MEMORANDUM

To	Jennifer Hinwood | Northern Grampians Shire Council
From	Ben Hughes | Water Technology
Date	1 May 2025
Subject	Stawell - Flood related planning scheme layer development
Our ref	25010371M01v02_Stawell_Planning_Scheme_Layers.docx

1 INTRODUCTION AND PURPOSE

Northern Grampians Shire Council (NGSC) are intending to update the flood related planning scheme controls for Stawell. This includes the Land Subject to Inundation Overlay (LSIO), Floodway Overlay (FO) and Special Building Overlay (SBO). The Stawell Flood Investigation was completed in December 2024, producing flood modelling and mapping for Stawell. This included modelling of the existing climate as well as modelling of climate change for a 1% AEP (Annual Exceedance Probability) event. The climate change modelling was completed using Australian Rainfall and Runoff (ARR) 4.1 recommendations. Since completion of the modelling, ARR 4.2 has been released, revising climate change projections.

This memorandum provides an update to Section 4.3 of the Stawell Flood Investigation Final Report, issued to NGSC on 2 December 2024 (WT ref. 23010370_R06V02). It details the revised climate change projections for the 1% AEP event for the 2100 SSP2-4.5, SSP3-7.0, and SSP5-8.5 scenarios, in line with the updated ARR V4.2 guidelines, as outlined in Book 1, Chapter 6, released in May 2024.

The update covers two study areas; the local Stawell township catchment (including Pleasant Creek) and the Stawell Golf Course catchment to the north of Stawell, as shown in Figure 1-1, producing modelling, standard flood mapping outputs and the aforementioned planning scheme layers. The planning scheme layers were developed using the 1% AEP, 2100 SSP3-7.0 scenario.

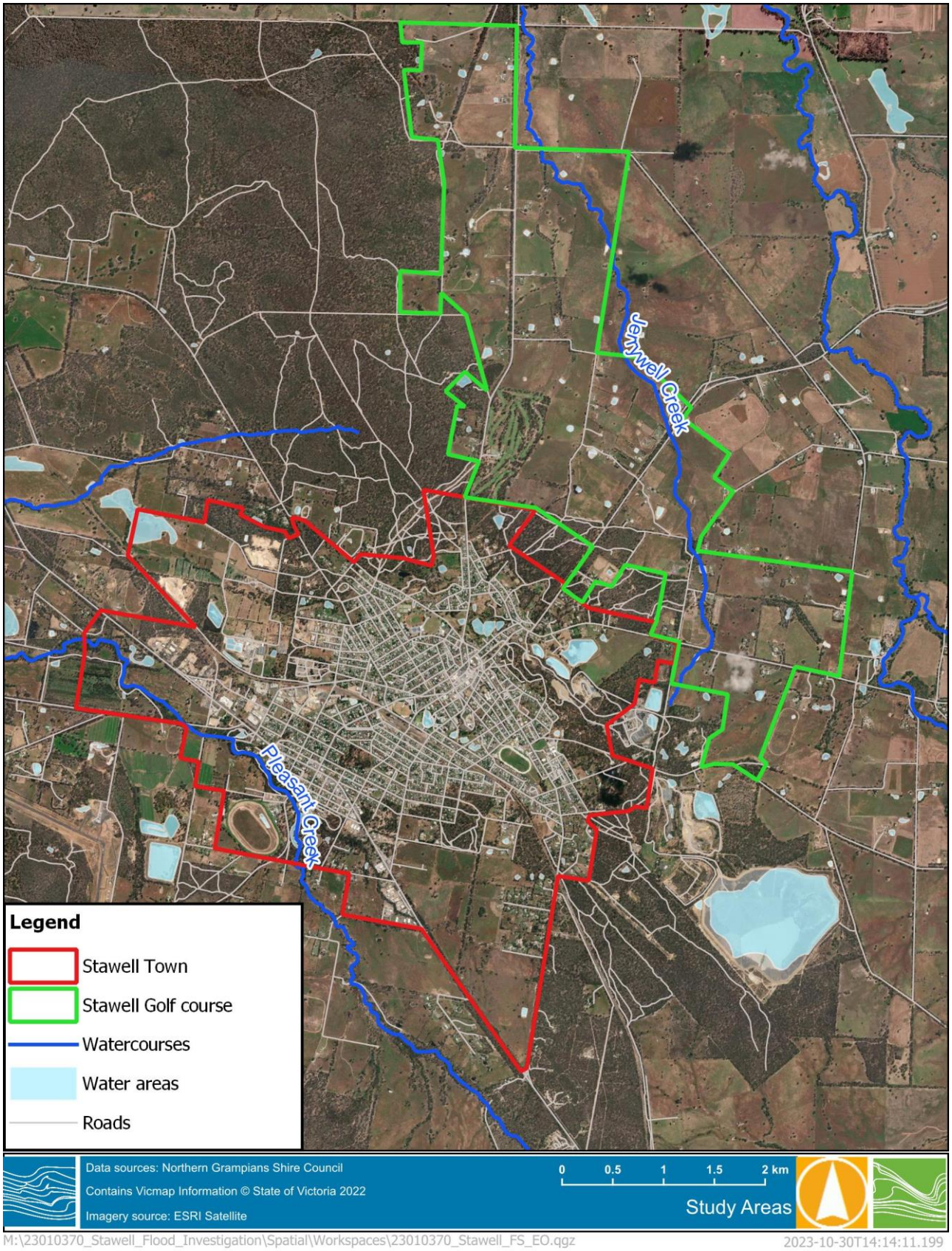

Figure 1-1 Stawell Study Area

2 METHODOLOGY

2.1 Overview

The Stawell Flood Investigation (Water Technology, 2024) undertook detailed hydrologic and hydraulic modelling of Stawell, the Pleasant Creek catchment and the Stawell Gold Course Catchment. Modelling was completed in both RORB and TUFLOW using a combined direct inflow and Rain on Grid approaches.

The updates to the TUFLOW model were conducted as follows:

- The initial and continuing loss values were updated based on the Climate Change Rainfall Loss Factor for the SSP2-4.5, SSP3-7.0 and SSP5-8.5 scenarios for the 1% AEP for year 2100.
- Rainfall intensities were updated based on the Climate Change Rainfall Intensity Increase Factor for the SSP2-4.5, SSP3-7.0 and SSP5-8.5 scenarios for the 1% AEP for year 2100.

Climate change modelling was developed in line with the draft Book 1 Chapter 6 update to ARR version 4.2 (currently available from Australian Rainfall and Runoff (arr-software.org).The chapter provides guidance as to how the impacts associated with current and future rises in global temperatures influence extreme rainfall and coastal conditions and how they should be considered in flood estimation. It includes IFD adjustment factors varying for storm durations, acknowledging the likely increase in more intense short duration storms.

Shared Socio-Economic Pathways (SSP) were used to assess climate change impact, where it explores how societal choices, such as population growth, economic growth, urbanisation, and technological developments, will likely affect global emissions. While there are similarities with the Representative Concentration Pathways (RCPs – formerly used in ARR 4.1), the SSPs are more highly developed and coherent and can be used in a broader range of applications in addition to climate modelling.

2.2 Climate Change Parameters

The infiltration losses (initial and continuing) and rainfall intensity values were initially adopted based on ARR2019 recommendations, then modified based on the climate change adjustment factors on the ARR datahub. The infiltration loss adjustment factors used for SSP 2-4.4, SSP 3-7.0 and SSP 5-8.5 are listed in Table 2-1, with the rainfall intensity factors shown in Table 2-2 and Table 2-3.

A comparison of the 2100 climate change infiltration losses and rainfall intensity increases with the present-day values is presented in Table 2-4.

Table 2-1 Rainfall infiltration loss adjustment factors per SSP

Climate Change Pathway	Initial Loss Factor	Continual Loss Factor
2100-year SSP 2-4.5	1.08	1.17
2100-year SSP 3-7.0	1.12	1.27
2100-year SSP 5-8.5	1.15	1.33

Table 2-2 Rainfall intensity increases per SSP for the 1% AEP event for the key critical durations (Stawell Township Model)

Stawell Township	Climate Change SSP2-4.5		Climate Change SSP3-7.0		Climate Change SSP5-8.5	
Critical Duration	1hr TP08	2hr TP05	1hr TP08	2hr TP05	1hr TP08	2hr TP05
Rainfall Intensity Increases	42%	35%	65%	54%	88%	72%

Table 2-3 Rainfall intensity increases per SSP for the 1% AEP event for the key critical durations (Stawell Golf Model)

Stawell Golf	Climate Change SSP2-4.5		Climate Change SSP3-7.0		Climate Change SSP5-8.5		
Critical Duration	1hr TP06	2hr TP05	1hr TP02	2hr TP05	0.5hr TP04	1hr TP08	2hr TP05
Rainfall Intensity Increases	42%	35%	65%	54%	88%	88%	72%

Table 2-4 Infiltration loss values and increases per SSP

	Present Day Losses	Climate Change SSP2-4.5	Climate Change SSP3-7.0	Climate Change SSP5-8.5
Initial Loss (mm)	20.0	21.6	22.4	23
Continuing Loss (mm/hr)	3.0	3.51	3.81	3.99
IL Loss Increases	-	8%	12%	15%
CL Loss Increases	-	17%	27%	33%

3 RESULTS

A comparison of peak flow rates for the 1% AEP flood event, for all three climate change scenarios at key locations across the Stawell Township and Stawell Golf Course catchment for the key event durations are presented in Table 3-1 and Table 3-2.

Table 3-1 1% AEP Climate Change Critical Durations for Stawell Township Model

Climate Change SSP2-4.5	Climate Change SSP3-7.0	Climate Change SSP5-8.5
1-hour TP 08	1-hour TP 08	1-hour TP 08
2-hour TP 05	2-hour TP 05	2-hour TP 05

Table 3-2 1% AEP Climate Change Critical Durations for Stawell Golf Course Model

Climate Change SSP2-4.5	Climate Change SSP3-7.0	Climate Change SSP5-8.5
1-hour TP 06	1-hour TP 02	0.5–hour TP 04
2-hour TP 05	2-hour TP 05	1-hour TP 02
		2-hour TP 05

Flood depth maps for the 1% AEP event including infiltration and rainfall intensity increases for SSP2, SSP3, and SSP5 scenarios for year 2100 across the Stawell township are presented in Figure 3-2, Figure and Figure 3-3, mapping for the Stawell Golf Course catchment are presented in Figure 3-2, Figure and Figure 3-3.

The 1% AEP flood depth, water surface elevation (WSE), velocity, and velocity x depth results for the broader area for SSP2 2100, SSP3 2100, and SSP5 2100 can be accessed via a separate data-sharing link provided in the accompanying email of this memorandum.

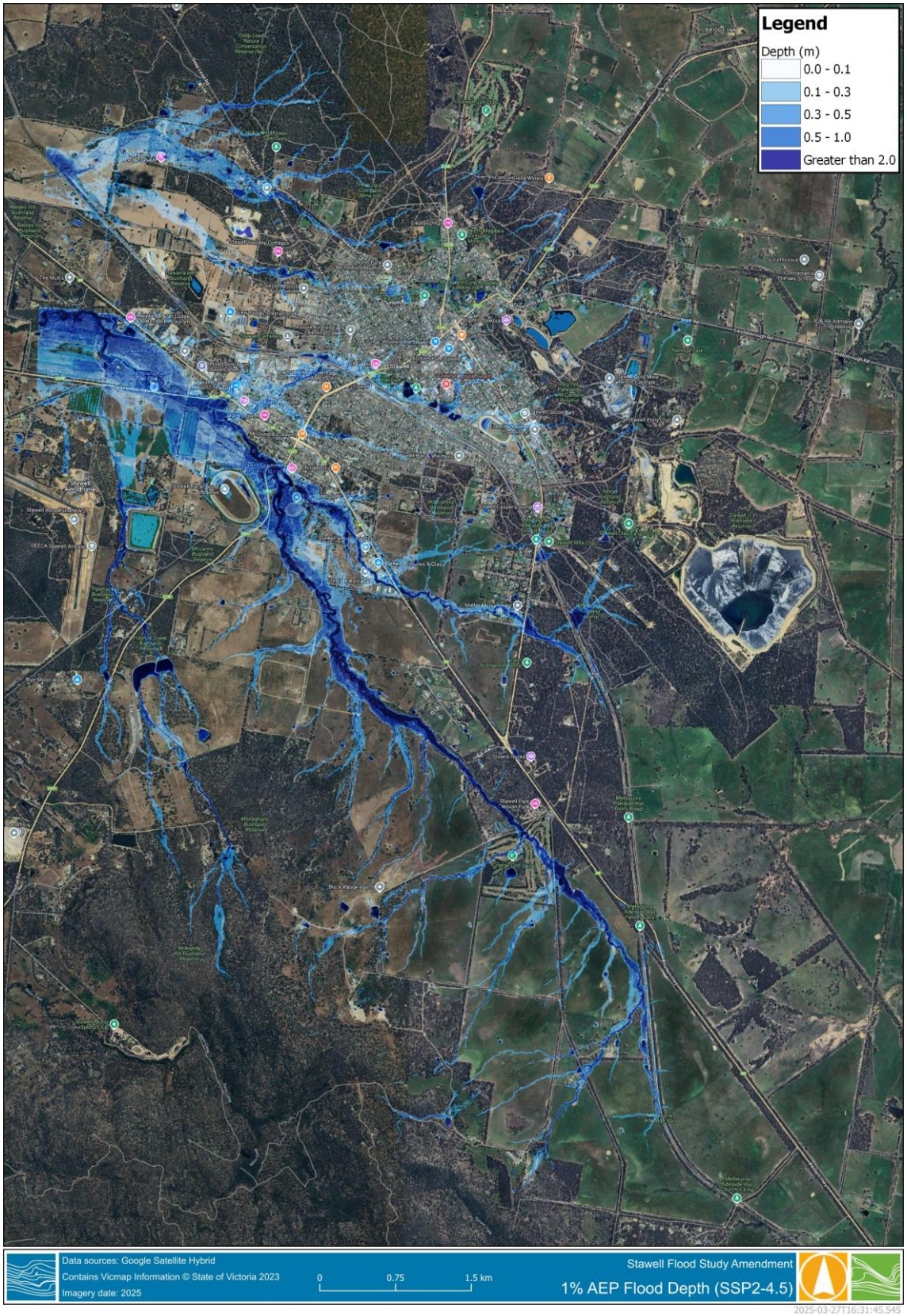

Figure 3-2 SSP2 2100 1% AEP Flood Depth – Stawell Township

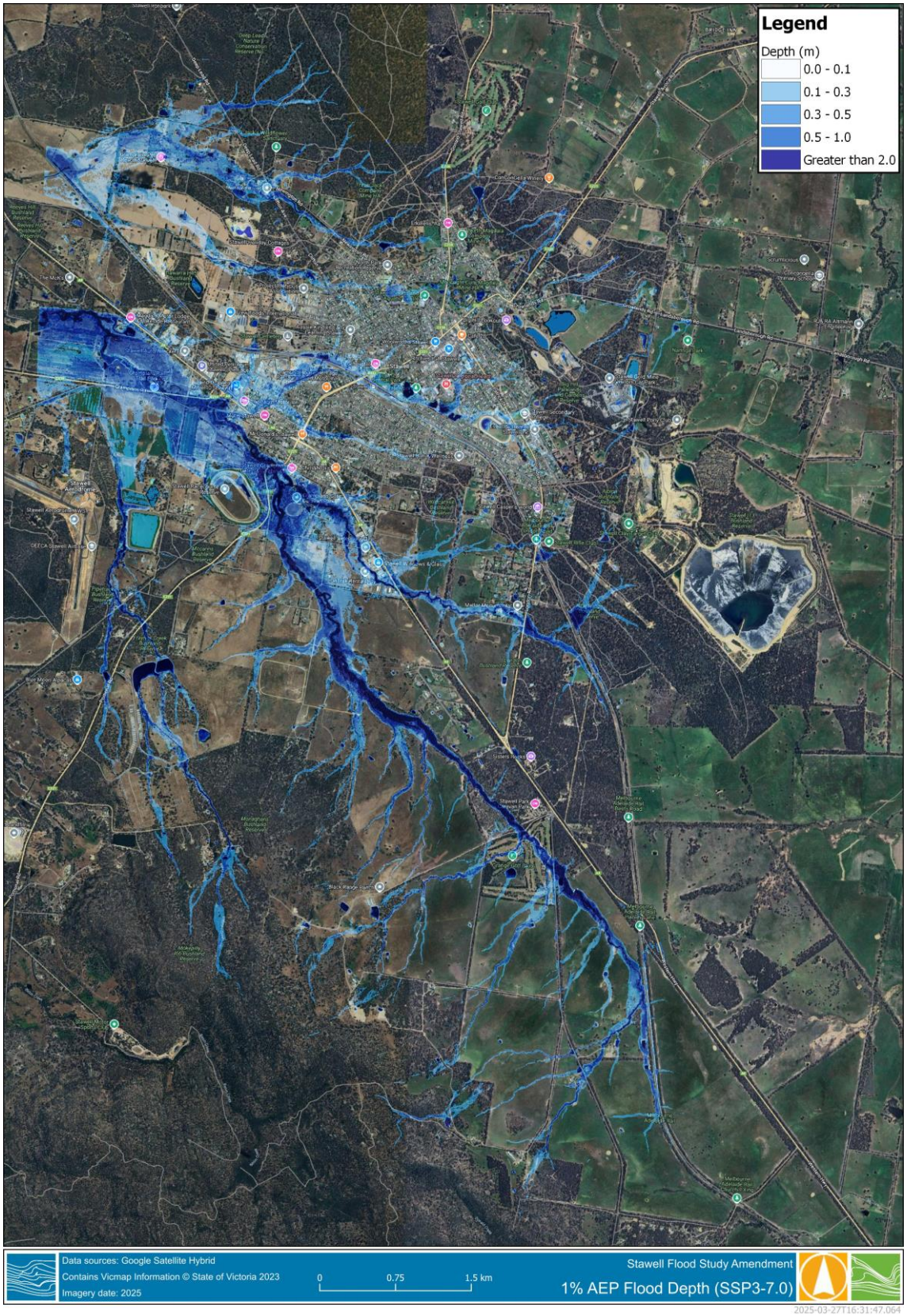

Figure 3-2 SSP3 2100 1% AEP Flood Depth – Stawell Township

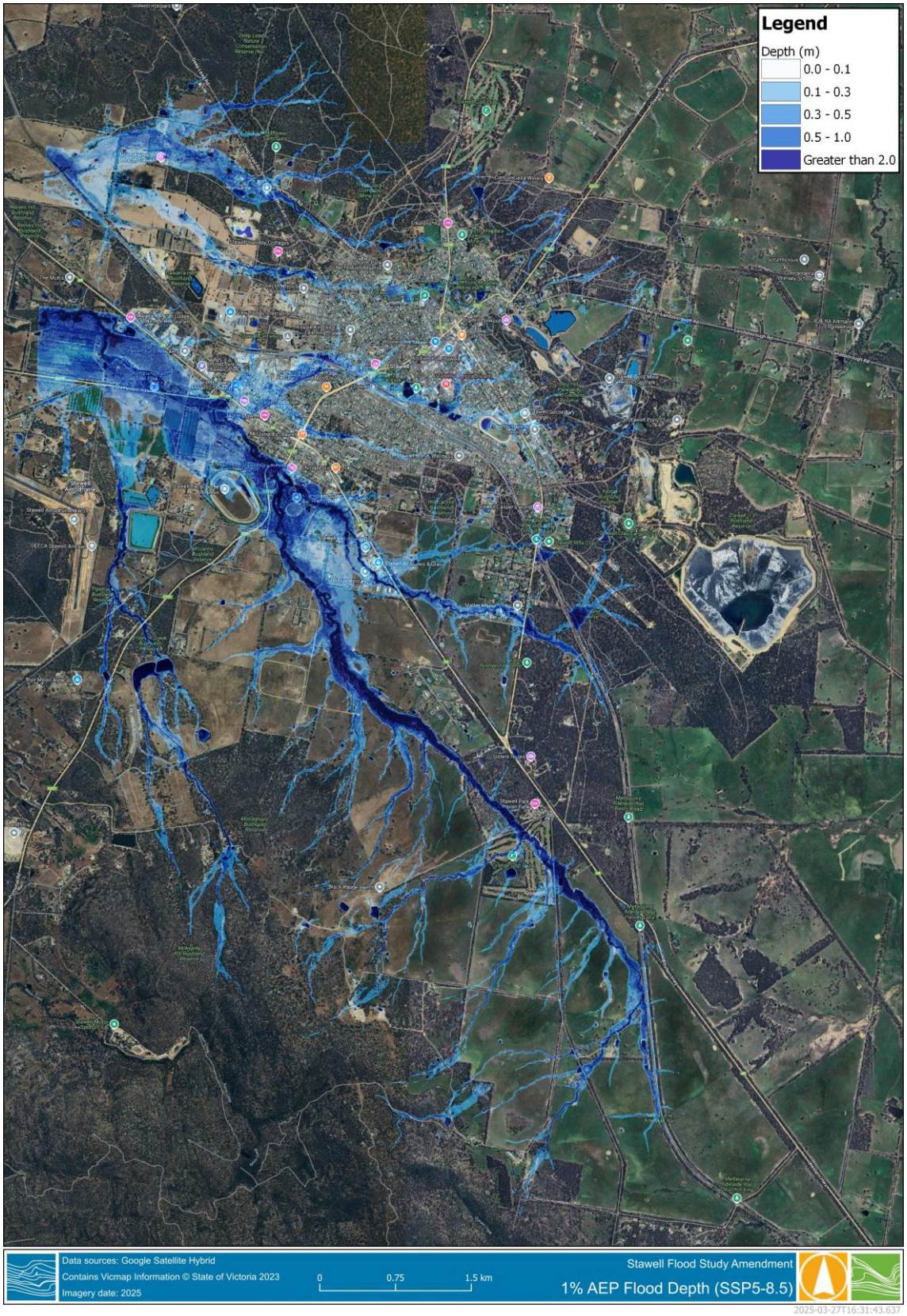

Figure 3-3 SSP5 2100 1% AEP Flood Depth – Stawell Township

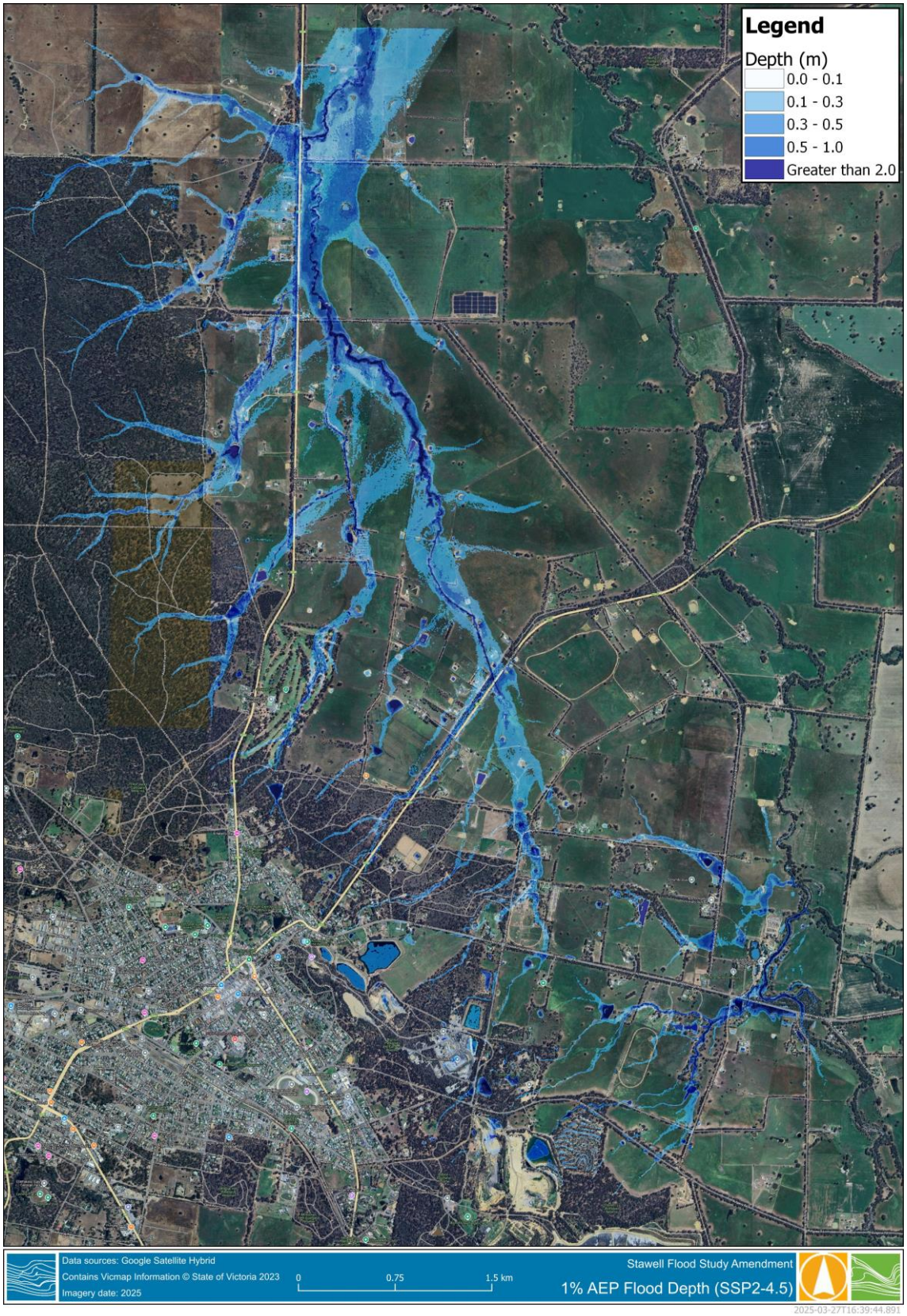

Figure 3-4 SSP2 2100 1% AEP Flood Depth – Stawell Golf

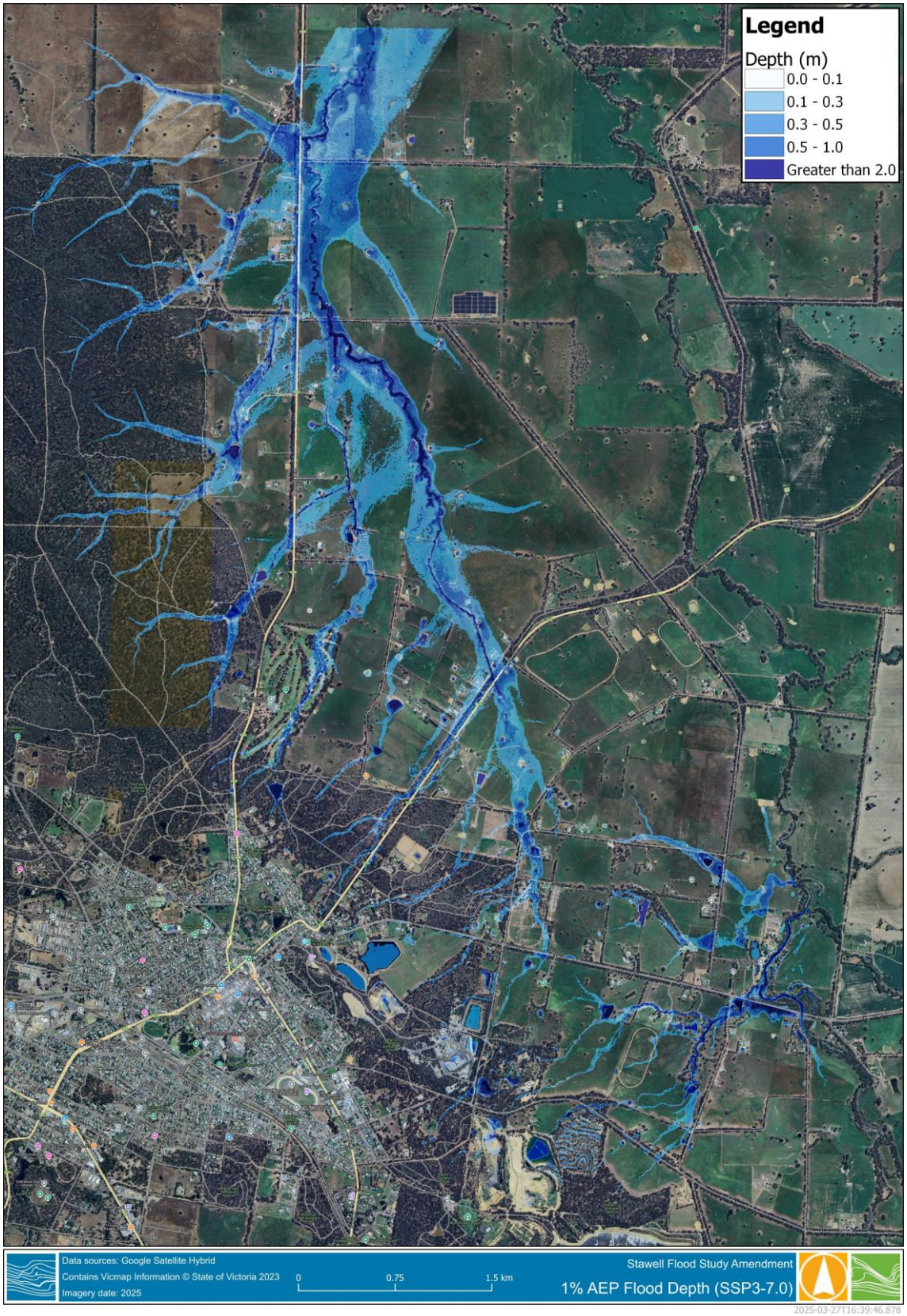

Figure 3-5 SSP3 2100 1% AEP Flood Depth – Stawell Golf

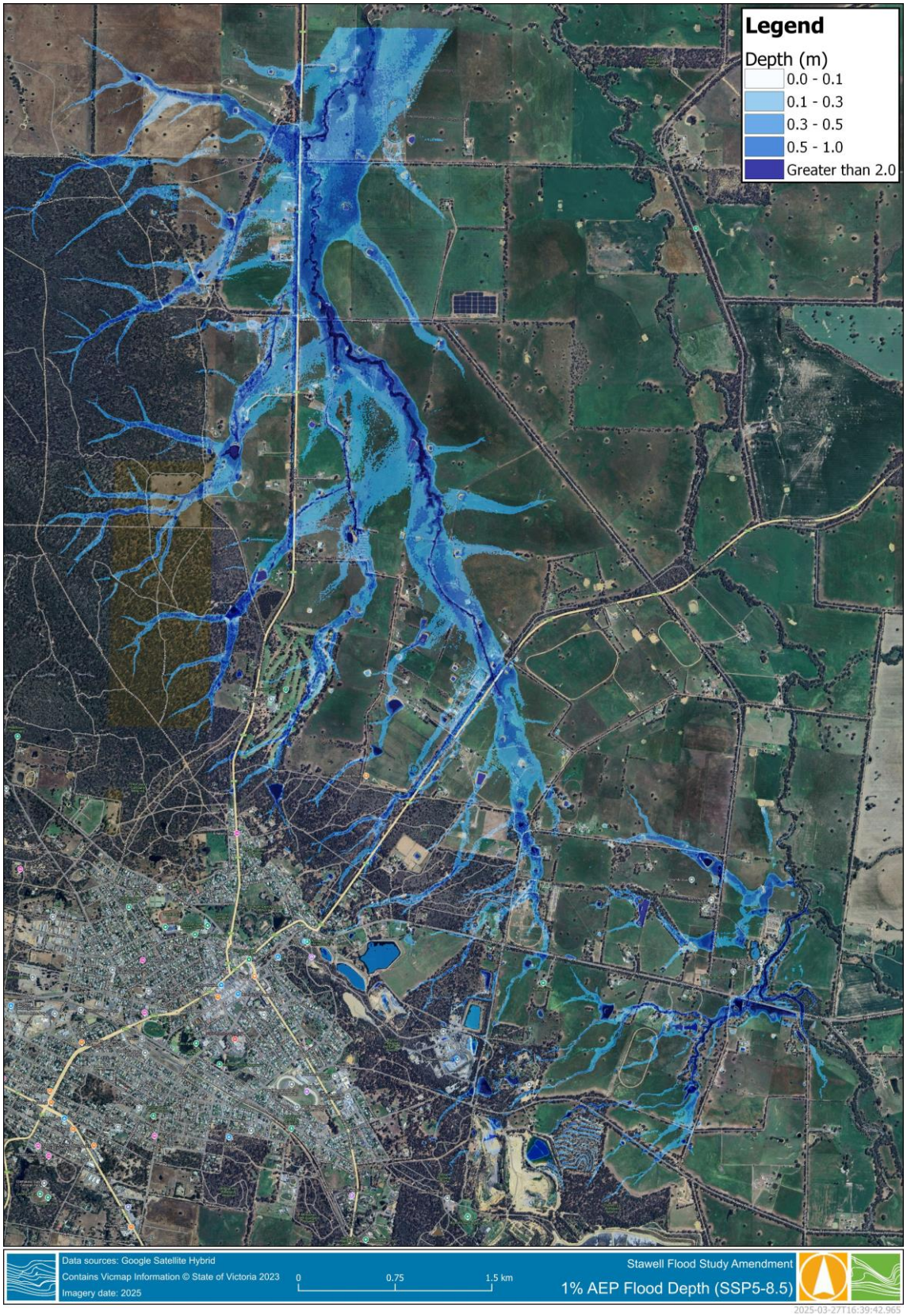

Figure 3-6 SSP5 2100 1% AEP Flood Depth – Stawell Golf

4 PLANNING SCHEME LAYERS

4.1 Overview

Land use planning controls and building regulations provide mechanisms for ensuring appropriate use of land and building construction, given the flooding risks to a particular area. Land use planning controls are aimed at reducing the growth in flood damages over time. The controls balance the likelihood of flooding with the consequences (flood risk).

As part of ongoing municipal reform, the State Government introduced a consistent planning scheme format for application across the State. The Victorian Planning Provisions (VPPs) are employed by all Victorian municipalities.

Victorian Building Regulations specify that floor levels should be at least 300 mm above a nominated flood level. If land is subject to flooding, the municipal council may set conditions that require a particular type of construction or particular types of construction materials.

This section details the input data, methodology and outputs for the land use planning flood mapping. The following are discussed:

- Victorian Planning Provisions – outlines the flood related Victoria Planning Provisions (VPPs).
- Flood related planning zones and overlay – details the available flood related planning zone and overlays.
- Flood related planning zone and overlays delineation – details the delineation of the flood related planning zone and overlays for the study area.

4.2 Victorian Planning Provisions

The Victoria Planning Provisions (VPPs) aim to achieve consistency in the application of planning controls for areas subject to flooding throughout the State. The stated objectives are to protect life, property and community infrastructure from flood hazard, and to preserve flood conveyance capacity, floodplain storage and natural areas of environmental significance.

The VPPs provide for three overlays and one zone associated with mainstream flooding as follows:

- Land Subject to Inundation Overlay (LSIO)
- Floodway Overlay (FO)
- Urban Floodway Zone (UFZ)
- Special Building Overlay (SBO)

The **SBO, LSIO and FO overlays** were considered relevant to the present study. The definitions of these overlays and their criterion are provided in the following sections:

For each of the overlays, the VPPs specify the appropriate types of land uses and developments which are to be regulated through a system of permits. These are intended to achieve consistency throughout the State, but local variations to these guidelines are allowed in planning permit exemptions through a schedule to a flood overlay and/or performance-based criteria through a local floodplain development plan that has been incorporated into the planning scheme.

4.3 Flood Related Zones and Overlays

4.3.1 Land Subject to Inundation Overlays (LSIO)

The LSIO identifies land liable to inundation by overland flow, in flood storage or in flood fringe areas affected by flooding. In this project the 1% AEP flood under 2100 SSP3-7.0 climate change scenario were used.

The permit requirements of LSIO are intended:

- To ensure that development maintains the free passage and temporary storage of floodwaters.
- To minimise flood damage.
- To be compatible with the flood hazard and local drainage conditions.
- Not to cause any significant rise in flood level or flow velocity.
- To protect water quality in accordance with relevant State Environment Protection Policies (SEPPs).

In general, emergency facilities (hospitals, schools and police stations etc.) must be excluded from this area (refer Clause 15.02). Similarly, developments or land uses which involve the storage or disposal of environmentally hazardous chemicals or wastes, and other dangerous goods should not be located within LSIO.

4.3.2 Floodway Overlay (FO)

The FO identifies waterways, main flood paths, drainage depressions and high hazard areas. The identification of FO has been based on the below criteria:

- 1% AEP SSPs depths > 0.5 m
- 1% AEP SSPs velocities > 1.5 m/s
- 1% AEP SSPs velocity x depth ≥ 0.4 m^2/s

4.3.3 Special Building Overlay (SBO)

The SBO is used to define flooding from overland flows where stormwater infrastructure plays controlling role in the inundation (as opposed to water escaping from a waterway). The overlay is generally used within built up areas where the nature of flooding from stormwater has been identified. This planning control is used to ensure that development within these areas identified as flood prone can be undertaken with due regard for the flood risk and in accordance with appropriate conditions and floor level requirements.

The primary objective of the SBO is:

- *"To ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity."*

SBO extents are recommended as part of this study and for only a select number of areas where inundation has been modelled outside of the designated waterways and infrastructure is a major controlling factor. This primarily inundation at the very top of catchments where a defined waterway is no longer present, i.e., urbanised catchments. Additionally, inundation in areas which have a catchment of 60 Ha or less were included in the delineation of SBO.

Further refinements to the extent of the proposed SBO were undertaken by assessing velocity vectors from the hydraulic model to determine where flows change from overland/stormwater flooding to riverine flooding.

Filtering was applied to the generated SBO extent to remove shallow depths from the proposed overlay to account for any inaccuracies the catchment wide maps might have one lot-by-lot scale. For this study, the SBO extents filtered out depths less than or equal to 5 cm.

4.3.4 Overlay Generation Criterion

In generating the draft overlays, the following principals and guidelines were developed and applied from the existing flood study and in consultation with NGSC:

- Raw gridded model results were smoothed on their fringes to create a plausible representation of the floodway and flood fringe boundaries. This removed the irregular 'saw tooth' edge.
- Irregularities in the floodway and flood fringe boundaries, such as small 'tongues' of flood-prone land extending out from the bulk of the identified flood extent were smoothed where necessary. The underlying Planning Scheme Zone was a consideration in doing this.
- Islands (high ground) within the Floodway Overlay (i.e. marooned by high hazard flooding) were in general covered by the Floodway Overlay due to access being cut. A planning permit application would be therefore filled the less than 1-hectare islands which ensures flooded access hazards are accounted for.
- The removal of isolated patches and paddles (such as dams) which less than 1 hectare and mapped outside of the main floodplain area and not connected to any stormwater infrastructure were removed.
- Each overlay polygon was smoothed by applying the Polynomial Approximation with Exponential Kernel (PAEK) in ArcGIS Pro with parameter as 25m.

An overview of the proposed SBO, FO and LSIO for Stawell and the Stawell Golf Course catchments are presented in **Error! Reference source not found.** and Figure 4-2, with a closer perspective of the SBO shown in Figure 4-3.

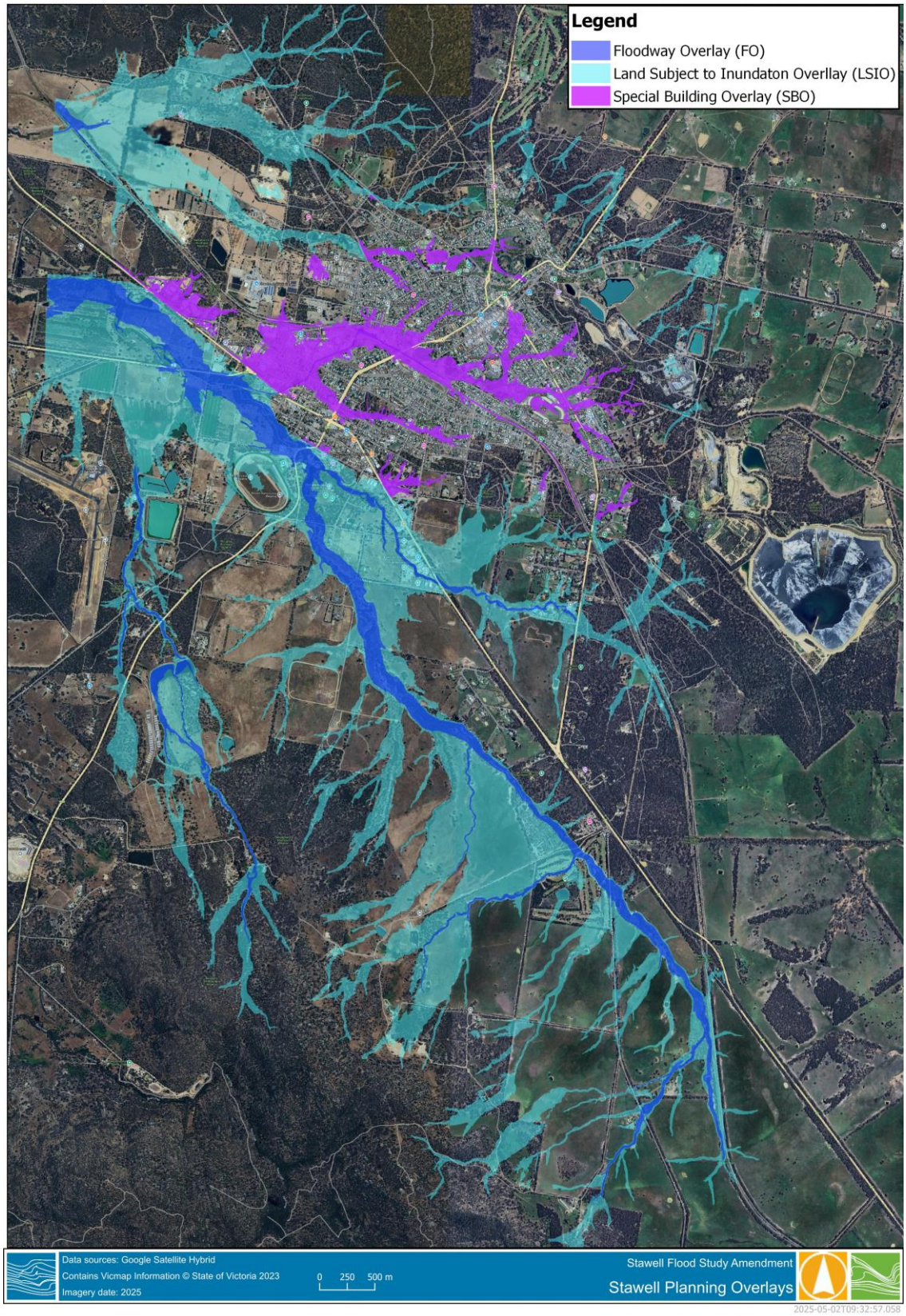

Figure 4-1 Stawell Planning Overlays

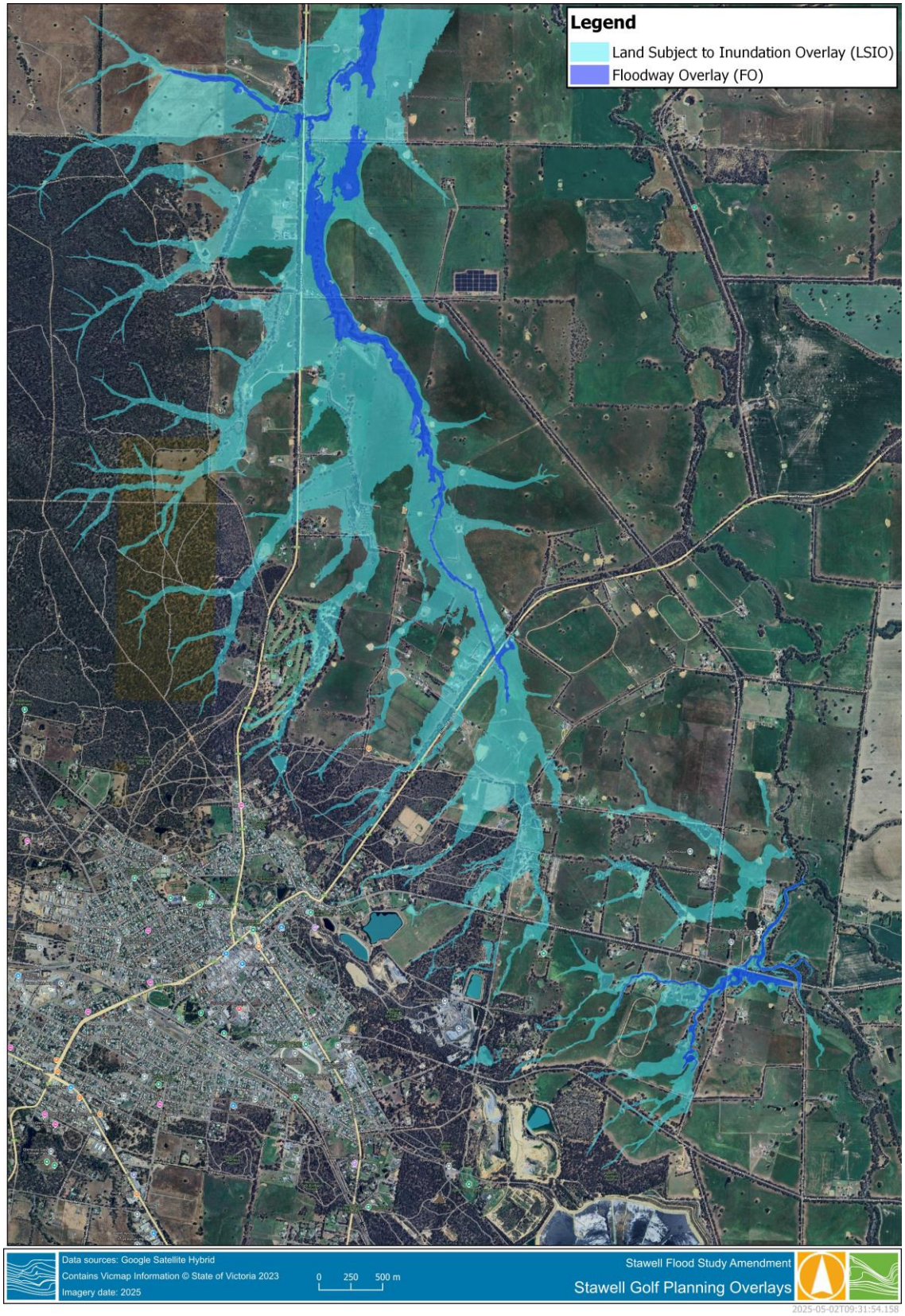

Figure 4-2 Stawell Golf Planning Overlays

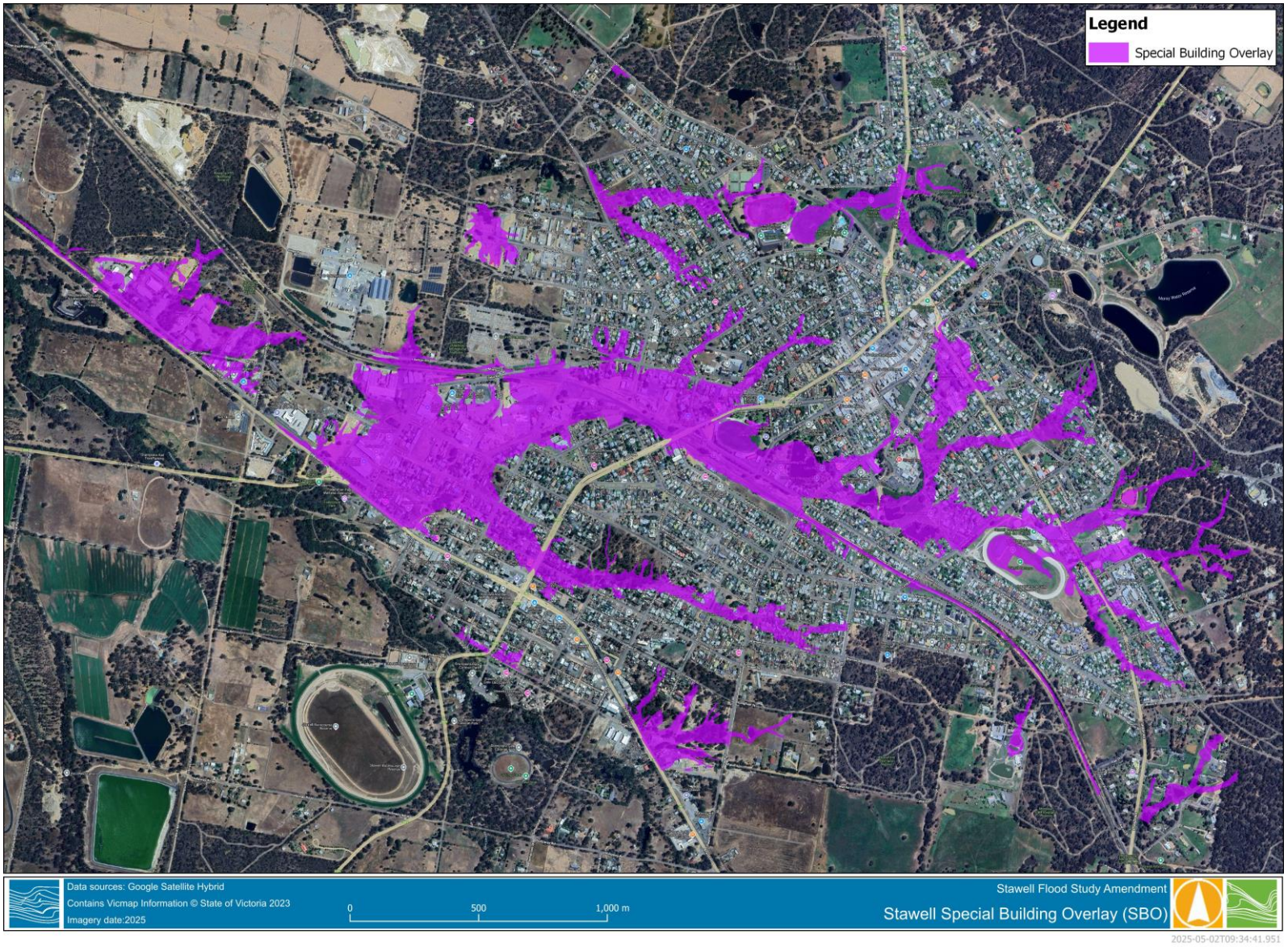

Figure 4-3 Stawell Special Building Overlays (Zoomed -In)