



Soukutsu Pty Ltd

1290 Greendale Road Flooding Assessment

November 2020

Table of contents

1.	Introduction	3
1.1	Background	3
1.2	Purpose of this report	4
1.3	Scope and Limitations	4
2.	Planning and Legislative Considerations	5
2.1	MKD Architects River Gardens Cemetery DA Masterplans	5
2.2	Liverpool City Council	5
2.3	Acts	7
2.4	Policies, Guidelines, and standards	7
3.	Site Analysis	9
3.1	Existing Site	9
3.2	Proposed Development	10
4.	Modelling	12
4.1	General Approach	12
4.2	Nepean River Boundary Conditions	12
4.3	Duncans Creek Hydrology	13
4.4	Flood Model	15
5.	Liverpool City Council Planning Control Assessment	22
6.	Summary and Findings	26

Table index

Table 4-1	Nepean Design Events	12
Table 4-2	Validation of XPRAFTS Model	13
Table 4-3	Adopted Flood Peaks	14
Table 5-1	Council 4-step Process to Identify Development Controls	22
Table 5-2	Liverpool City Council Planning Control Assessment	23

Figure index

Figure 1-1	Location of proposed development site	3
Figure 2-1	LEP 2008 Map 4900_COM_FLD_001_020_20090731	5
Figure 3-1	Existing Site	9
Figure 3-2	Proposed Site	11
Figure 4-1	Hydrological Catchments	14

Figure 4-2 Typical sub-grids at the site15

Figure 4-3 HECRAS 2D Model Domain16

Figure 4-4 1 in 20 AEP Events (figure a left and b right)17

Figure 4-5 1 in 100 AEP Events (figure a left and b right)18

Figure 4-6 1 in 20 AEP Event (left) and 1 in 100 AEP Event (right).....18

Figure 4-7 1 in 20 AEP Events (figure a left and b right)19

Figure 4-8 1 in 100 AEP Events (figure a left and b right)20

Figure 4-9 1 in 20 AEP Event (left) and 1 in 100 AEP Event (right).....20

Appendices

Appendix A – Development Proposal

Appendix B - Flood Maps – Existing Conditions

Appendix C - Flood Maps – Proposed Development Conditions

Appendix D - Flood Impact

1. Introduction

1.1 Background

Soukutsu Pty Ltd ATF Wallacia Trust (Soukutsu) engaged GHD Pty Ltd (GHD) to undertake a Flooding Assessment to provide the relevant documentation in support of a Development Application (DA) to Liverpool City Council.

The subject of the DA is a proposed development comprising of the demolition of existing structures and construction of a cemetery, crematoria, community facilities, administration buildings, halls, chapels and other buildings and structures all associated with the operation of a cemetery with a garden, parkland and landscape setting. The proposal also includes internal roads, lakes and ponds.

The proposed development is located on the site identified as 1290 Greendale Road, Wallacia (see Figure 1-1) and legally described as Lot 1 in DP 776645 in the Liverpool City Council Local Government Area (LGA). The site is located on the western side of Greendale Road and eastern side of the Nepean River. The surveyed land area is approximately 73.46 ha.



Figure 1-1 Location of proposed development site

1.2 Purpose of this report

Purpose of this report is to compile a Flooding Assessment at DA stage for the proposed development which will accompany the DA application to Liverpool City Council.

1.3 Scope and Limitations

This report: has been prepared by GHD for Soukutsu Pty Ltd and may only be used and relied on by Soukutsu Pty Ltd for the purpose agreed between GHD and the Soukutsu Pty Ltd as set out in this report.

GHD otherwise disclaims responsibility to any person other than Soukutsu Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Soukutsu Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Planning and Legislative Considerations

2.1 MKD Architects River Gardens Cemetery DA Masterplans

The development proposal (Appendix A) comprises of a cemetery, crematoria, community facilities, administration buildings, halls, chapels and other buildings and structures all associated with the operation of a cemetery with a garden, parkland and landscape setting. The proposal also includes internal roads, lakes and ponds.

2.2 Liverpool City Council

Local government is the primary authority responsible for land use planning in NSW. The proposed development is in the Liverpool City Council LGA

2.2.1 Liverpool Local Environmental Plan (LEP) 2008

The LEP 2008 is a legal document containing development standards applying to land in Liverpool. It guides planning decisions and for each piece of land and specifies what may be built, what land may be used for, and what building heights and floor spaces are allowed. The proposed development is in Rural Zone RU1 Primary Production.

Cemeteries and associated civil works are permissible in the RU1 zone, subject to complying with the objectives of the RU1 zone and relevant requirements contained in Liverpool LEP 2008 and Liverpool DCP 2008.

The Liverpool City Council LEP 2008 Flood Planning Area Map shows areas of the property denoted as a both Flood Planning Area and Flood Prone Land (Figure 2-1). It is likely that these designations were assigned due to Nepean River flooding. Additional planning areas would likely apply due to Duncan's Creek flooding, not necessarily shown on the figure below. The LEP defines objectives and development consent conditions for both Flood Planning Areas and Flood Prone Land, which should be referred to.

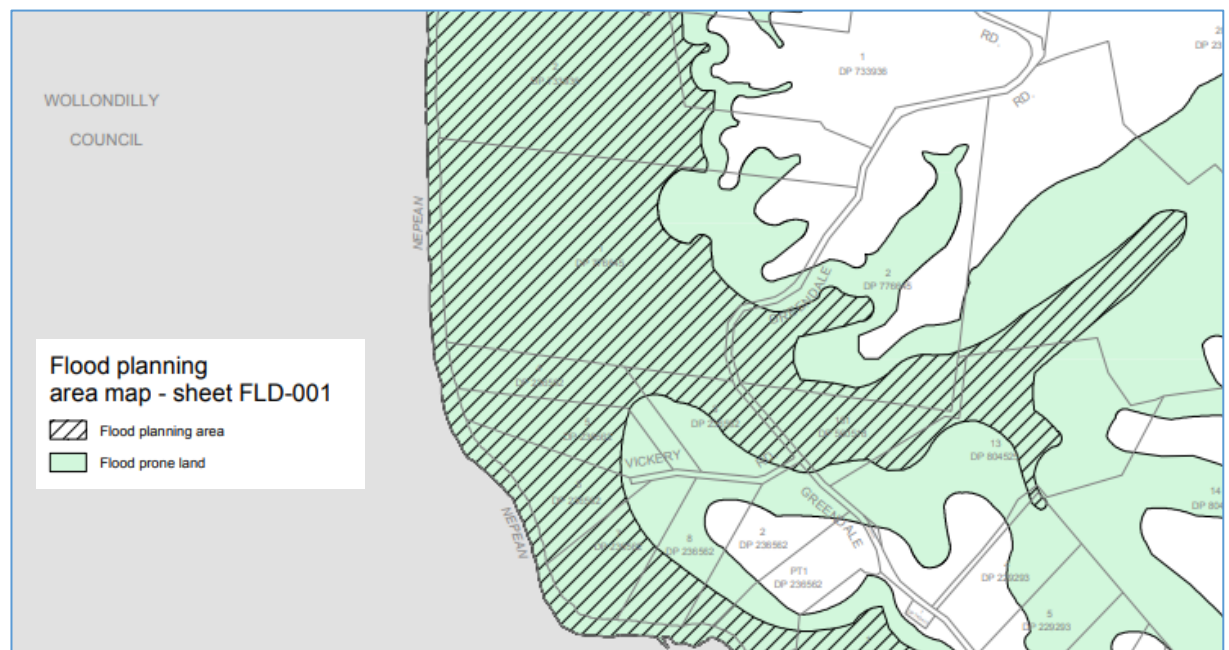


Figure 2-1 LEP 2008 Map 4900_COM_FLD_001_020_20090731

2.2.2 Liverpool Development Control Plan (DCP) 2008

Liverpool DCP guides growth in the Liverpool LGA, and Part 1 General Controls for all Development applies to all proposed developments. This includes Section 9 – Flood Risk.

In addition to the complying with Part 1 of the Liverpool DCP, the proposal must also comply with Part 5 Development in Rural and Environmental Zones (Clause 9.13 Cemeteries, Crematoriums and Funeral Chapels).

The Liverpool Council DCP 2008 provides background, objectives, and controls for land under the flood planning level. The controls vary depending on the sensitivity of a land use to flooding, the severity of flood impact on site and the specific floodplain in which a site is located. A 4-step process is provided in the DCP to determine the relevant controls and should be referred to.

2.2.3 Pre - Development Application Advice (PL-34/2020)

Following the pre-DA meeting of the 27 May 2020, Council issued the following requirements with respect to flooding:

- *The proposed development site is located on the floodplain of Nepean River, and the site is affected by flooding under the 1% Annual Exceedance Probability (AEP) event. The proposed development site is also intersected by Duncans Creek and is affected by flash flooding.*
- *A flood impact assessment undertaken by suitably qualified and practicing floodplain engineer demonstrating no adverse impact of flooding due to the proposed development at the vicinity of the development site is required. The assessment shall be undertaken using hydrologic and 2D hydraulic modelling (preferably TUFLOW) for up to the 1% Annual Exceedance Probability (AEP) flood event. The assessment shall consider the impact of mainstream flooding (from Nepean River) and flash flooding (from Duncans Creek) separately.*
- *There shall be no net loss of flood storage volume below the 1% AEP flood level of Nepean River. Volume of cut and fill for earthwork shall be provided. Compensating flood storage shall exclude all passive flood storage within the 1% AEP flood extent.*
- *For any basement car parks, the crest of driveway ramp to the basement carpark and/or entrance to basement shall be 100mm above the 1% AEP flood level.*
- *Finished floor levels of habitable rooms shall be no lower than the 1% AEP flood level plus 500mm freeboard.*
- *On-site water quality control measures shall be provided and maintained. Water quality treatment works shall be designed using MUSIC modelling software and the water quality treatment system performance shall be verified using Council's MUSIC link.*
- *Flood risk management plan / flood evacuation plan prepared by a suitably qualified and practicing floodplain engineer is required.*
- *Details of flood compensatory works and cut & fill volume calculations shall be submitted.*
- *Flood impact assessment report shall be submitted. The flood impact assessment report shall include catchment map, hydrologic and hydraulic assessments, pre and post development Digital Elevation Model (DEM), pre and post development flood depth and velocity maps, flood depth and velocity difference maps and pre and post-development 1% AEP flood level contours.*
- *Electronic copies of hydrologic and 2D hydraulic models (preferably TUFLOW) shall be submitted. Complete TUFLOW model set-ups from both pre and post-development simulations shall be submitted preserving relevant subfolders so that model simulations can*

be undertaken as required. The modelling files shall include model simulation control files, geometry files including DEM, boundary condition files including boundary database/input time-series data, model simulation log files and all files generated during the model simulations.

- *The result files obtained from TUFLOW model simulations obtained for both pre and post-development scenarios shall be submitted. The result files shall provide maximum water level (h), flood depth (d), velocity (v) and unit flow (q). The 2D hydraulic model simulation results shall be supplied in dat or xmdf format.*

2.3 Acts

2.3.1 Environmental Planning and Assessment Act 1979

The EP&A Act, administered by the NSW Department of Planning, Industry and Environment, is the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposals are assessed. The EP&A Act aims to encourage the proper management, development and conservation of resources, environmental protection and ecologically sustainable development.

2.3.2 Water Management Act 2000

The Water Management Act 2000, (WM Act) is administered by regulators including WaterNSW and Department of Industry: Water to manage water resources. The aim of the WM Act is to ensure that water resources are conserved and properly managed for sustainable use benefiting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions. Fresh water sources throughout NSW are managed by water sharing plans (WSPs) under the WM Act.

Principles of the WM Act relating to drainage and floodplain management include the need to avoid or minimise land degradation including soil erosion, compaction, geomorphic instability, and waterlogging, and the need for controlled activity approval when working near watercourses.

2.3.3 Protection of the Environment Operations Act 1997

The Protection of the Environment Operations (POEO) Act 1997, is administered by the NSW Environment Protection Authority (EPA) and is implemented throughout NSW to protect, restore and enhance the quality of the environment. The aim of the POEO Act is to reduce risks to human health, provide increased opportunities for public involvement and participation in environment protection, rationalise, simplify and strengthen the regulatory framework for environment protection and improve the efficiency of administration of environment protection legislation.

To ensure that potential impacts on stormwater are managed in accordance with the objectives of the POEO Act, mitigation measures that would need to be implemented during the construction and operational phases.

2.4 Policies, Guidelines, and standards

2.4.1 NSW Floodplain Development Manual

The Floodplain Development Manual and NSW Flood Prone Land (NSW Government, 2005) policy concerns the management of flood-prone land within NSW. It provides guidelines in relation to the management of flood liable lands, including any development that has the

potential to influence flooding, particularly in relation to increasing the flood risk to people and infrastructure. Activities of the project which have the potential to increase flood risk through, for example, increasing stormwater runoff would be subject to consideration under the Floodplain Development Manual.

2.4.2 Australian Rainfall and Runoff (ARR, 2019)

Australian Rainfall and Runoff (ARR, 2019) is the primary technical publication for stormwater and hydrological estimates and design considerations. The publication was the result of a number of years of updates to the previous version of Australian Rainfall and Runoff (Engineers Australia, 1987). The technical analysis and development of the hydrologic and hydraulic models, including the management and flooding at the site would need to consider this guideline.

2.4.3 Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004)

The document Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom, 2004) outlines the basic principles for the design and construction of sediment and erosion control measures. This document relates particularly to urban development sites; however, it is relevant to the Project as it provides guidance on the configuration of erosion and sedimentation controls required during construction.

3. Site Analysis

3.1 Existing Site

The existing site generally comprises paddocks with little to no hardstand areas. Referring to Figure 3-1. There are four general areas of elevated topography. The site west of Elevated Topography 2 and 3 drains to the Nepean River, while the catchment east of this location drains to Duncans Creek. The site is located within the Nepean River floodplain.

Within the Nepean River floodplain, topographic levels are generally in the range of 36 to 38 m AHD, with Duncans Creek invert ranging between 32 to 35 m AHD depending on location. The Nepean River invert is approximately 23 to 24 m AHD with the elevated topography at 42 to 44 m AHD. Duncans Creek is thus elevated with respect to the Nepean River and there are significant topographic undulations across the site.

The Nepean River is located along the western boundary of the site draining in a northerly direction towards Wallacia. Duncans Creek bisects the site on the eastern half of the site, also draining in a northerly direction towards the confluence with the Nepean River. The site is flood affected by:

- The Nepean River breaking the banks and discharging across the site, in an easterly direction.
- The Nepean River, back flooding up Duncans Creek from the downstream confluence, entering the site along the northerly boundary.
- Duncans Creek flooding due to the local Duncans Creek catchment.

The Nepean River and Duncans Creek flooding occur as different modes, with the former being a much slower response due to the large catchment area. Duncans Creek on the other hand will have a much faster catchment response and faster rising flood hydrographs.

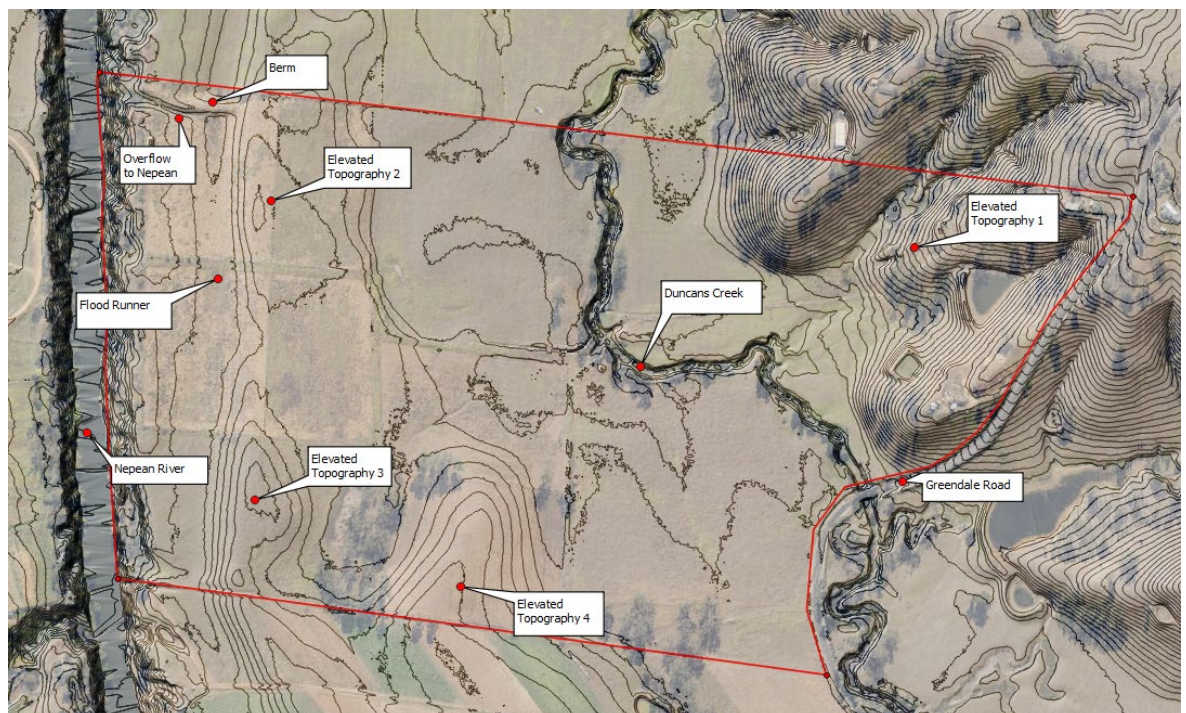


Figure 3-1 Existing Site

3.2 Proposed Development

With reference to Figure 3-2, the proposed development comprises four distinct pad areas with Pad 1 located east of Duncan's Creek and pads 2 to 4 located west of Duncan's Creek. These pads raise ground levels above the 1 in 100 AEP Nepean River flood level and are approximately located at the locations of the elevated topographies on the existing site.

Referring to Figure 3-2:

- Pad 1, will comprise inground, traditional burial plots, and vertical stacking cremation walls. Pad 1 will also be the location of the Chapel, Crematorium, access roads and gatehouse and function facilities.
- Pads 2 to 4 will comprise inground, traditional burial plots, and vertical stacking cremation walls in some locations
- To offset the loss of floodplain storage and win fill for the pads, the centre of the site is depressed (via excavation). This area will house five circular flood proofed Mausoleum structures. A larger Mausoleum is located between Pad 2 and Pad 3. This centre of the site (the valley floor) will accommodate roads, paths and landscaping designed to receive minimal damage due to flood inundation. There will be controlled site access to the valley floor so this area could readily be precluded in times where flood inundation has been forecast.
- All pads are bisected by internal access roads, located at the pad level, and connected by bridges.

The central depressed area of the site will also house gardens and internal walkways together with maintenance and walking tracks.

The development proposes to substantially regrade the site to provide flood free pads and the central depressed area, required as floodplain storage compensation. For the purposes of flood management, the following has been proposed:

- The depressed flood compensatory storage has been sized by the Project Architects to balance cut and fill across the site in the 1 in 100 AEP flood event associated with the Nepean River.
- All buildings across the site will be flood proofed up to a minimum of 45.3 m AHD where required, being the Nepean 1 in 100 AEP flood event plus 0.5m.
- The Mausoleum between Pad 2 and Pad 3 provides a flood barrier to control and manage Nepean River flood overflow onto the Duncans Creek floodplain between the pads. The building will be tied into Pad 2 and Pad 3 with two walls. The walls will have an overflow level set at 44.45 m AHD. The Mausoleum permits overflow at the level of 44.5 m AHD.
- The depressed flood compensatory storage area west of Pad 2 and 3 will be sited to maintain the existing berm along the northern property boundary. This berm will need to be raised to 39.7 m AHD where below this level.

Further to the above:

- There are several locations where overflows will occur into the depressed central areas and between the proposed pads. At these locations concentration of flow may lead to increased flow velocities and the risk of erosion due to inherent alterations to the flood conveyance. In future civil design iterations, these areas may need to be constructed as formal overflow flood ways. To prevent scour in these areas appropriate erosion protection will need to be provided.

- The hydraulic design parameters will need careful consideration during the design of the pads, walls, and the mausoleums. This will inform structural and building design.

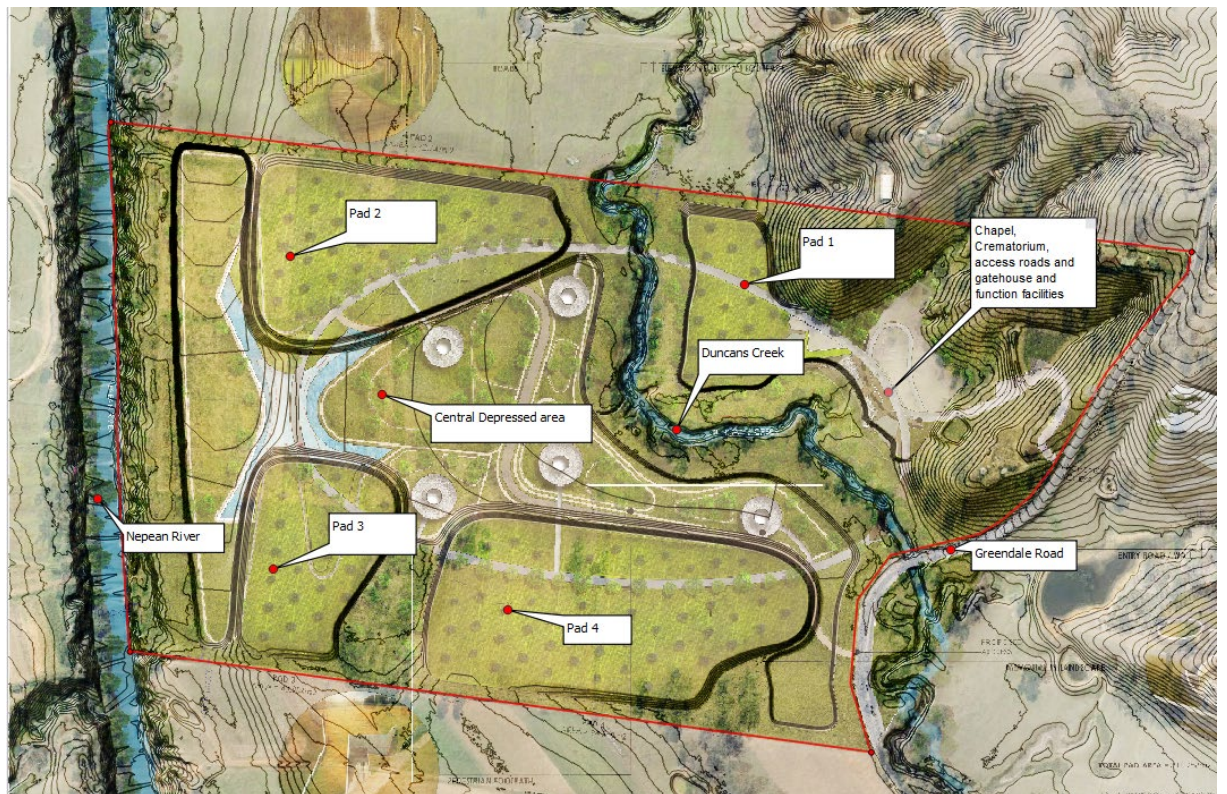


Figure 3-2 Proposed Site

4. Modelling

4.1 General Approach

Flooding at the site was simulated using the following approach:

- For Duncans Creek the hydrology was developed with a RAFTS model for the local catchment.
- For the Nepean River representative flood events were sought from the authors of the Hawkesbury Nepean Valley Flood Study (iNSW, 2019) for use in the local flooding assessments. These events were extracted from the Hawkesbury Nepean Valley Flood Study Monte Carlo modelling series, comprising some 20 000 combinations of rainfall events in the valley, as recommended applicable to the site by the authors of the 2019 study. The data provided were downstream stage hydrographs and upstream inflow hydrographs for a selection of Monte Carlo flood events corresponding approximately to design flood events.
- A self-standing HECRAS 2D model (2D flexi-mesh) was developed for the floodplain at the site, extending from Hopewood downstream to Ravenswood upstream, encompassing some 6.5 km of the Nepean River. The model included Duncans Creek. It is acknowledged that Council preferred a TUFLOW mode, however a flexi-mesh is better suited to the current application than a grid-based model, particularly with multiple domains. It is also noted that the TUFLOW SGS and quadtree functionality was not available at the time of this study. Notwithstanding these recent improvements in TUFLOW, the HECRAS 2D hydraulic solver is expected to simulate the Nepean River floodplain more accurately. A further benefit is that results interpretation can be undertaken 'on-the-fly', which is important when understanding the complex flooding that occurs at this site.

4.2 Nepean River Boundary Conditions

With knowledge of the entire Hawkesbury Nepean Valley flood processes and specific requirements for the current projects, the authors of the Hawkesbury Nepean Valley Flood Study (iNSW, 2019) recommended a series of flood events, which would approximate 1 in 20 and 1 in 100 AEP design flood events at the site. It must be noted that these flood events were extracted from the series of 20 000 Monte Carlo flood events, and therefore are not deterministic design events. The events are listed in Table 4-1.

For each flood event, the flood discharge and flood stage hydrographs were provided at Ravenswood, Saraville and Hopewood.

Table 4-1 Nepean Design Events

Scenario	Monte Carlo Scenario	Flood Level at Blaxland Bridge (m AHD)
Approximate 1 in 20 AEP Design Flood		
1in20AEP(RD06569)	RD06569	39.005
1in20AEP(RD00507)	RD00507	37.096
Approximate 1 in 100 AEP Design Flood		
1in100AEP(RD04853)	RD04853	43.889
1in100AEP(RD08858)	RD08858	44.603

4.3 Duncans Creek Hydrology

4.3.1 Compilation

The hydrology of catchments draining to Duncan's Creek (Figure 4-1) were compiled using an XPRAFTS hydrologic model, using Australian Rainfall and Runoff 2019 (ARR 2019) procedures. Inputs to the XPRAFTS model were:

- ARR 2019 rainfall: Intensity Frequency Duration (IFD) Design Rainfall Depth (mm) issued on 02 October 2019 for the requested coordinates: Latitude, -33.909000, Longitude, 150.673000.
- Catchment and impervious areas: The catchment area (2,125 ha with 0.46% average slope) is mostly pervious, with a 5% impervious fraction adopted to account for roads, paths, and other less pervious areas.
- Initial and continuing losses: The loss values adopted for 5% and 1% AEP events were obtained from the ARR 2019 data hub, with a factor of 0.4 applied to continuing losses as per NSW specific guidelines. Initial losses were taken as 38 mm. Continuing losses were taken as 1.48 mm/hr. For PMF simulations, ARR 2019 recommends initial losses of 0 mm, and continuing losses of 1 mm/hr.
- It is assumed that any dams, lakes and/or reservoirs in the catchment area will be at full supply level, to represent a worst-case flooding scenario.

Simulations were undertaken for the 5%, 1% AEP and PMF storm events in Duncan Creek at the property.

4.3.2 Validation

Validation of the hydrological modelling approach was undertaken using two separate methods, namely the compilation of a hydrologic RORB model and a Regional Flood Frequency Estimate (RFFE). The validation was undertaken by comparing the XPRAFTS model to these two approaches, when simulated for the 1% AEP storm event. The results in Table 4-2 show that:

- The RORB model provides a similar maximum flood peak when comparing the maximum mean, of each duration's ensemble. The model was simulated with the Kleemola kc value of 4.81 based on the study area.
- The RFFE method provides a wide spread of flood peaks. The catchment size is significantly smaller than the majority of catchments sizes used for the RFFE estimate. However when factoring the nearest gauged data on catchment areas, a favourable flood peak estimate is noted when compared to the RORB model.

Based on the above, the XPRAFTS model simulations have been adopted.

Table 4-2 Validation of XPRAFTS Model

Method	1% AEP Flood Peak (m3/s)
XPRAFTS	107 (12 hour, median of ensemble)
RORB	103 (12 hour, median of ensemble)
RFFE	264 to 2550.3 (5% to 95% percentile) 146 (factored by area)

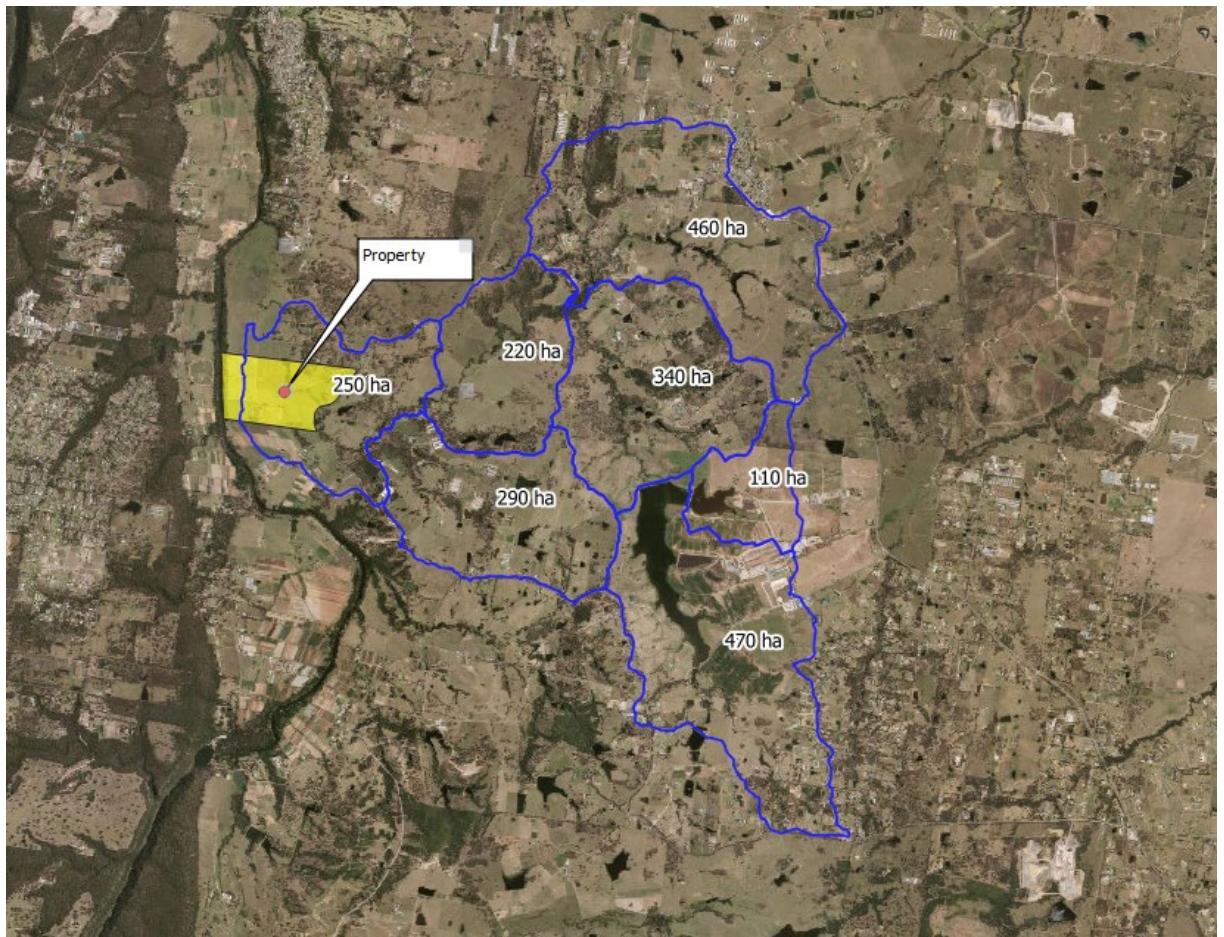


Figure 4-1 Hydrological Catchments

4.3.3 Results

For each of the storm events (5%, 1% and PMF), a range of storm durations were simulated to determine the critical storm duration for Duncan's Creek at the property. These critical durations were then used to determine the ensembles that closely approximate the median flood peak. The adopted flood peak results are tabulated below.

Table 4-3 Adopted Flood Peaks

Event	Critical Duration	Median Flood Peak (m ³ /s)	Ensemble Number
20-year	9 hour	68.3	8
100-year	12 hour	107.4	10
PMF	12-hour	569.6	-

4.4 Flood Model

4.4.1 Model Compilation

A self-standing HECRAS 2D model (2D flexi-mesh) was developed for the Nepean River floodplain extending from Hopewood downstream to Ravenswood upstream, encompassing some 6.5 km of the Nepean River. The hydraulic model domain is shown below in Figure 4-3, and includes Duncans Creek from approximately 550 m upstream of Greendale Road.

- A model was configured with sub-meshes of the following general sizes:
 - Outer Nepean floodplain = 40 m
 - Inner Nepean floodplain and river channel = 10 m
 - Duncans Creek floodplain = 5 m
 - Duncans Creek channel = 2 m

The mesh was adjusted using break lines in key locations. These included the Duncan's Creek invert and the road crest of Greendale Road. For each mesh face HECRAS 2D, samples a large number of points, providing a better representation than a regular grid model such as TUFLOW.

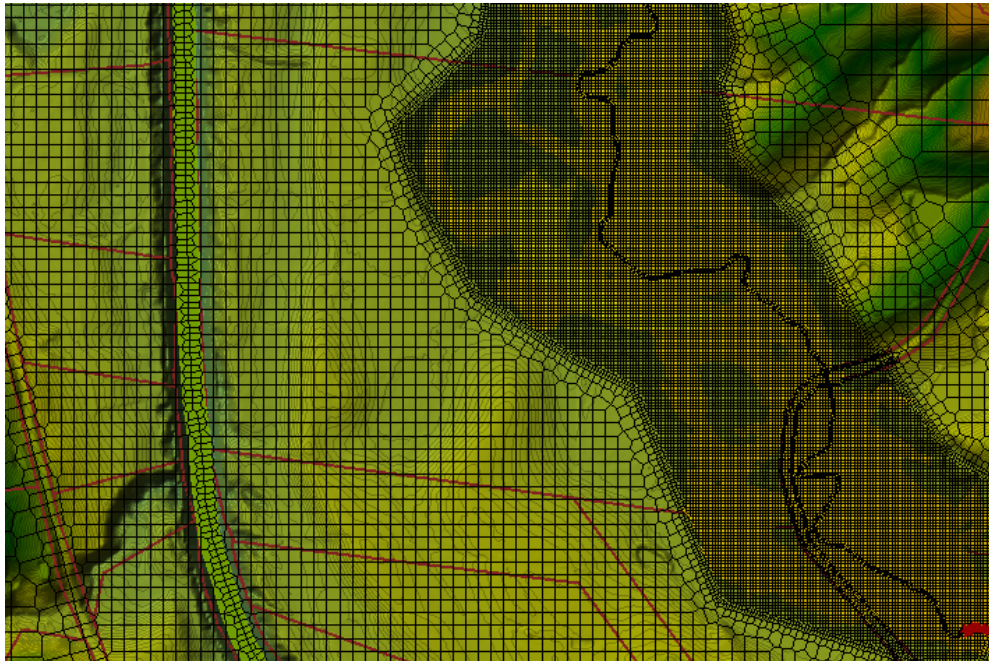


Figure 4-2 Typical sub-grids at the site

- Manning's "n" roughness values of 0.05 was adopted for the creek channel and floodplain based on topographical observations, and values used in the Hawkesbury Nepean Valley Flood Study (iNSW, 2019). Roads were configured as Manning's "n" roughness values of 0.02.
- The 2.8 m by 2 m dual-barrelled box culvert under Greendale Road was configured in the model. Data of the culvert was supplied by the Client.
- Topographic data was sourced from LiDAR data (1 m grid) obtained from the ICSm, ELVIS - Elevation - Foundation Spatial Data data portal.
- The XPRAFTS inflow hydrographs were adopted as the upstream boundary condition inflow on Duncans Creek. The concurrent upstream flow hydrographs and downstream

stage hydrographs were used on the Nepean River, as provided by the authors of the Hawkesbury Nepean Valley Flood Study (iNSW, 2019).

- For developed conditions, only the pads and central depression area as represented by the bulk earthworks were simulated. Other infrastructure and bridges connecting the pads were not simulated.

Simulations were undertaken as follows for both existing and proposed development conditions:

- Nepean River flooding 1 in 20 and 1 in 100 AEP events, without flooding of Duncans Creek. The 1 in 20 AEP events were represented by the RD06569 and RD00507 stochastic sequences while the 1 in 100 AEP events were represented by the RD04853 and RD08858 stochastic sequences, as provided by the authors of the Hawkesbury Nepean Valley Flood Study (iNSW, 2019).
- Duncans Creek flooding 1 in 20, 1 in 100 AEP events and PMF events, without Nepean River flooding. In this scenario, normal depth was assumed as downstream boundary on the Nepean River.

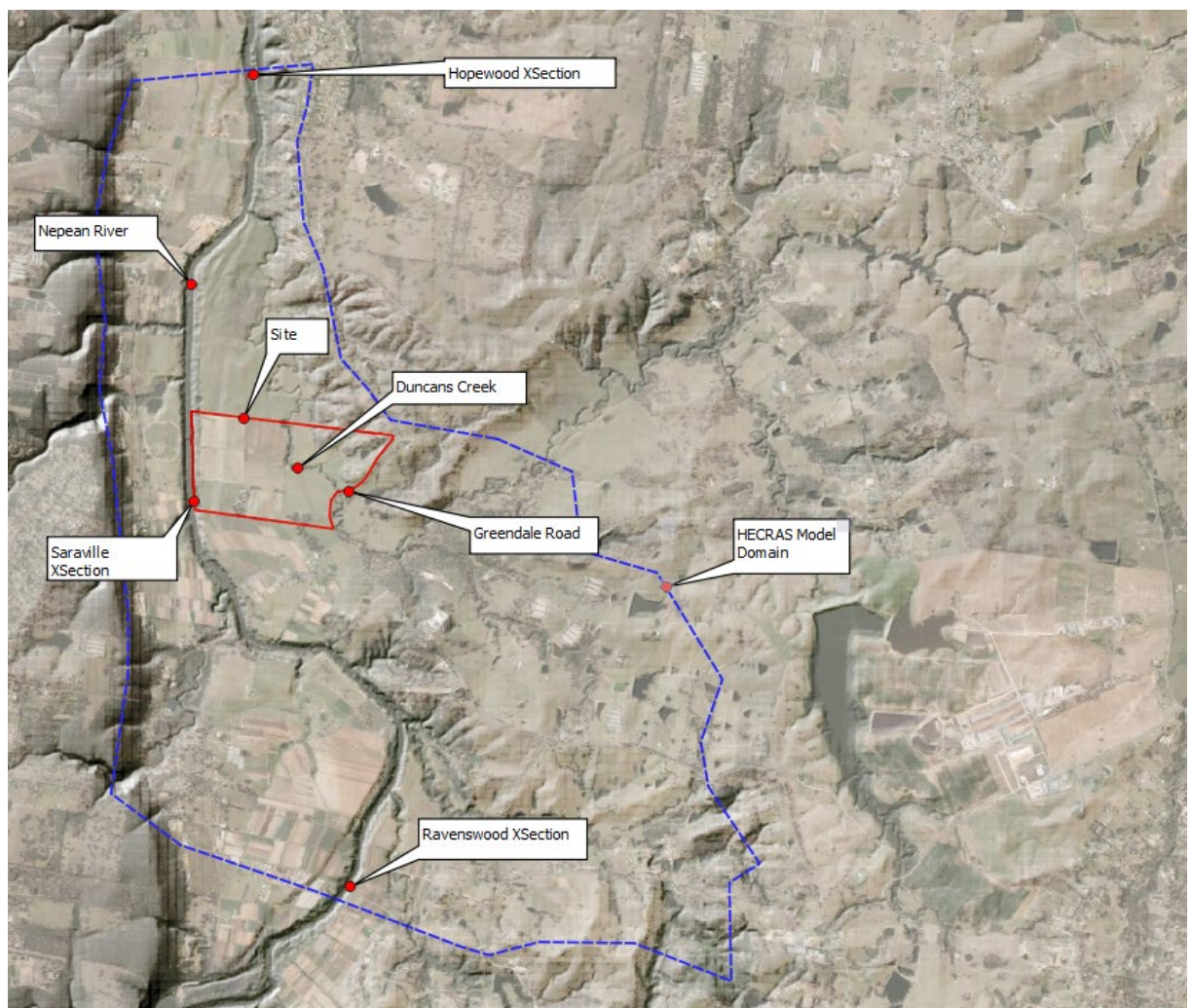


Figure 4-3 HECRAS 2D Model Domain

4.4.2 Flood Results - Existing Conditions

The simulated flood maps for existing conditions are provided in Appendix B. From the figures it is noted that:

Nepean River Flooding

- In the 1 in 20 AEP event (RD00507) Figure 4-4-a, flood waters do not surcharge onto the site from the Nepean River. Some backwater flooding occurs onto the site from downstream, via Duncans Creek. In the 1 in 20 AEP event (RD06569) Figure 4-4-b, flood waters surcharge onto the site from the Nepean River, activating a flood runner between the river bank and the Elevated Topography 2 and 3 on Figure 3-1. The backwater flooding onto the site from downstream, via Duncans Creek is more substantial.

In the more severe of the two events (namely RD06569), backwater flood depths in the lower Duncans Creek floodplain are approximately 1.5 to 2.5 m deep with flood velocities of less than 0.1 m/s.

- In the 1 in 100 AEP event (RD04835) Figure 4-5-a, flood waters surcharge onto the site from the Nepean River, overflowing the site and discharging via both the Duncans Creek and Nepean River floodplains in a northerly direction. In the 1 in 100 AEP event (RD08858) Figure 4-5-b, similar flooding is noted, however flood depths are marginally deeper.

In the more severe of the two events (namely RD08858), flood depths in the Duncans Creek floodplain are approximately 6 to 7 m deep with flood velocities of approximately 0.2 to 0.3 m/s. On the Nepean River floodplain, west of the Elevated Topography 2 and 3 on Figure 3-1, flood depths are approximately 5 to 6 m deep with flood velocities of with flood velocities of approximately 1.0 to 1.2 m/s in the flood runner.

The 1 in 100 AEP across the site is on average 44.8 mAHD which has been used for the development planning.

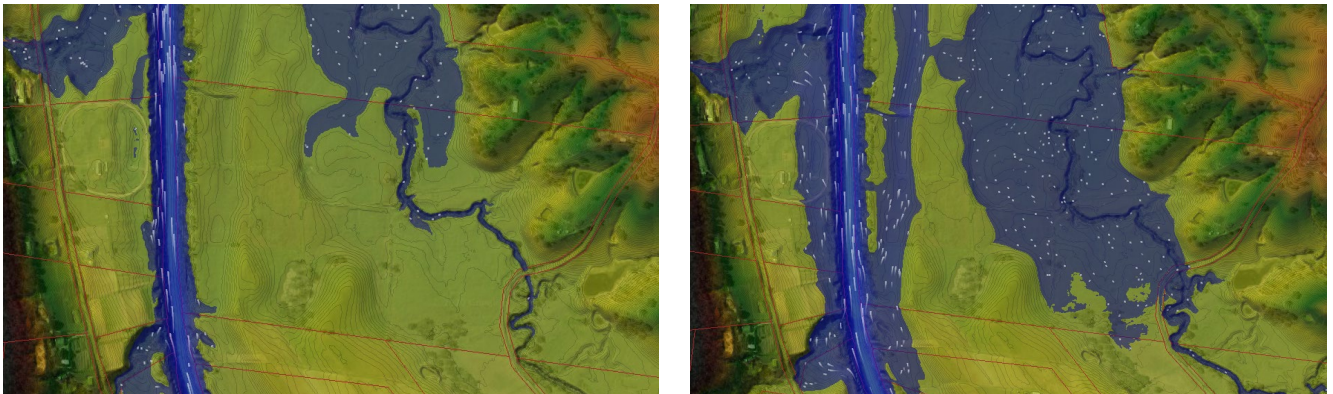


Figure 4-4 1 in 20 AEP Events (figure a left and b right)

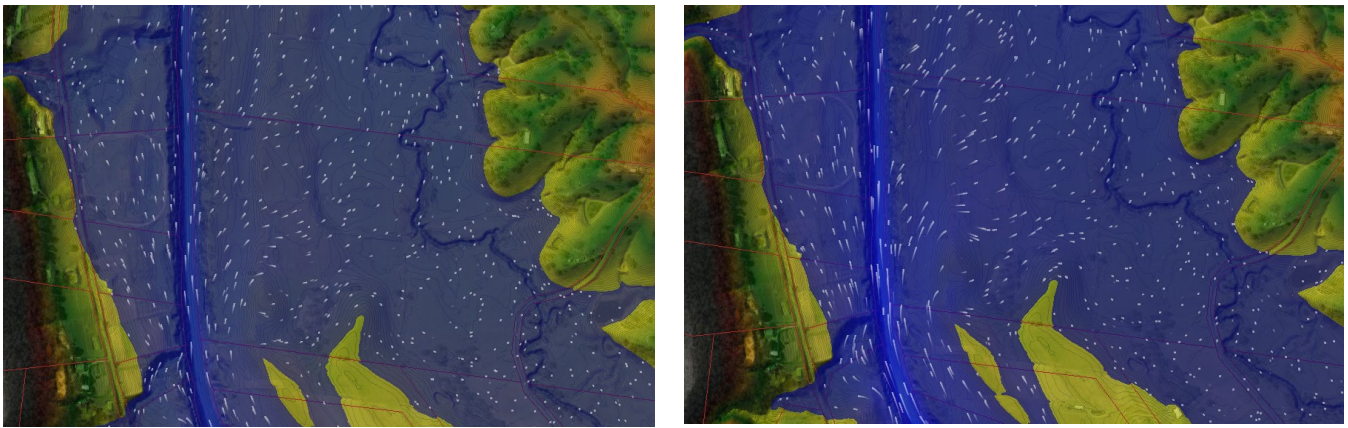


Figure 4-5 1 in 100 AEP Events (figure a left and b right)

Duncans Creek Flooding

- In the 1 in 20 AEP event, flood depths are mostly contained within the Duncan's Creek channel, with some shallow surcharge on the adjoining floodplain, in a few locations. Upstream of the Greendale Road culverts the model shows some surcharge of flood waters onto Greendale Road, which are routed along the roadway to the culverts.

Flood velocities in the order of 2 m/s would be expected in the creek channel, with flow velocities in the order of 0.1 to 0.4 m/s in the floodplain areas.

- In the 1 in 100 AEP storm event, the surcharge on the adjoining floodplain is more pronounced. Floodplain flood depths are in the order of 0.2 m increasing to 0.5 m in lower lying areas. Upstream of the Greendale Road culverts the model shows overflow of Greendale Road onto the property, which creates a secondary flow path. A further flow path is noted to occur on the left bank in the centre part of the site.

Flood velocities in the order of 2 m/s would be expected in the creek channels, with flow velocities in the order of 0.2 to 0.5 m/s occurring in the floodplain areas.

- In a PMF storm event, widespread flooding would be expected across the site. Overflow depths in the order of 1 m would be expected in the Duncan Creek floodplain areas.

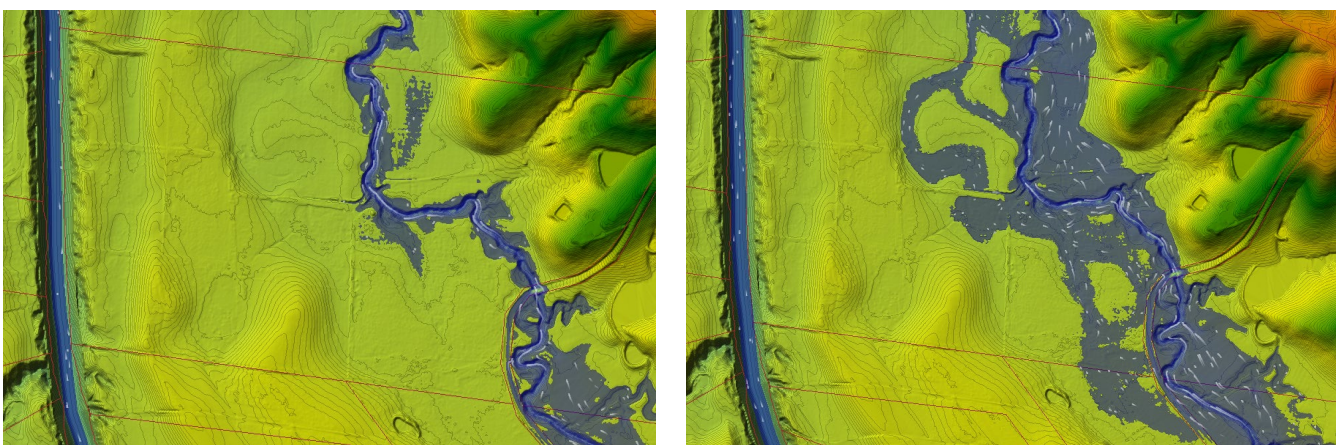


Figure 4-6 1 in 20 AEP Event (left) and 1 in 100 AEP Event (right)

4.4.3 Flood Results - Design Conditions

The simulated flood maps for proposed development conditions are provided in Appendix C. From the figures it is noted that:

Nepean River Flooding

- In the 1 in 20 AEP event (RD00507) Figure 4-7-a, flood waters are expected to just overflow into the depressed area, west of Pad 2 and 3. The flood depth in this depressed area would be 3.5 m midway along, to 8 m deep at the northern end. Pad 3 would prevent flood waters from discharging onto the site through backwater from Duncans Creek, and minor overflow onto the depressed area east of Pad 2 and 3 is expected. In the 1 in 20 AEP event (RD06569) Figure 4-7-b, flood waters surcharge onto the site from the Nepean River and via backwater flooding from Duncans Creek. Both depressed areas east and west of Pad 2 and 3 are inundated as is the Duncan Creek floodplain.

In the more severe of the two events (namely RD06569), flood depths in the depressed areas are approximately 9 m deepening to 13 m west of Pad 2 and 3, and 3.5 m deepening to 6 m west of Pad 2 and 3. Flood velocities of less than 0.1 m/s east of Pad 2 and 3, and 1 to 2 m/s west of Pad 2 and 3. The Mausoleum between Pad 2 and 3 is not overtopped.

- In the 1 in 100 AEP event (RD04835) Figure 4-8-a, flood waters surcharge onto the site from the Nepean River, overtopping the Mausoleum between Pad 2 and 3 and discharging via both the Duncans Creek and Nepean River floodplains in a northerly direction. In the 1 in 100 AEP event (RD08858) Figure 4-8-b, similar flooding is noted, however flood depths are marginally deeper.

In the more severe of the two events (namely RD08858), flood depths in the eastern depressed area are approximately 9 to 12 m deep with flood velocities of approximately 0.2 to 0.3 m/s. However, at the edges of overflow into the depressed central area, maximum flow velocities can be much more severe at 4 m/s. On the Nepean River floodplain, flood depths in the eastern depressed area are approximately 9 to 18 m deep with flood velocities of approximately 1.5 to 2 m/s. Again, in areas of overflow, maximum flow velocities can be much more severe at approximately 4 m/s.

The 1 in 100 AEP across the site is on average maintained at 44.8 mAHD.

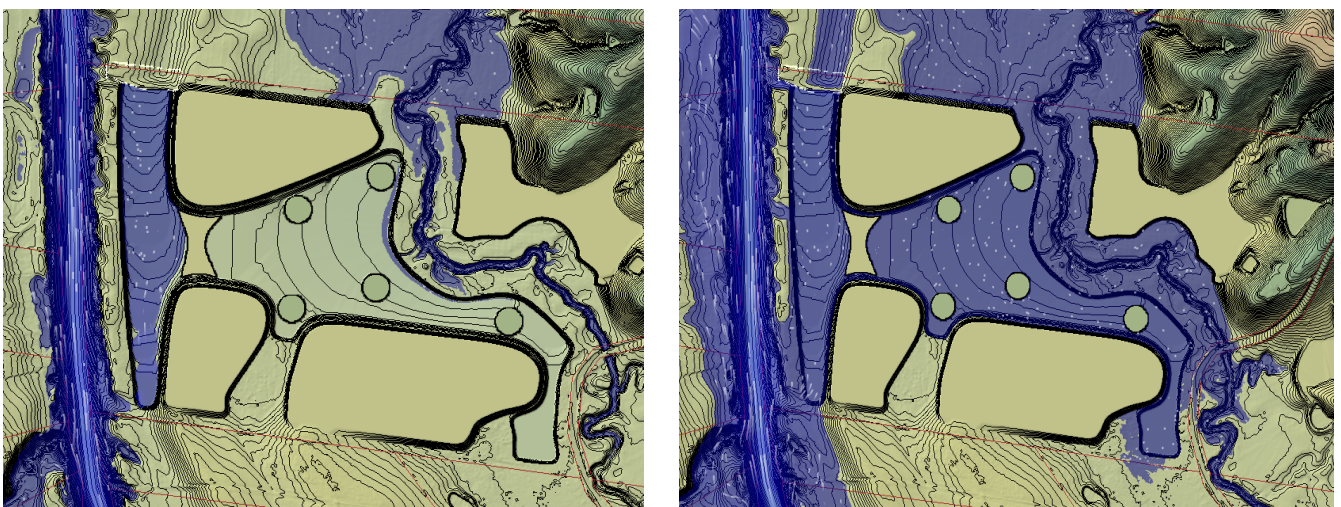


Figure 4-7 1 in 20 AEP Events (figure a left and b right)

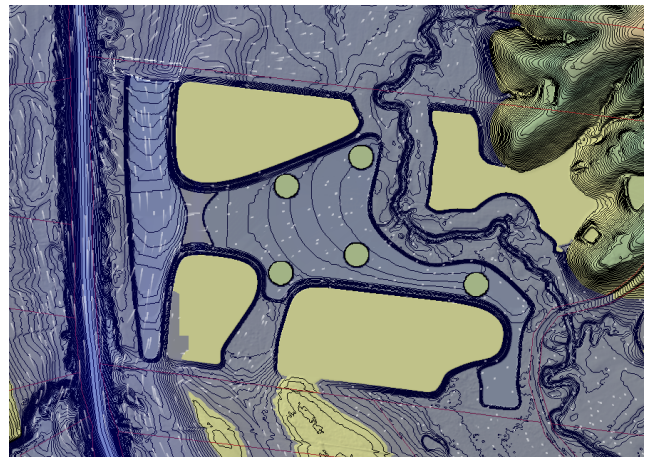
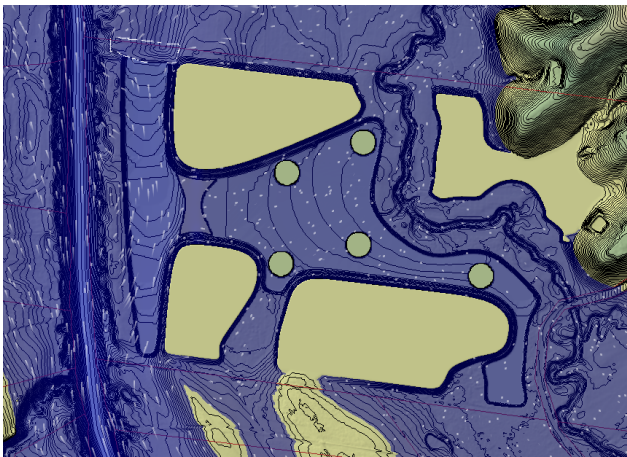


Figure 4-8 1 in 100 AEP Events (figure a left and b right)

Duncans Creek Flooding

- In the 1 in 20 AEP event, flood depths are mostly contained within the Duncan's Creek channel, with some shallow surcharge into the adjoining depressed area east of Pad 2 and 3, in a few locations. Upstream of the Greendale Road culverts the model shows some surcharge of flood waters onto Greendale Road, which are routed along the roadway to the culverts.
- In the 1 in 100 AEP storm event, the surcharge into the adjoining depressed area east of Pad 2 and 3, is more pronounced. Flood depths within the adjoining depressed area at around 2.5 to 2.7 m in the lower lying areas. Upstream of the Greendale Road culverts the model shows overflow of Greendale Road onto the property, which creates a secondary flow path, that discharges into the adjoining depressed area east of Pad 2 and 3.
- In a PMF storm event, widespread flooding would be expected across the site. Overflow depths in the order of 1 m would be expected in the Duncan Creek floodplain areas.

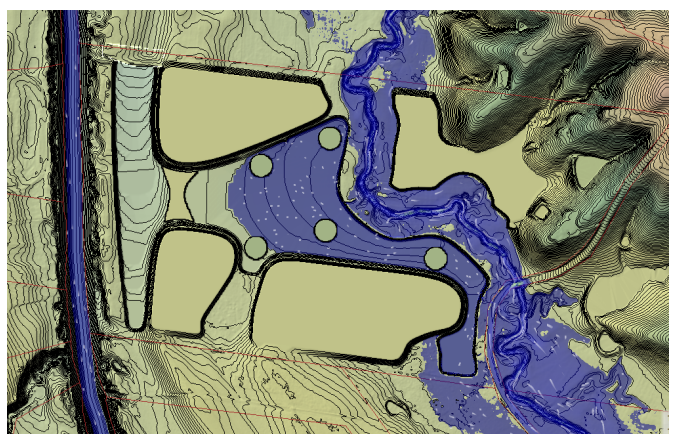
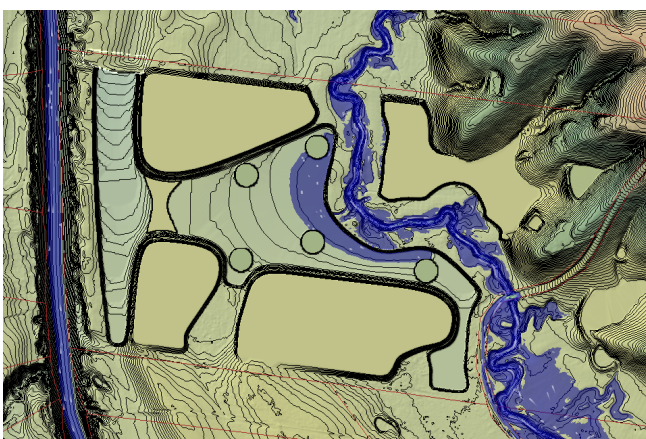


Figure 4-9 1 in 20 AEP Event (left) and 1 in 100 AEP Event (right)

4.4.4 Flood Impact

The simulated flood maps for proposed development conditions are provided in Appendix D. In the case of the Nepean River, given the magnitude of flooding, a 25 mm threshold was adopted to define a measurable flood impact. For Duncans Creek, a 10 mm threshold was adopted to define a measurable flood impact. Both figures are considered conservative, given the rural nature and significant flooded extents. From the figures it is noted that:

Nepean River Flooding

- The 1 in 20 AEP flood impact maps show that in the 1 in 20 AEP event (RD00507) there are no offsite impacts beyond the adopted threshold. In the 1 in 20 AEP event (RD06569) flood levels are increased in the depressed area west of Pad 2 and 3. These increases are contained within the site boundaries and are due to the flood water discharging into the depressed area. There is an improvement and reduction of flood levels on the neighbouring property to the north, with flood level decreases of approximately 100 mm.
- The 1 in 100 AEP flood impact maps show that in the 1 in 100 AEP event (RD04853) there are no offsite impacts beyond the adopted threshold. In the 1 in 100 AEP event (RD08858) flood levels are increased in the depressed area west of Pad 2 and 3. These increases are contained within the site boundaries and are due to the flood water discharging into and via the depressed area. There is an improvement and reduction of flood levels on the neighbouring property to the south, with flood level decreases of approximately 20 mm. On the south eastern corner of the site there is a slight increase in flood level of 30 mm within approximately 15 m of the site boundary. This is attributed to the natural topography interface with the depressed area excavation and can be managed by providing a flood channel to convey Greendale Road overflows more efficiently in this area.
- Some velocity increases are noted in the vicinity of the site. These velocity increases are considered small (approximately 0.2 to 0.4 m/s) and occur where the floodplain velocity is already low. The flow velocities in the floodplain underdeveloped conditions are generally below 0.5 and 0.8 m/s.

Duncans Creek Flooding

- In the 1 in 20 AEP event, flood levels in Duncans Creek north and downstream of the site are reduced by approximately 20 to 30 mm as some flood waters overflow into the depressed area east of Pad 2 and 3.
- In the 1 in 100 AEP event, flood levels in Duncans Creek north and downstream of the site are reduced by approximately 170 to 200 mm as local flood waters overflow into the depressed area east of Pad 2 and 3.
- The flood modelling shows that the proposal generally results in a lowering of velocities in Duncan Creek in the 1 in 10 and 1 in 100 AEP events, downstream of the site.

The flood simulations show that both Nepean River and Duncan Creek flood impacts are managed to within the adopted afflux thresholds, with impacts contained within the site boundary.

5. Liverpool City Council Planning Control Assessment

The table below documents an assessment against key relevant Liverpool City Council stormwater planning controls, Section 9. Since the intention is to alter the topography of the site, the stormwater planning controls have been assessed for the proposed development.

Table 5-1 Council 4-step Process to Identify Development Controls

Step	Future Site
1. Identify Flood Risk Category (degree of flooding risk)	The pads across the site would be designated as Low Flood Risk The areas on the site below the pads and the depressed compensatory storage area (the valley floor) would be designated as High Flood Risk
2. Identify Land Use Risk Category	Commercial or Industrial - Cemetery
3. Identify relevant Floodplain	DCP Table 2 (Nepean River Floodplains) and DCP Table 5 (Local Overland Flooding) apply
4. Identify relevant Floodplain Controls	See Table 5-2

Table 5-2 Liverpool City Council Planning Control Assessment

Clause	Subject		
Table 2 Low Flood Risk	Floor Level	<p>Non habitable floor levels to be as high as practical but no less than the 5% AEP flood level</p> <p>Habitable floor levels to be equal to or greater than the 1% AEP flood level plus 500mm freeboard.</p>	<p>All buildings will be sited on or above the pads, which are above the Nepean River 1 in 100 AEP flood level.</p> <p>There are no habitable buildings proposed.</p>
	Building Components	All structures to have flood compatible building components below the 1% AEP flood level plus 500mm freeboard or a PMF if required to satisfy evacuation criteria (see below)	This will be provided
	Structural Soundness	Applicant to demonstrate that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus 500mm freeboard	This will be a matter for the detailed design at construction certificate stage
	Flood Effects	<p>The flood impact of the development to be considered to ensure that the development will not increase flood effects elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood conveyance; and (iii) the cumulative impact of multiple potential developments in the floodplain. An engineer's report may be required</p> <p>A floodway or boundary of significant flow may have been identified in this catchment. This area is the major conveyance area for floodwaters through the floodplain and any structures placed within it are likely to have a significant impact on flood behaviour. Within this area no structures other than concessional development, open type structures or small non habitable structures (not more than 30sqm) to support agricultural uses will normally be permitted. Development outside the Boundary of Significant flow may still increase flood effects elsewhere and therefore be unacceptable.</p> <p>Any filling within the 1% AEP flood will normally be considered unacceptable unless compensatory excavation is provided to ensure that there is no net loss of floodplain storage volume below the 1% AEP flood.</p>	<p>Flood modelling has shown that the development will not increase flood levels beyond the development site boundary as demonstrated by this report. Comments on velocities changes caused by alterations to the flood conveyance are provided in Section 3.2.</p> <p>The effects of the Nepean River flooding have been simulated in this report. Flood modelling has shown that the development will not increase flood levels beyond the development site boundary as demonstrated by this report.</p> <p>Compensatory excavation will be provided to ensure no net loss of storage.</p> <p>Some velocity increases are noted in the vicinity of the site. These velocity increases are considered small (approximately 0.2 to 0.4 m/s) and occur where the floodplain velocity is already low. The flow velocities in the floodplain underdeveloped conditions are generally below 0.5 and 0.8 m/s.</p>
	Car Parking & Driveway Access	<p>The minimum surface level of a car parking space, which is not enclosed (e.g. open car parking space or carport) shall be as high as practical, but no lower than the 5% AEP flood level or the level of the crest of the road at the highest point where the site can be accessed. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 5% AEP flood.</p> <p>Garages capable of accommodating more than 3 vehicles on land zoned for urban purposes, or basement car parking, must be protected from inundation by floods equal to or greater than the 1% AEP flood plus 0.1m freeboard.</p> <p>The level of the driveway providing access between the road and car parking space shall be no lower than 0.3m below the 1% AEP flood or such</p>	<p>Car parking will be sited on or above the pads, which are above the Nepean River 1 in 100 AEP flood level.</p> <p>Car parking will be sited on or above the pads, which are above the Nepean River 1 in 100 AEP flood level. The requirement for freeboard is noted.</p> <p>Car parking will be sited on or above the pads, which are above the Nepean River 1 in 100 AEP flood level. The requirement for freeboard is noted.</p>

		<p>that depth of inundation during a 1% AEP flood is not greater than either the depth at the road or the depth at the car parking space. A lesser standard may be accepted for single detached dwelling houses where it can be demonstrated that risk to human life would not be compromised.</p> <p>Basement car parking or car parking areas accommodating more than 3 vehicles (other than on Rural zoned land) with a floor level below the 5% AEP flood or more than 0.8m below the 1% AEP flood level; shall have adequate warning systems, signage and exits.</p> <p>Barriers to be provided to prevent floating vehicles leaving a site during a 1% AEP flood.</p>	<p>No basement car parking is proposed</p> <p>The requirement for barriers is noted</p>
	Evacuation	<p>Reliable access for pedestrians or vehicles required during a 1% AEP flood to a publicly accessible location above the PMF</p> <p>The development is to be consistent with any relevant flood evacuation strategy or similar plan.</p> <p>Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel</p>	<p>There is access to land above the Nepean River PMF from Pad 1. A site evacuation strategy will be developed, and several hours of warning is available in a Nepean River flood event.</p> <p>The centre of the site (the valley floor) will accommodate roads, paths and landscaping designed to receive minimal damage due to flood inundation. There will be controlled site access to the valley floor so this area could readily be precluded in times where flood inundation has been forecast, appropriately and safely managing the flood hazard.</p>
	Management & Design	<p>Site Emergency Response Flood Plan required where floor levels are below the design floor level, (except for single dwelling-houses).</p> <p>Applicant to demonstrate that area is available to store goods above the 1% AEP flood level plus 500mm freeboard.</p> <p>No storage of materials below the design floor level which may cause pollution or be potentially hazardous during any flood.</p>	<p>Site Emergency Response Flood Plan will be compiled. The other controls are noted and will need to be incorporated into the design.</p>
Table 2 High Flood Risk	All controls	Commercial or Industrial development is not suitable.	
Table 5 Local Overland Flood Risk	Floor Level	All floor levels to be equal to or greater than the 1% AEP flood level plus 300mm freeboard. Freeboard may be reduced if justified by site specific assessment.	The control is noted and will be applicable to flooding associated with overland swales and basins.
	Building Components	All structures to have flood compatible building components below the 1% AEP flood level plus 300mm freeboard.	The control is noted, and will be applicable to future design at construction certificate stage
	Structural Soundness	Applicant to demonstrate that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP flood plus 300mm freeboard.	The control is noted, and will be applicable to future design at construction certificate stage

	Flood Effects	The flood impact of the development to be considered to ensure that the development will not increase flood affectation elsewhere having regard to changes in flood levels and velocities caused by alteration of conveyance of flood waters. An engineer's report may be required if Council considers a significant affectation is likely. The unmitigated obstruction, concentration, or diversion of overland flow paths to adjacent property shall not be permitted.	The management of local overland flooding will not result in flood impacts beyond the site boundary
	Car Parking & Driveway Access	Controls 4, 7 and 8	These controls have been addressed above
	Evacuation	Control 5	These controls have been addressed above
	Management & Design	Controls 3 and 5	These controls have been addressed above
	Fencing	Fencing is to be constructed in a manner that does not obstruct the flow of floodwaters so as to have an adverse impact on flooding. Fencing shall be constructed to withstand the forces of floodwaters.	These matters will be subject to future design

6. Summary and Findings

- Soukutsu Pty Ltd ATF Wallacia Trust (Soukutsu) engaged GHD Pty Ltd (GHD) to undertake a Flooding Assessment to provide the relevant documentation in support of a Development Application (DA) to Liverpool City Council. The subject of the DA is a proposed development comprising of the demolition of existing structures and construction of a cemetery, crematoria, community facilities, administration buildings, halls, chapels and other buildings and structures all associated with the operation of a cemetery with a garden, parkland and landscape setting. The proposal also includes internal roads, lakes and ponds. The proposed development is located on the site identified as 1290 Greendale Road, Wallacia and legally described as Lot 1 in DP 776645 in the Liverpool City Council Local Government Area (LGA).
- The existing site generally comprises paddocks with little to no hardstand areas. There are four general areas of elevated topography. The site west of Elevated Topography 2 and 3 drains to the Nepean River, while the catchment east of this location drains to Duncans Creek. The site is located within the Nepean River and Duncans Creek floodplains.
- The proposed development comprises four distinct pad areas with Pad 1 located east of Duncan's Creek and pads 2 to 4 located west of Duncan's Creek. These pads raise ground levels above the 1 in 100 AEP Nepean River flood level and are approximately located at the locations of the elevated topographies on the existing site.
- Flooding at the site was simulated using the following approach:
 - For Duncans Creek the hydrology was developed with a RAFTS model for the local catchment.
 - For the Nepean River representative flood events were sought from the authors of the Hawkesbury Nepean Valley Flood Study (iNSW, 2019) for use in the local flooding assessments. The data provided were downstream stage hydrographs and upstream inflow hydrographs for a selection of Monte Carlo flood events corresponding approximately to design flood events.
 - A self-standing HECRAS 2D model (2D flexi-mesh) was developed for the floodplain at the site, extending from Hopewood downstream to Ravenswood upstream, encompassing some 6.5 km of the Nepean River. The model included Duncans Creek.
- Simulations were undertaken as follows for both existing and proposed development conditions, for the Nepean River flooding 1 in 20 and 1 in 100 AEP events, without flooding of Duncans Creek and for Duncans Creek flooding 1 in 20, 1 in 100 AEP events and PMF events, without Nepean River flooding. The flood simulations show that both Nepean River and Duncan Creek flood level impacts are managed to within the adopted afflux thresholds, with impacts generally contained within the site boundary. There is an improvement and reduction of flood levels on the neighbouring property to the south, with flood level decreases of approximately 20 mm. On the south eastern corner of the site there is a slight increase in flood level of 30 mm within approximately 15 m of the site boundary. This is attributed to the natural topography interface with the depressed area excavation and can be managed by providing a flood channel to convey Greendale Road overflows more efficiently in this area.

- The assessment against key relevant Liverpool City Council flooding controls shows that the proposed development can meet the requirement of these controls. It is thus considered that the proposed development can meet the requirements of the Liverpool City Council DCP 2008.

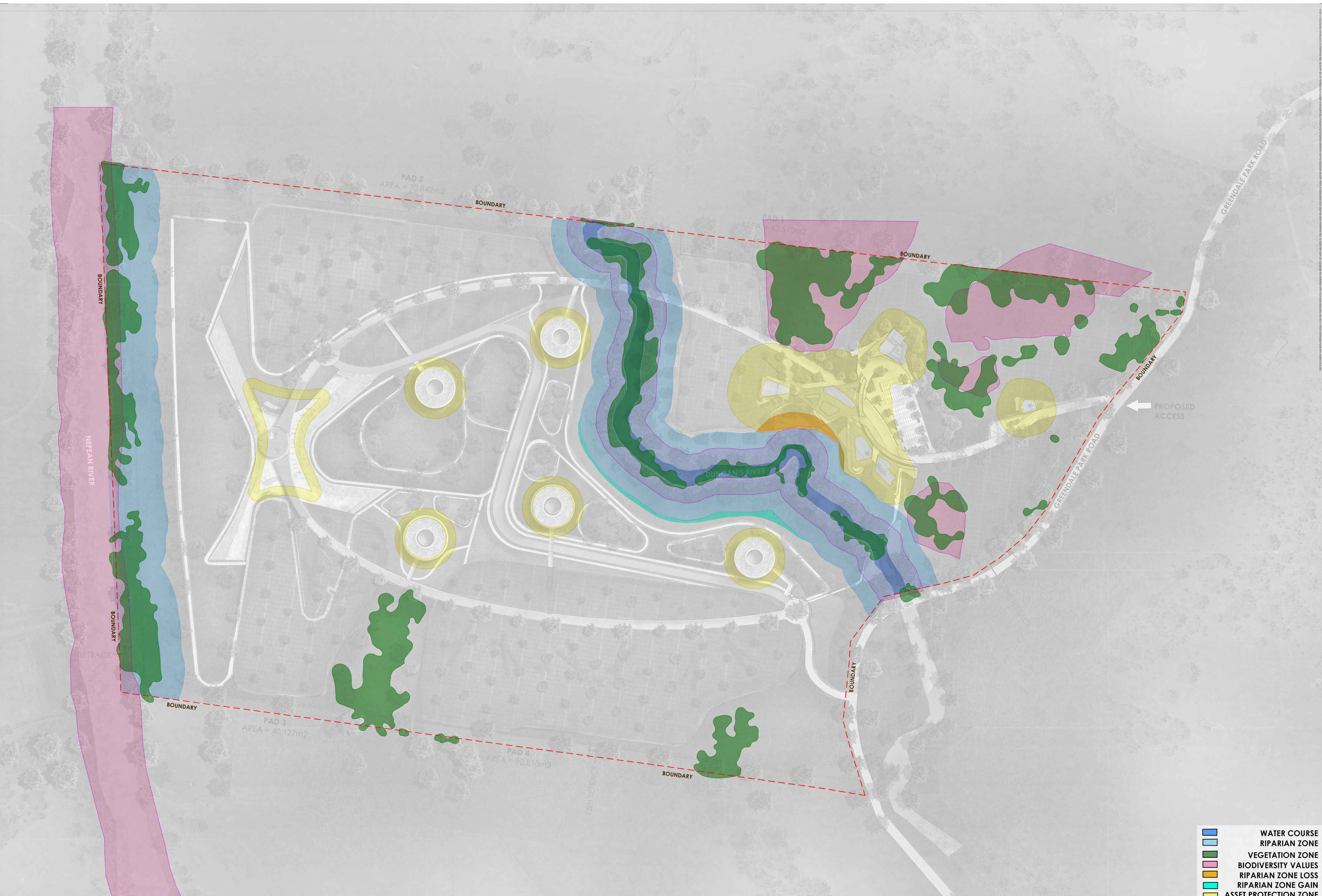
Appendix A – Development Proposal

I. MASTERPLAN

PROPOSED MASTERPLAN

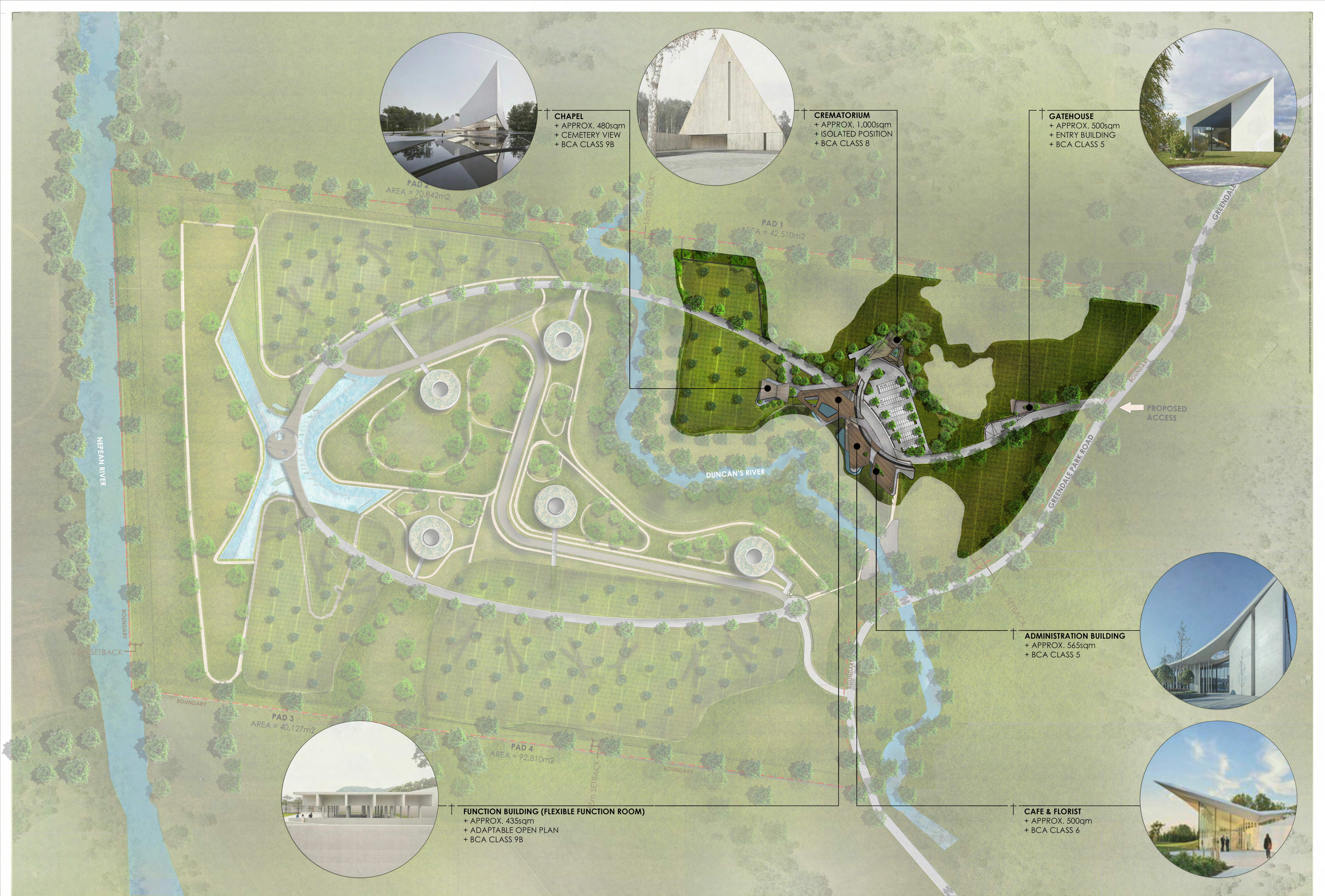


- 12mts WIDE ROAD (2 WAYS TRAFFIC + 1 SIDE PEDESTRIAN WALKWAY + PARALLEL PARKING)
- PEDESTRIAN FOOTPATH
- 3mts WIDE PEDESTRIAN FOOTPATH (RAISED TO RL 44.80)



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- WATER COURSE
- RIPARIAN ZONE
- VEGETATION ZONE
- BIODIVERSITY VALUES
- RIPARIAN ZONE LOSS
- RIPARIAN ZONE GAIN
- ASSET PROTECTION ZONE





MAUSOLEUM
+ FLOOD PROOF < RL 44.80
+ VERTICAL STACKING SYSTEM
+ INDIVIDUAL BURIAL PLOTS
+ PRIVATE BURIAL AREAS
+ BCA CLASS 7B

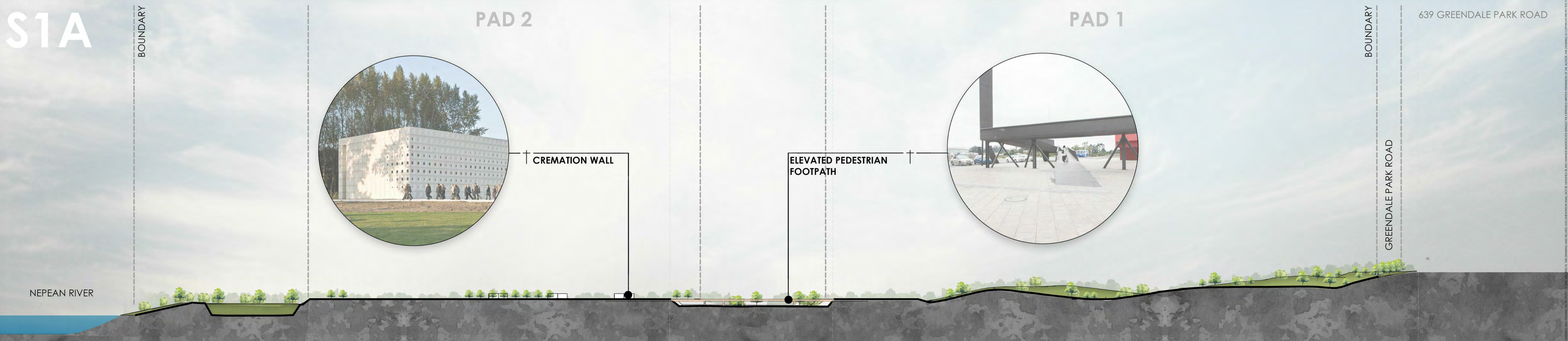
IN-GROUND
+ TRADITIONAL / GREEN
+ SINGLE TOMB OR VERTICAL STACKING VAULTS

CREMATION WALLS
+ VERTICAL STACKING SYSTEM
+ URN NICHES

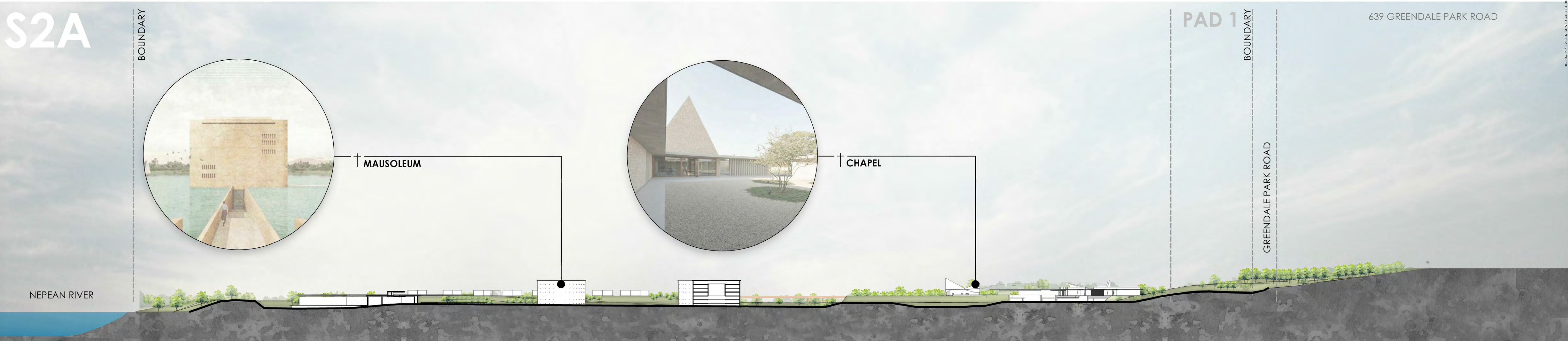
MAUSOLEUM
+ VERTICAL STACKING SYSTEM
+ INDIVIDUAL BURIAL PLOTS
+ PRIVATE BURIAL AREAS
+ BCA CLASS 7B

IN-GROUND BURIAL PLOTS = 120,000
MAUSOLEUM PLOTS = 555,000
CREMATION WALL BURIAL PLOTS = 100,000
TOTAL BURIAL PLOTS = 775,000

S1A



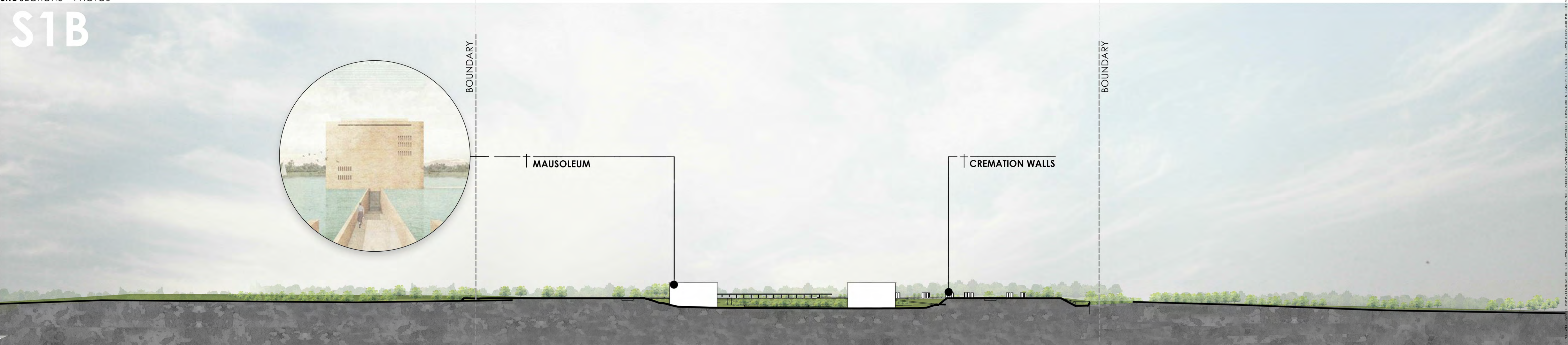
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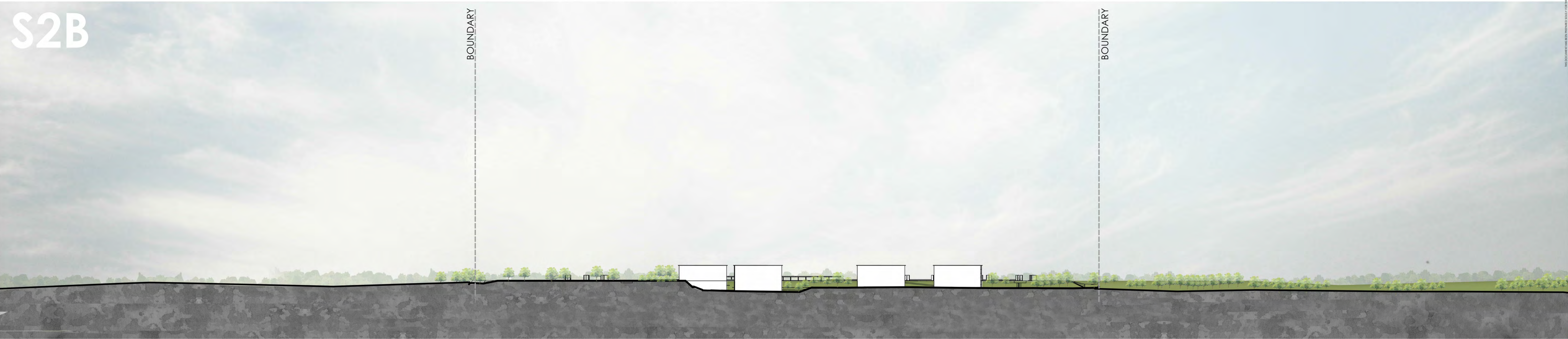
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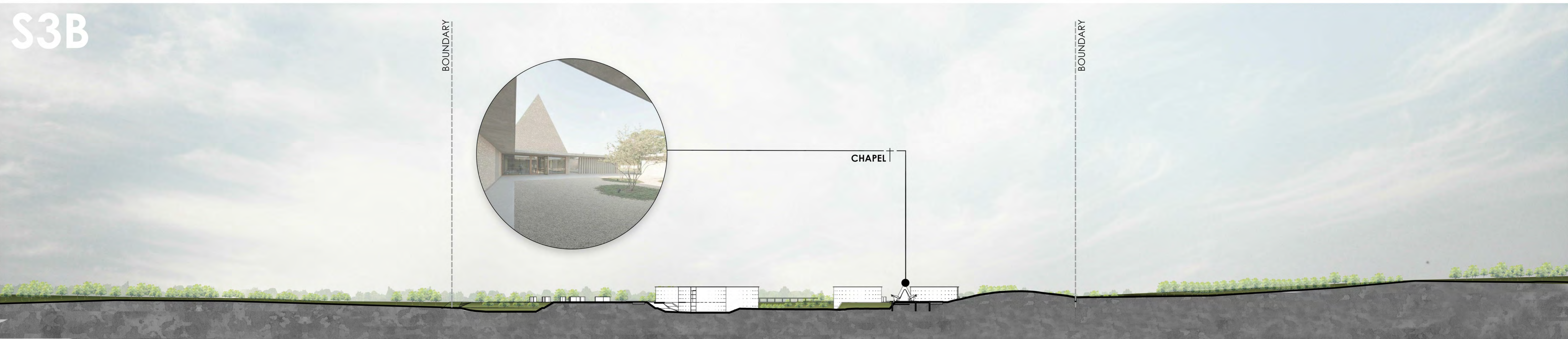
S1B



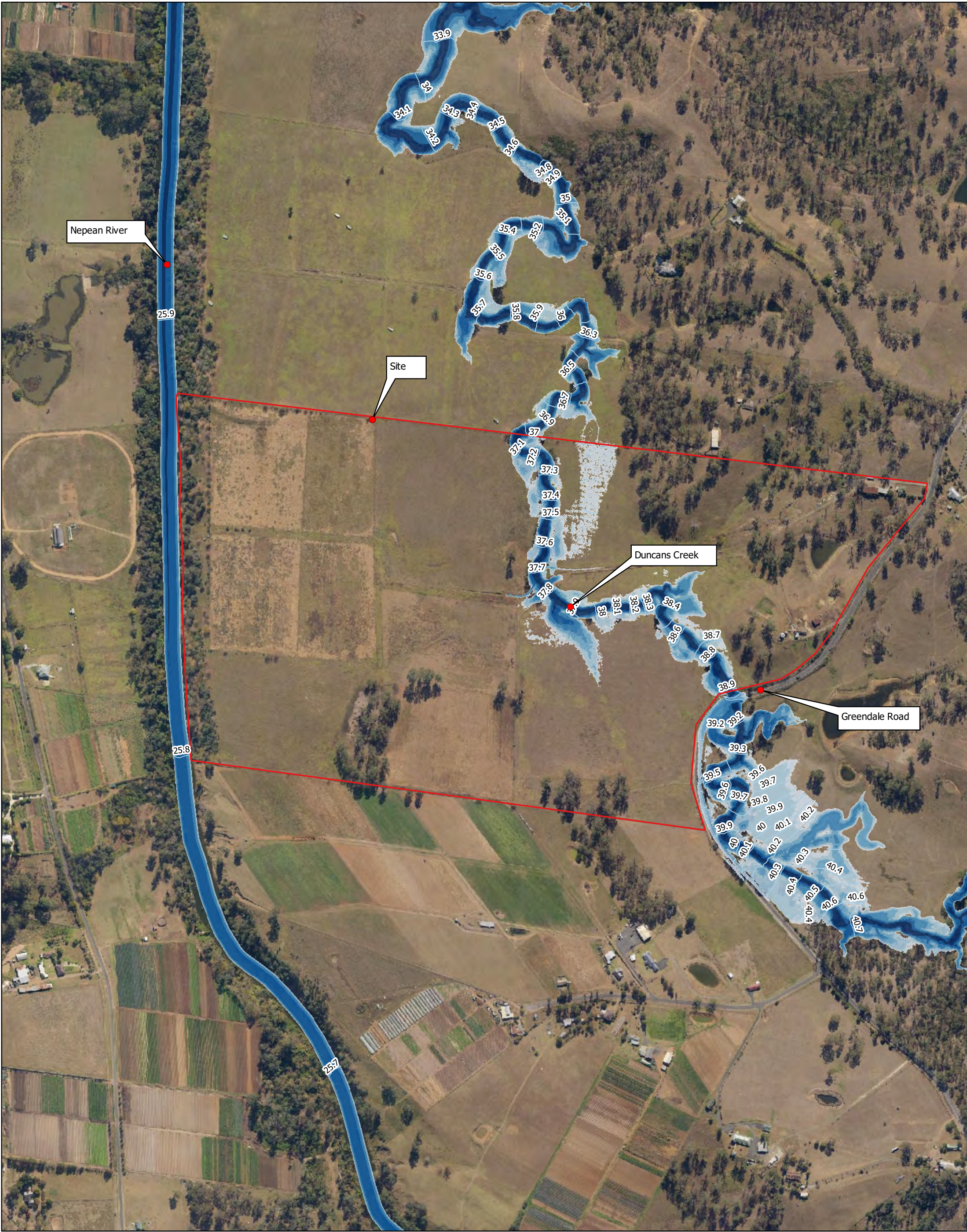
S2B



S3B



Appendix B - Flood Maps – Existing Conditions



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Flood Level (mAHD)

Flood Depth (m)

0.015

0.1

0.3

0.5

1

2

>2

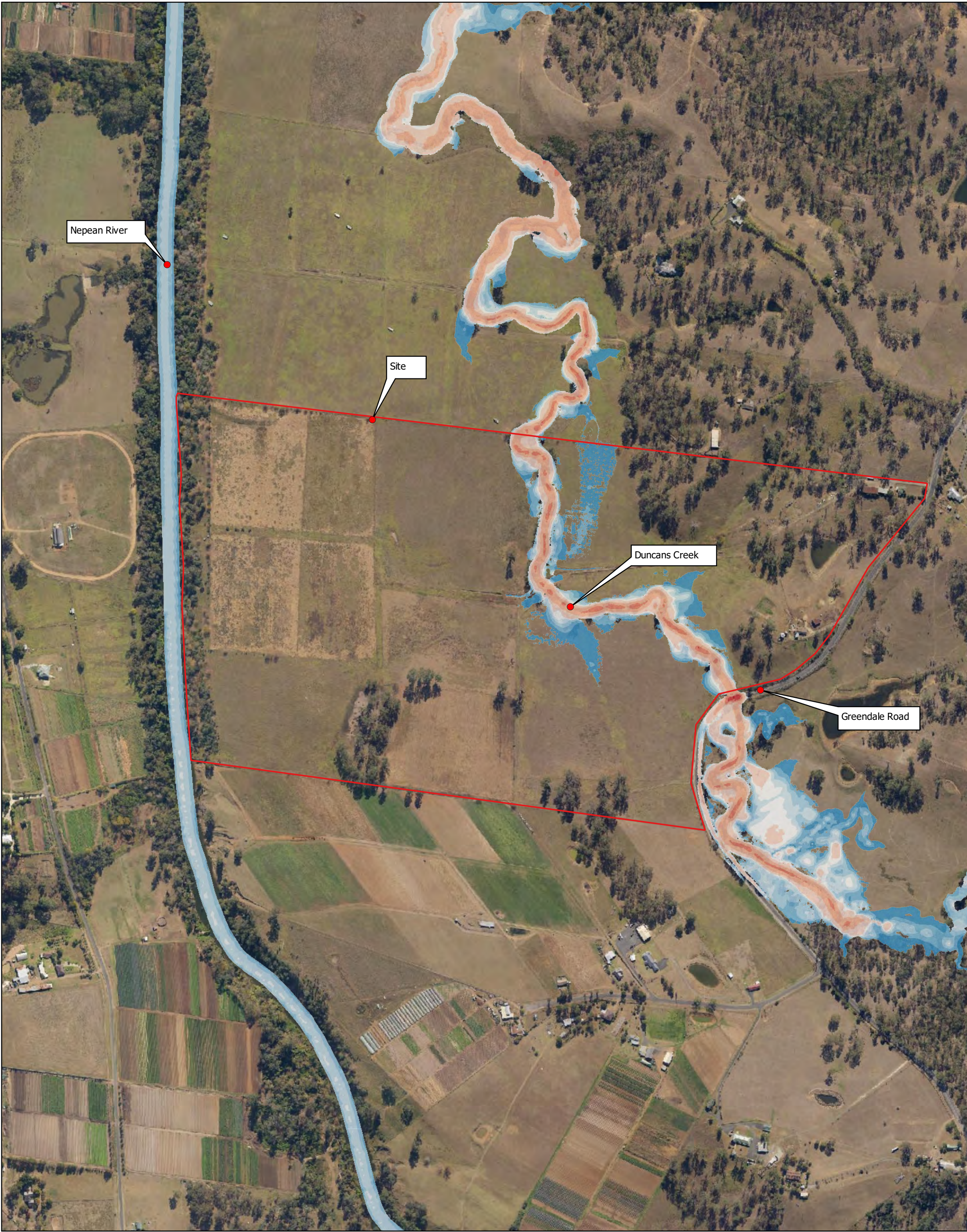


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Existing)
20AEP Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure B01



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Velocity (m/s)

<0.1

0.1-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1.0

1.0-2.0

2.0-3.0

3.0-5.0

>5.0



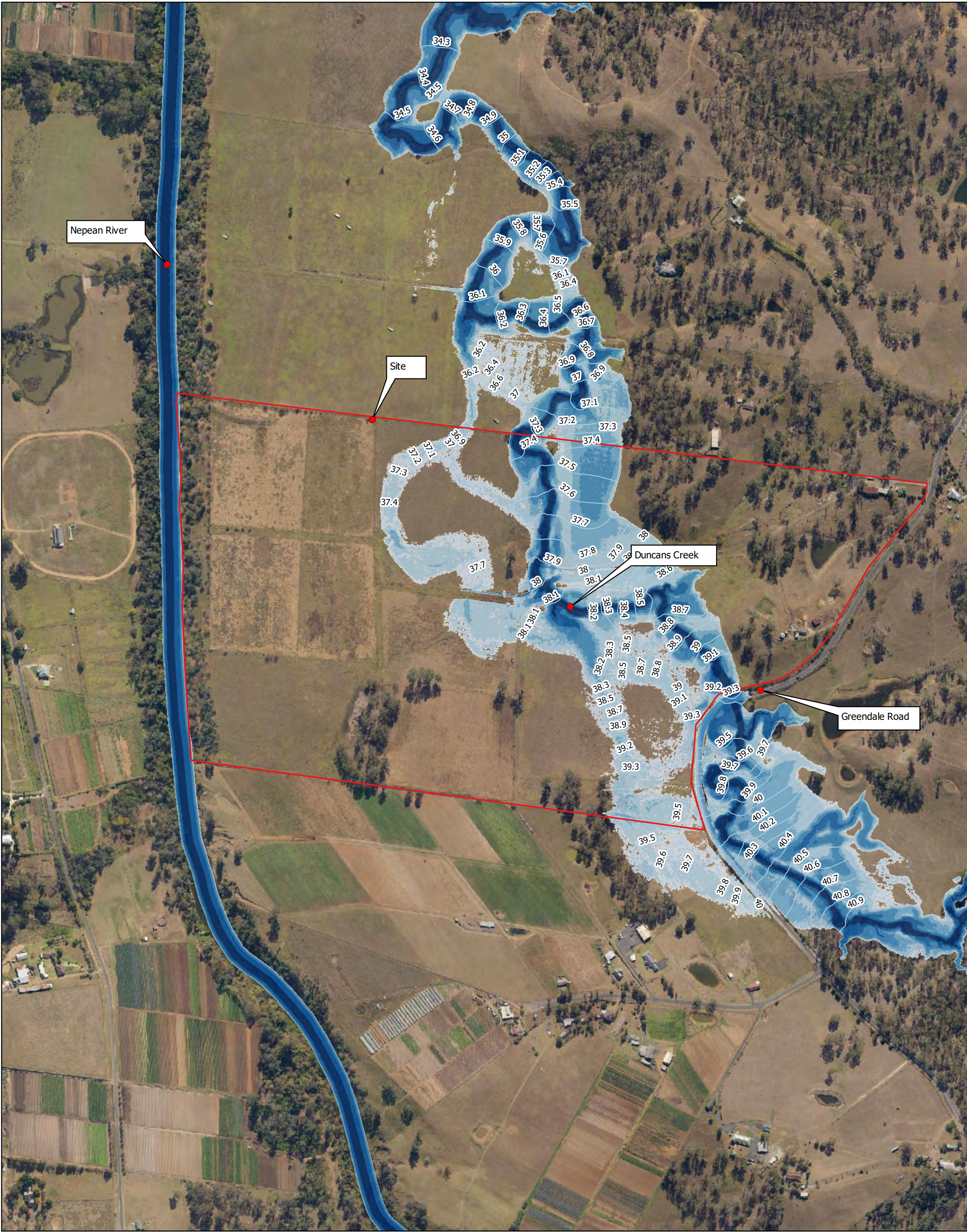
Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Existing)
20AEP Flood Velocity

Job Number
Revision
Date

12517741
Oct 20

Figure B02



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Flood Level (mAHD)

Flood Depth (m)

0.015

0.1

0.3

0.5

1

2

>2

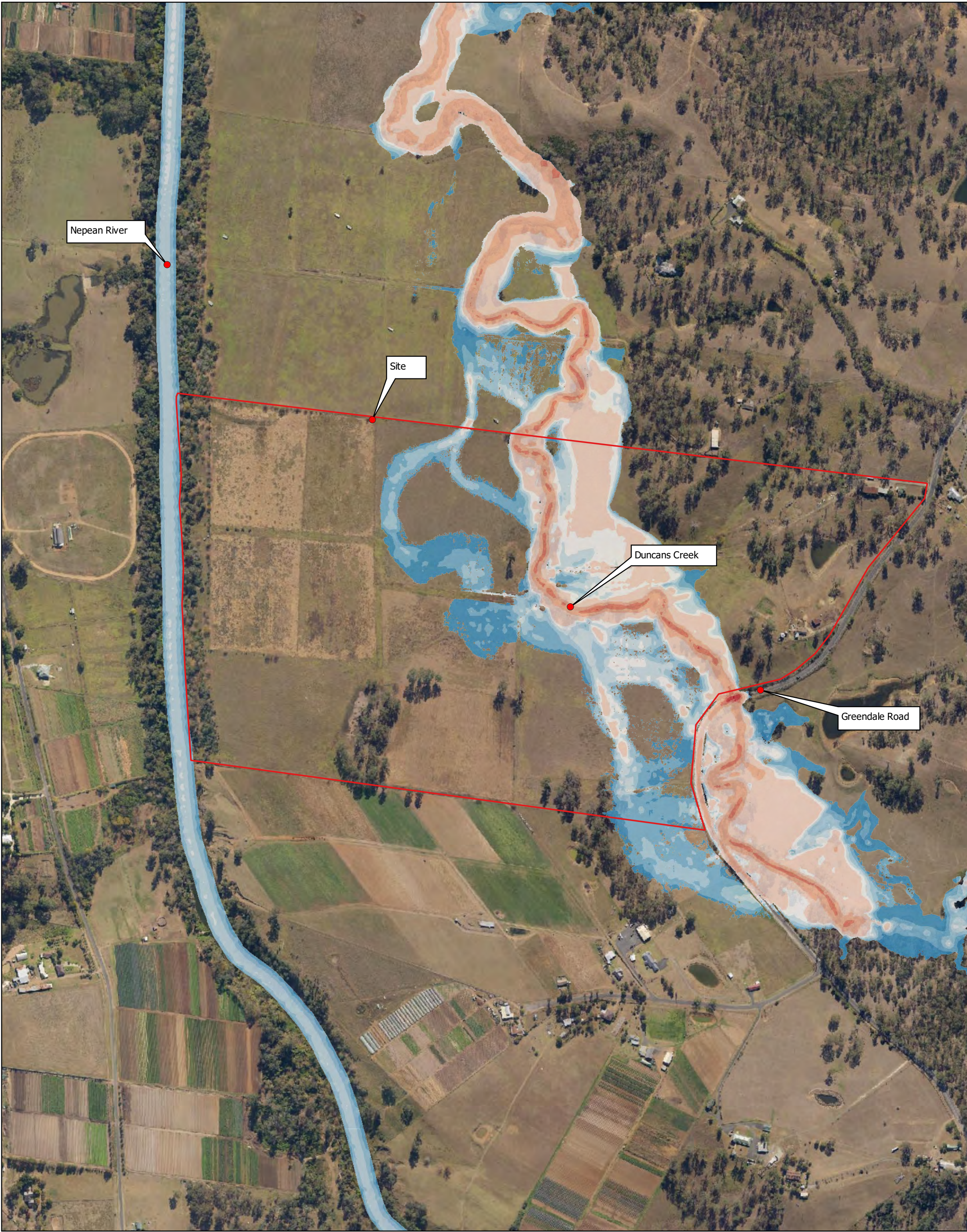


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Existing)
100AEP Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure B03



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Velocity (m/s)

<0.1

0.1-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1.0

1.0-2.0

2.0-3.0

3.0-5.0

>5.0

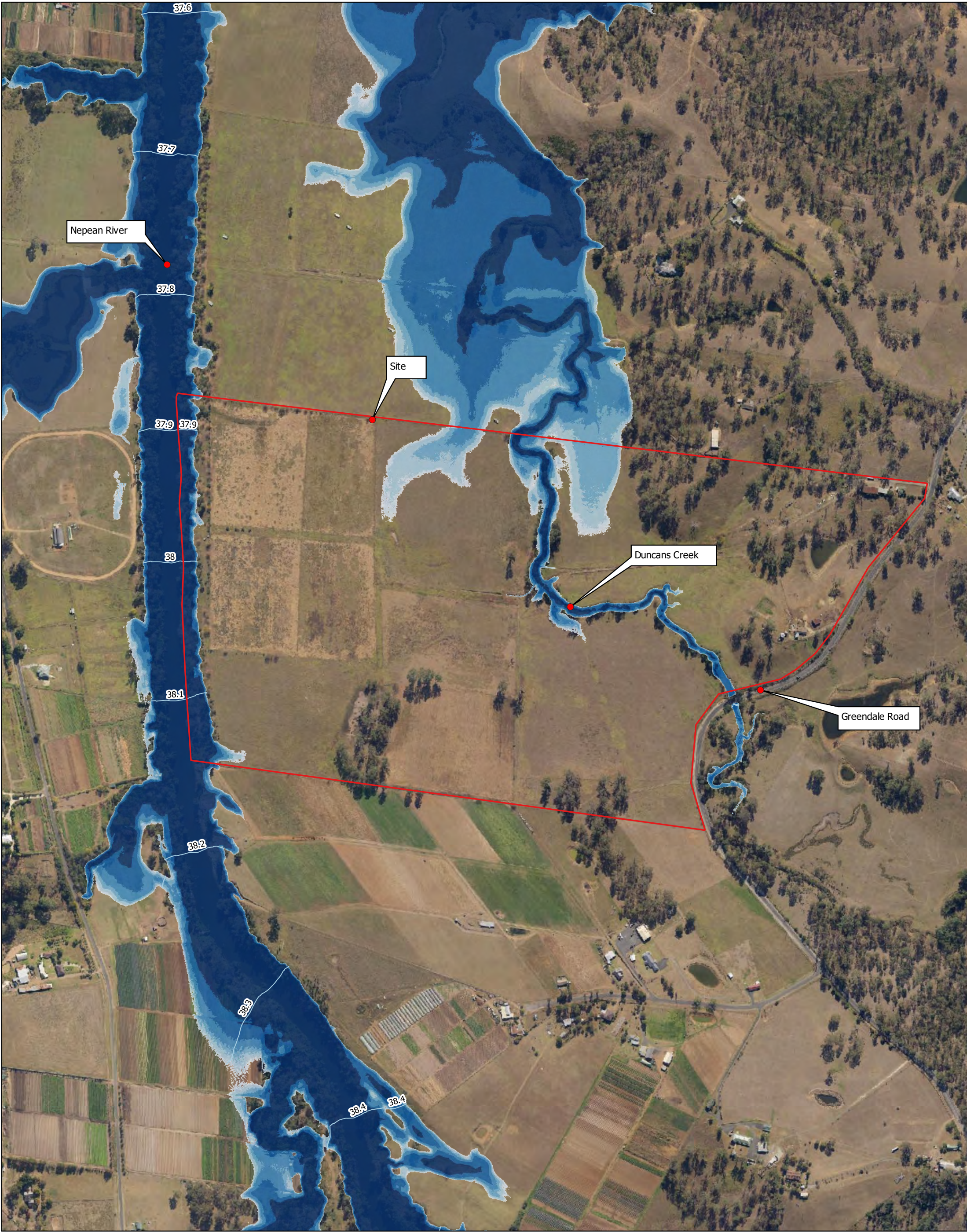


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Existing)
100AEP Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure B04



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
- Property
- Flood Level (mAHD)
- Flood Depth (m)
- 0.015

- 0.1
- 0.3
- 0.5
- 1
- 2
- >2

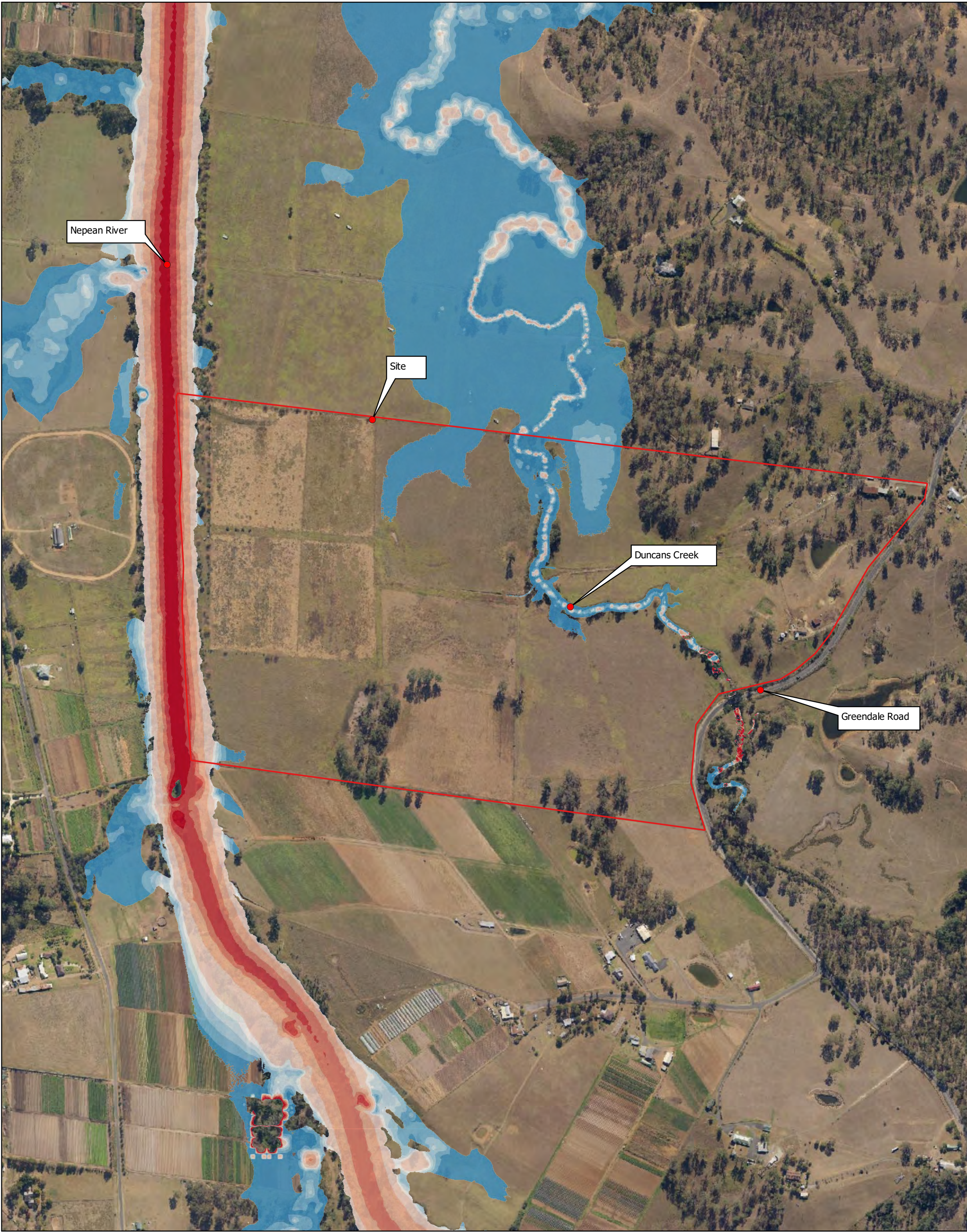


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
20AEP RD00507 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure B05



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Velocity (m/s)

<0.1

0.1-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1.0

1.0-2.0

2.0-3.0

3.0-5.0

>5.0

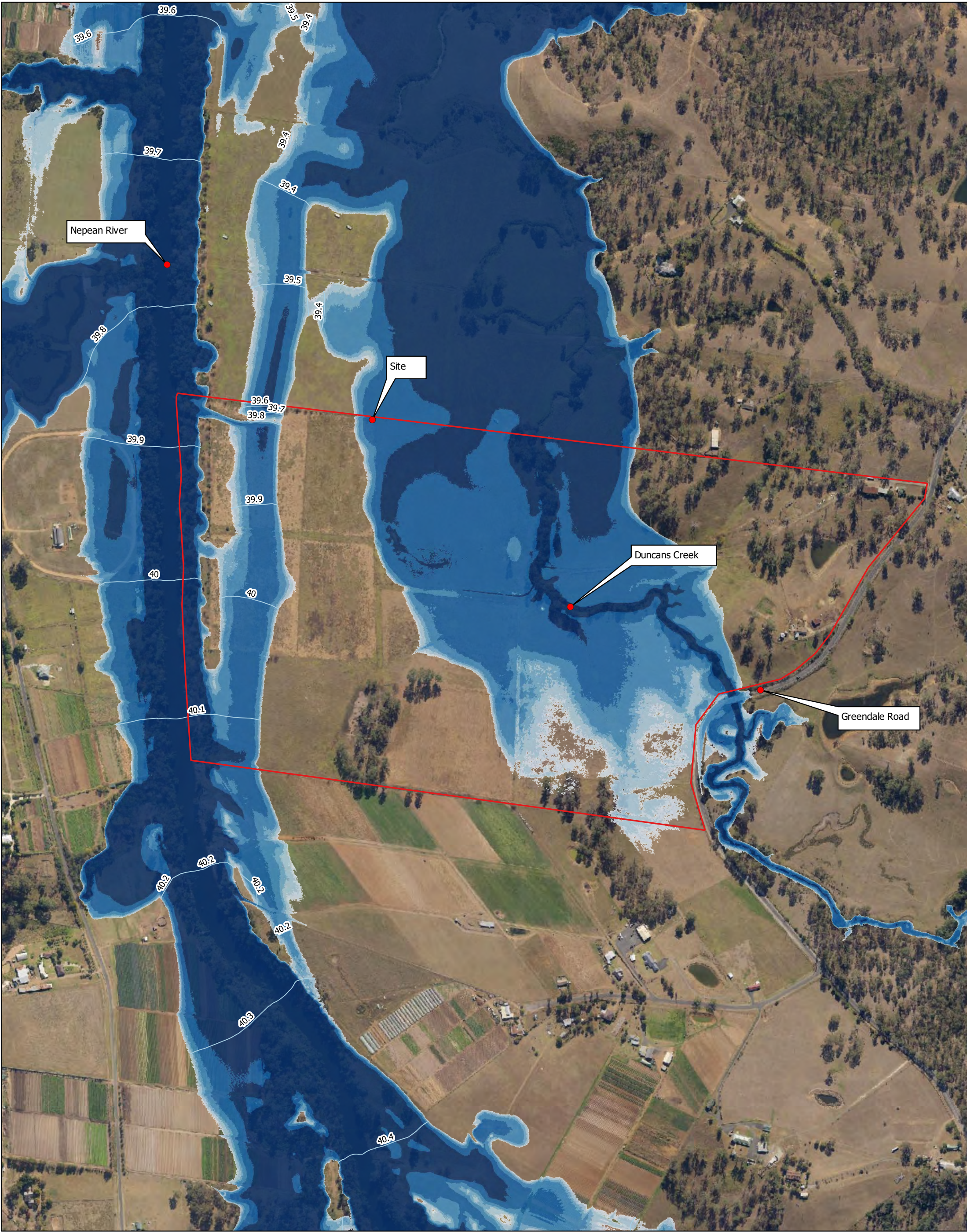


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
20AEP RD00507 Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure B06



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
Property
Flood Level (mAHD)
Flood Depth (m)
0.015

- 0.1
0.3
0.5
1
2
>2

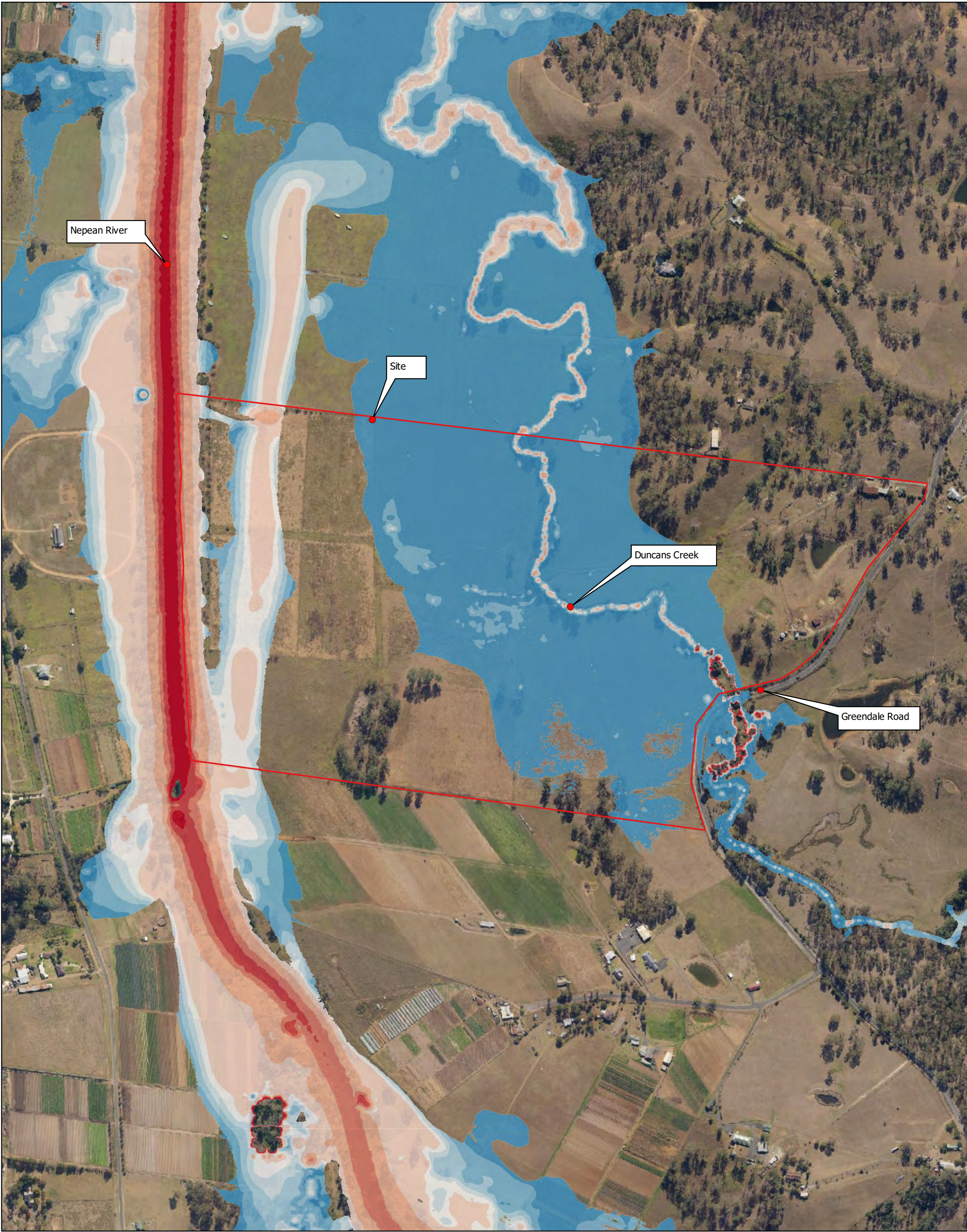


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
20AEP RD06569 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure B07



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

Velocity (m/s)
<0.1

0.1-0.2	1.0-2.0
0.2-0.3	2.0-3.0
0.3-0.4	3.0-5.0
0.4-0.5	>5.0
0.5-1.0	

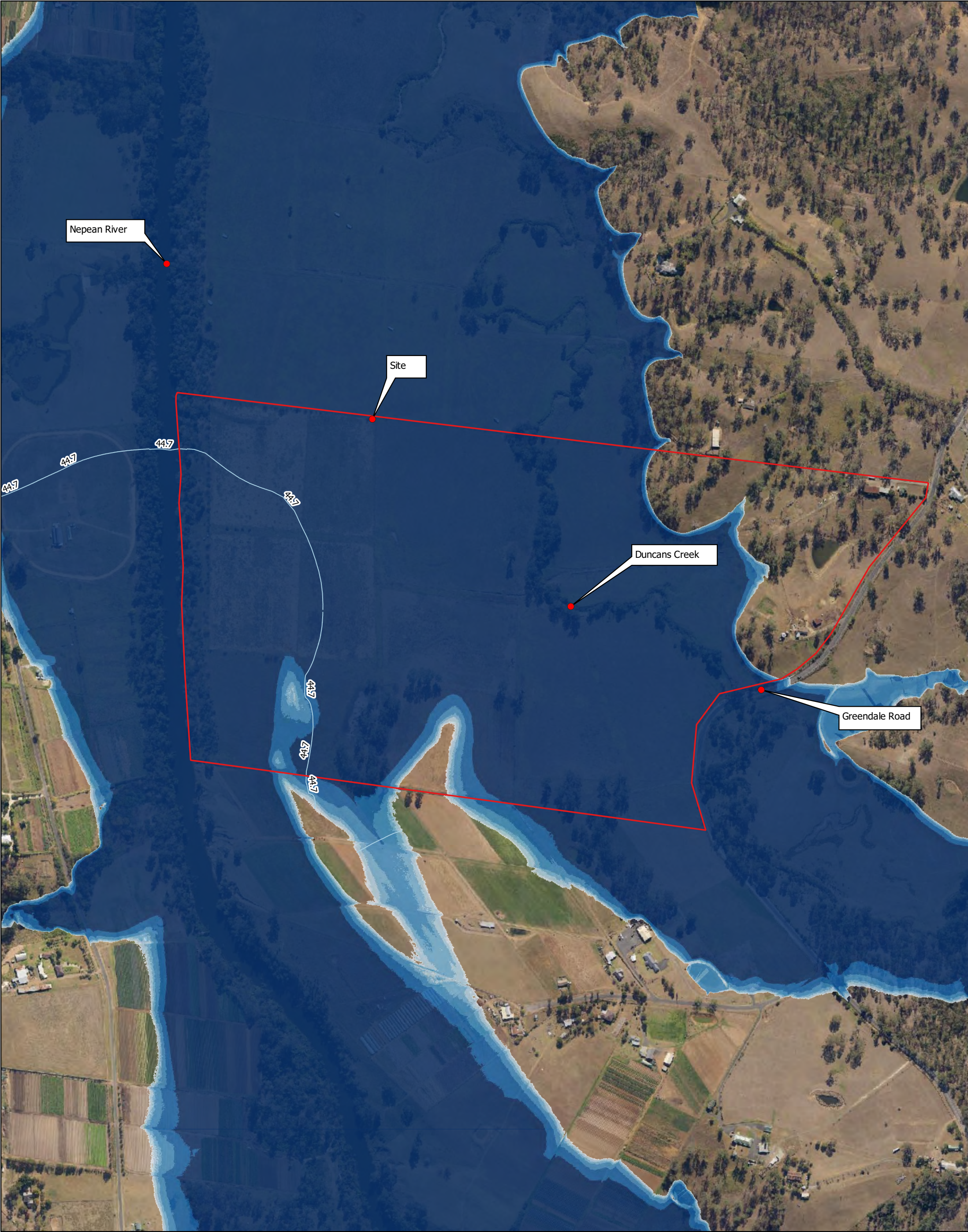


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
20AEP RD06569 Flood Velocity

Job Number	12517741
Revision	
Date	Oct 20

Figure B08



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
Property
Flood Level (mAHD)
Flood Depth (m)
0.015
- 0.1
0.3
0.5
1
2
>2

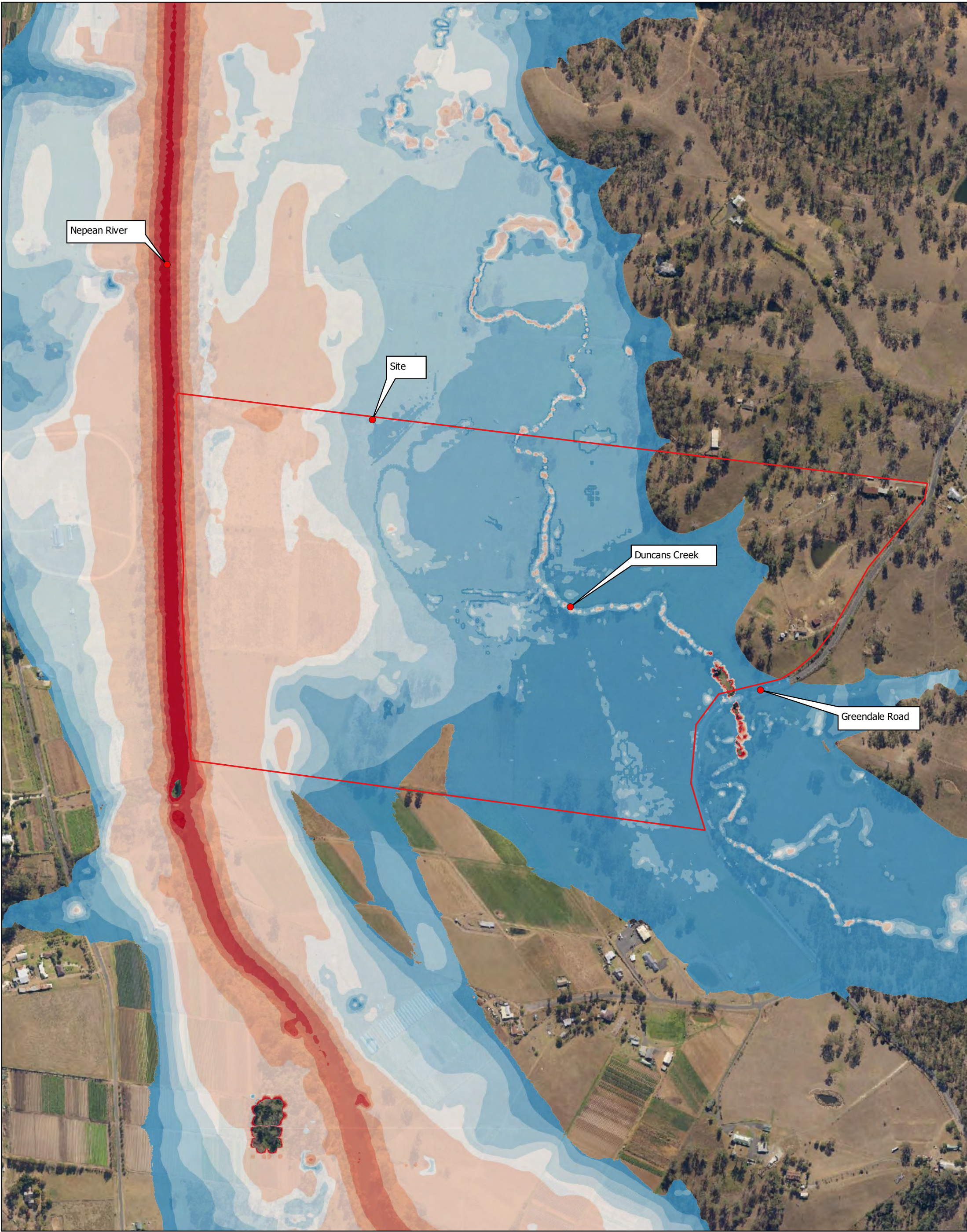


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
100AEP RD04853 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure B09



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Velocity (m/s)

<0.1

0.1-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1.0

1.0-2.0

2.0-3.0

3.0-5.0

>5.0

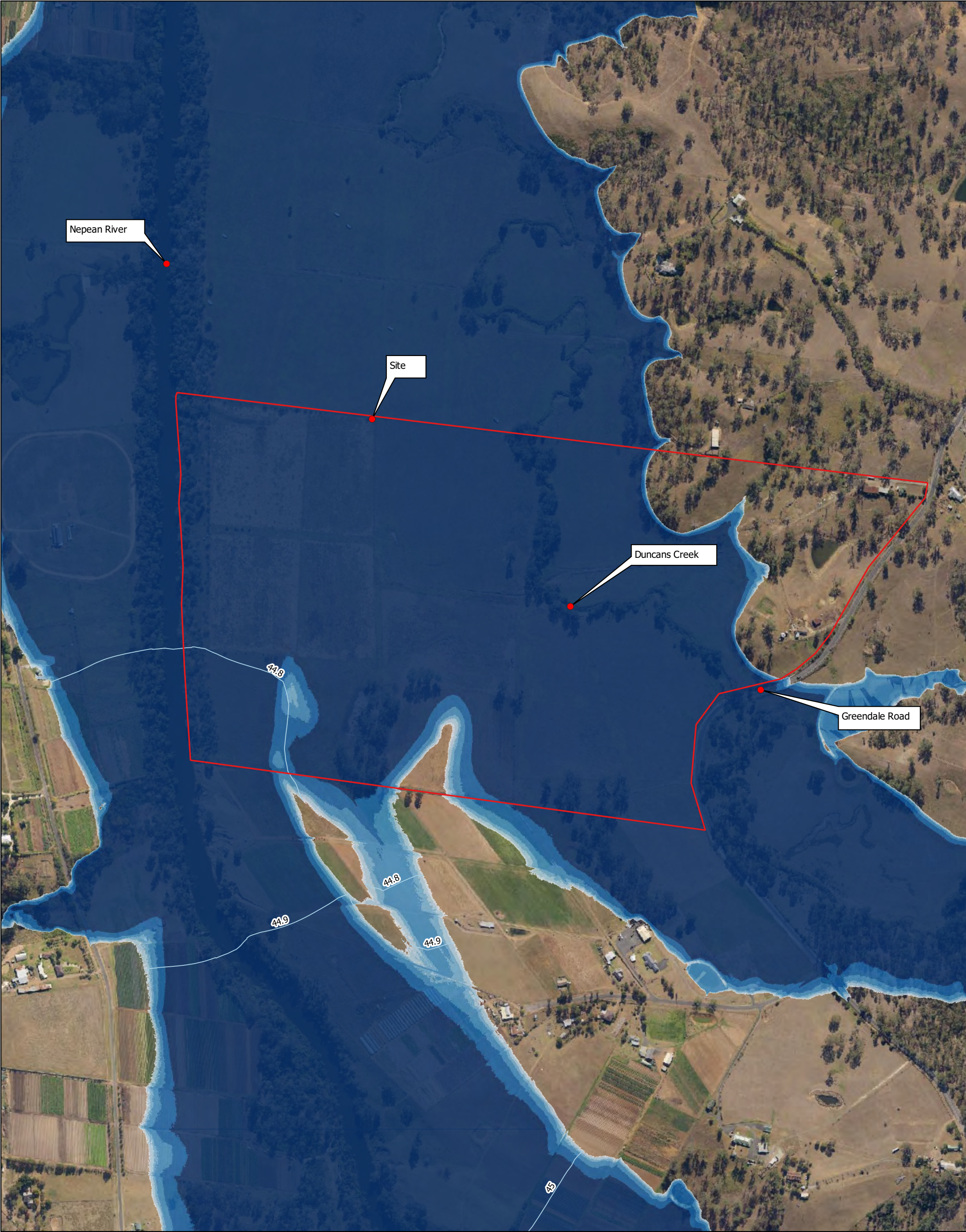


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
100AEP RD04853 Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure B10



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
Property
Flood Level (mAHD)
Flood Depth (m)
0.015
- 0.1
 - 0.3
 - 0.5
 - 1
 - 2
 - >2

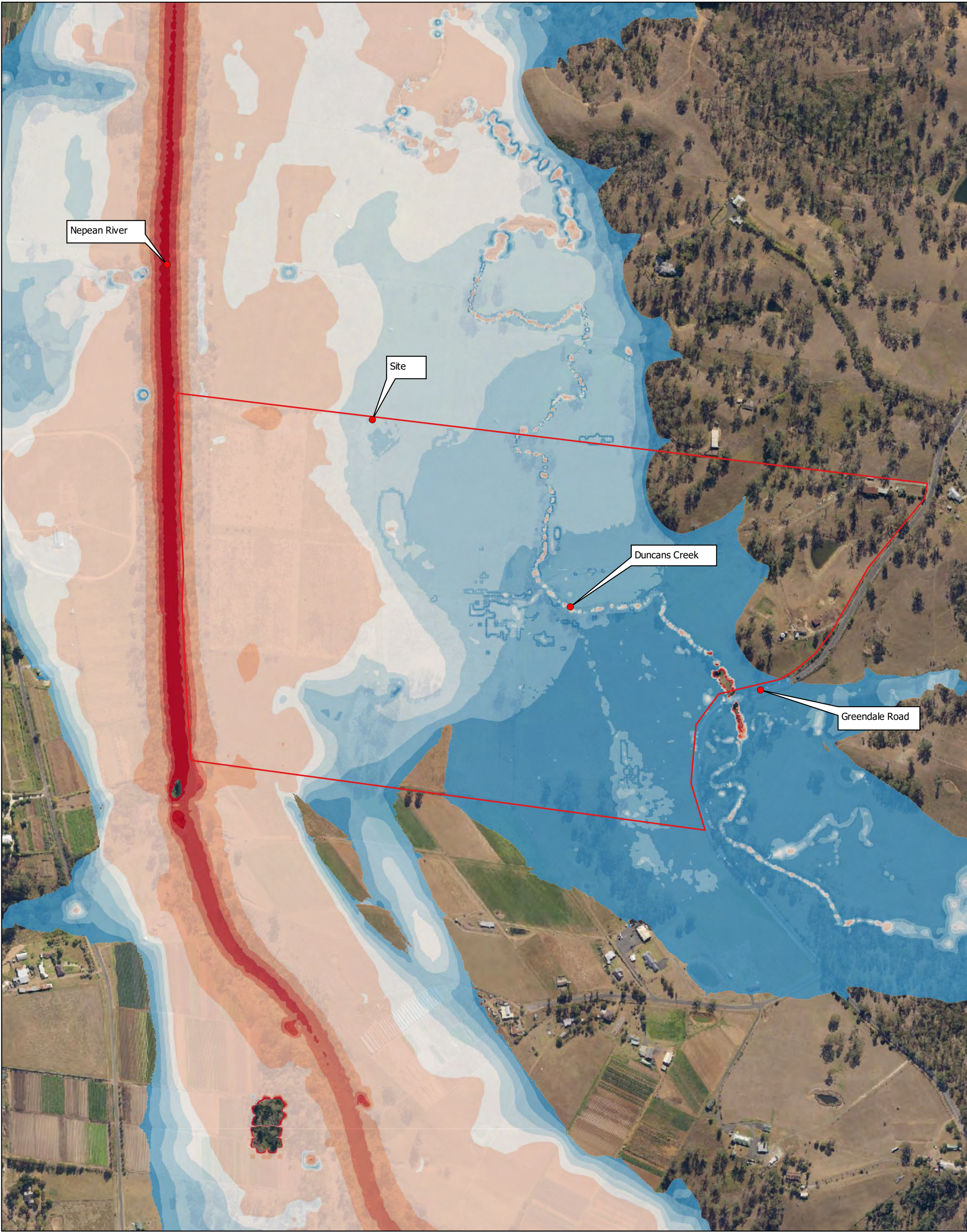


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
100AEP RD08858 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure B11



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

Velocity (m/s)
<0.1

0.1-0.2	1.0-2.0
0.2-0.3	2.0-3.0
0.3-0.4	3.0-5.0
0.4-0.5	>5.0
0.5-1.0	



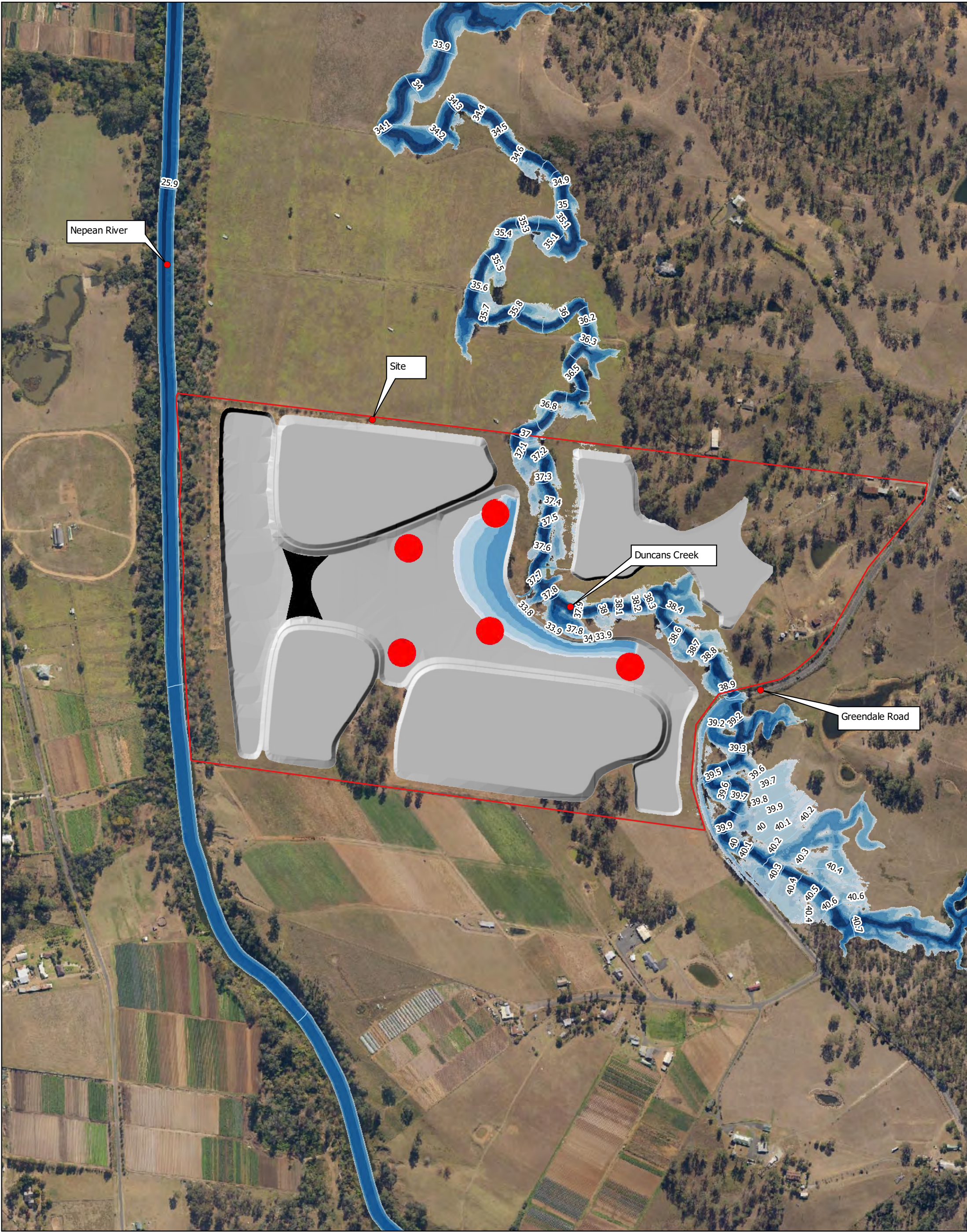
Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Existing)
100AEP RD08858 Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure B12

Appendix C - Flood Maps – Proposed Development Conditions



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Flood Level (mAHD)

Flood Depth (m)

0.015

0.1

0.3

0.5

1

2

>2

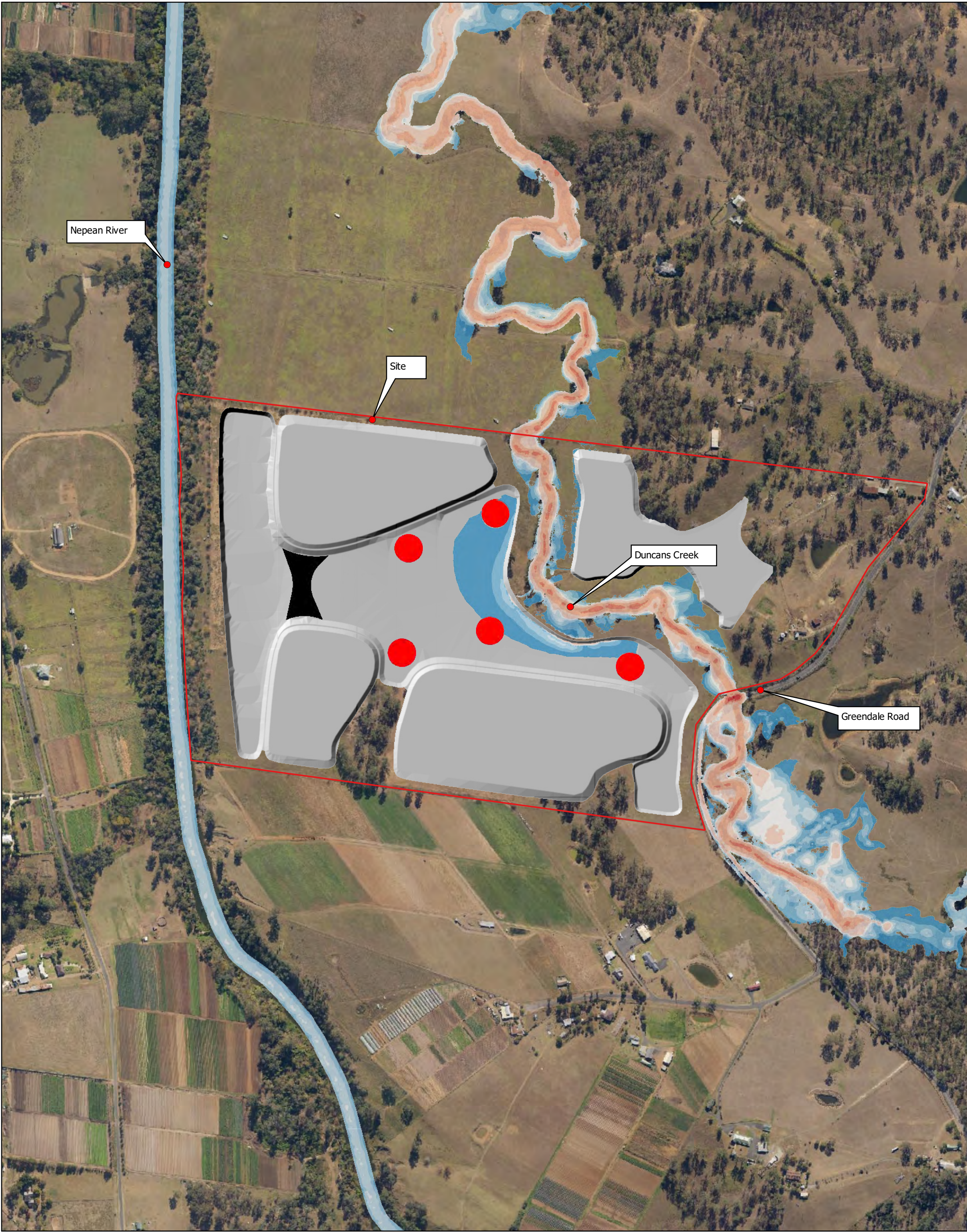


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Proposed)
20AEP Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure C01



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

Velocity (m/s)
<0.1

0.1-0.2	1.0-2.0
0.2-0.3	2.0-3.0
0.3-0.4	3.0-5.0
0.4-0.5	>5.0
0.5-1.0	

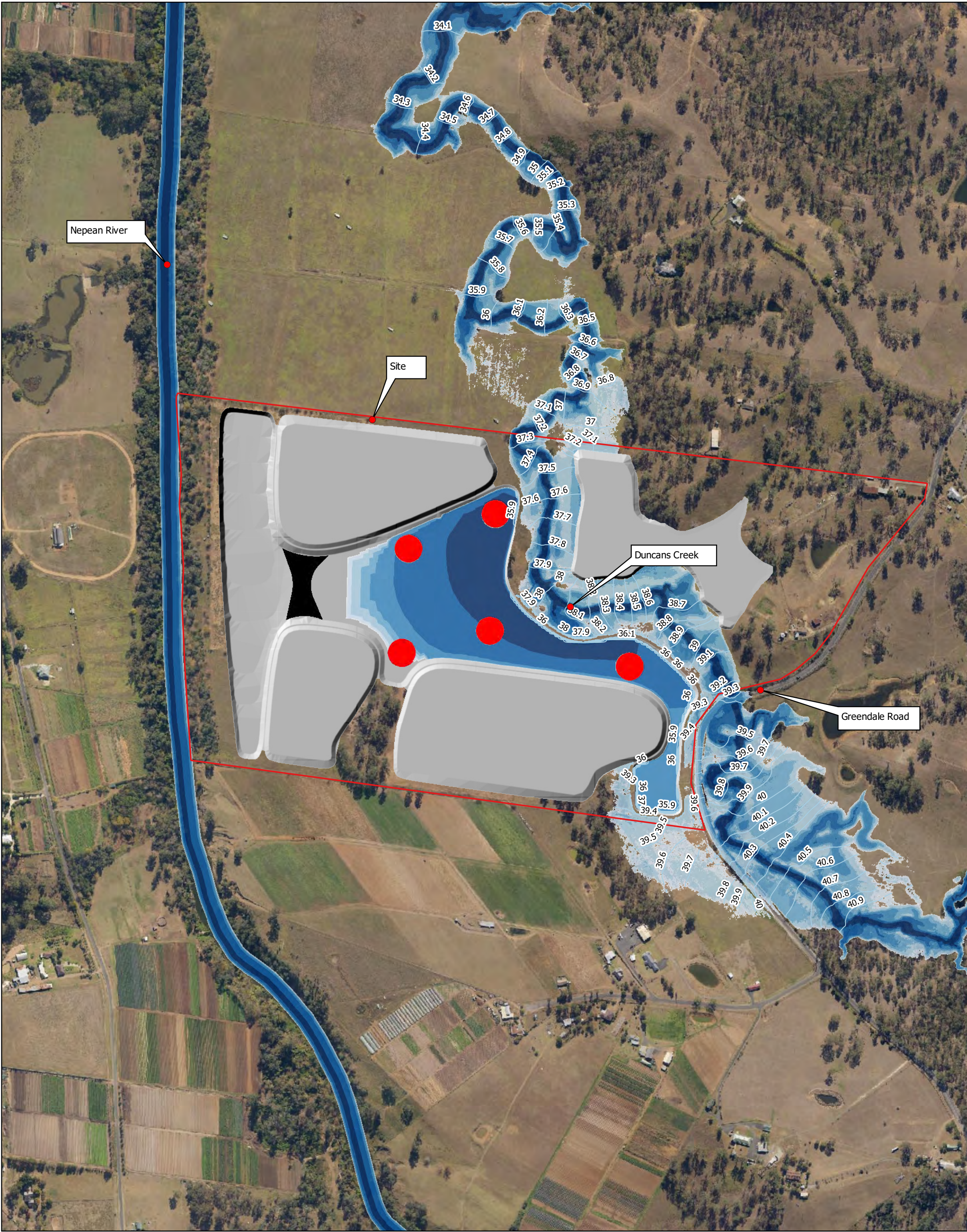


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Proposed)
20AEP Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure C02



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Flood Level (mAHD)

Flood Depth (m)

0.015

0.1

0.3

0.5

1

2

>2

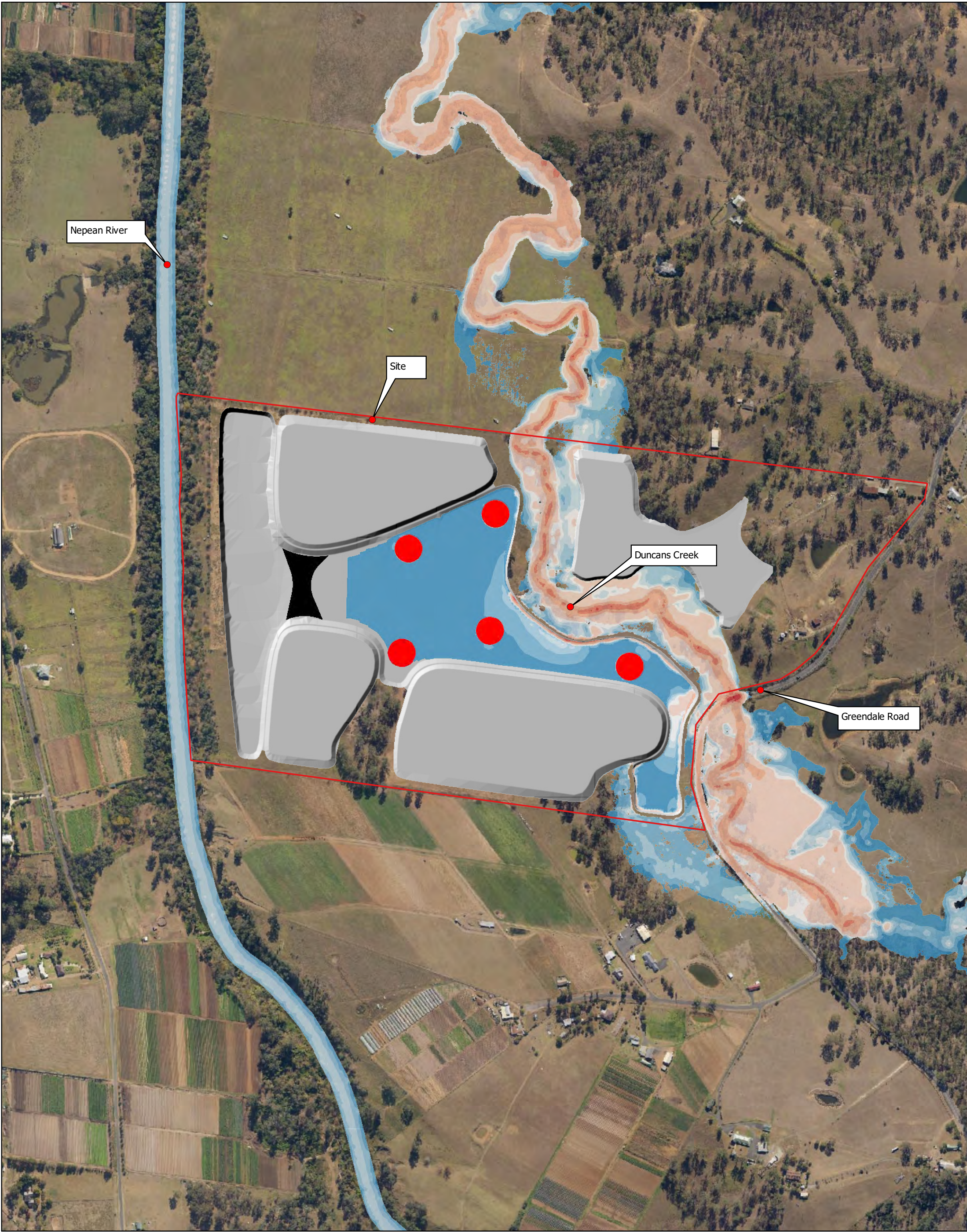


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Proposed)
100AEP Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure C03



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Velocity (m/s)

<0.1

0.1-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1.0

1.0-2.0

2.0-3.0

3.0-5.0

>5.0

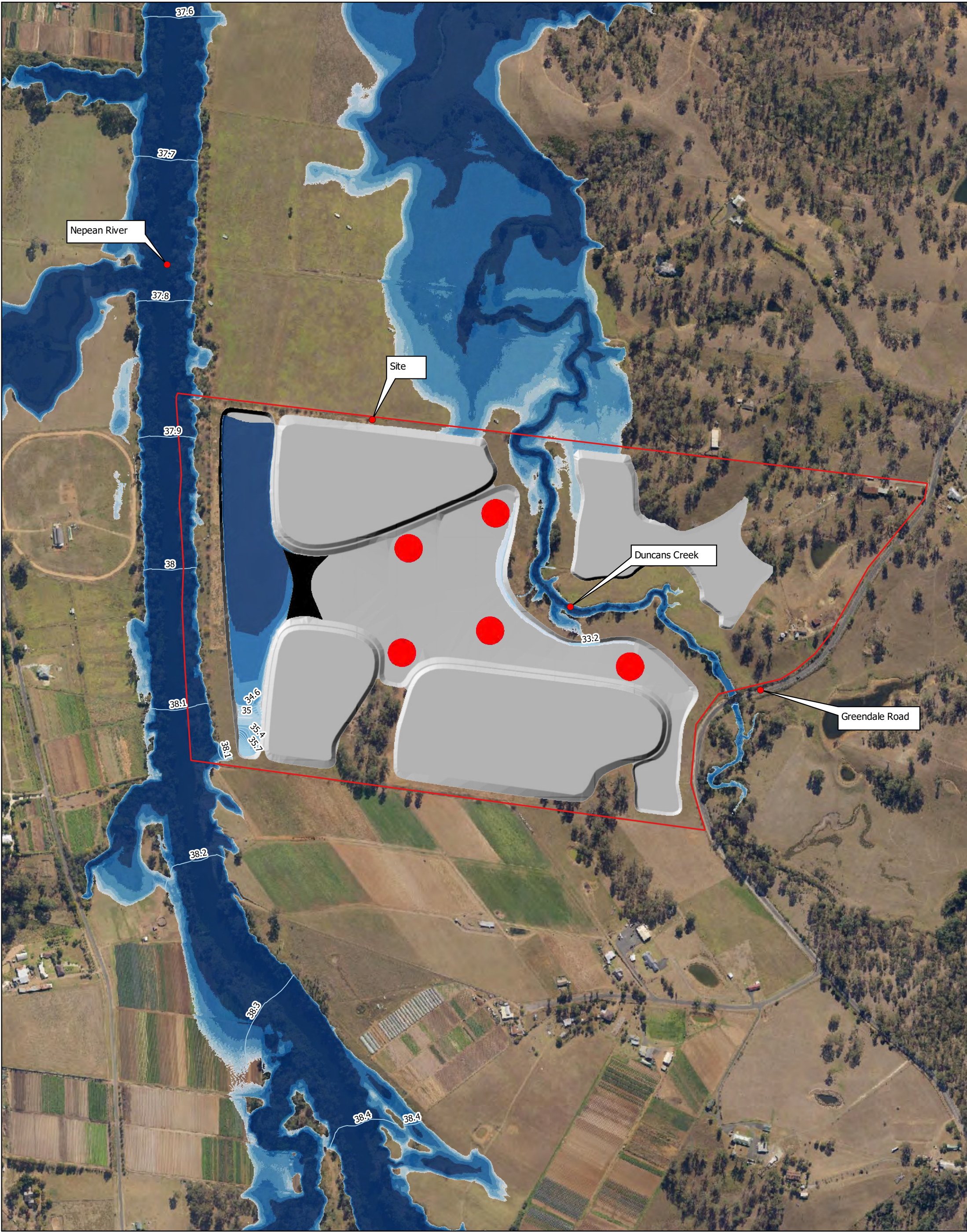


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek (Proposed)
100AEP Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure C04



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
- Property
- Flood Level (mAHD)
- Flood Depth (m)
- 0.015

- 0.1
- 0.3
- 0.5
- 1
- 2
- >2

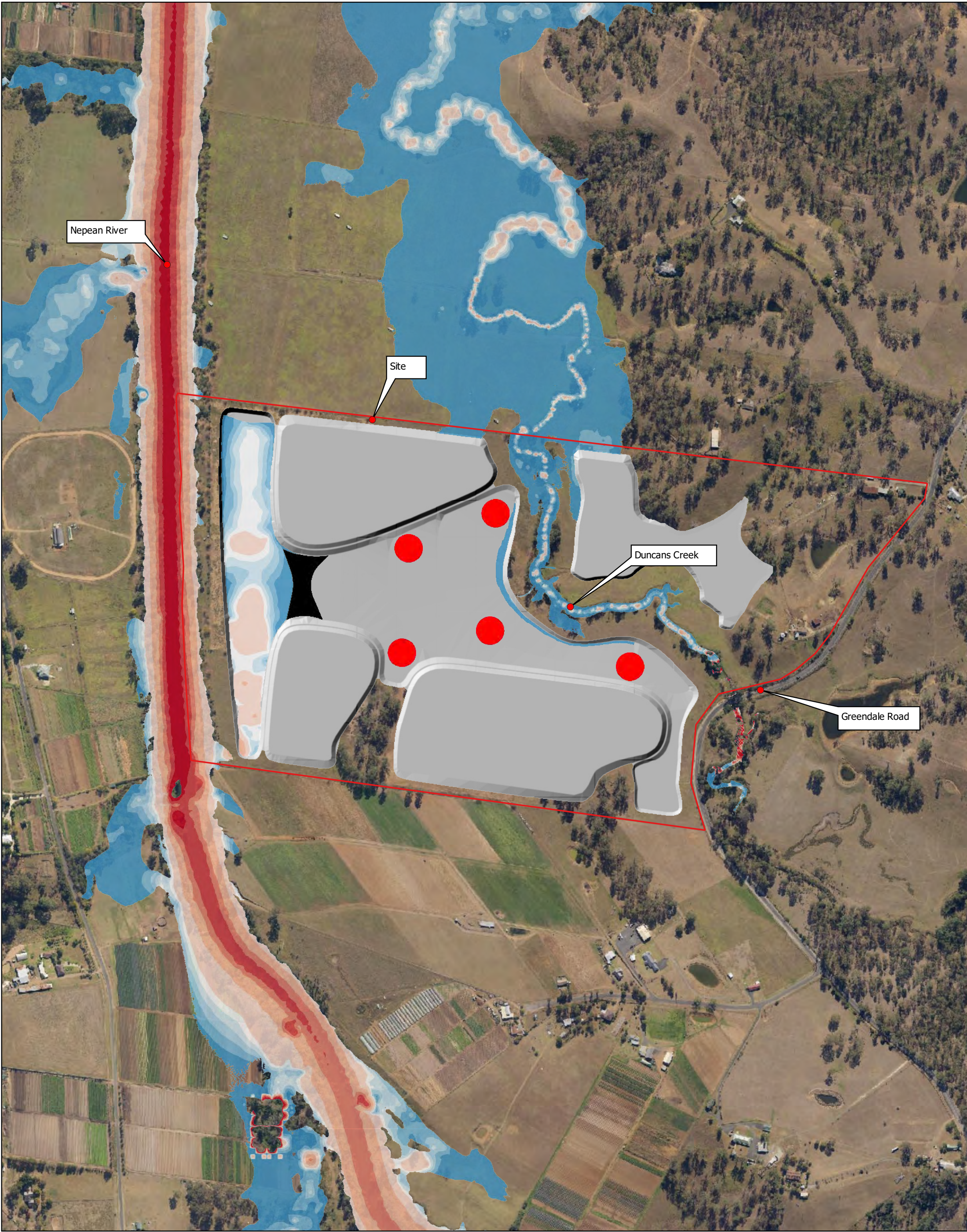


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
20AEP RD00507 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure C05



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property
Velocity (m/s)
<0.1

0.1-0.2	1.0-2.0
0.2-0.3	2.0-3.0
0.3-0.4	3.0-5.0
0.4-0.5	>5.0
0.5-1.0	

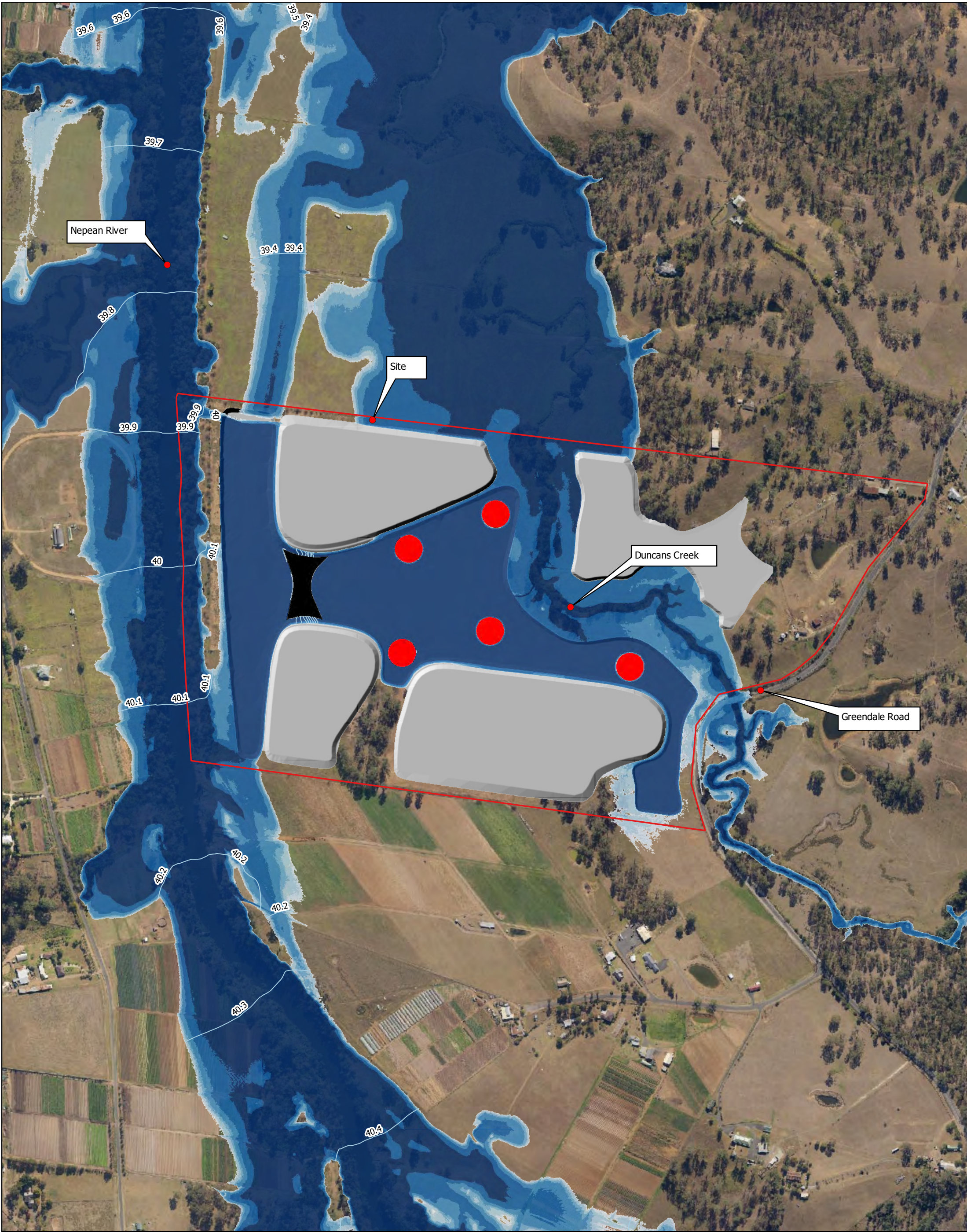


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
20AEP RD00507 Flood Velocity

Job Number	12517741
Revision	
Date	Oct 20

Figure C06



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
Property
Flood Level (mAHD)
Flood Depth (m)
0.015

- 0.1
0.3
0.5
1
2
>2

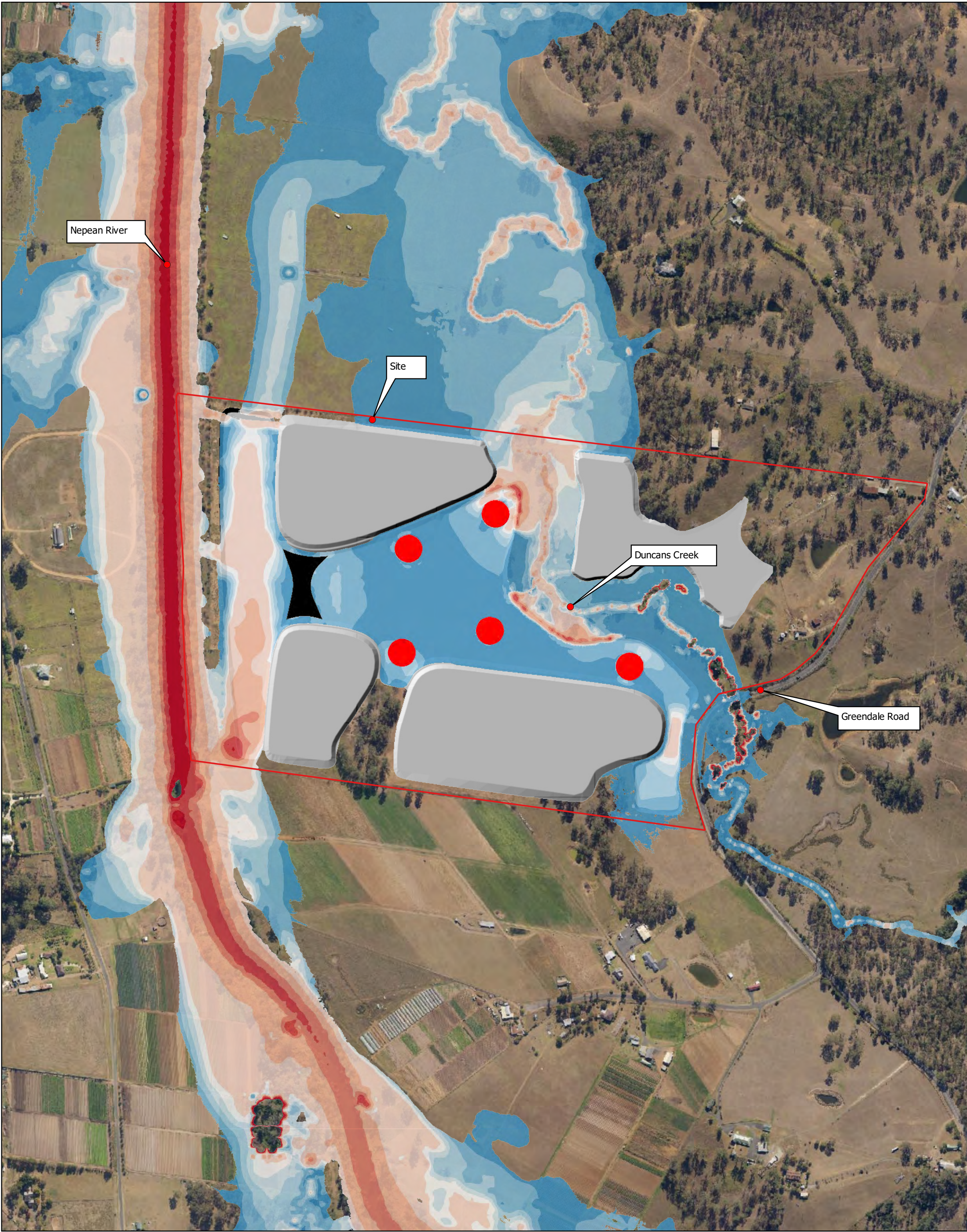


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
20AEP RD06569 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure C07



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

Velocity (m/s)
<0.1

0.1-0.2	1.0-2.0
0.2-0.3	2.0-3.0
0.3-0.4	3.0-5.0
0.4-0.5	>5.0
0.5-1.0	

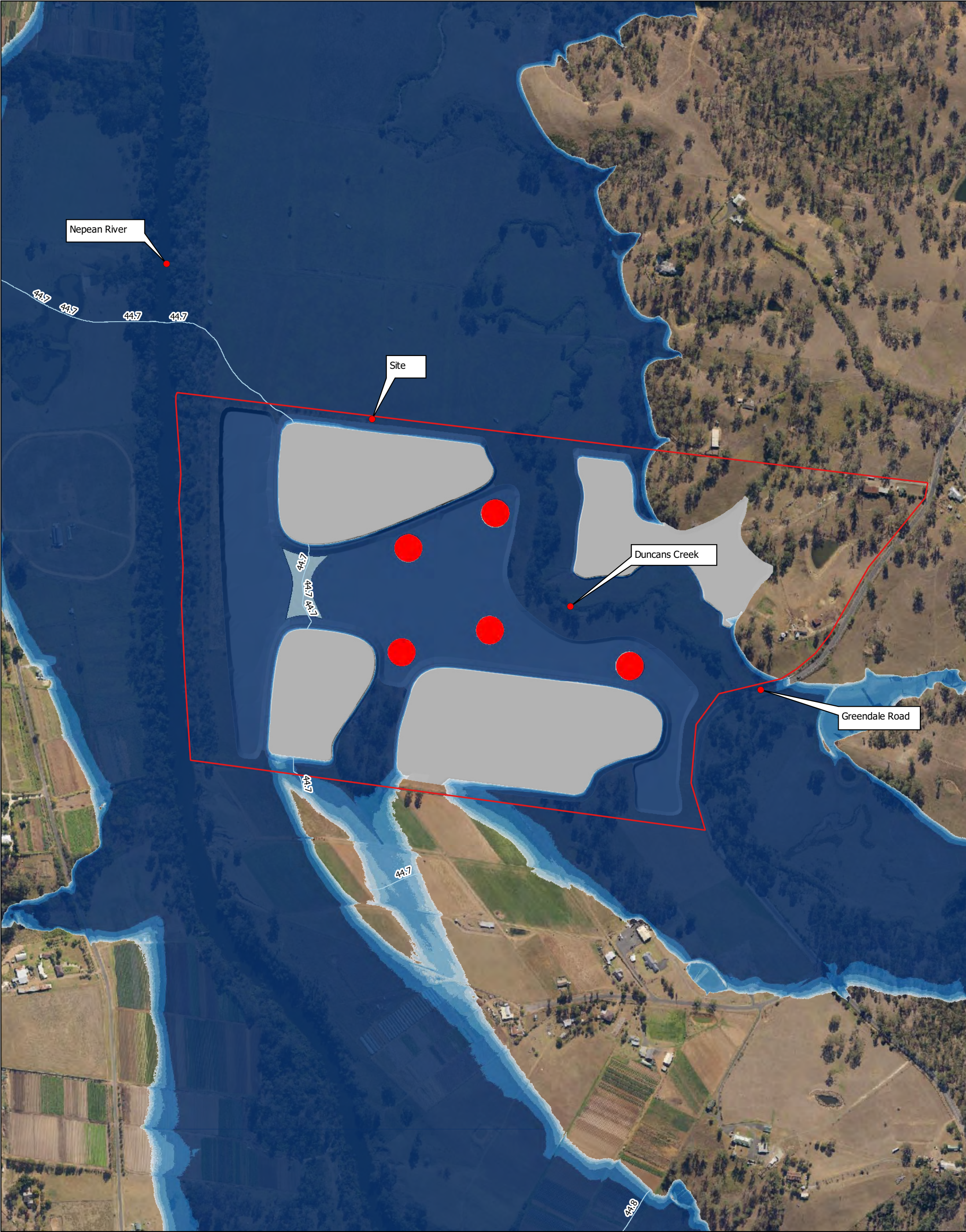


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
20AEP RD06569 Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure C08



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
Property
Flood Level (mAHD)
Flood Depth (m)
0.015

- 0.1
0.3
0.5
1
2
>2

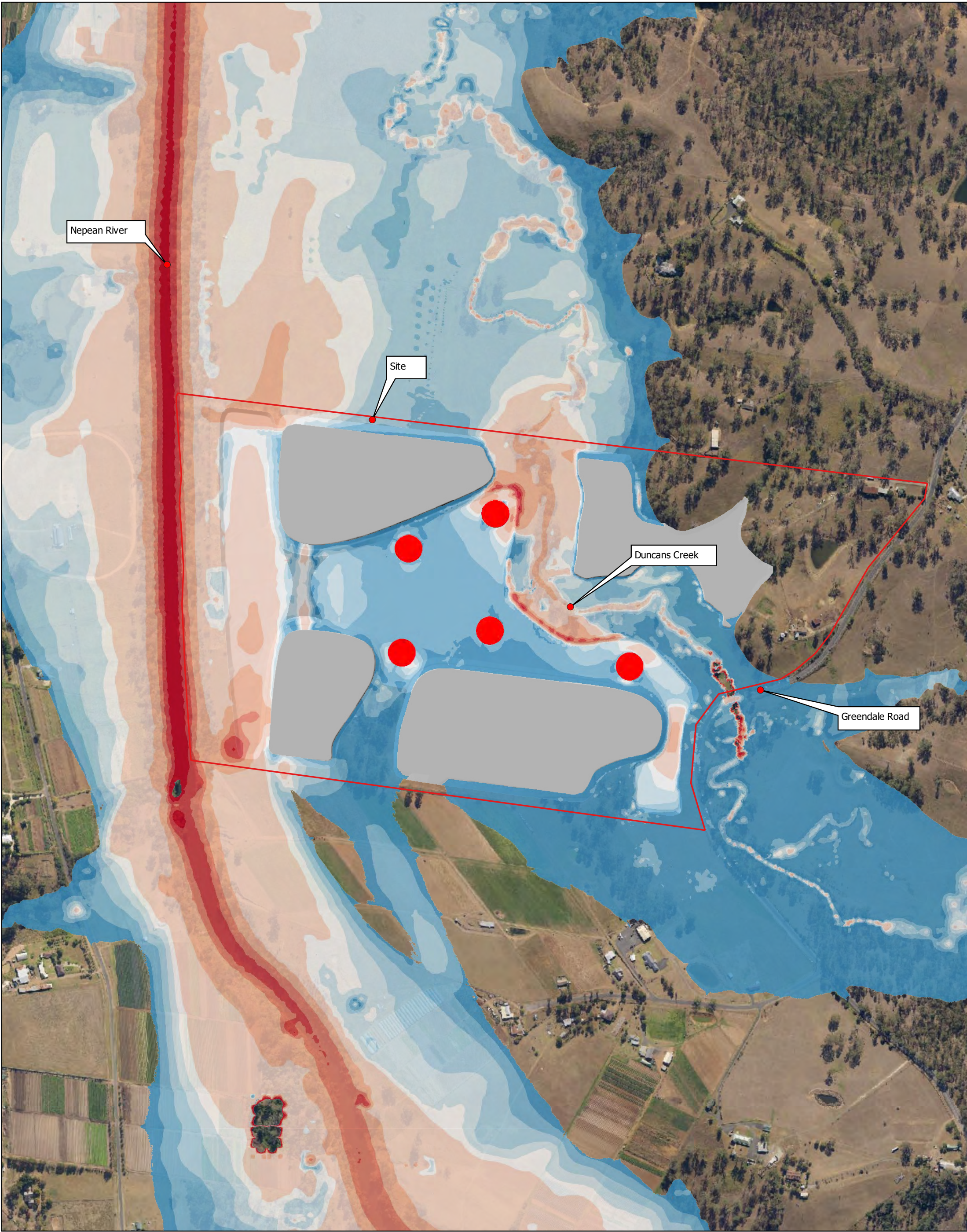


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
100AEP RD04853 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure C09



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

Velocity (m/s)
<0.1

0.1-0.2	1.0-2.0
0.2-0.3	2.0-3.0
0.3-0.4	3.0-5.0
0.4-0.5	>5.0
0.5-1.0	

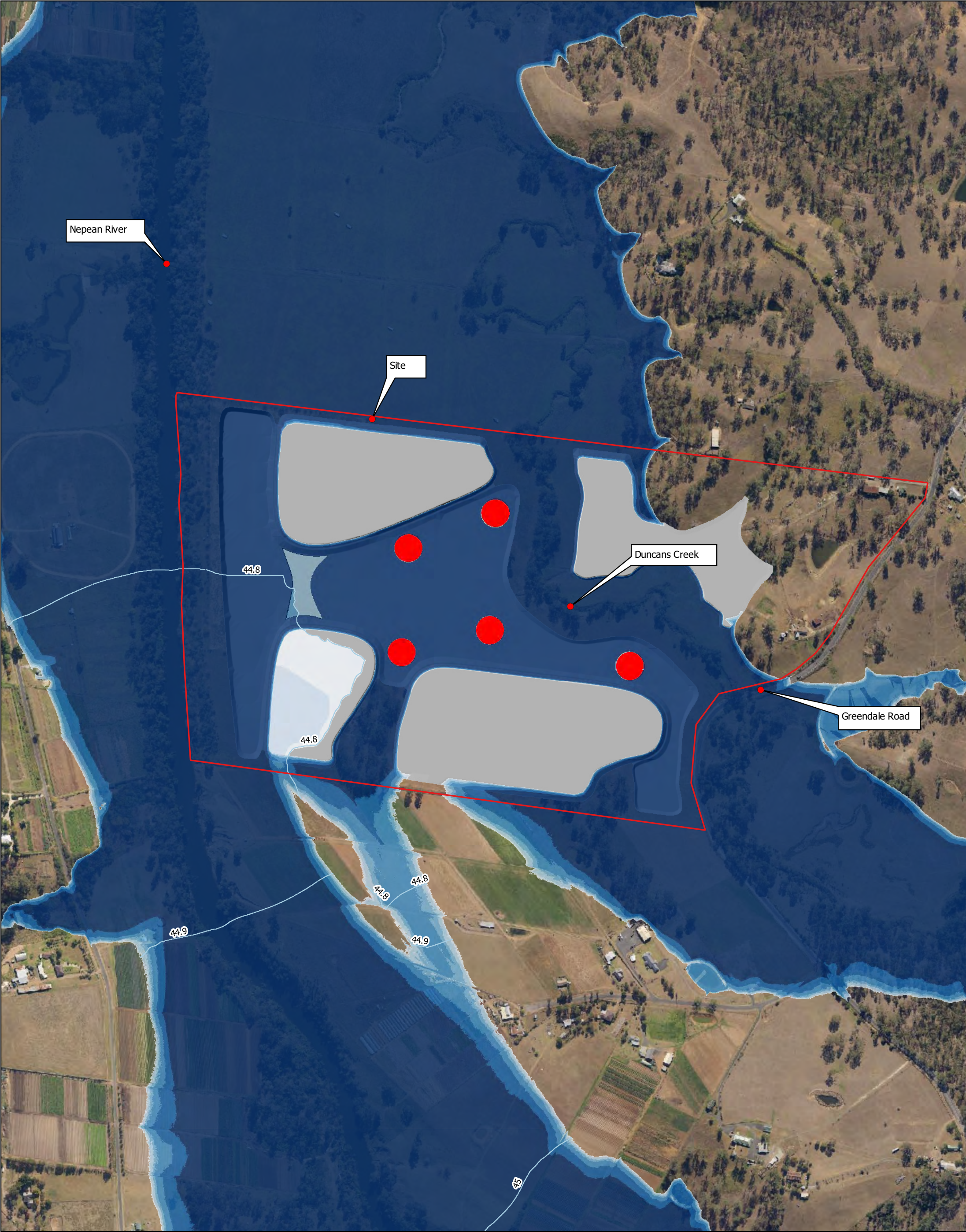


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
100AEP RD04853 Flood Velocity

Job Number 12517741
Revision
Date Oct 20

Figure C10



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- lots
Property
Flood Level (mAHd)
Flood Depth (m)
0.015
- 0.1
 - 0.3
 - 0.5
 - 1
 - 2
 - >2

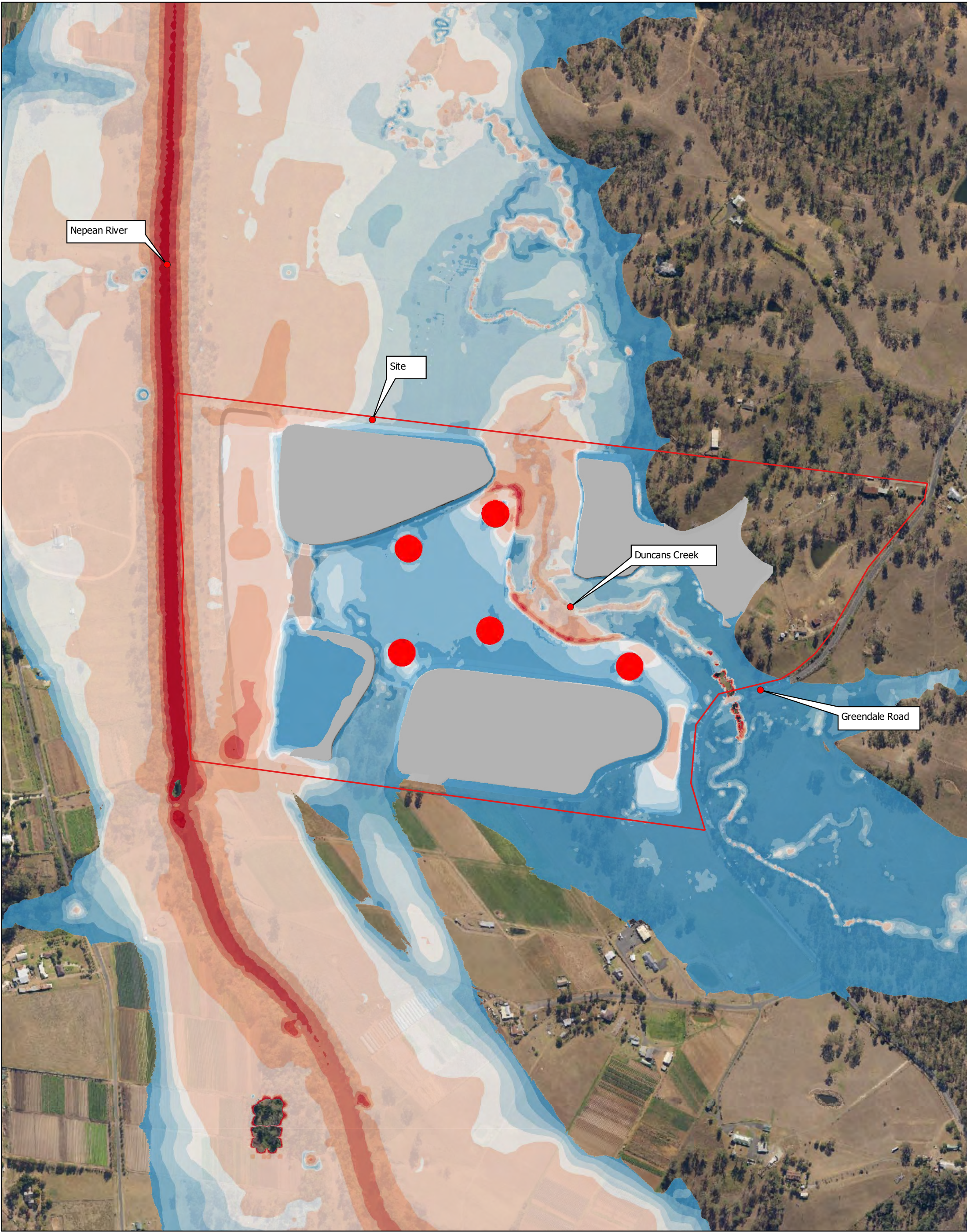


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River (Proposed)
100AEP RD08858 Flood Depth and Level

Job Number 12517741
Revision
Date Oct 20

Figure C11



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots

Property

Velocity (m/s)

<0.1

0.1-0.2

0.2-0.3

0.3-0.4

0.4-0.5

0.5-1.0

1.0-2.0

2.0-3.0

3.0-5.0

>5.0



Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

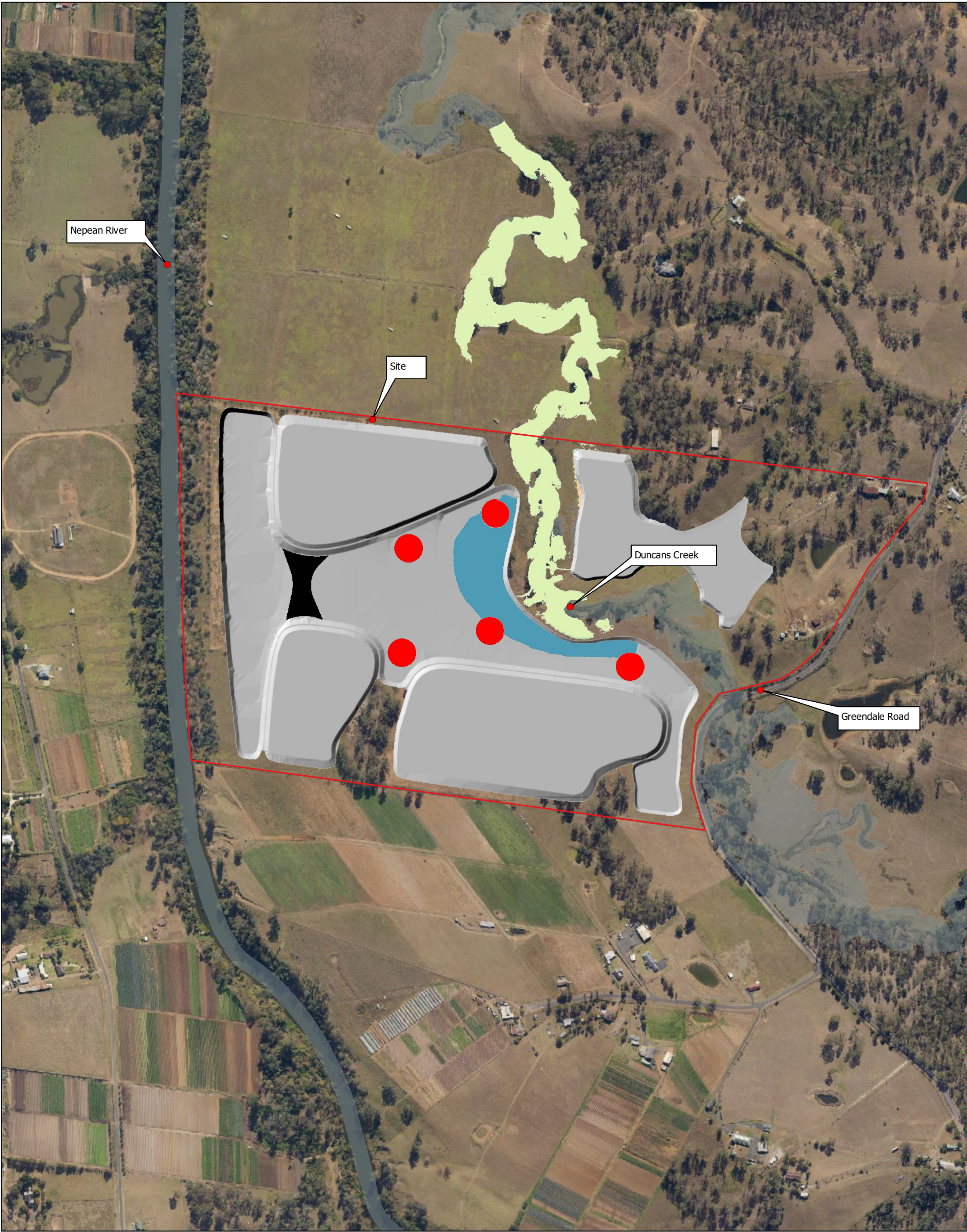
Nepean River (Proposed)
100AEP RD08858 Flood Velocity

Job Number
Revision
Date

12517741
Oct 20

Figure C12

Appendix D - Flood Impact



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-1
Property	-0.5	<0.025	1-2
	-0.10	0.01-0.05	2-5
Impact (m)	-0.05	0.05-0.1	>5
	-0.025	0.1-0.5	
	<-2		
	-2		

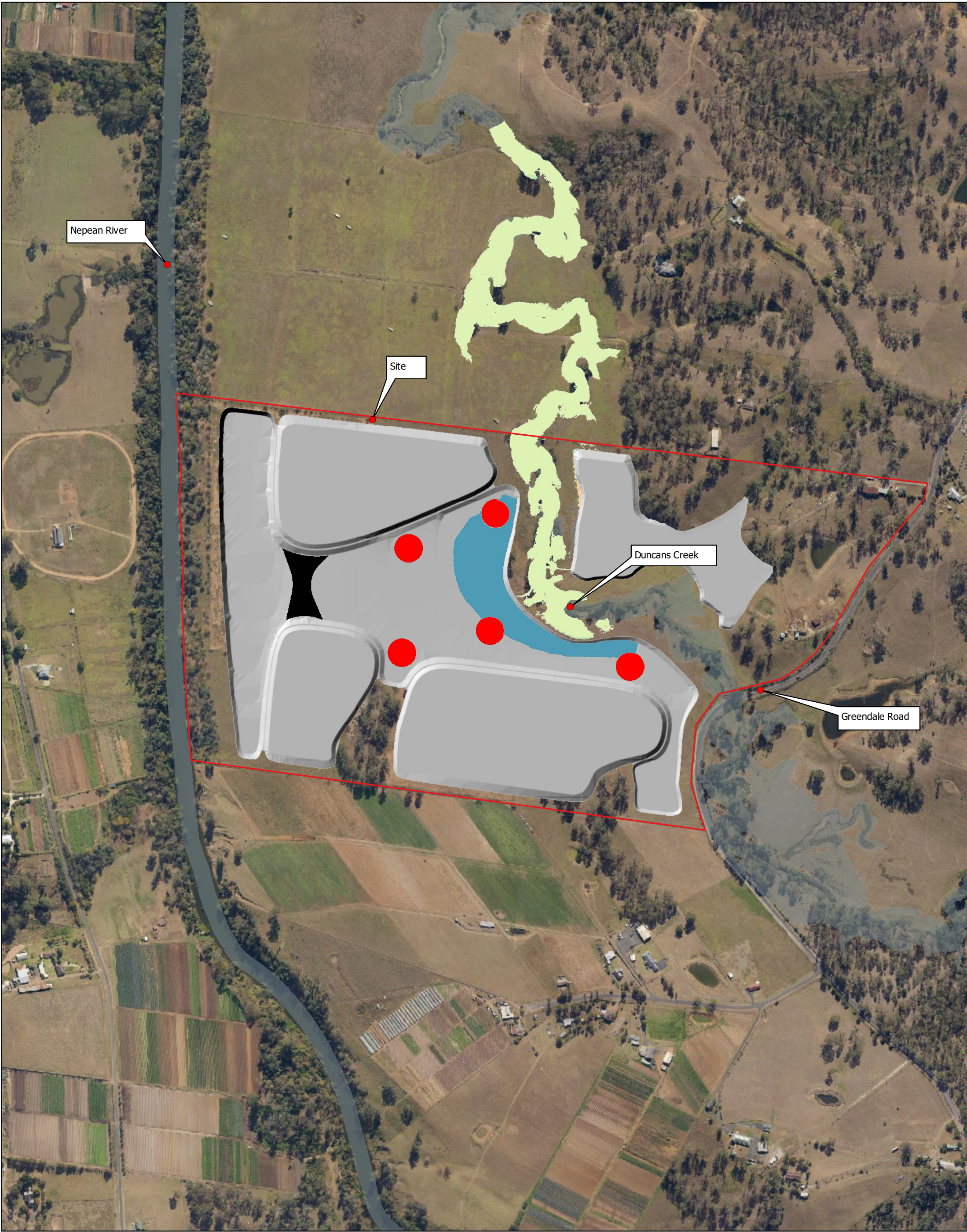


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek
20AEP Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D01



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-1
Property	-0.5	<0.025	1-2
Impact (m)	-0.10	0.01-0.05	2-5
<-2	-0.05	0.05-0.1	>5
-2	-0.025	0.1-0.5	

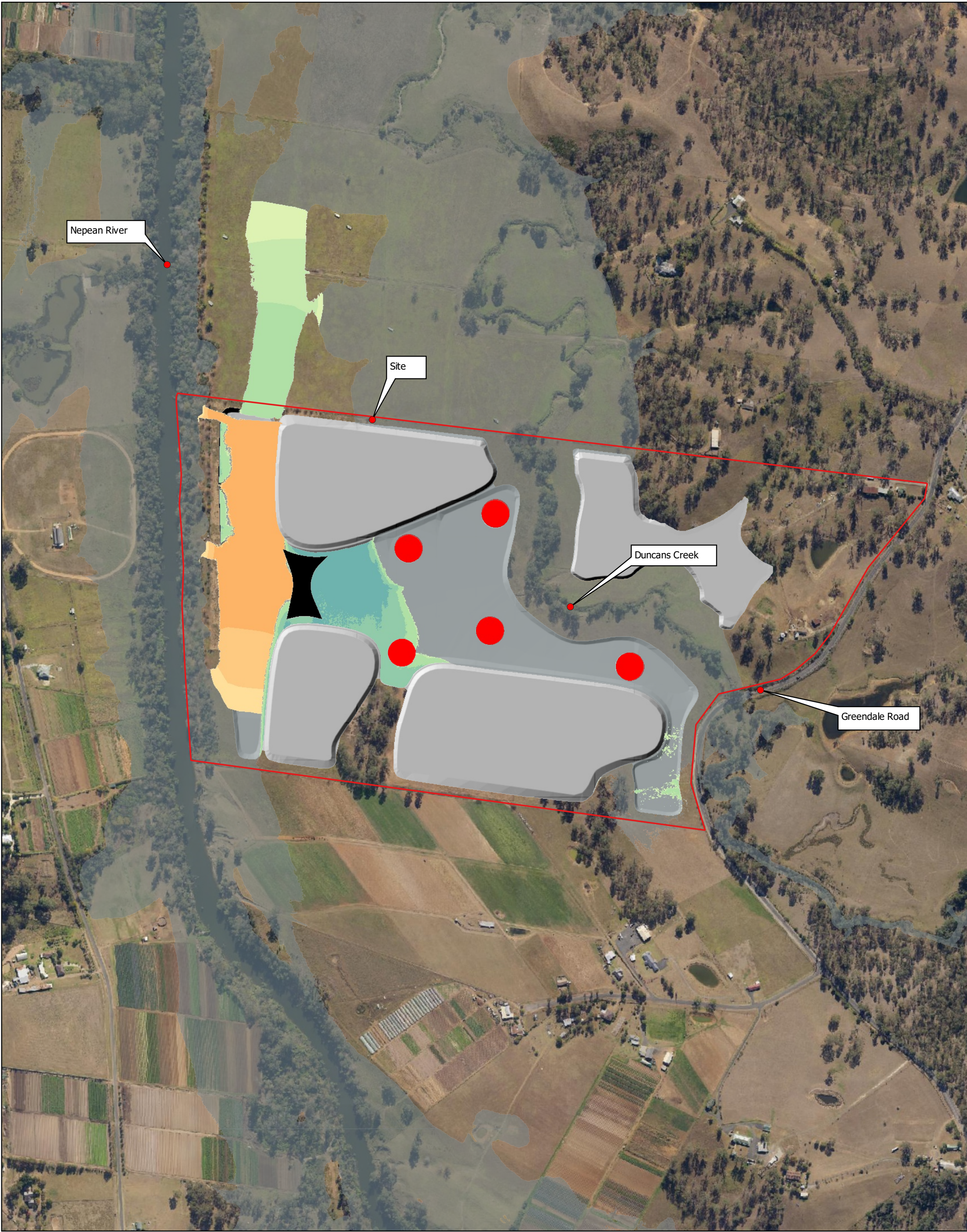


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek
100AEP Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D02



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-1
Property	-0.5	<0.025	1-2
Impact (m)	-0.10	0.01-0.05	2-5
<-2	-0.05	0.05-0.1	>5
-2	-0.025	0.1-0.5	

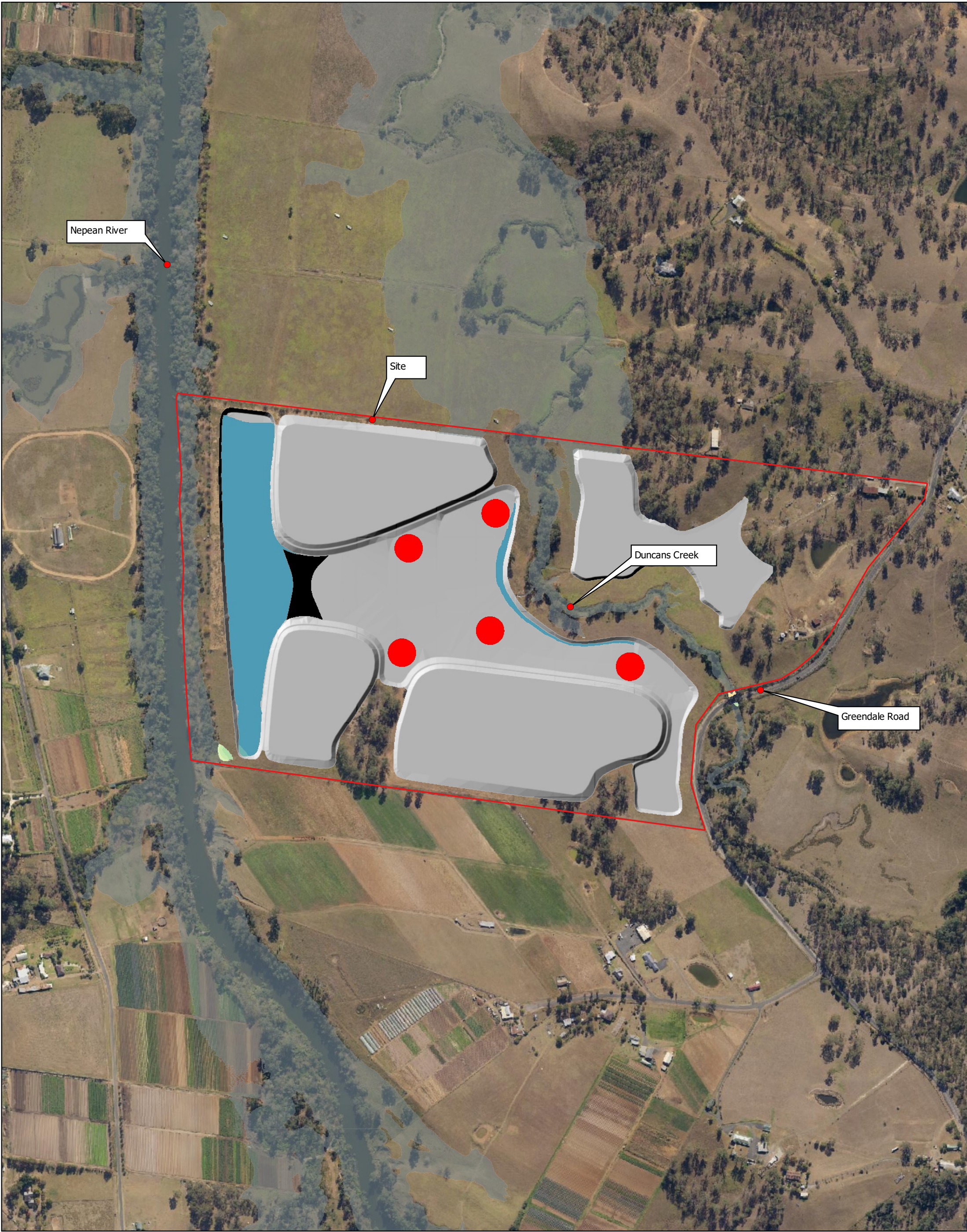


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
20AEP RD06569 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D03



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-1
Property	-0.5	<0.025	1-2
Impact (m)	-0.10	0.01-0.05	2-5
<-2	-0.05	0.05-0.1	>5
-2	-0.025	0.1-0.5	

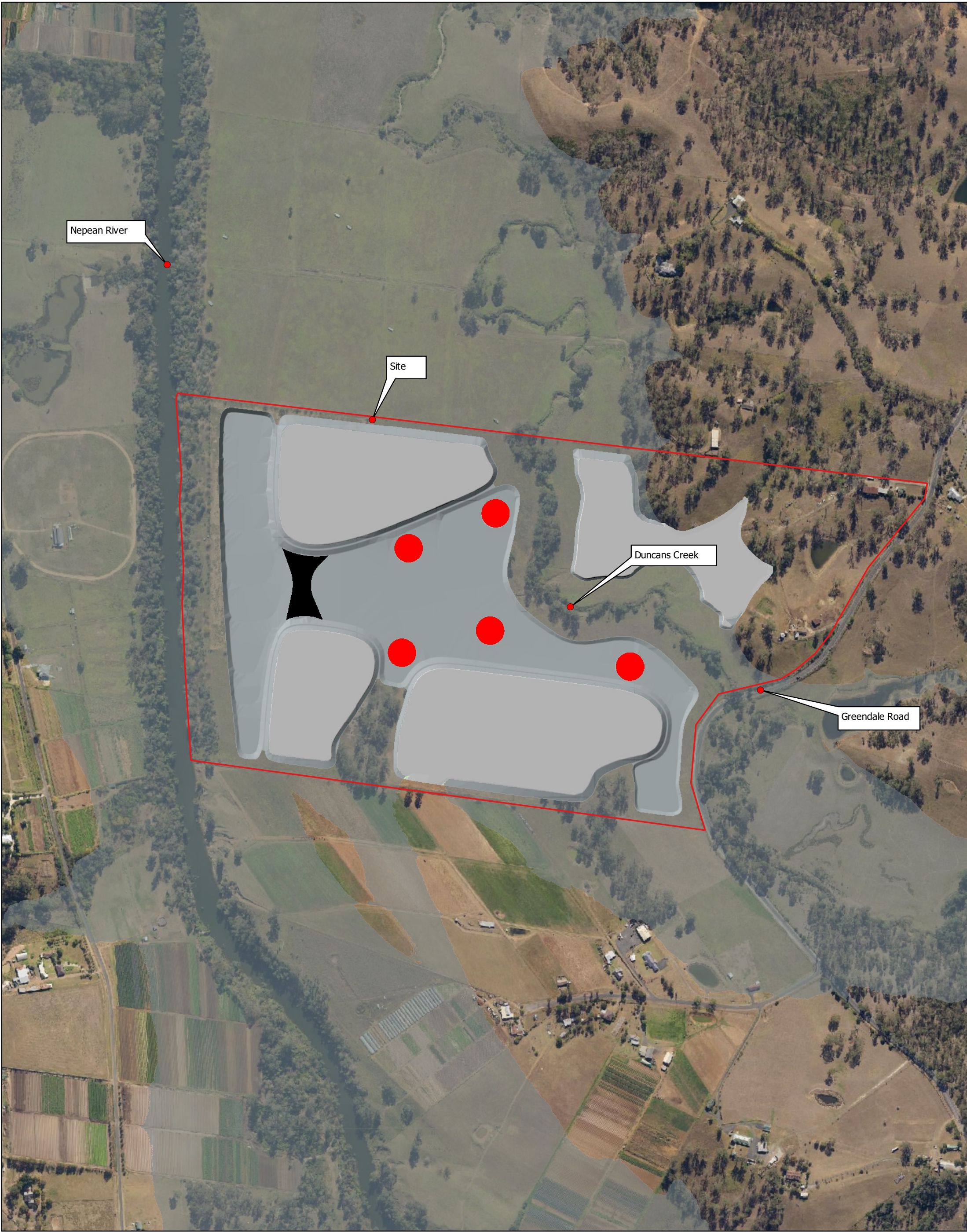


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
20AEP RD00507 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D04



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-1
Property	-0.5	<0.025	1-2
Impact (m)	-0.10	0.01-0.05	2-5
<-2	-0.05	0.05-0.1	>5
-2	-0.025	0.1-0.5	

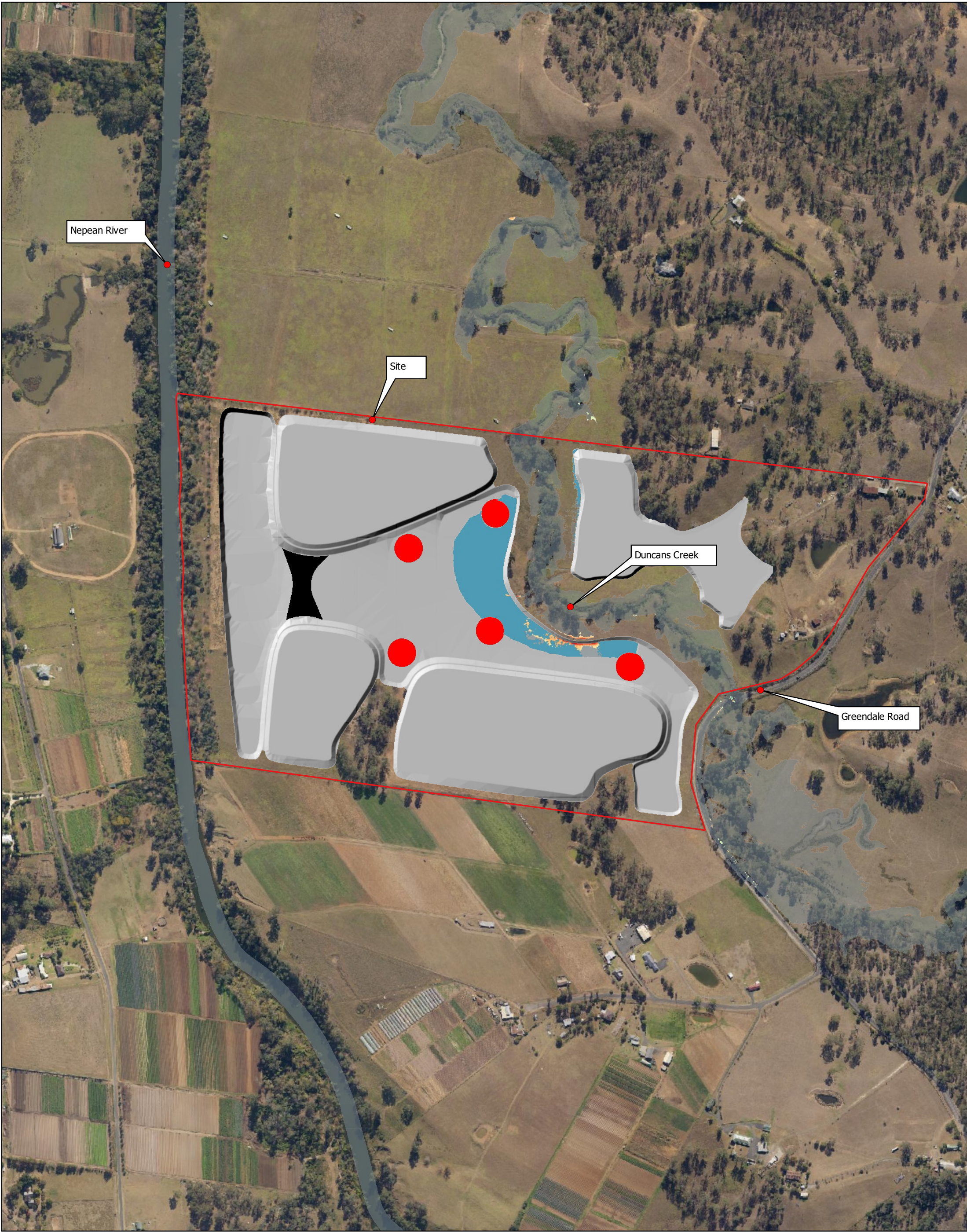


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
100AEP RD04853 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D06



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-0.7
Property	-0.5	<0.1	0.7-1
V change (m/s)	-0.2	0.1-0.15	1-2
<-2	-0.15	0.15-0.2	>2
-2	-0.1	0.3-0.5	

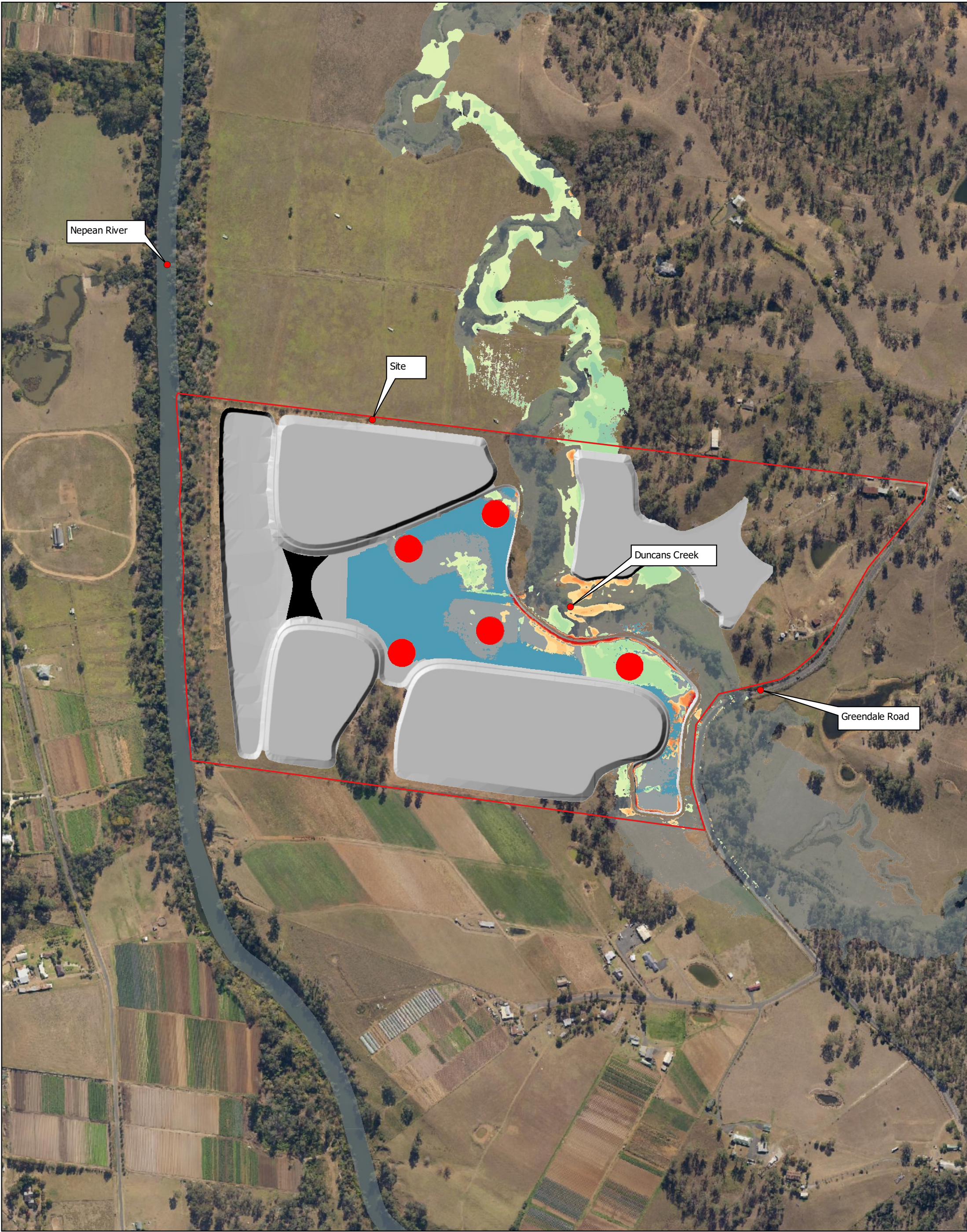


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek
20AEP Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D07



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-0.7
Property	-0.5	<0.1	0.7-1
V change (m/s)	-0.2	0.1-0.15	1-2
<-2	-0.15	0.15-0.2	>2
-2	-0.1	0.3-0.5	

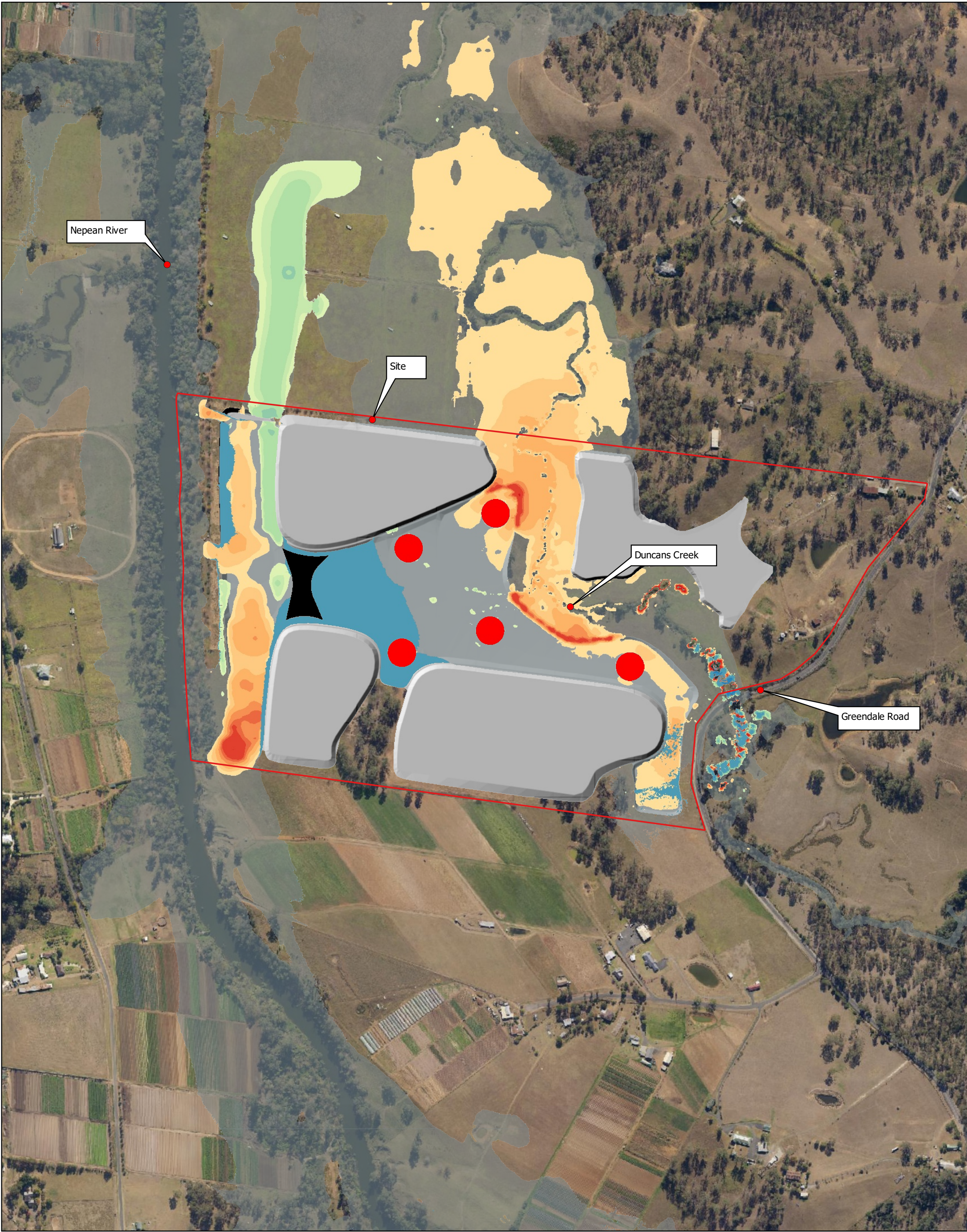


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Duncans Creek
100AEP Flood Impact

Job Number	12517741
Revision	
Date	Oct 20

Figure D08



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

V Change (m/s)
-2
-2

-1	0	0.5-0.7
-0.5	<0.1	0.7-1
-0.2	0.1-0.15	1-2
-0.15	0.15-0.2	>2
-0.1	0.3-0.5	

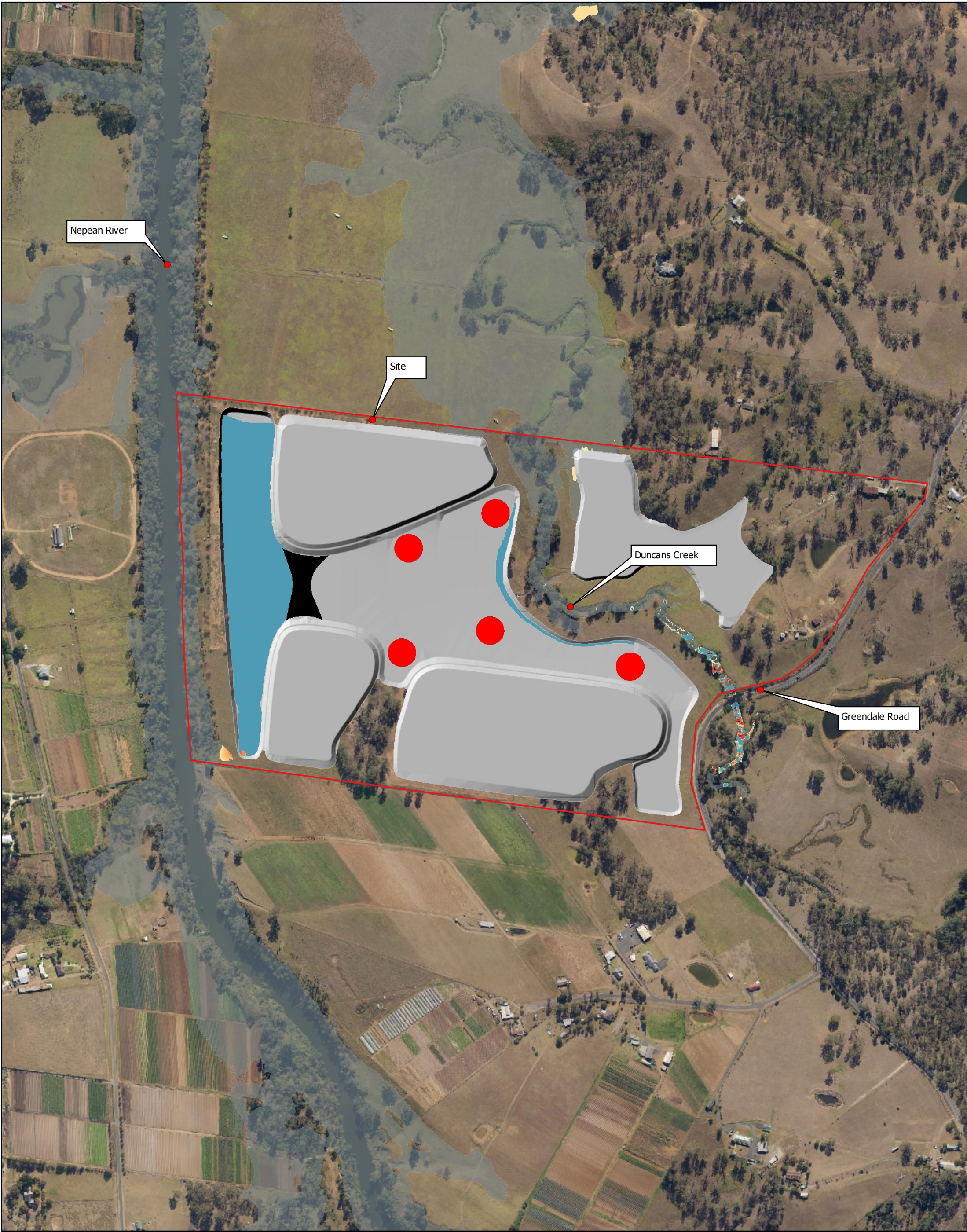


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
20AEP RD06569 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D09



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots
Property

V Change (m/s)
<-2
-2

-1
-0.5
-0.2
-0.15
-0.1

0
<0.1
0.1-0.15
0.15-0.2
0.3-0.5

0.5-0.7
0.7-1
1-2
>2

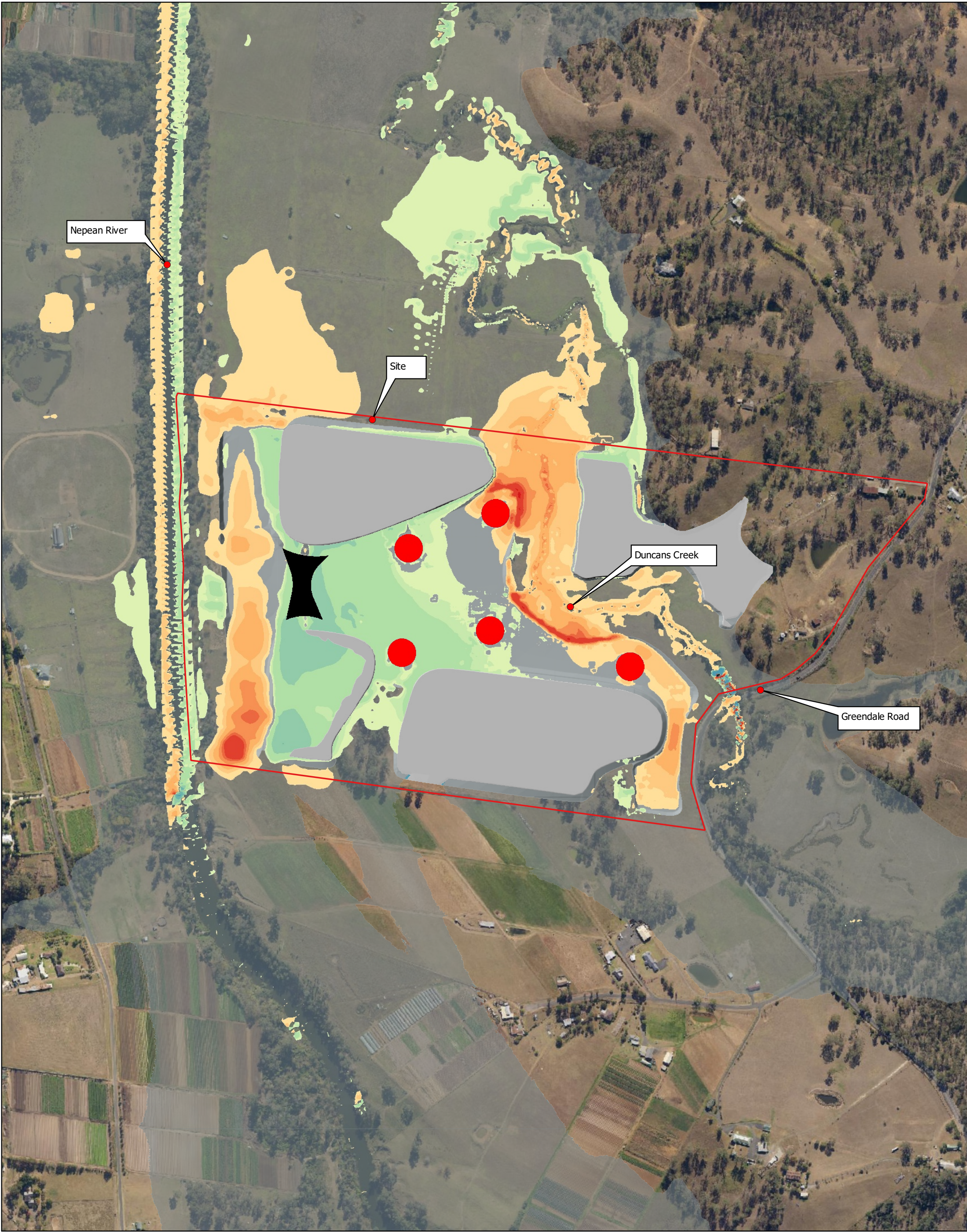


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
20AEP RD00507 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D10



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-0.7
Property	-0.5	<0.1	0.7-1
V Change (m/s)	-0.2	0.1-0.15	1-2
<-2	-0.15	0.15-0.2	>2
-2	-0.1	0.3-0.5	

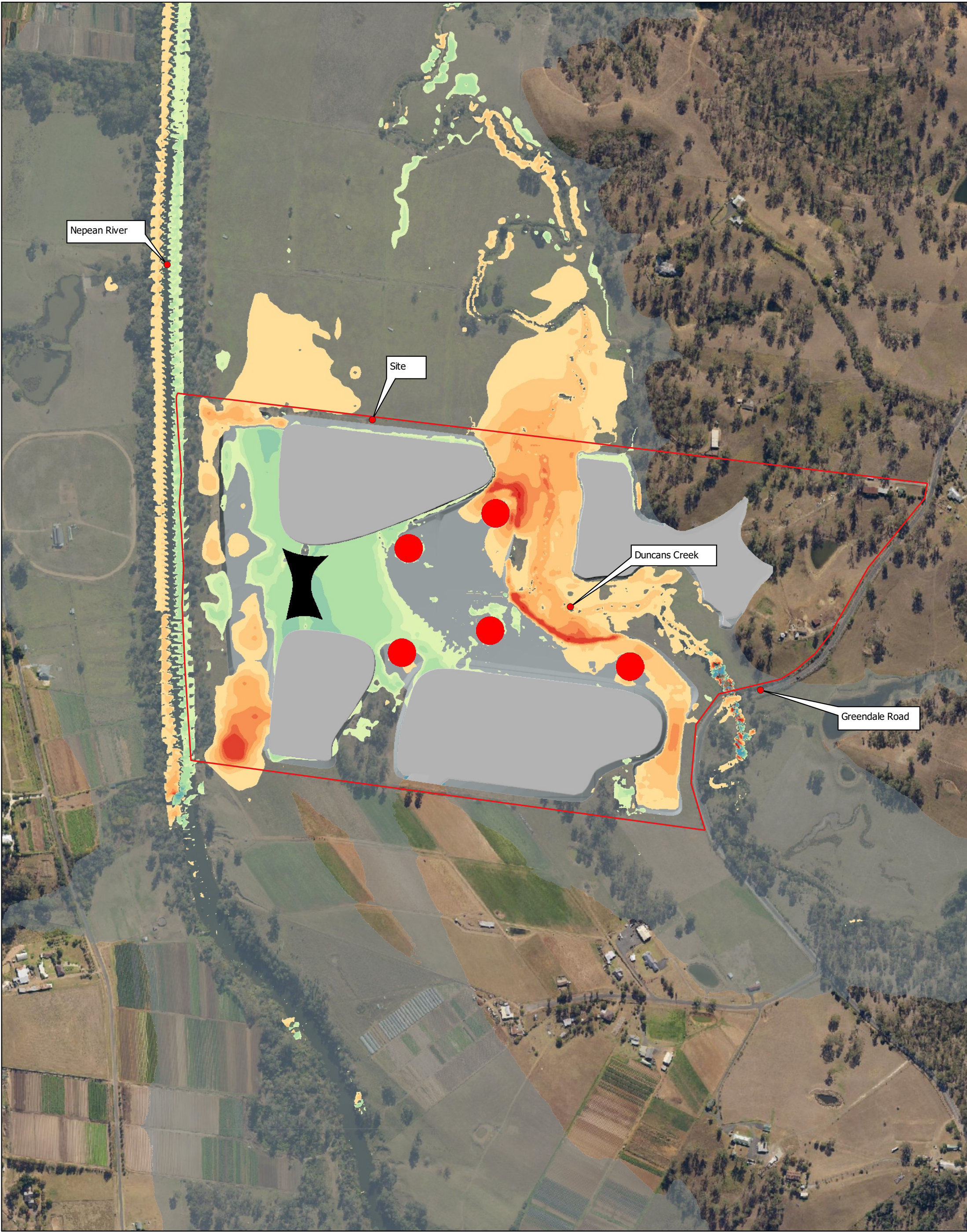


Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
100AEP RD08858 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D11



Scale 6000

Paper Size A3

Map projection: Transverse Mercator
Horizontal datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

lots	-1	0	0.5-0.7
Property	-0.5	<0.1	0.7-1
V Change (m/s)	-0.2	0.1-0.15	1-2
<-2	-0.15	0.15-0.2	>2
-2	-0.1	0.3-0.5	



Saukutsu Pty Ltd ATF Wallacia Trust
1290 Greendale Road

Nepean River
100AEP RD04853 Flood Impact

Job Number 12517741
Revision
Date Oct 20

Figure D12

GHD

Level 3

22 Giffnock Avenue

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35/https://projectsportal.ghd.com/sites/pp15_04/1290greendaleroad/ProjectDocs/12517741_REP_1290GreendaleRoad_FloodStudy.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft	R Berg	A Priory	iConnect	N Bailey	iConnect	29/10/2020
Rev 1	R Berg	A Priory	minor	N Bailey		30/11/2020

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