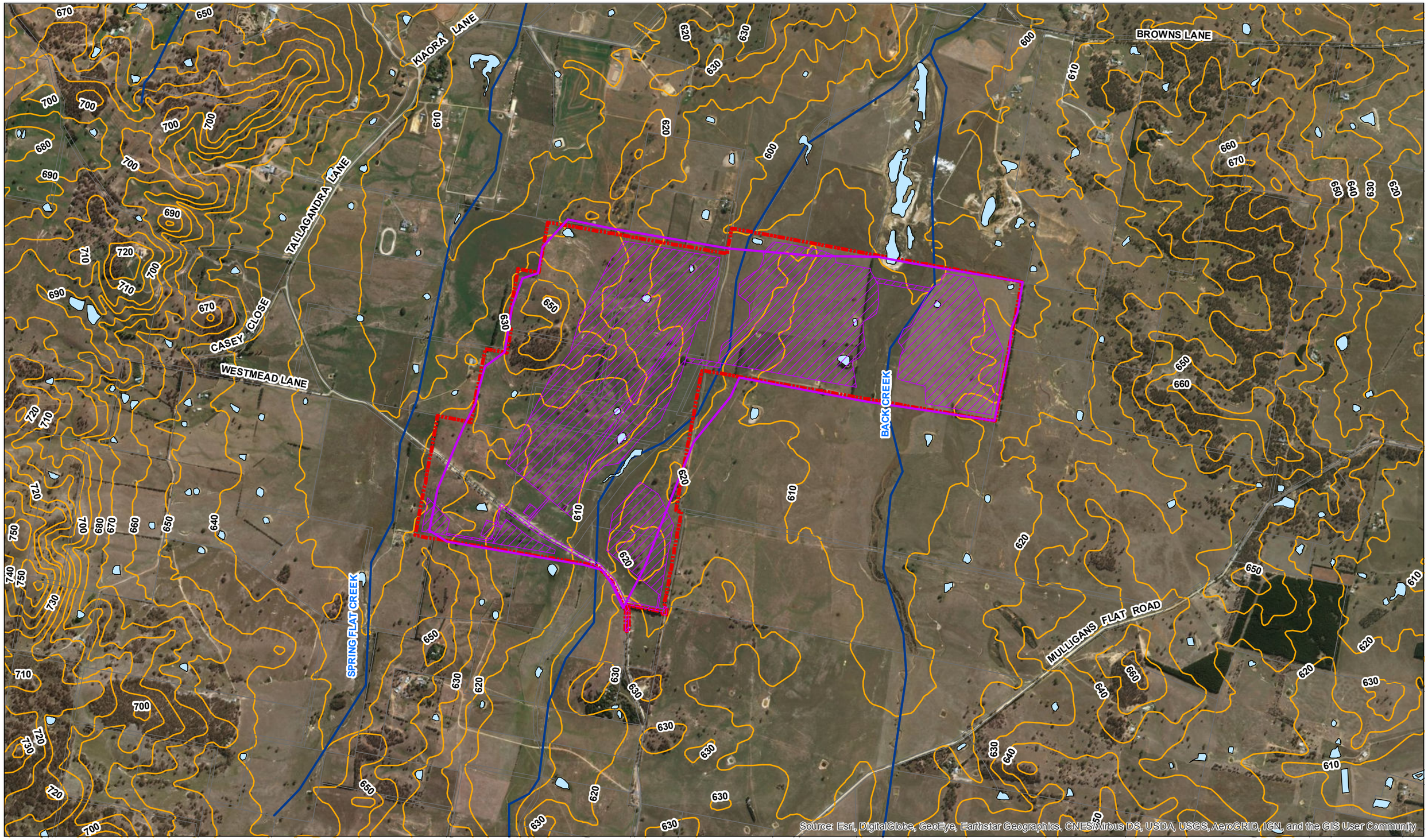
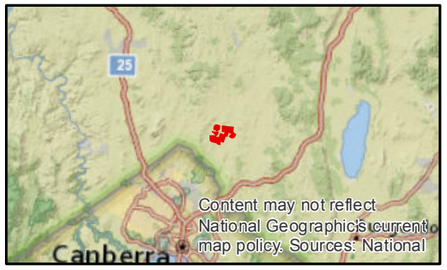


Figure 3: Springdale Solar Farm - Flood Model Extent

LEGEND

- Cadastre
- Site Boundary
- Development Envelope
- Flood Model Extent
- Drainage/Creek Lines
- 10m_Contours
- Waterbodies



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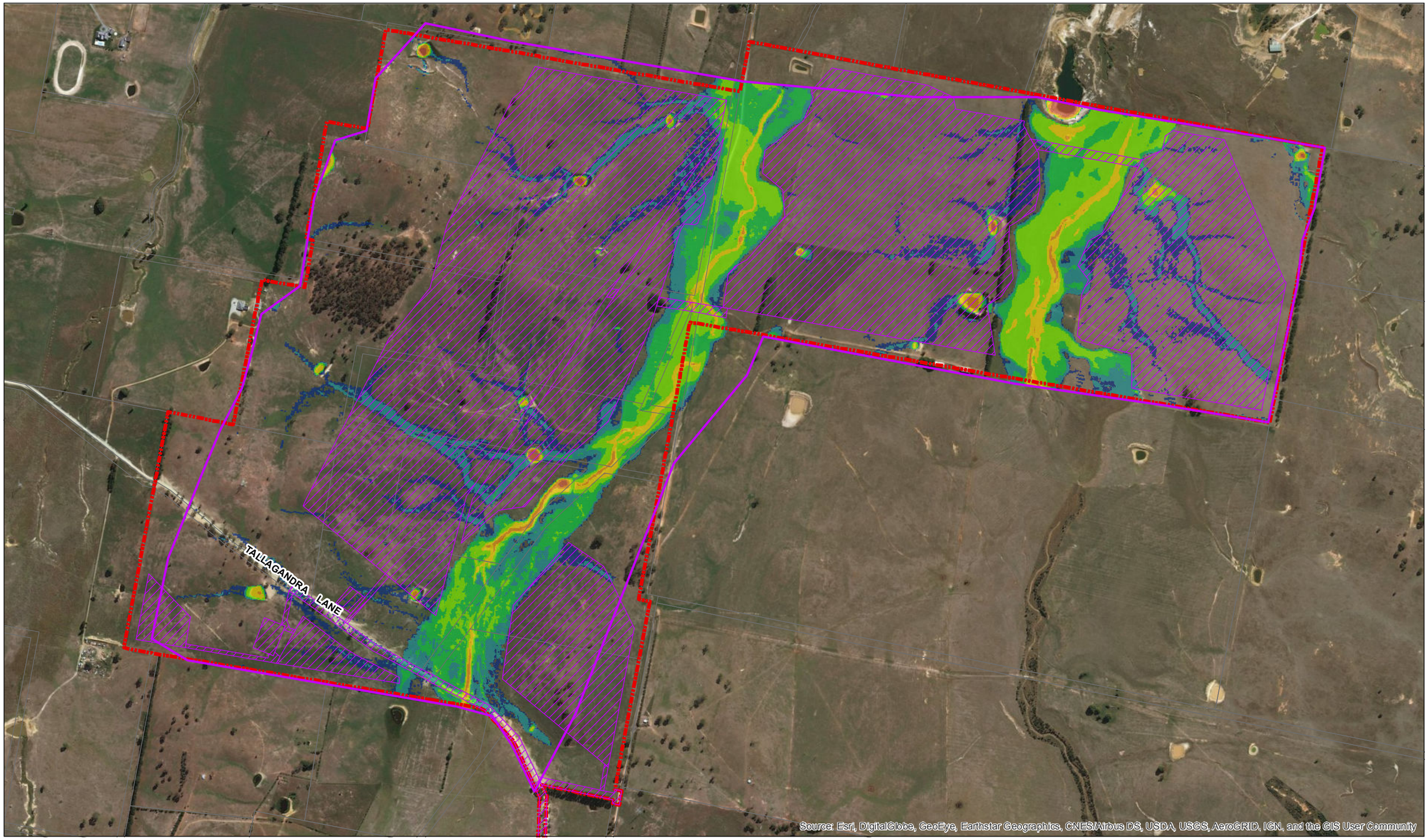


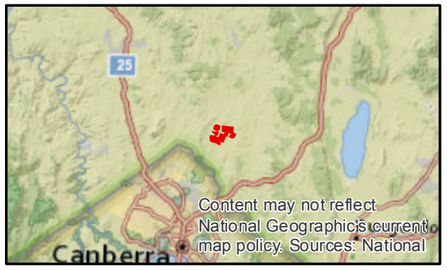
Figure 4: Springdale Solar Farm - 1% AEP Peak Flood Depth

LEGEND

Peak Flood Depths (m)

- <0.1
- 0.1 - 0.25
- 0.25 - 0.4
- 0.4 - 0.8
- 0.8 - 1.5
- 1.5 - 3.0
- >3.0

- Cadastre
- Site Boundary
- Development Envelope
- Flood Model Extent



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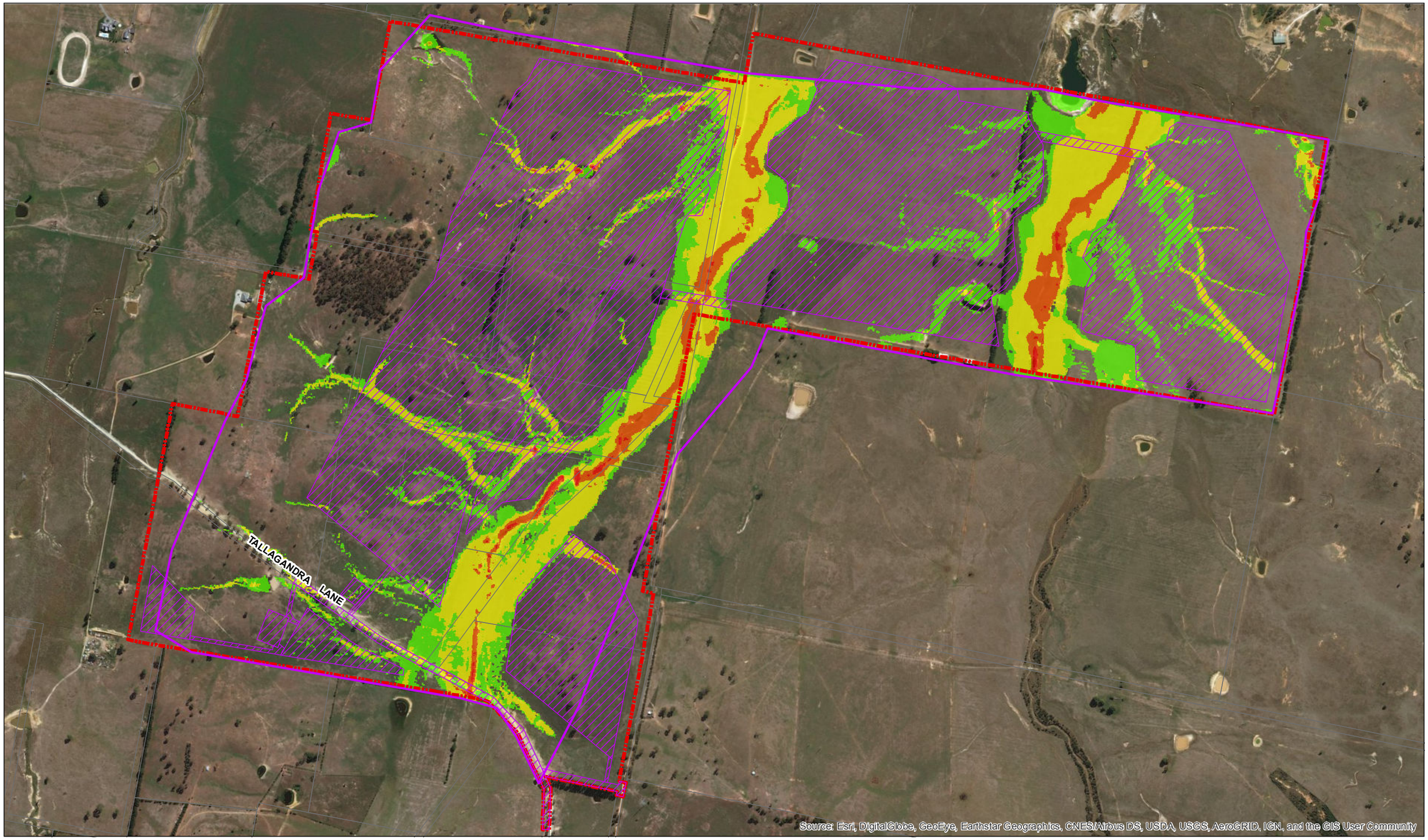


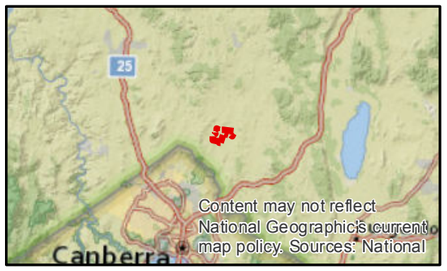
Figure 5: Springdale Solar Farm - 1% AEP Peak Flow Velocity

LEGEND

Peak Flow Velocity (m/s)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- >1.5

- Cadastre
- Site Boundary
- Development Envelope
- Flood Model Extent



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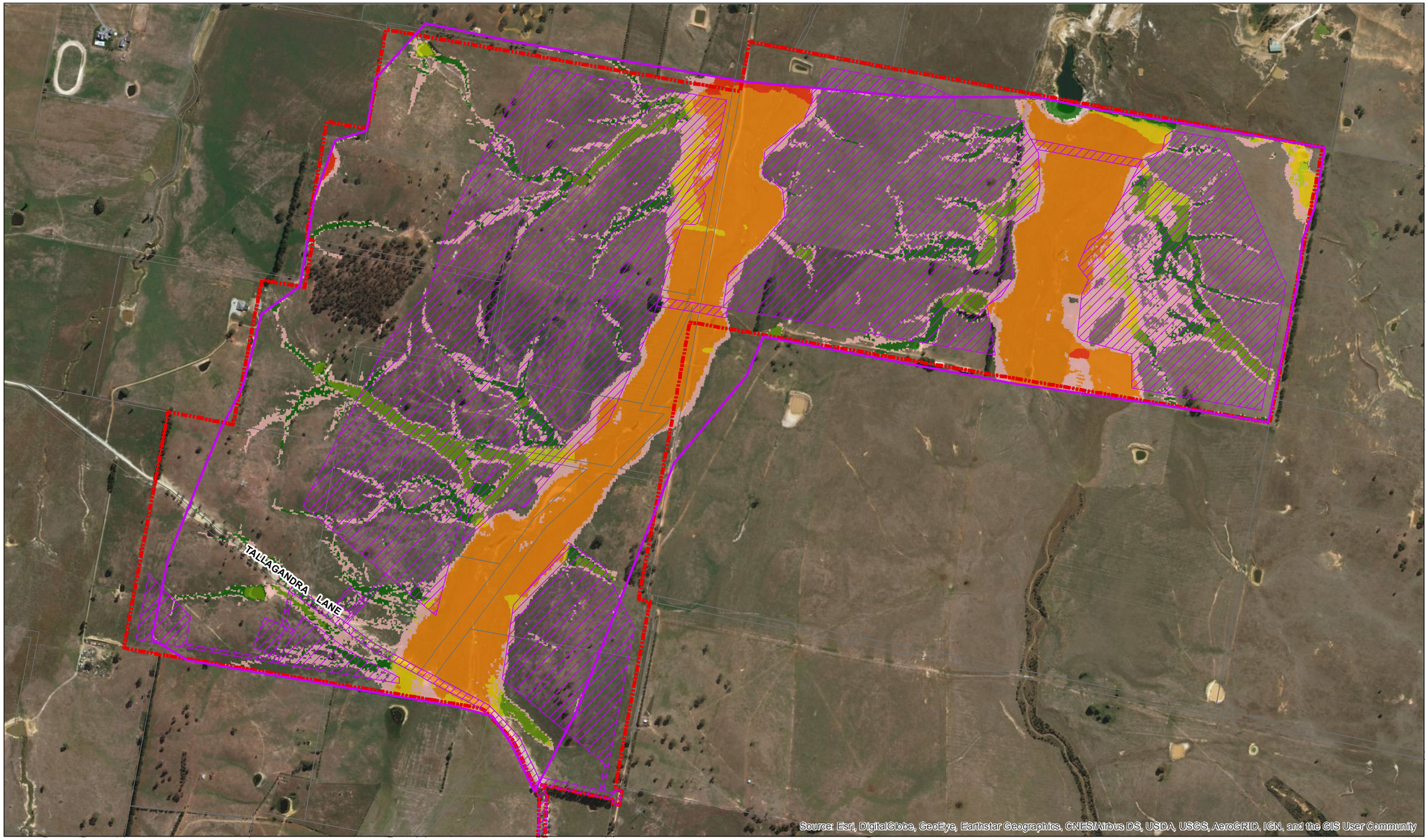


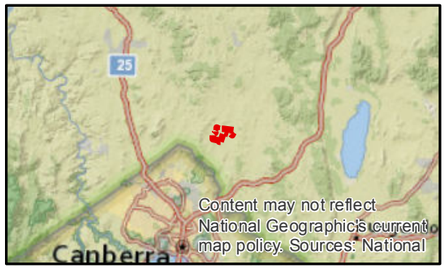
Figure 6: Springdale Solar Farm - Increase in 1% AEP Flood Level and Extent with Climate Change

LEGEND

Increase in Flood Level (m)

- <0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- >1.0

- Was dry, now wet
- Cadastre
- Site Boundary
- Development Envelope
- Flood Model Extent



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