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Preliminary Geotechnical and Natural Hazards Review

Cherry Orchard Farm

Ripponvale Road, Cromwell

Report prepared for:

Rippon Holdings Limited

Report prepared by:

GeoSolve Limited

Distribution:

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Rippon Investments Limited

Jake Woodward (Planner)

GeoSolve Limited (File)

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0	20/03/2026	Client issue for fast-track resource consent referral.	JAS	FAW
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GEOTECHNICAL WATER RESOURCES PAVEMENTS

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1 Introduction

1.1 General

This report presents the results of a preliminary geotechnical and natural hazards review for the proposed Cherry Orchard Farm Subdivision, Cromwell. Reference to the National Policy Statement for Natural Hazards (NPS-NH 2025) is made where applicable. GeoSolve Limited have completed this report to provide preliminary information for the development and to assist the application process for fast-track resource consent.

Photo 1. Panoramic overview of the proposed development site looking southeast from the existing subdivision at Shannon Farm.

The work described in this report has been completed in accordance with the terms and conditions outlined in GeoSolve Ltd.'s Short Form Agreement (ref no. 260149) dated 4th of March 2026.

1.2 Development Overview

The development comprises an extensive residential subdivision, being a subdivision of several existing horticultural allotments. Industrial and commercial precincts are also proposed off the intersection of Ripponvale and Kawarau Gorge Roads. It is understood that several stormwater channels and basins will be interspersed through the development to manage the expected stormwater runoff.

A development scheme plan, produced by Rough Milne Mitchell Landscape Architects (RMMLA), is provided on Figure 1a, Appendix A which outlines the extent and layout of the development. Earthworks plans indicating proposed cut and fills are yet to be produced. Two existing orchard irrigation dams will require backfilling with certified engineered fill.

2 Site Description

2.1 General

The development site is located on the northwestern fringes of Cromwell Township and lies at the base of an alluvial outwash terrace east of the Pisa Range front. The site is currently a working cherry orchard which includes existing buildings and irrigation dams.

The property is bounded by Ripponvale Road and the Cromwell Racecourse to the south, Shannon Farm subdivision to the west, undeveloped rural land to the north, and Ripponburn Retirement Village to the east.

2.2 Topography and Surface Drainage

The topography is dominated by degraded terrace risers immediately north of the site, which trend roughly northwest-southeast. The overall ground surface within the development slopes gently southeast away from the terrace slopes toward the Ripponvale and Kawarau Gorge Road intersection.

Several ephemeral gullies transect the terrace crest north of the site and drain localised catchment areas. The largest ephemeral flow path enters site on the northwestern corner and has been termed the “Eastern Gully” in previous geotechnical reporting by GeoSolve for the neighbouring subdivision. Any previous evidence of overland flow paths within the development look to have been obscured by the present cherry orchard. All the ephemeral gullies were dry at the time of our inspection.

Refer to Figure 1c, Appendix A for the mapped topographic and surface drainage features discussed above.

3 Subsurface Conditions

3.1 Geological Setting

The site is underlain by the regionally extensive Haast Schist. Schist bedrock forms the Pisa Range to the west and underlies the development at depth. Dunstan Formation quartz gravels and over consolidated Bannockburn Formation lake sediment of the Manuherikia Group overlies the schist and is present locally at the ground surface. Glacial outwash gravels derived from former glacial periods form prominent terraces immediately north of the development and overlie the older formations. Relatively recent alluvial fans have developed away from the Pisa Range and bounding outwash terraces. Superficial deposits of topsoil, windblown loess and colluvium commonly blanket the ground surface.

Regional scale geological mapping for the site is presented on Figure 1b, Appendix A.

3.2 Preliminary Subsurface Stratigraphy

No confirmatory subsurface investigations have been undertaken as part of our preliminary assessment. The subsurface stratigraphy as observed and inferred from field mapping is anticipated to comprise the following in order of geologic age:

- **Uncontrolled fill**, **topsoil**, **loess** and **colluvium** overlying;
- **Alluvial fan sediment** overlying;
- **Outwash gravel** and **Manuherikia Group**.

Uncontrolled fill associated with the previous farming and existing horticultural operation are expected to be present, but the precise locations of these fills are currently unknown.

Surficial deposits of **topsoil**, **loess** and **colluvium** will be common across the site but will vary in depth and extent depending on the local setting. Windblown loess typically blankets the ground surface below the topsoil horizon while colluvium is the product of proximal erosion and develops on the surface or margin of adjacent slopes.

Alluvial fan sediment is expected to comprise the most abundant near surface soil type within the subdivision. Fan deposits will grade between silt, sand and gravel but are expected to become progressively finer from the source areas southeast toward the toe of the fans along Ripponvale and Kawarau Gorge Roads. The overall dip of the fan surface can be traversed from the western end of Ripponvale Road towards the intersection.

Outwash gravel is exposed in a batter cut on the northeastern corner of the existing cherry orchard. The gravels are predominantly composed of weathered greywacke derived from the former outwash of a retreating glacier further up the Clutha Valley. The development straddles a transition zone between separate outwash surfaces above and below the site which represent older and younger outwash sequences respectively.

Manuherikia Group has been observed within the neighbouring Shannon Farm subdivision and comprises both the lacustrine Bannockburn Formation and the underlying fluviatile Dunstan Formation. A possible ridge of isolated Bannockburn Formation has been identified on contours within the existing cherry orchard at the western end of the site but is yet to be confirmed. Very weak Bannockburn Formation effectively forms the local basement rocks for the development.

Schist bedrock underlies the Manuherikia Group at an unconfirmed depth but is unlikely to be encountered during earthworks construction on this site.

Subsurface investigation is recommended at the detailed design stage to confirm the underlying stratigraphy and associated earthworks recommendations.

3.3 Groundwater

Otago Regional Council (ORC) registered water bores located on the south-western (F41/0247) and south-eastern (F41/0253) edges of the site encountered the regional groundwater table at 33 & 24 m below ground level (bgl) respectively. This substantial depth to regional groundwater is expected to be typical of the wider subdivision. No spring flows or groundwater seepages were observed at the ground surface within the development, although spring flows are present within the upper catchment area of the Eastern Gully.

4 Natural Hazards

Desktop geomorphological and natural hazards field mapping of the development site and surrounding area has been completed by an engineering geologist. Natural hazards to be considered for design and eventual construction are discussed below. Figure 1c, Appendix A summarises our field mapping observations.

4.1 Alluvial Fan and Flooding

The ORC natural hazards regional scale database indicates the development site is affected by an ‘active floodwater-dominated’ alluvial fan adjacent the hillside slopes. Although this classification is clearly of a coarse resolution and without the benefit of high-resolution

contour data it is broadly correct. Several alluvial fans converge inside the boundaries of the development and can be clearly defined by topographic contours. While ORC designates the fans as 'active floodwater-dominated' no active alluvial fan activity or recent sediment deposition was observed in the field. It is also noted that higher resolution supplementary work by GNS (2009) did not support the 'active' classifications designated by ORC, instead identifying the relevant fans as generally 'less recently active', 'unspecified' or 'undifferentiated'.

The alluvial fans themselves are interpreted to be dormant historic features and were probably most active immediately post glaciation. The catchment areas upslope of the mapped fan surfaces are currently stable but still capable of producing sheet floods during heavy or prolonged rainfall. Some sedimentation was noted in catchment areas on stereo-pair aerial photographs, but this appears to be associated with historic water race blowouts on terrace slopes rather than alluvial fan activity per se. Water races on the hillside north of the development are no longer active. Ephemeral flows are expected to bifurcate through the existing cherry orchard in the absence of defined channels.

The alluvial fans mapped by GeoSolve on Figure 1c, Appendix A are discrete geomorphic features, however it is quite likely that most of the development is underlain by alluvial fan sediment between Shannon Farm subdivision and Kawarau Gorge Road to variable depths.

4.1.1 Stormwater Runoff and Flooding Management

The potential for upslope stormwater runoff and overland flows must be accounted for during detailed engineering and civil design for the subdivision. Shallow sheet flooding of relatively short durations can be expected during intense and/or prolonged rainfall from the adjacent hillsides and ephemeral gullies.

Local mitigation measures include channels, contoured swales; cut-off drains and landscape bunding to capture and divert stormwater runoff away from building platforms. However, we understand a stormwater engineer is engaged on the project and the current scheme plan has been designed to accommodate overland flow paths and runoff via engineered stormwater channels and soakage basins. Flooding will need to be considered for any structures located in the vicinity of stormwater channels, soakage basins and overland flow paths. The suitability of any proposed stormwater disposal to ground should be verified by location specific infiltration testing both prior to design and during construction.

4.2 Seismic Hazard

The active Pisa Fault is located at the base of the Pisa Range. Published geological maps indicate the fault trace runs within 1 km northwest of the development's western boundary, although the development is located outside the active fault awareness area associated with the Pisa Fault.

The western side of the subdivision area is located within an active fault awareness area (2025) associated with the Smallburn Monocline of the Pisa Fault Zone. The Smallburn Monocline awareness area is shown on Figure 1b, Appendix A relative to the development boundary. The monocline location is classed as "likely, not expressed (uncertain deformation)" fault complexity on published geological mapping.

GeoSolve has completed an assessment of the risk posed by the Smallburn Monocline using guidelines provided by the Ministry for the Environment for subdividing and developing land close to active faults. For the assessment the Smallburn Monocline has been categorised

with a recurrence interval of 22,000 years (GNS Science, Active Faults Database), and the location is classed as likely, not expressed (uncertain) as indicated on published geological mapping by Geological and Nuclear Science (GNS).

Following the Ministry for the Environment guidelines provided in Section 11 "Taking a Risk Based Approach to Resource Consent", building importance category structures 1, 2 and 3 are a permitted activity. We understand the proposed buildings and structures on the western side of the development are generally expected to be category (Importance Level) 1 and 2 structures in accordance with a residential development.

In conclusion, given the substantial recurrence interval for earthquakes on the Smallburn Monocline (22,000 years), the Alpine Fault located approximately 120 km to the northwest along the West Coast of the South Island is considered to provide the governing seismic risk for the development with a return period for major earthquakes of 300-350 years. Furthermore, there is a high probability that a major earthquake of Mw 8 or greater will occur along the Alpine Fault within the next 50 years. Such a rupture is likely to result in strong and prolonged ground shaking in the vicinity of Cromwell.

4.3 Landslides

There are no mapped pre-existing landslide features within the development area, and none were identified during our assessment. Extensive schist debris landslides are present on the lower slopes of the Pisa Range and localised landsliding has been identified in Bannockburn Formation within the "Eastern Gully" off the northwestern corner of the site; however, these landslides are located well outside of the proposed subdivision area.

Geotechnical assessment in conjunction with earthworks modelling will be required to establish stable cut and fill batter slopes for construction.

4.4 Liquefaction

The substantial depth to regional groundwater recorded in onsite water bores between 24 & 33 m bgl is expected to be typical of the wider subdivision. Liquefaction risk for the development is therefore considered low based on the deep-water table.

4.4.1 Natural Hazard Risk Assessment

In accordance with the guidelines of the National Policy Statement for Natural Hazards (2025)[1] we have undertaken a natural hazard risk assessment to people and property associated with the proposed subdivision use. The risk assessment considers the site in its current state and following completion of the development. We have relied on the best information available to us at the time of our preliminary assessment which also considers residual risk.

The NPS-NH 2025 specifies that the risk must be assessed using:

a) The likelihood of a natural hazard event occurring; and,
b) The consequence of a natural hazard event for life and property.

Figures 1 to 3 below have been extracted from the NPS-NH document for the "likelihood" and "consequence" definitions, as well as the risk matrix classification Table 1, respectively.

[1] https://environment.govt.nz/assets/publications/RMA/npsnh-2025.pdf

Likelihood level	Annual exceedance probability (AEP)	Average recurrence interval (ARI) or 'return period'
Almost certain	10% or more	Up to and including 10 years
Very likely	10% to 5%	Over 10 and up to and including 20 years
Likely	5% to 2%	Over 20 and up to and including 50 years
Possible	2% to 1%	Over 50 and up to and including 100 years
Unlikely	1% to 0.2%	Over 100 and up to and including 500 years
Rare	0.2% to 0.02%	Over 500 and up to and including 5,000 years
Very rare	Less than 0.02%	More than 5,000 years

Figure 1. Likelihood table extracted from the NPS-NH 2025.

Consequence level	Damage to property	Potential for injury or fatalities
Catastrophic	Severe damage to land and building(s), potential for collapse or total destruction of structures. Building(s) need to be demolished, rebuilt or relocated.	High threat to life safety, with probable fatalities and/or critical injuries.
Major	Major damage to land and building(s), including structural damage. Loss of use and substantial repair required.	Unsafe for people, with potential for many injuries, or critical injuries and/or fatalities.
Moderate	Some damage to land and non-structural damage to building(s). Limited loss of use, repairs required.	Unsafe for people, with potential for injuries, although expected to be minor.
Minor	Minor damage to land and building(s). No loss of use, minimal repairs required.	Isolated minor injuries possible.
Negligible	No loss of use, no building repairs required.	No injuries.

Figure 2. Consequence table extracted from the NPS-NH 2025.

Consequence Level	Likelihood Level: Almost Certain	Very Likely	Likely	Possible	Unlikely	Rare	Very Rare
ARI (years)	up to 10	10-20	20-50	50-100	100-500	500-5000	> 5000
AEP	10% or more	10% to 5%	5% to 2%	2% to 1%	1% to 0.2%	0.2% to 0.02%	< 0.02%
Catastrophic	Very High	Very High	Very High	High	Medium	Medium	Medium
Major	Very High	Very High	High	High	Medium	Medium	Medium
Moderate	High	High	High	Medium	Medium	Low	Low
Minor	Medium	Medium	Medium	Medium	Low	Low	Low
Negligible	Low	Low	Low	Low	Low	Low	Low

Figure 3. Risk matrix classification table extracted from the NPS-NH 2025.

A risk matrix summarising our assessment for this development is provided in Table 1 below.

Table 1. NPS-NH risk matrix summary table for the proposed development.

Natural Hazard	Natural Hazard Risk Level	Mitigated Natural Hazard Risk Level	Justification of Assigned Risk Level
Alluvial Fan	Medium	Low	ORC hazard mapping and site-specific assessment by GeoSolve has identified alluvial fan hazard for the development. However, as discussed in Section 4.1 these hazards can be effectively mitigated during the detailed engineering and civil design process for the subdivision.
Flooding and Stormwater Runoff	Medium	Low	ORC hazard mapping and site-specific assessment by GeoSolve has identified sheet flooding and stormwater runoff hazards for the development. However, as discussed in Section 4.1 these hazards can be effectively mitigated during the detailed engineering and civil design process for the subdivision. The mitigation design for flooding and stormwater will be completed by others.
Landslides	Low	Low	There are no mapped pre-existing landslide features within the development area, and none were identified during our assessment.
Coastal Erosion	Low	Low	The development is not located near the coast.
Coastal Inundation	Low	Low	The development is not located near the coast.
Seismic Hazard (active faults)	Low	Low	GeoSolve has completed a site-specific assessment of the risk posed by nearby active faults detailed in Section 4.2. A regional seismic risk is present; however, this is addressed by the building code and is not specifically covered by the NPS-NH.
Liquefaction	Low	Low	The site is shown on the ORC natural hazard mapping as Domain A, which is described as *'ground predominantly underlain by rock or firm sediments. There is little or no likelihood of damaging liquefaction occurring. In MBIE (2017) terms liquefaction damage is unlikely.'* As discussed in Section 4.4 GeoSolve considers the liquefaction risk is low, and no further assessment is required with respect to this natural hazard.
Tsunami	Low	Low	The development is not located near the coast.
The risk matrix considers the impacts of climate change over at least a 100-year timeframe. However, in this instance the effects of climate change are only relevant to alluvial fan, flooding and stormwater runoff hazards which can be accounted for by the subdivision stormwater engineer during detailed design.			

5 Preliminary Engineering Considerations

5.1 General

The preliminary recommendations and opinions contained in this report are based upon field mapping observations and historical information held on the GeoSolve database.

Subsurface investigations are required at the detailed design phase of the project to confirm all recommendations provided in this report.

5.2 Subdivision Preparation and Earthworks

All engineered fill that is utilised as bearing for foundations, roads or infrastructure should be placed and compacted in accordance with the recommendations of NZS 4431:2022, Central Otago District Council standards and certification provided to that effect (during good weather and in accordance with an earthfill specification). Subgrade benching should also be completed for all fill placed on sloping ground.

Topsoil/buried topsoil, uncontrolled fill, organic matter, and other unsuitable soils including tree roots will not be suitable for reuse as engineered fill and needs to be kept separate from all engineered fill sources. Unsuitable soils can be stockpiled separately for reuse as landscaping fill, topsoiling and bunding.

In all cases, cobbles and boulders over 100 mm in size will need to be screened or crushed from site won engineered fill sources. Alluvial fan gravel and outwash gravel will afford the most suitable site won fill sources. Specific laboratory testing will be required prior to reuse to confirm soil grading and compaction criteria. Alternatively, fill can be imported to site from nearby quarries.

Soils present at the site will be prone to erosion, by both wind and water, and should be protected by hardfill capping or re-topsoiled/mulched and re-vegetated as soon as the finished batter or subgrade levels are achieved. We recommend topsoil stripping and subsequent earthworks be undertaken only when a suitable interval of fair weather is expected, or during the earthwork's construction season.

A severe seismic risk is present in the region, as discussed above, and, as per building code requirements and recognised engineering practice, appropriate allowance should be made for seismic loading during detailed design of all structures, foundations and earthworks.

6 Conclusions and Recommendations

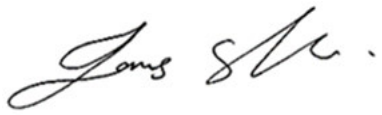
GeoSolve consider the proposed development to be technically feasible from a geotechnical perspective. However, specific engineering design by a water/civil engineer is required to manage stormwater runoff and potential flood flows within the subdivision considering the effects of climate change. Sheet flooding and stormwater runoff is one of the principle natural hazards requiring mitigation to enable development.

A regional seismic risk is present, as per the wider South Island from the Alpine Fault, however no site-specific natural hazards have been identified that would preclude development, or which cannot be addressed by standard engineering assessment.

In general, no issues have been identified during our preliminary review that could not be addressed by standard geotechnical engineering and assessment practice. In accordance with similar developments, subsurface geotechnical investigation and assessment will be required to complete the engineering design process and subsequent construction.

7 Applicability

This report has been prepared for the sole use of our client, Rippon Holdings Limited, with respect to the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior review and written agreement.

Report prepared by:	Reviewed for GeoSolve Ltd by:
	
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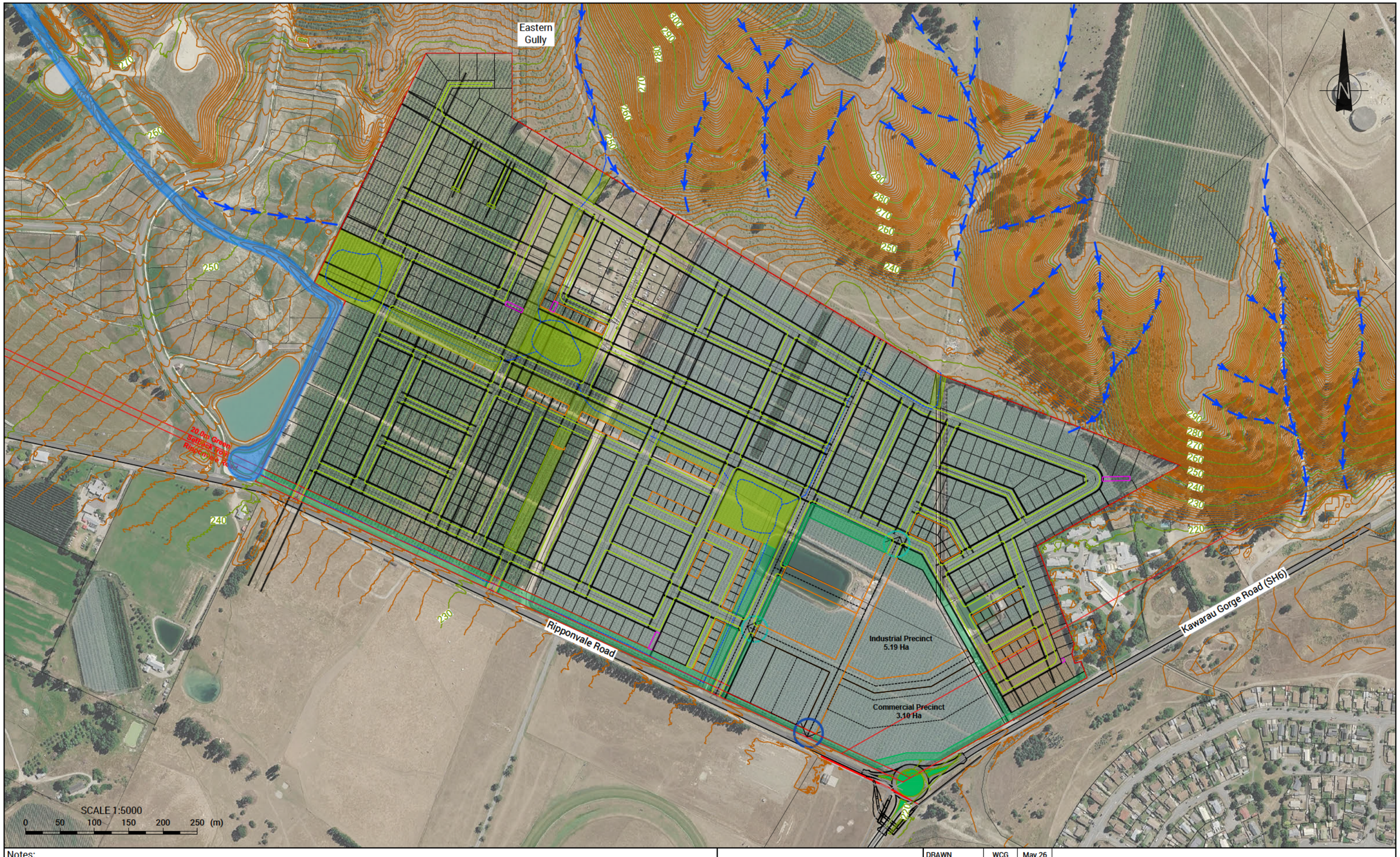
James Stewart Engineering Geologist	Fraser Wilson Senior Engineering Geologist

Appendix A: Site Assessment Plans



Notes:
1. These drawings have been prepared for the benefit of Rippon Holdings Limited with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Legend:
- Existing ground contour (1 m Minor interval, 10 m Major interval)
- Existing Stormwater Channel and Soakage Basin
- Ephemeral Flow Paths

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Rippon Holdings Limited

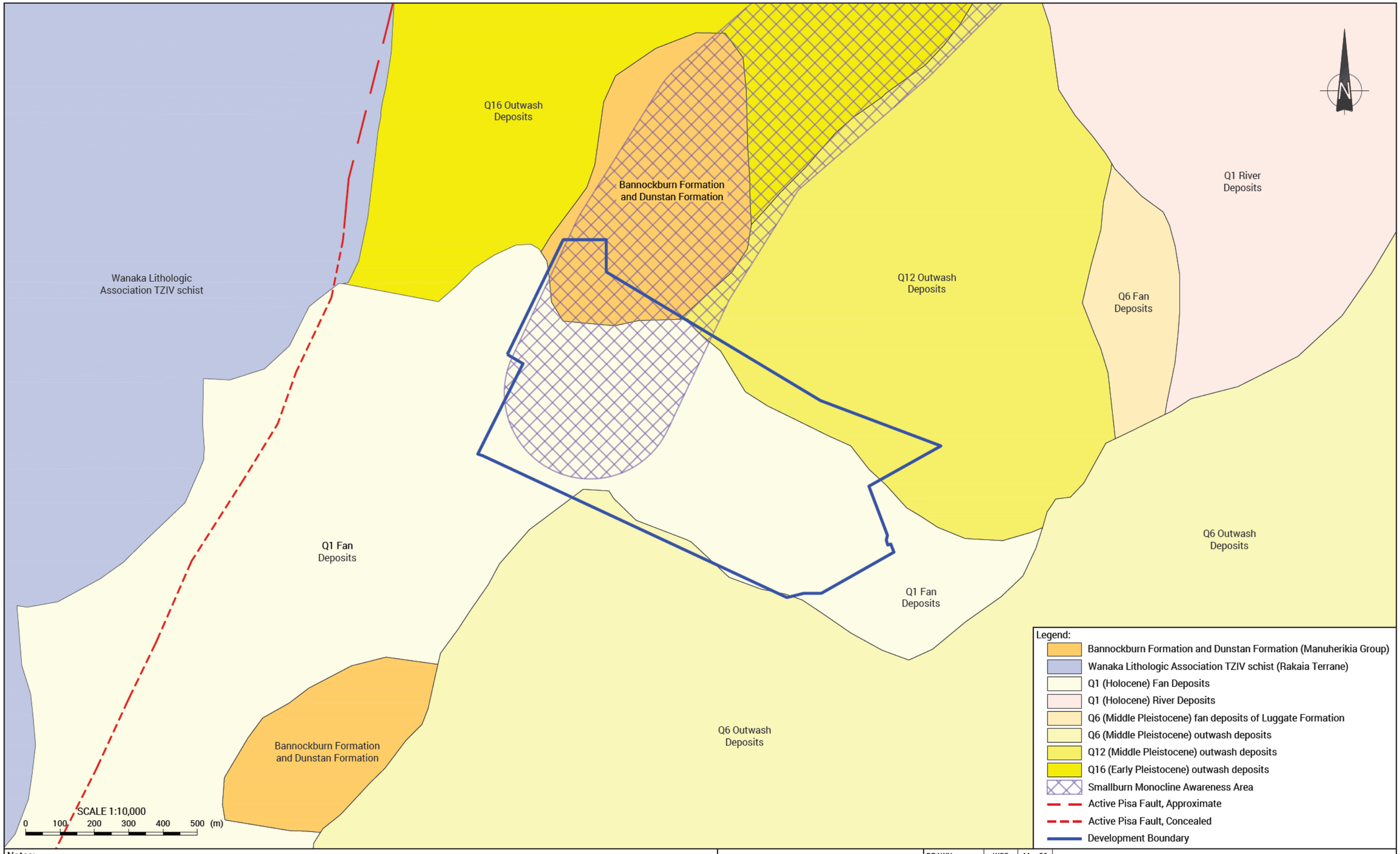
Cherry Orchard Farm, Ripponvale Road, Cromwell

Preliminary Geotechnical and Natural Hazards Assessment

Scheme Plan

Figure No.: Appendix A, Figure 1a

Revision: 1



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Cherry Orchard Farm, Ripponvale Road, Cromwell

Preliminary Geotechnical and Natural Hazards Assessment

GNS 1:250k Geology Plan

Figure No.: Appendix A, Figure 1b

Revision: 1

Eastern Gully

Historic water race blowout

Historic water race blowout

Historic water race blowout

Ridge of Bannockburn Formation exposed above surrounding cover sediments

Paleo stream channel

Existing stormwater channel within Shannon Farm Subdivision

Existing landscape bunds

Redundant border dykes in paddock

Possible ridge of Bannockburn Formation

Q12a Outwash Terrace

Existing stormwater soakage basin

Outwash soils exposed in batter cut

F41/0247

F41/0255

Fan surface modified by quarrying post deposition

Ripponvale Road

Kawarau Gorge Road (SH6)

Existing irrigation dams

F41/0252

F41/0253

Q6a Outwash Terrace

SCALE 1:5000

0 50 100 150 200 250 (m)

Notes:

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Legend:

- Alluvial Fan, Active, Debris Dominated (ORC Regional Scale Mapping)
- Alluvial Fan, Active, Floodwater Dominated (ORC Regional Scale Mapping)
- Existing ground contour (1 m Minor interval, 10 m Major interval)
- ORC Registered Wells
- Development Boundary
- Dormant Alluvial Fans
- Existing Stormwater Channel and Soakage Basin
- Ephemeral Flow Paths
- Existing Landscape Bunds

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Preliminary Geotechnical and Natural Hazards Assessment

Field Mapping Plan

Figure No. Appendix A, Figure 1c

Revision 1

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