MT FYANS
WIND FARM

APPENDIX V

SURFACE WATER ASSESSMENT

ENTURA

AUGUST 2022

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Surface Water Assessment

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Mt Fyans Wind Farm

ENTURA-2068DD
9 August 2022

Prepared by Hydro-Electric Corporation ABN48 072 377 158

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1. Introduction

1.1 Background

Woolnorth Wind Farms Holding Pty Ltd (Woolnorth) has proposed the development of the Mt Fyans wind farm 5 km north of Mortlake. The proposed wind farm lies at the centre of Victoria's western plains. Elevated fields to the north of the development would deliver inflows to the wind farm. The proposed wind farm footprint encompasses several catchments, including Salt Creek: a clearly defined water channel to the west of the site; and Blind Creek: a watercourse through the middle of the site where some ridges suggest possible inflows.

Entura was appointed by Hydro Tasmania acting on behalf of Woolnorth to undertake preliminary environmental assessments to understand the potential risk to the environment of construction and operation of the proposed Mt Fyans wind farm. The outcomes of the assessments will be used to support the referrals and future planning permit applications under the Policy and Planning Guidelines for the Development of Wind Energy Facilities in Victoria, January 2016.

Construction and operation information for the proposed wind farm as provided by Woolnorth is summarised in Table 1.1.

Table 1.1: Mt Fyans Wind Farm Project information provide by Woolnorth (October 2017)

Parameter	Details
Location	5km north of Mortlake at the centre of Victoria's western plains
Client and Proponent	Woolnorth Farms Holding Pty Ltd
Wind turbine foundations	Likely gravity foundations, 3-4 m depth
Local government area	Moyne
Catchment management authority	Glenelg Hopkins - Corangamite
Land-use	Pasture, Agriculture
Proposed electricity connection point	Mortlake Substation

1.2 Purpose of assessment

This assessment provides information on local and regional flooding at the site of the proposed wind farm development. These results can be used to further refine the placement of turbine locations and for planning approvals, and help scope more a more detailed design flood model.

The assessment utilises a 2D hydraulic model to estimate the pre-development flood depths and velocities across the proposed wind farm site and any interactions with designated waterways.

Both regional and local flooding is considered with all floods defined as 1% Annual Exceedance Probability (1% AEP) events.

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At this stage of design it is understood that some existing roads and tracks are planned to be used. These are captured within the underlying digital elevation models used in the hydraulic model. The digital elevation model does not include potential changes to levels from new roadways, waterway crossings, and bulk earthworks. Additional hydraulic modelling will be required to understand the flood behaviour around these, which shall be undertaken during detailed design.

1.3 Approval for works within designated waterways

The Glenelg Hopkins Catchment Management Authority (GHCMA) is the responsible authority for the issuing of Works on Waterways licenses for proposed works or activities that are in, on or around designated waterways under the *Water Act 1989*. Specifically section 219 of the *Act* enables CMAs to make by-laws to cover:

- Minimising or preventing disturbance to designated waterways
- Regulating activities and works on land that forms part of a designated waterway

In accordance with the *Act* most Catchment Management Authorities in Victoria are operating under a by-law that regulates works on waterways through a process that established a requirement for an application and a licence from the relevant CMA. The GHCMA instead issues licences under section 67 of the *Water Act 1989* that states an Authority or any other person may apply to the minister for the issue of a licence to construct, alter, operate, remove or decommission any works on a waterway.

Works on Waterways licenses are granted by the GHCMA through completing a waterways licence application form. This process ensures the CMA can fulfil their role in protecting the health of the catchment, encourage appropriate development, and reduce the impacts of flooding on life, property and infrastructure. A licence is applicable for any works within the bed and banks of any designated waterway declared under section 188 of the *Act*.

1.4 Identifying designated waterways

Hydro Tasmania acting on behalf of Woolnorth has engaged with the GHCMA to provide information on indicative designated waterways at a risk of being impacted by onsite works. Under section 188 of the *Act*, designated waterways were declared by the GHCMA through a publicly gazetted process that occurred in 2001. A designated waterway may be of any size, form or shape. It may be ephemeral or have a permanent flow, naturally occurring or man-made. It could be a river, wetland, lake or a natural depression in the land. Some waterways may have changed or been moved over time meaning gazetted waterways do not always represent actual waterway locations.

The indicative Map of Designated Waterways (Figure 1.1) is based on preliminary information provided by GHCMA and field data obtained by Hydro Tasmania acting on behalf of Woolnorth. This map refines the GHCMA gazetted data through additional research and ground truthing. Please note this map is indicative only and may be modified through further ground research and consultation with the GHCMA and landowners. This is especially true of the northern region that has poor access and in which current waterway locations are unclear and unable to be confirmed at this time. The GHCMA has identified additional waterways within the northern part of development of the project site shown in Figure 1.1. These waterways have not been depicted in the map as they are complex and require extensive ground surveys to confirm. No construction relating to the Mt Fyans project is expected to occur in this area.

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Prior to construction the final layout plan be will be reviewed by Glenelg Hopkins CMA and where works related to designed waterways, GHCMA works licences will be required for approval. The GHCMA are the relevant authority for considering water flow matters and will require that the wind farm does not have any adverse flood impacts or an increase in flood levels, including on nearby landholders.

1.5 Design of work in and near waterways

None of the wind turbines, or associated infrastructure are in close proximity to the major waterways in the wind farm area, however the grid connection route, underground cable trenching and access tracks intersect the major waterways at multiple locations (Figure 3.1). All turbines have been located a minimum of approximately 200 m from any of the two natural waterways (Salt Creek and Blind Creek) that intersect the site and a minimum of 30 m from all smaller intermittent streams.

The aim of the detailed design is to ensure the proposed wind farm does not significantly alter waterway hydrology. Careful design of infrastructure that intersects a waterway (i.e. fords or culverts) is required. An appropriate drainage and filter system will be required to manage the risks associated with surface water runoff to the waterways carrying increased sediment load during the construction phase.

The design of a culvert to enable an access track should consider appropriate dimensions and loads to ensure it does not significantly impede catchment flows during minor storms. Design should also adopt best practice "stream simulation" for passage of fish and aquatic animals and reduce the risk of blockage by flood debris as well as structural damage and failure. Roadways and culverts should also consider maintenance requirements and safety for rarer storms (such as the 1% AEP storm) that may overtop structures. Culvert and bridges would need to consider the requirements of serviceability and ultimates limit states design.

Some existing low lying or ground level roads and tracks in the southern part of the site are subject to flooding at levels less than 1% AEP. These roads and tracks will be maintained to ensure the flow of water is not significantly impeded when passing across them and no harmful runoff is created. New internal roads and tracks proposed in more flood prone areas will also be designed to these standards.

All proposed infrastructure will be designed to have no significant adverse flood impacts on nearby landholders.

Higher resolution terrain models and hydrology/hydraulic modelling may be required to better understand flood dynamics. In some locations additional data may also be required to accurately determine the location of existing and new waterways. This process will be undertaken subsequent to the planning approval stage. Any permits or licences that will be required will be determined and entered into once the final turbine and infrastructure layout is identified in the planning permit compliance process.

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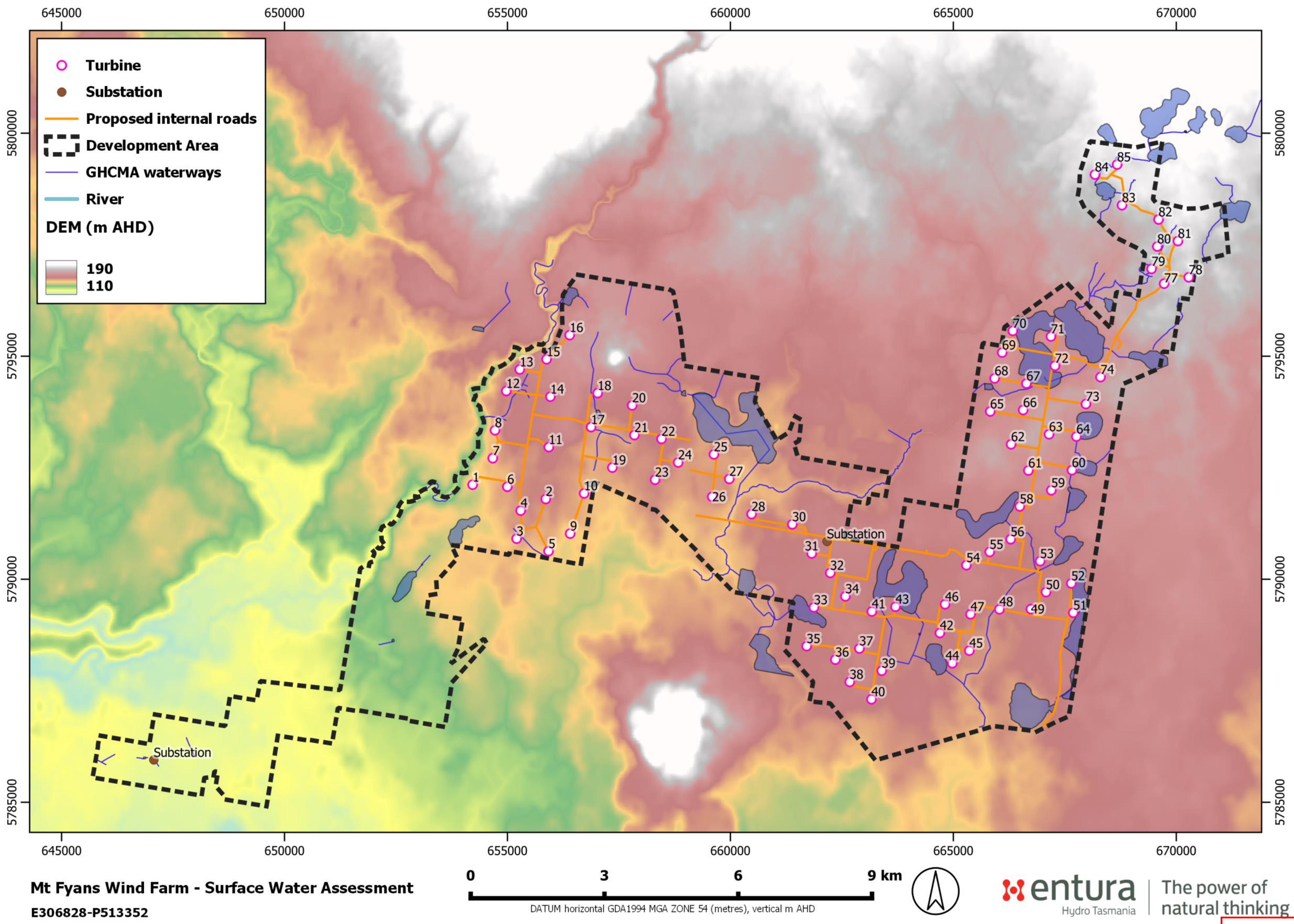

Figure 1.1: The indicative map of designated waterways across GHMCA.

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2. Data, assumptions and limitations

The locations and details of wind turbines foundations, along with the development extent area are as supplied by Hydro Tasmania acting on behalf of Woolnorth.

In addition to the Water Data Online (2017) information, Australian Rainfall Runoff (ARR, 2017) data consisting of Intensity-Frequency-Durations (IFDs), Areal Temporal Patterns, Areal Reduction Factors (ARF), and losses have been utilised for the modelling and evaluations. Hydrological-hydraulic modelling is based on 1% AEP rainfall events.

The digital elevation model used for hydraulic modelling is based on a 1 m contour dataset derived from a digital surface model/digital terrain model (DSM/DTM) database as provided by Hydro Tasmania (Madden 2012). The terrain model has been derived from a surface model captured by World View 2 satellite in 2012. The algorithms used to create the terrain model were not able to provide spatial data on the complex and extensive network of drainage lines that exist in the western and southern sections of the site.

A 25 m grid size was chosen for the purpose of this planning level hydraulic modelling. This choice was based on the limitations of the underlining DEM. It is likely flood levels will be conservatively over estimated because the DEM does not pick up the finer drainage network.

Given the large extent of the development area (> 500 km^2), Areal Temporal Patterns are required to be applied. These patterns cover a range of rainfall durations from 12 to 120 h. Rainfall losses were set to zero to provide conservative results and it is assumed that losses (especially initial loss) are well represented within the 2D hydraulic modelling domain.

A depth-varying Manning's n has been applied by using linear interpolation between thresholds presented in Table 2.1: . The higher Manning's n values are applied at depths below the specified depth ranges, and also the lower ones applied at depths above the specified depth range.

Due to the lack of rainfall and hydrometric stations over the development area, no event-based calibration was implemented. Model calibration at the 1% AEP level was based on matching peak flows with regional flood frequency analysis results.

Since there is no permanent watercourse or significant surface water body inside the development site, the initial water surface depth was assumed to be zero (i.e. DEM ground level).

Any buildings within the model extent were considered to be at the level of the relevant DEM cell.

Table 2.1: Adopted Manning's n hydraulic roughness coefficients (Chow 1959).

Land use	Depth range (m)	Manning's n
Open Space	0.15–0.75	0.07–0.04
Creeks and Rivers	0.3–1.5	0.08–0.06

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3. Critical rainfall duration

To determine the critical storm duration of Salt Creek, initially, the entire basin was split into five sub-catchments as shown in Figure 3.1. This figure also presents the modelled 1% AEP flood extent from the flood data transfer project (DELWP, 2017). No significant flood inundation has been previously identified across the development area.

Following the ensemble approach elaborated in ARR guideline (2016), a hydrological model was set-up in XPSWMM (Ver 2017.2) applying the Laurenson equation to calculate hydrographs at the outlet of each sub-catchment.

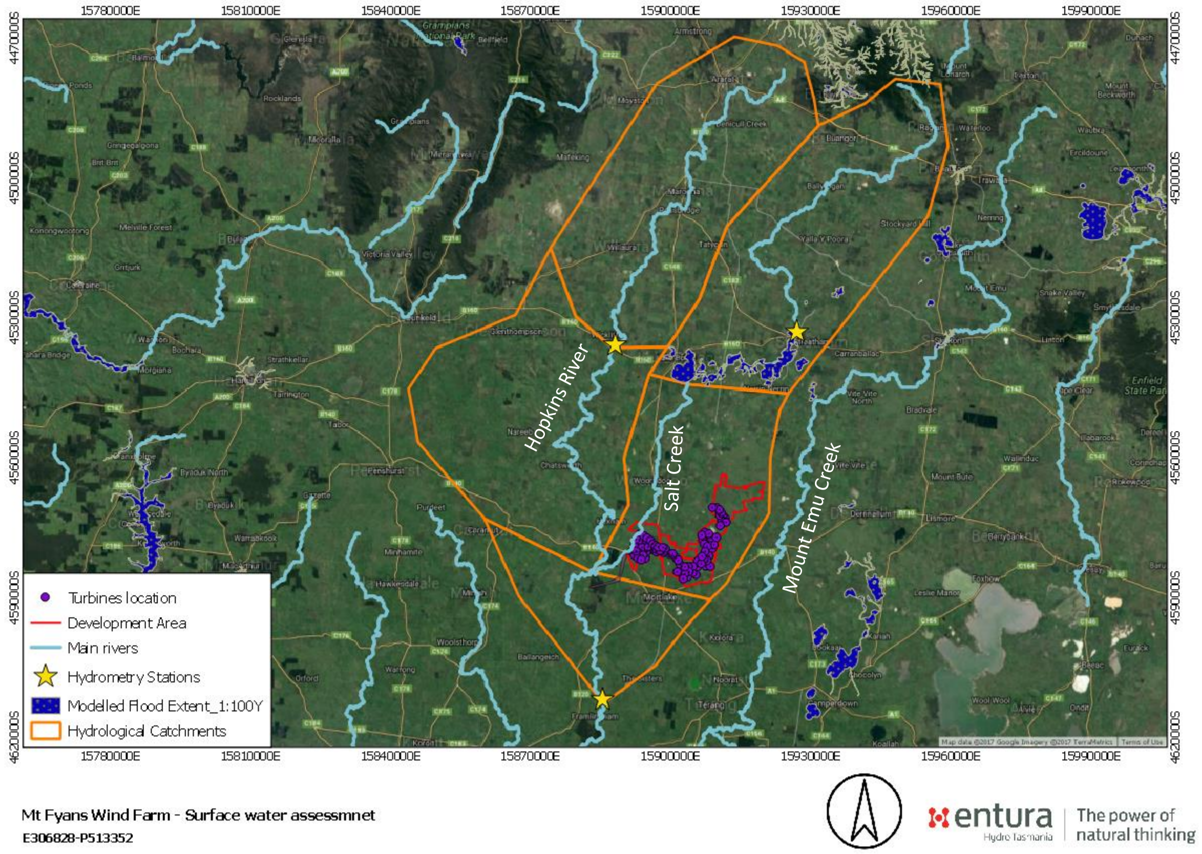

Figure 3.1: Indicative sub-catchments, available hydrometric stations on the main watercourses, and modelled 1% AEP flood extent based on flood data transfer project (DELWP, 2017).

Figure 3.2 illustrates the flood frequency analysis at the Hopkins River at Framlingham hydrometric station location near the outlet of the entire basin. This figure also illustrates boxplots showing the maximum flows (m^3/s) at the same location. Considering the rainfall duration of 12 hours, the median of boxplot represents the maximum flow of 327 m^3/s and is consistent with the corresponding value from flood frequency analysis (332 m^3/s for 1% AEP flood).

Therefore, a 12-hour rainfall duration (as the critical duration) with its associated temporal pattern was adopted for the hydraulic modelling.

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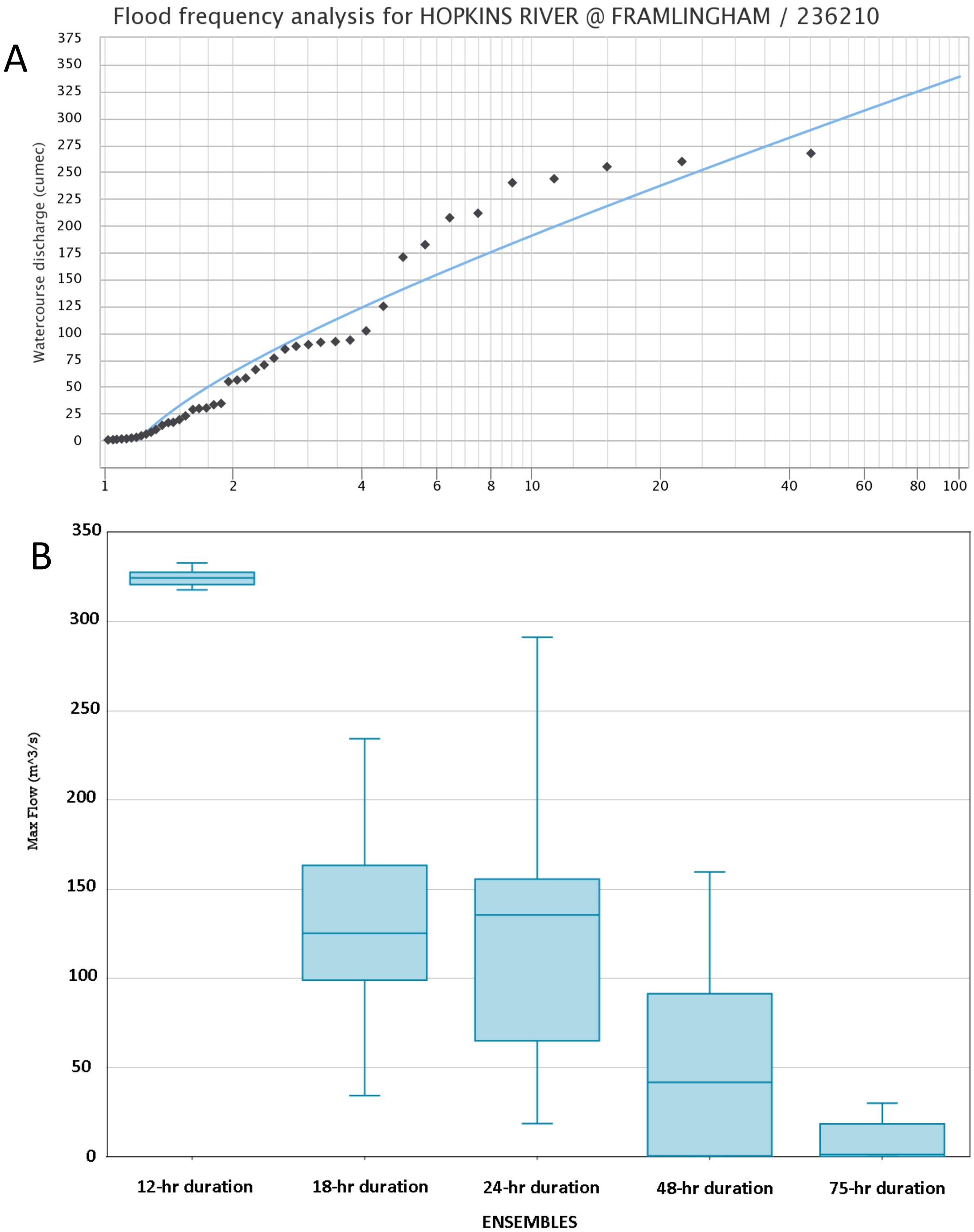

Figure 3.2: Framlingham hydrometric station data analysis A) flood frequency analysis, B) Boxplots showing the maximum flow (m^3/s) after the ARR 2016 ensemble approach

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4. Critical rainfall duration

Following the rain-on-grid approach, Figure 4.1 shows the 2D modelling extent with 25 m grid sizes covering the development area and the transmission corridor. This figure also illustrates downstream boundary conditions at the outlet of the hydraulic model.

In order to minimise model runtime and avoid the simulation failure, the study area was split into two separate models of 1) the extent from Blind Creek (in the centre of development area) westwards to Salt Creek, and 2) the extent from Blind Creek eastwards to the model boundary. Each sub-model simulated up to 1 million grid cells.

The location of upstream streamflow (a 1% AEP flood event) is highlighted in purple. The associated hydrograph is extracted from the hydrology model shown in Figure 4.2.

A 5-second calculation time-step and 5-day total modelling time were used for the 2D hydraulic modelling. Results were saved every 1 minute.

To solely consider the impact of turbines on the surface water modelling (regardless of roading and local drainages of each turbine), turbines were assumed as 25 m-diameter circles with 5 m heights included as "Elevation Shape polygons" in the XPSWMM model.

A mass balance check in the XPSWMM model was activated to check instabilities throughout the 2D modelling.

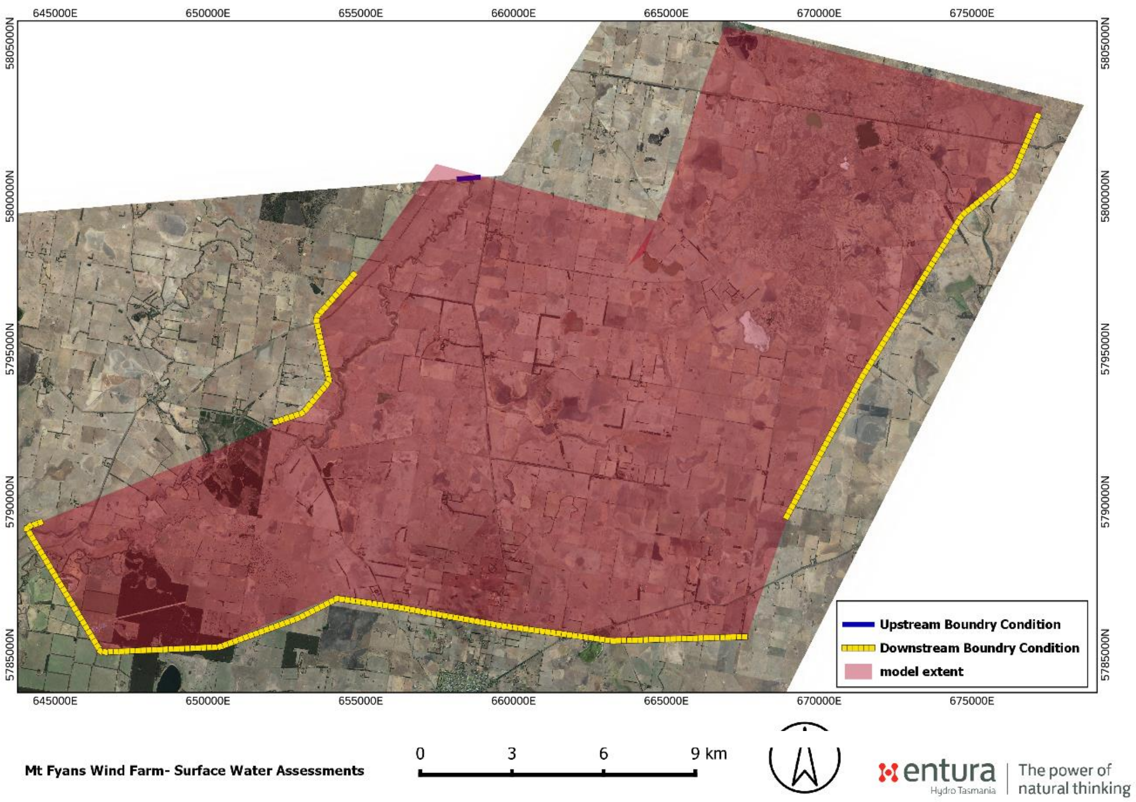

Figure 4.1: The hydraulic model's properties.

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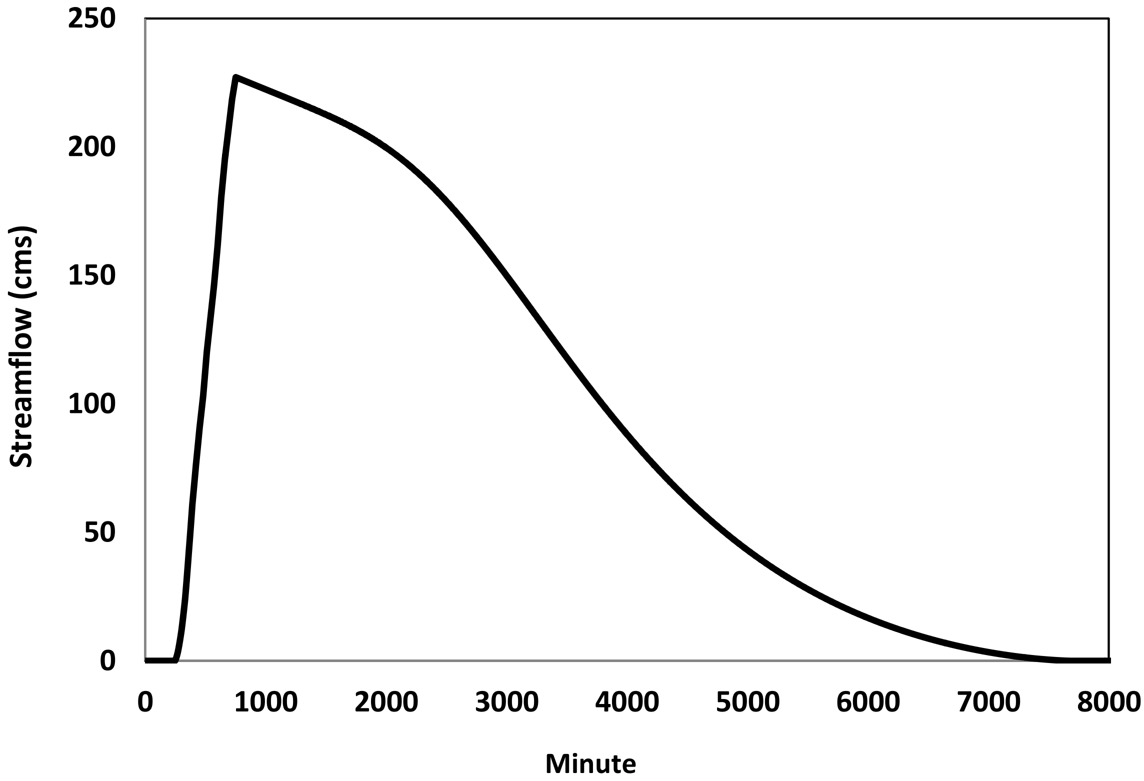

Figure 4.2: The estimated upstream inflow hydrograph from Salt Creek.

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5. Results

5.1 Behaviour of flood water

A large percentage of incident rainfall and surface runoff is captured by temporary waterbodies and watercourses.

Water levels within Salt Creek were always within the bank.

Figure 5.1 and Figure 5.2 illustrate the indicative maximum surface water depths, and indicative maximum velocity × depth product derived from hydraulic modelling.

Except inside Blind and Salt Creeks, the depth x velocity product was < 1 m^2/s which is considered unlikely to cause erosion or risk to infrastructure or lives.

5.2 Relationship with proposed site

At the location of the proposed turbines, marginal differences (water depth <10 mm; velocity <0.01 m/s) were identified between without and with the turbine scenarios.

Modelling indicates that most parts of development area are affected by maximum water depths < 0.4 m. Temporary waterbodies water may capture water up to 2 m depth.

Figure 5.1 presents the values of above-mentioned criteria at the locations of wind turbines. The depth of inudation is less than 0.4 m at all turbine sites with the exception of the turbine B63 where the estimated depth is 0.43 m. On this basis no significant damage is expected due to inundation or from erosion due to the low modelled Hazard values (and also velocity values).

Modelled maximum water depths in the transmission corridor are typically less than 0.1 m with hazard values less than 0.1 m^2/s, except where it crosses Blind Creek and other minor waterways with locally higher values. The inaccuracy of the DEM makes these values indicative only.

Both substation compound sites have been located outside of the mapped 1% AEP flood hazard areas (Figure 5.1). The onsite substation is on a slightly elevated land more than 3 m higher than the area south of south road which is susceptible to flooding. The grid connection substation site is on land more than 3 m higher than the land to the north along Salt Creek that is susceptible to flooding risk. Local flash flooding around these sites will need consideration during detailed design once the site civil works are designed, as this study did not cover this.

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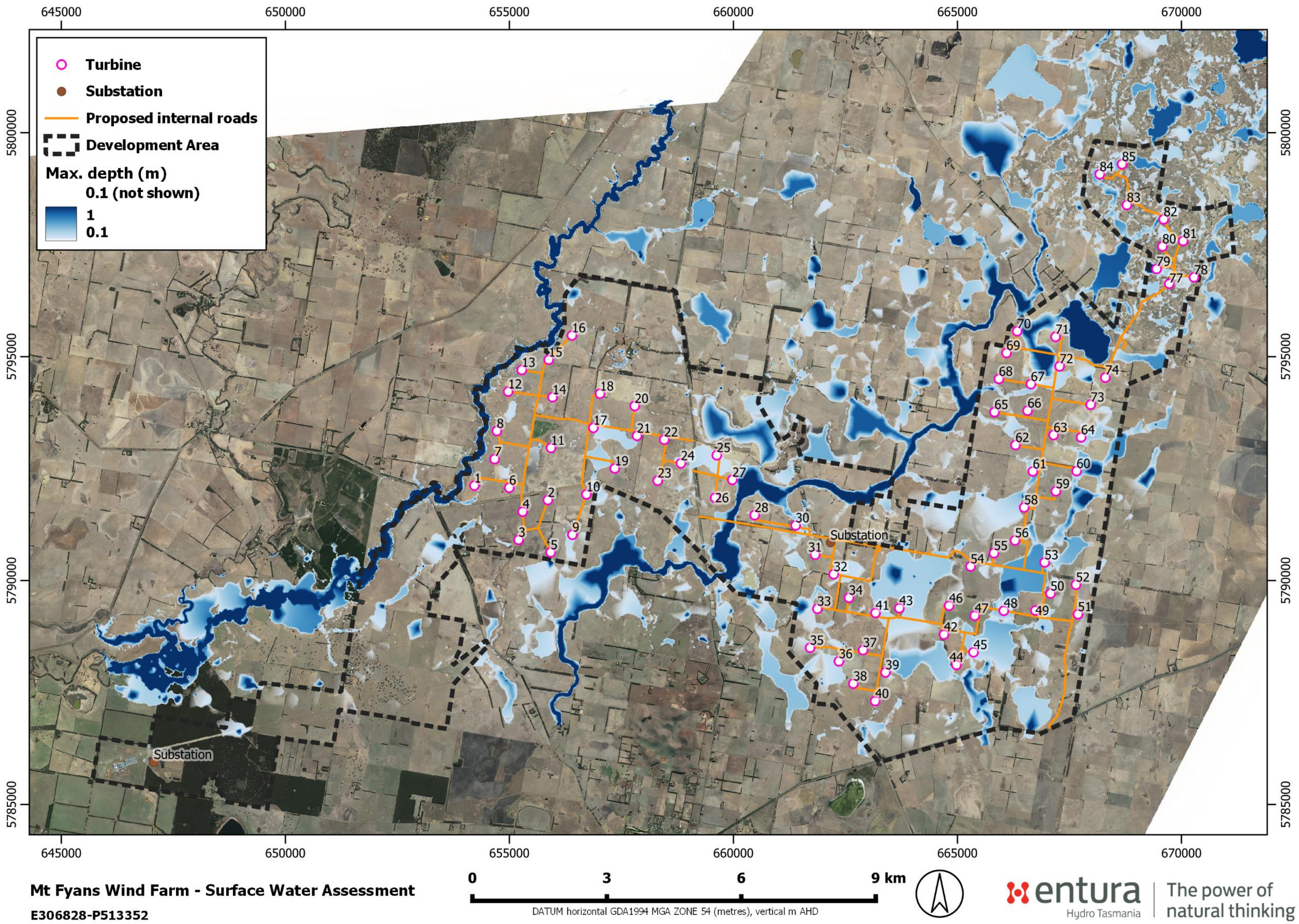

Figure 5.1: Map of indicative maximum 1% AEP surface water depth (m) across the development area. Values less than 0.1 m have not been shown.

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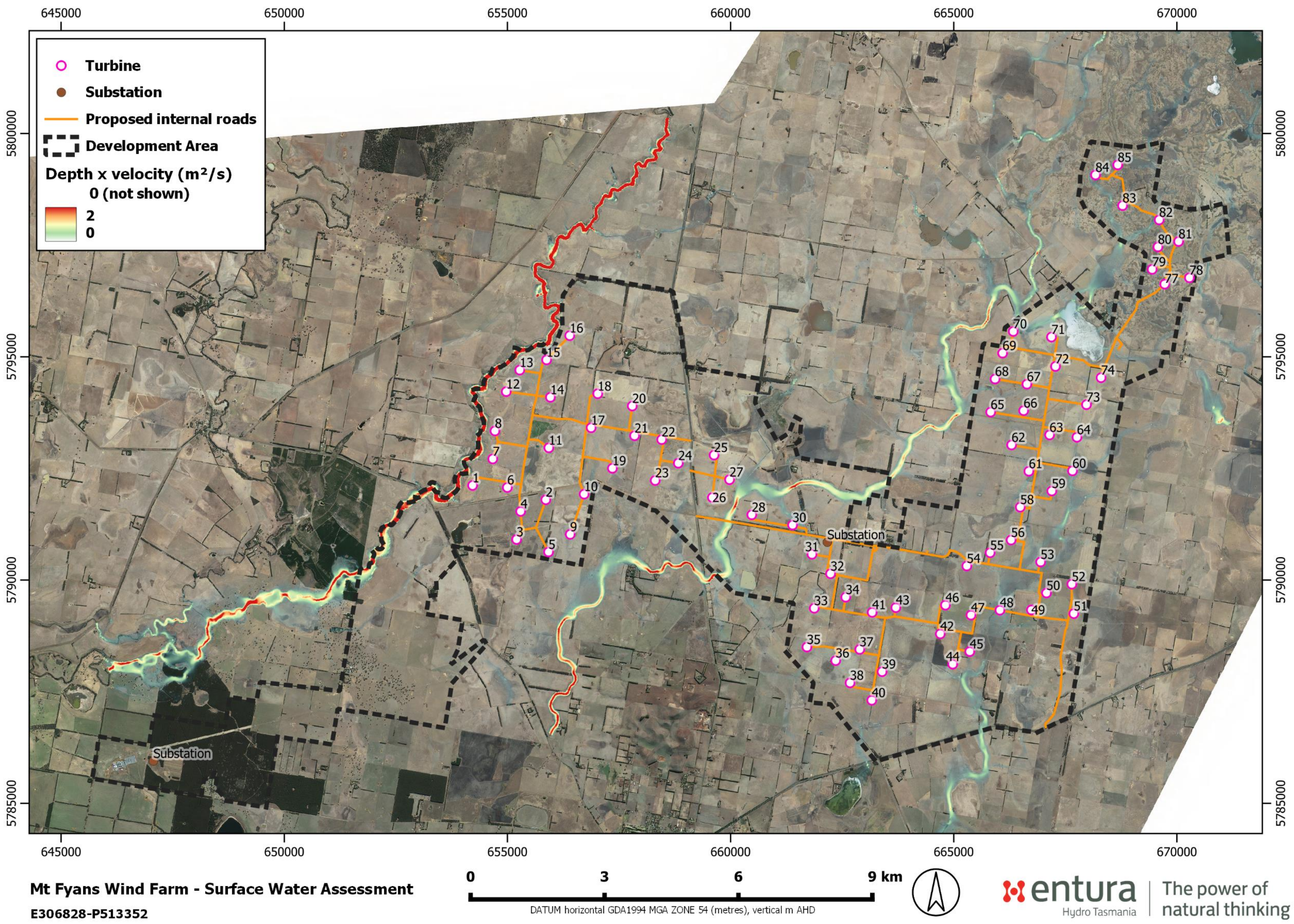

Figure 5.2: Map of indicative maximum 1% AEP flood hazard (Depth×Velocity) (m^2/s) across the development area. Values less than 0.5 m^2/s have not been shown.

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6. Conclusions

Based on indicative results provided by the grid based modelling-mapping completed for this report:

- None of the turbines are located within 12.5 m buffer zones (circles with 25 m diameter) from permanent water-bodies.
- The presence of the proposed wind turbines is unlikely to significantly change water depth and velocity across the development area compared with current conditions.
- It is concluded that the presence of turbines does not affect the natural flood flow across the development area. No check was made for roads and earthworks at this stage of design.
- The development area will typically encounter flood depths < 0.4 m.
- Current modelling indicates that turbines that are proposed to be located most adjacent to temporary waterbodies (i.e. ID: B63) may be touched by water depths ~0.4 m. However, no significant damage or erosion is expected due to the low modelled velocities.
- A significant proportion of the transmission corridor is likely to be inundated with shallow water depths and it does cross Blind Creek and other minor waterways with deeper flows; nonetheless, considering the accuracy of current model there may be potential deeper flooding over other sections of the transmission corridor.
- Electrical plant or equipment needs to be located above flood areas based on a risk-cost assessment (with appropriate freeboard). This should be able to be readily achieved by considering local drainage systems, relocation or elevation of the equipment.
- Considering the accuracy of available DEM, the current results are representing the flood extent-depth conservatively (especially in south-east regions of development site).
- At the detailed design stage, a high resolution DEM and other hydrological-hydraulic components (i.e. local drainages, culverts, roads) will be required as an input for flood modelling of different regions across development area.

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