RILEY CONSULTANTS

FLOOD ASSESSMENT
104 TOWNSEND ROAD AND 141 SOUTH BELT WAIMAKARIRI, RANGIORA

Engineers and Geologists

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FLOOD ASSESSMENT
104 TOWNSEND ROAD AND 141 SOUTH BELT WAIMAKARIRI, RANGIORA

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Contents

Appendices

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1.0 Introduction

The following report has been prepared by Riley Consultants Ltd (RILEY) at the request of Summerset Villages (Rangiora) Limited. It details the findings of a flood assessment of a 13.83ha greenfield site, located in south-west Rangiora at 104 Townsend Road and 141 South Belt.

The report has been prepared to support a private plan change to amend parts of the Waimakariri District Plan (WDP) pursuant to Section 73(2) and Clauses 21(1) and 22 of the First Schedule to the Resource Management Act 1991 (RMA).

This report presents the findings of modelling undertaken of the 200-year local catchment rainfall flood event and the 200-year Ashley River breakout event to assess the flooding extents across the site, determine site freeboard requirements and assess the effects of development of the site on the surrounding environment.

The report is to be read in conjunction with RILEY reports covering the civil infrastructure servicing (RILEY Ref: 170743-A), environmental preliminary/detailed site investigation (RILEY Ref: 170743-B) and geotechnical investigation (RILEY Ref: 170743-C).

1.1 Summary

Development of the site for residential purposes has been assessed where site earthwork levels have been raised above the expected flood levels and the impact of future residential development of the land on existing surrounding residential properties determined. It is considered that with appropriate stormwater management solutions, as detailed in the report, the effects of flooding risk for the site and surrounding areas can be appropriately managed.

2.0 Site Description

2.1 Application Site

The location of the site is shown in Figure 1 below.

Figure 1: Plan Change Site Location

The site is located in the south-western area of Rangiora township, with the northern site boundary adjoining South Belt, and Townsend Road adjoining the western boundary. East of the site is Southbrook Park, and the southern boundary adjoins Southbrook Stream (which flows west to east).

The site slopes down very gently from the north-west to south-east. Site contours show an approximate ground surface elevation of RL 26.0m at the north-western boundary and a minimum elevation of approximately RL 22.0m at the south-eastern boundary (Lyttelton Vertical Datum (LVD)).

The majority of the site area is currently grassed, with a horse training track present at the northern end, adjacent to South Belt. There are two dwellings and numerous farm buildings located in the north-western corner of the site.

Medium density residential property is located to the north of the site, and a substantial new residential subdivision known as Townsend Fields is currently under construction to the north-west of the site. Southbrook Park is located to the east of the site, with the remainder of the site bounded by rural land.

Vehicle access to the site is via two access points; one on the western boundary from Townsend Road and one from South Belt.

2.2 Background

The application site was previously part of a 23ha title that extended from South Belt, across Southbrook stream and south towards Ellis Road. An application to subdivide the property has been lodged with Waimakariri District Council (WDC) to split the land at Southbrook Stream, creating the application site which is 13.83ha in area.

3.0 Proposal

This Private Plan Change Request proposes to amend the WDP to change the zoning of the site from the Residential 4B to Residential 2 zone and modify the existing planning maps covering the site with a new Outline Development Plan (ODP).

In its current status (Residential 4B), the site can be developed into approximately 13 sections comprising lifestyle blocks with dwellings. The proposed new provisions for the Residential 2 zone will allow for up to 150 sections (and dwellings). It is also proposed to incorporate within the zone some specific rules to provide for the construction of a retirement village. This would result in allowing a retirement village to be constructed on all or part of the site, or all or part of the site to be developed for typical residential dwellings (in accordance with the Residential 2 zone rules).

The ODP attached in Appendix A, shows key elements to be incorporated into future residential activity on the site. These include:

- The required location of future roading links to the existing transport network,
- the provision of an esplanade reserve adjacent to Southbrook Stream,
- the location and extent of a stormwater management area and;
- the allowance for a specified area for a taller main retirement village building.

The intention of the ODP is to provide certainty regarding key requirements for any future residential activity on the site, whilst allowing flexibility as the detailed design phases evolve in the future.

4.0 Flood Assessment

4.1 Background

The site has been identified as being located within the flood hazard area as specified within the WDC District Plan, based on a 200-year Annual Recurrence Interval (ARI) rainfall flood event, and is also located within the Ashley River floodplain.

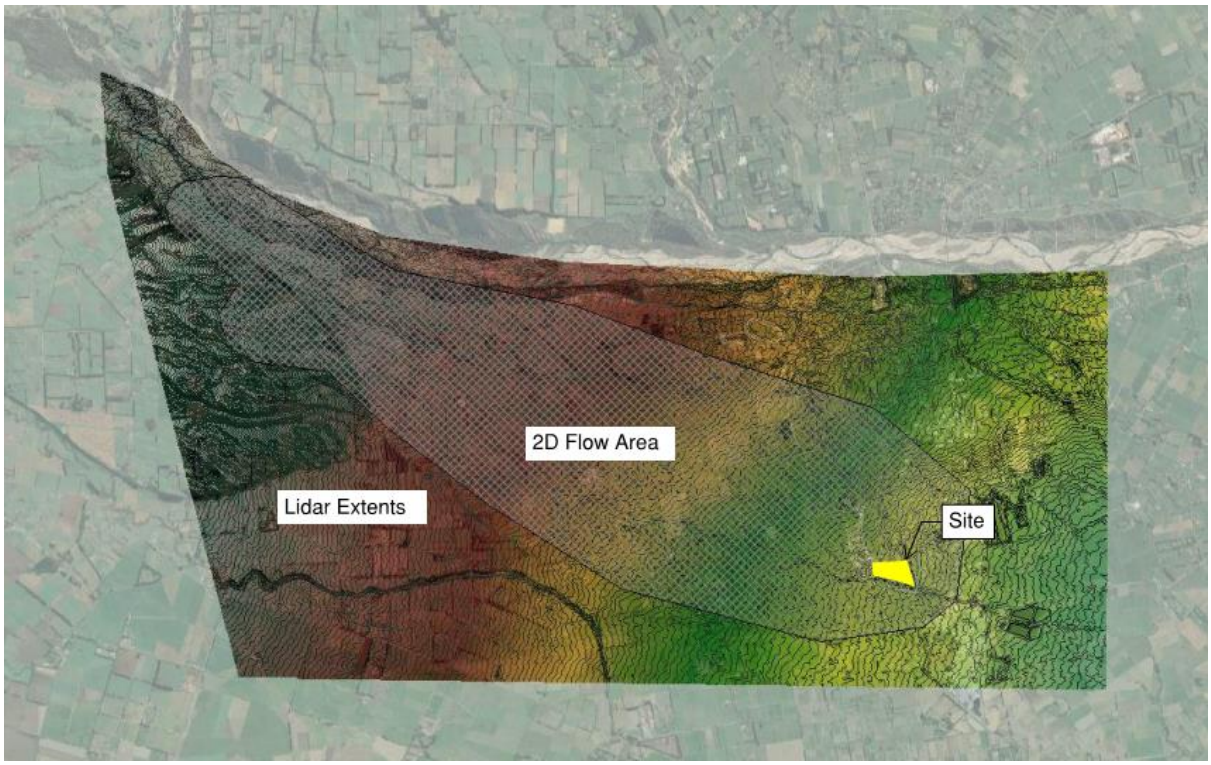
Modelling of the 200-year local catchment rainfall flood event and the 200-year Ashley River breakout event has been undertaken where model set-up, key parameters and model results are outlined below.

4.2 Overview of Model

The model has been built using HEC-RAS version 5.0.7 stormwater modelling software. The model is a 2D model created by importing ground surfaces and hydrological flow inputs including rainfall and the Ashely River breakout flow.

The model extends from the Ashley River breakout location to downstream of the site covering approximately 29km^2 as shown in Figure 2.

Figure 2: Model Extents



Various scenarios have been modelled, including:

Pre-Development

- 200-year Ashley River breakout and 200-year local catchment rainfall event, referred to as the 200-year combined flood event.
- 200-year Ashley River breakout and 200-year local catchment rainfall event including a 10% increase in rainfall (sensitivity analysis).
- 200-year local catchment rainfall only.

Post-Development

- 200-year Ashley River Breakout and 200-year local catchment rainfall event (200-year combined flood event).

The only difference between the pre-development and post-development modelled scenario is the site terrain and site roughness.

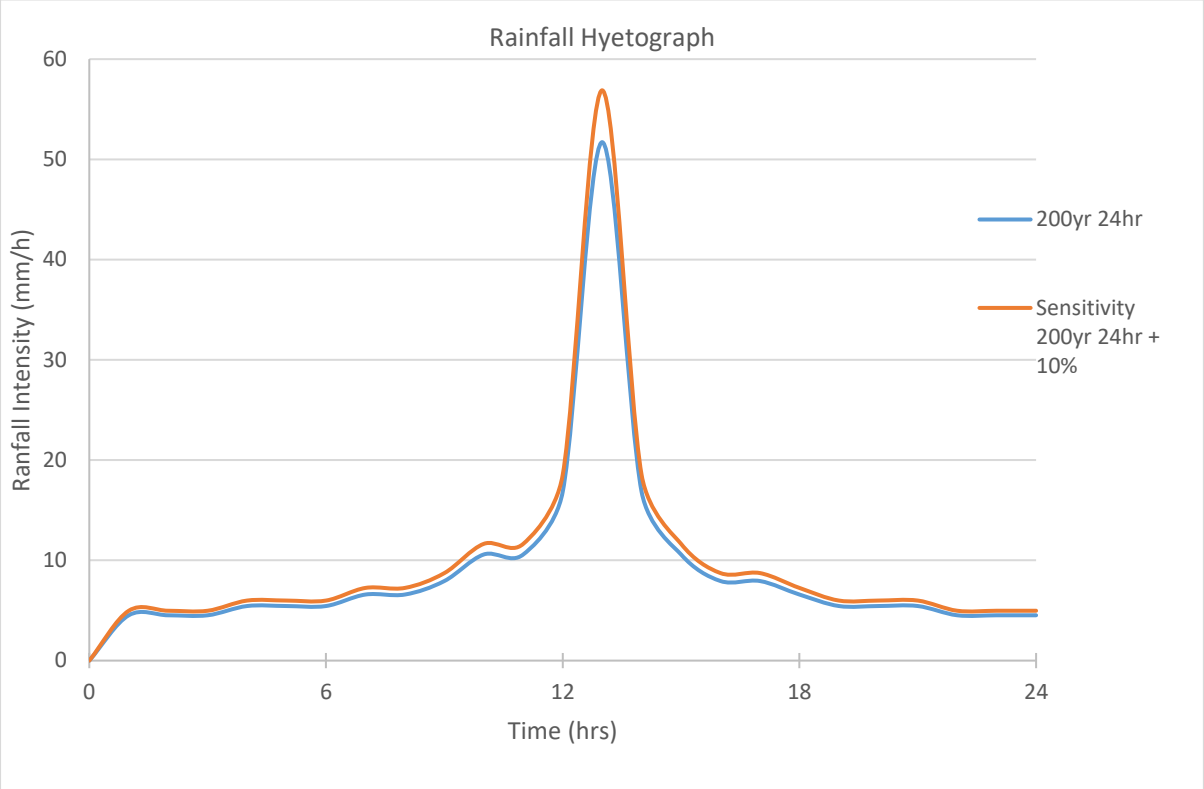
4.3 Hydrology

4.3.1 Rainfall

WDC has previously completed modelling for the 200-year rainfall event. Rainfall hyetographs from this modelling were provided for the various spatial distributions and soil types. An analysis of these hyetographs was completed, and a single rainfall graph used for the modelling as shown within Figure 3. The rainfall graph used for the modelling is the same as what was used for the modelling completed for Townsend Fields.

The rainfall includes a 16% increase in the intensity for climate change allowance. The rainfall has been applied to the model via rain on grid over the model extents. A sensitivity case has also been analysed where the rainfall has been increased by 10%, this is in addition to the 16% climate change. This increase in rainfall results in very minor increase to flow and water depths across and adjacent to the site, as discussed further in Section 4.6.2.

Figure 3: 200-year Rainfall Hydrograph



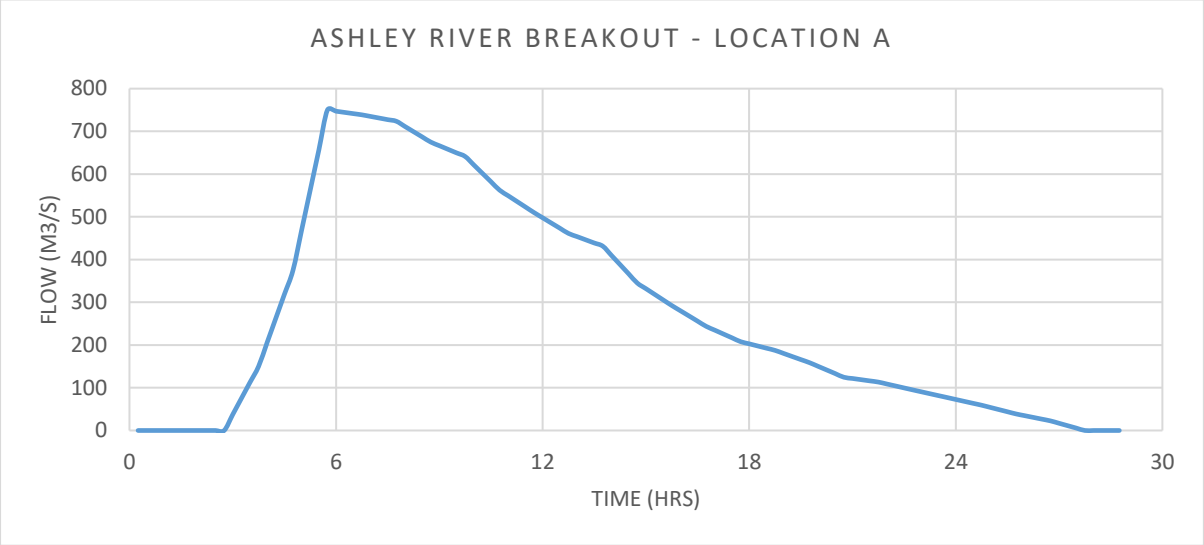
4.3.2 Ashley River Breakout Flow

Environment Canterbury has completed detailed modelling of the Ashley River to estimate flood overflows and locations where breakouts are considered most likely to occur along the stopbank reaches of the river. The predicted breakout locations are shown in Figure 4.

Figure 4: Ashley River Breakout Locations

On analysis of the breakout locations in relation to site, flow from breakout A has been used within the modelling only. Flow from breakout locations B and C are not considered to affect the site due to the existing terrain. The 200-year breakout flow hydrograph provided by Environment Canterbury at breakout A occurs over a duration of approximately 24 hours and has a peak discharge of 750m^3/s as shown in Figure 5 below.

Figure 5: 200-year Ashley River Breakout Flow Hydrograph



4.3.3 Storm Timing

The Ashley River breakout flow and rainfall graph have been modelled such that the peak from each event approximately coincides at the site. This is considered conservative due to the different catchment response times.

4.3.4 Infiltration

Due to the nature of the Ashley River breakout flow causing rapid inundation over the area, which has been modelled to coincide with the 200-year rainfall event, the ground is likely to become rapidly saturated and soil infiltration effects will likely be minor. Therefore, no soil infiltration losses have been accounted for from the Ashely River breakout flow or from the rainfall.

4.4 Hydraulics

4.4.1 Pre-Development Terrain

A number of ground surfaces were used to build a digital terrain model (DTM) which encompasses the model extents. Digital Elevation Model (DEM) topographical data was obtained from Land Information New Zealand (LINZ) and was used as the base terrain data.

Other topographical surveys and development design surfaces were available for various areas within and adjacent to the site which provides a greater level of accuracy than the base terrain data. These additional surfaces were incorporated with the base terrain data creating an overall existing ground surface, which included:

- Detailed topographical survey of the site including the adjacent Southbrook, Townsend Road and South Belt;

- Townsend Fields design surface including Stage 1 earthwork formation levels, flood management bund running along the western site extents, stormwater management area and the Townsend Road extension;
- Surveyed cross-sections within Southbrook from upstream of Oxford Road to downstream of the site at Railway Road.

On comparison of the LINZ DEM captured in 2014 and the site survey completed in 2019, the site survey sits below the DEM. The accuracy of the LINZ DEM is usually within a range of approximately +/-200mm. Some of the observed difference in levels may also be attributed to the Kaikoura earthquakes in 2016, as there has been an adjustment of the adjacent LINZ benchmark by 40mm between 2014 and 2019. Given the level of accuracy of DEM and the fact it sits higher than the site survey, these surveys have been used in their current form.

It is noted that reported water levels for adjacent properties will be based off the LINZ DEM and shall not be used to set floor levels from, this has been used for the purpose of direct comparison of the effects of site development.

All data is in Mt Pleasant 2000 horizontal projection and uses Lyttelton Vertical Datum.

A 10m grid has been used across the wider catchment extents and refined to a 5m grid approximately 1500m upstream of the site boundary to achieve better accuracy while optimising the model processing times.

4.5 Post Development Terrain

A post-development surface for the site was created within 12D software. This surface was used to generate a DTM of the post-development topography which was imported to HEC-RAS to assess flooding impacts as a result of the site development. The post-development scenario has been run with the same hydrology as the pre-development scenario, although includes modifications of the ground profiles and site surface roughness to account for site development.

The post-development surface includes the following modifications:

- Raised earthwork levels across the site above the 200-year combined flood event. To grade from existing ground levels up to the proposed earthwork level, a 1V:5H batter slope is located within the Esplanade Reserve;
- Includes site wetpond stormwater management facilities sized to attenuate up to the 50-year 12-hour event (see RILEY Ref: 170743-A);
- Road upgrades along the southern side of South Belt adjacent to the site, this includes widening the southern lane to 5.8m (3.3m minimum lane width and 2.5m parking lane) with a 3% crossfall falling to kerb and channel. It is assumed that the road centreline will be maintained during the widening works;
- Kerb cutdown and localised depression within South Belt at the north-eastern corner of the site. This facilitates flow to overtop from South Belt to the channel running along the eastern site boundary.
- Road upgrades along the eastern side of Townsend Road adjacent to the site, this includes widening the eastern lane to 5.8m, i.e. similar to South Belt, with a 3% crossfall falling to kerb and channel. It is assumed that the road centreline will be maintained during the widening works;

- Works within the Esplanade Reserve, this maintains the existing Southbrook northern top of back level and provides a 12m wide strip adjacent to Southbrook which sits at a level close to the existing ground and grades at 3% towards South Brook. Beyond this 12m wide strip, a 1V:5H batter slope is provided to grade from the existing ground levels to the required site development levels.
- The Esplanade Reserve adjacent to Townsend Road is narrower at 10m wide, a 4m wide access strip has been provided, however, in order to grade up to the site, a retaining structure will likely be required along that portion of the boundary.

The above modifications are shown in RILEY Dwg: 170743-6 in Appendix B.

4.5.1 Surface Roughness

Surface roughness is represented by Manning's n values and affects the extents, depths and velocities of the floodwaters. Manning's n values within the model have been listed in Table 1.

Surface types have been assigned default values based on the land cover. The allocation of the land covers is based on LINZ land use data from 2012. Manning's n values were determined from several papers that listed Manning's values for different land covers.

Table 1: Surface Roughness – Manning's n Values Based on Land Use

Land Use	Manning's n
Mixed Exotic Shrubland	0.40
Gorse and/or Broom	0.40
Deciduous Hardwoods	0.36
Orchards, Vineyards or Other Perennial Crops	0.32
Exotic Forest	0.32
Built-up Area (settlement)	0.0678
High Producing Exotic Grassland	0.06
Short-rotation Cropland	0.06
Lake or Pond	0.04
Surface Mine or Dump	0.0404
Urban Parkland/Open Space	0.0404
River	0.04
Gravel or Rock	0.0113

A review of aerial imagery showed some additional development has occurred around the outskirts of Rangiora since completion of the LINZ land use allocations from 2012. These additional development areas as well as Townsend Fields which is currently being developed to the north-west of the site have been included within the model as "Built-up Area (settlement)" with a Manning's n of 0.0678.

As it is proposed to change the zoning of the site to Residential 2, the development model has been run with an increased site Manning's value of 0.0678 for "Built-up Area (settlement)".

4.5.2 Structures

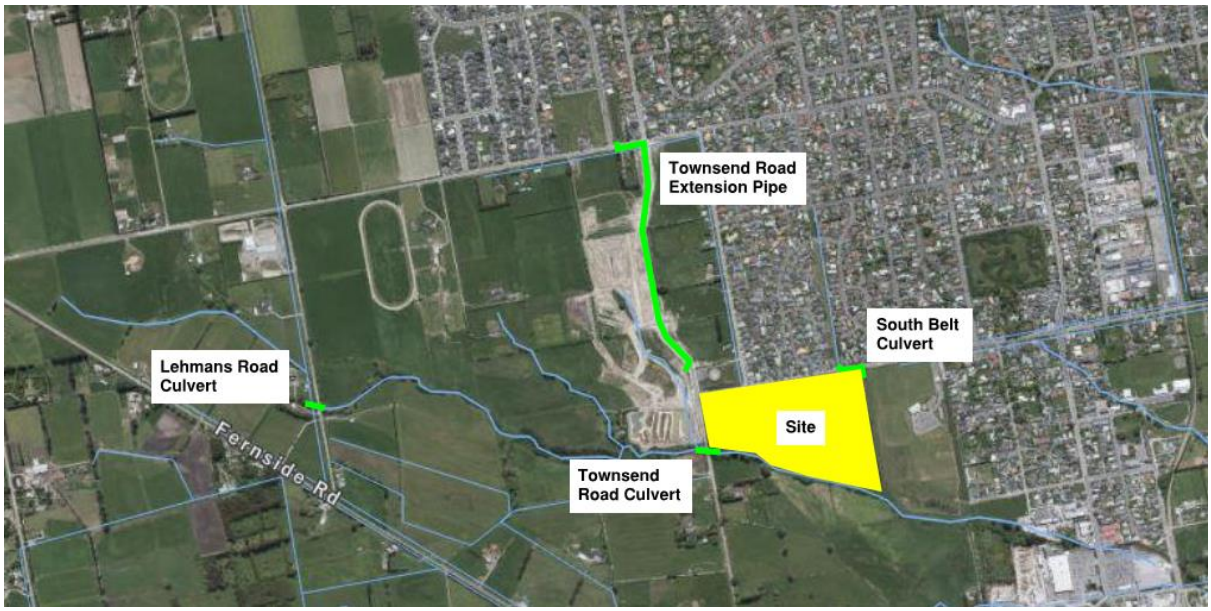
The primary stormwater reticulation network is generally sized for the 5-year storm event. The Ashley River breakout and the 200-year rainfall event will cause widespread flooding of the area and will be well in excess of the capacity of this network, therefore, it has not been included within the modelling.

Some large stormwater infrastructure pipes exist in close proximity to the site which convey flows within open channels beneath roads. These structures convey large quantities of flow and reduce the extent of road overtopping, therefore, have been include in the modelling.

Four structures have been modelled, these structures are shown in Figure 6 and summarised below:

- Lehmans Road Culvert: A 2.35m by 1.6m box culvert which conveys flows within Southbrook beneath Lehmans Road.
- Townsend Road Culvert: A 4.7m by 1.5m box culvert which conveys flows within Southbrook beneath Townsend Road at the south-western extents of the site.
- South Belt Culvert: A 1.8 by 1.2m concrete box culvert which conveys flows beneath South Belt to the channel running along the eastern site boundary.
- Townsend Road Extension Pipe: A Ø900 pipeline conveys flows from the Oxford Estate Stormwater Management Area discharging to Southbrook prior to Townsend Road.

Figure 6: Modelled Structures



4.6 Model Results

4.6.1 Flood Levels and Extents

The flood extents for the 200-year local catchment rainfall event and the 200-year combined flood event is shown in RILEY Dwg: 170743-4 to -6 in Appendix B.

In the pre-development scenario, inundation occurs predominantly over the southern site extents due to flow from Southbrook encroaching into the site as existing ground levels are lower adjacent to Southbrook. Flow also enters the site along the western boundary via overtopping of Townsend Road with minor flows entering from South Belt via the northern boundary.

In the post-development scenario, the site has been filled above the flood levels adjacent to the site. The water shown within the site is a result of the rain on grid on the developed surface flowing overland to the stormwater management areas rather than flood flows passing through the site.

4.6.2 Flows Adjacent to the Site

As the site has been raised above the flood levels, flood flows which previously passed through the site are now diverted around the site. A comparison of the flows within the channels adjacent to the site are shown in Table 2.

Table 2: Flow comparison within Southbrook and the Eastern Site Channel (m^3/s)

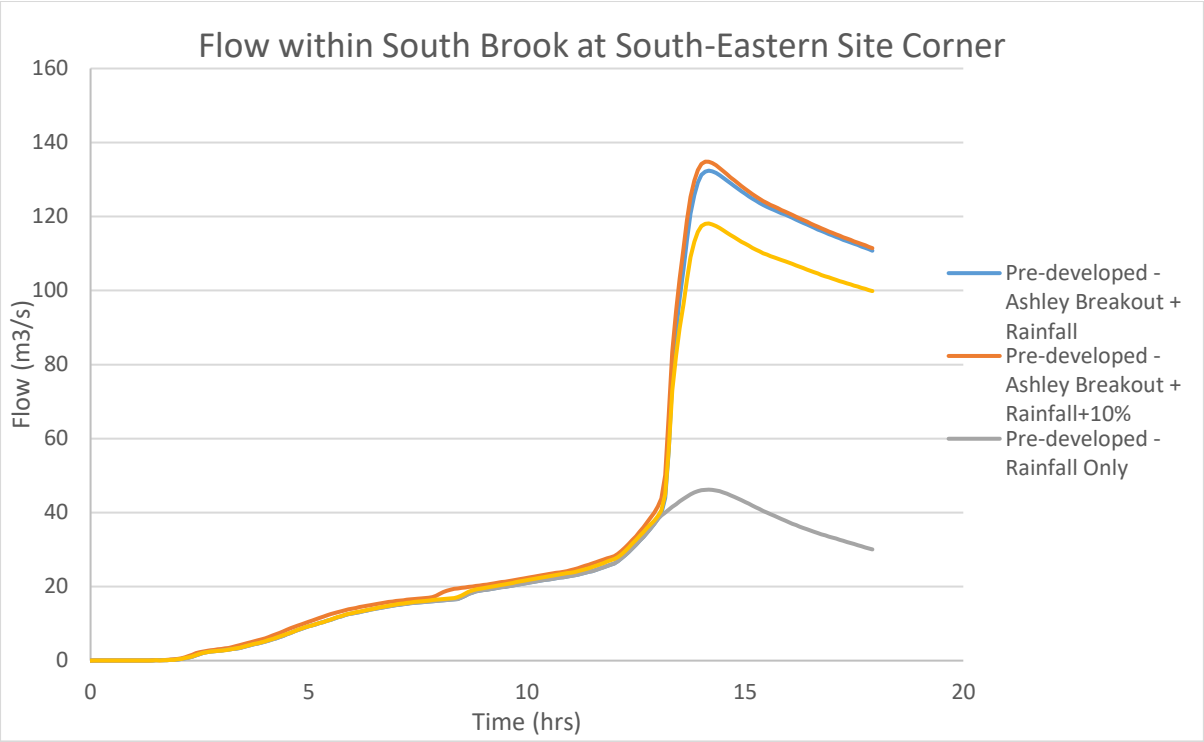
Location*	Pre-Development (200yr Rain Only)	Pre-Development (Breakout + Rain)	Pre-Development (Breakout + Rain with 10% increase)	Post-Development
Southbrook – approximately 50m downstream of Townsend Road	64	196	200	196
Southbrook – adjacent south-east corner of site	46	132	135	118
Eastern Channel – at South Belt	2.9	2.9	3.3	3.9
Eastern Channel - adjacent south-east corner of site	3.3	5.6	6.0	4.2

The table above shows that approximately 35% the flow within Southbrook is a result of the rainfall, while the rest is a result of the Ashley River breakout flow. Due to the rainfall contribution, a model has also been run with the rainfall increased by 10% to assess the sensitivity to rainfall. This resulted in an increase of flow within Southbrook of approximately 2% which corresponded to an increased flow depth of approximately 10mm around the site boundary.

The flows within Southbrook following raising of the site levels increase at Townsend Road, however, there is a decrease in flows within the channel along the site eastern boundary. This is primarily due to flood flows not entering the site from Townsend Road and passing to the channel along the eastern boundary. The decrease in flow observed along Southbrook is due to flow overtopping from Southbrook and flowing overland to the south-east, this occurs in both the pre-development and the post-development scenarios. The overtopping results in an increase in water levels which is mainly isolated to the area around Southbrook and diminishes away as the distance to Southbrook increases.

Figure 7 shows the flow within Southbrook adjacent the south-eastern corner of the site.

Figure 7: Flow in Southbrook adjacent south-eastern corner of site



4.6.3 Existing Properties

There are a number of existing properties adjacent to the development site. A comparison of the maximum water levels for the pre-development and post-development modelling is provided in Table 3.

Table 3: Maximum Water Surface Level (m) - 200yr ARI Rainfall and 200yr Breakout Flow

Location*	Pre-Development	Post-Development	Difference (Post-Pre)
92 South Belt	24.29	24.29	0.00
98 South Belt (Overland Flow Path between 96 and 100 South Belt)	24.03	24.06	0.03
98 South Belt – adjacent 12 Chamberlain Lane	24.11	24.12	0.01
112 South Belt	25.41	25.41	0.00
116 South Belt	25.70	25.70	0.00
130 South Belt	26.28	26.28	0.00
11 Pentecost Road	26.95	26.95	0.00
12B Pentecost Road	26.61	26.61	0.00
WDC Reservoir	26.85	26.85	0.00
Townsend Road Extension - upstream channel	26.46	26.47	0.01
75 Townsend Road	25.56	25.56	0.01
84 Townsend Road	25.29	25.32	0.03
91 Townsend Road	27.15	27.15	0.00
113 Townsend Road	26.97	26.97	0.00
Townsend Fields Stormwater Management Area	26.50	26.50	0.00
Southbrook - upstream of Townsend Road	25.81	25.86	0.05
Southbrook - downstream of Townsend Road	25.62	25.68	0.06
Southbrook - midpoint site boundary	24.43	24.48	0.05
Southbrook – south-eastern site boundary	23.11	23.08	-0.03
Eastern Channel - at South Belt	23.23	23.26	0.03
Eastern Channel - midpoint of boundary	23.12	23.02	-0.10
Eastern Channel – south-eastern site boundary	23.06	22.96	-0.10
Saracens Rugby Football Club	22.78	22.78	0.00
WDC Stormwater Basins	22.45	22.42	-0.03

Note: *The above locations are shown in RILEY Dwg: 170743-3 in Appendix D. Levels are measured nearest to residential dwellings.

The maximum difference between the pre-developed and post-development water levels for the 200-year combined flood event is within Southbrook at the Townsend Road culvert located at the south-eastern corner of the site and midway along the site boundary.

The increase in maximum water levels adjacent to the culvert passing beneath Townsend Road is approximately 50mm at the upstream end and 60mm at the downstream end. The increase at the downstream end is a result of flow from Townsend Road entering Southbrook at this location. The increase in water levels midway along the site boundary is approximately 60mm. This maximum increase in water levels is mainly isolated to Southbrook with increases to water levels diminishing away from Southbrook. The estimated maximum water level increase adjacent to existing dwellings is in the order of 30mm which is observed at 84 Townsend Road located south of the culvert. Further assessment for this property is summarised in section 4.6.3.1.

An isopach map showing the difference in maximum water depths pre-development versus post-development is shown in RILEY Dwg: 170743-7 in Appendix C.

4.6.3.1 84 Townsend Road

Further analysis has been completed for the property at 84 Townsend Road as modelling has shown the proposed development will result in an increase in water level of up to 30mm adjacent to existing dwellings as shown in RILEY Dwg: 170743-7.

In order to assess the effect of this increase in water level, a survey of the finished floor levels (FFL) and some spot levels have been taken across the site. This survey was completed by Graham Surveying Limited on 25 October 2019.

There are a number of structures located at 84 Townsend Road, where the main dwelling is located closest to Townsend Road (referenced as Dwelling 1) while there is a second structure located to the east of Dwelling 1 at the end of the driveway (referenced as Dwelling 2). The location of these structures are shown in RILEY Dwg: 170743-3. There are other structures located across this property. We have assumed that these are non-habitable structures consisting of sheds etc.

Review of the survey information shows Dwelling 1 sits in the order of 550mm above surrounding pavement levels, while Dwelling 2 generally sits less than 100mm above the surrounding pavement levels.

A comparison of the surveyed FFL for each dwelling compared to the modelled water levels is provided in Table 4. Spot levels have taken across the property, these levels show that the surveyed levels are lower than the LINZ DEM levels (as previously noted the LINZ DEM generally has an accuracy range of approximately +/-200mm). The modelled water levels across this site is based on the LINZ DEM information, therefore an adjustment to the surveyed finished floor levels has been made based on an average difference between the surveyed levels and LINZ DEM levels around each dwelling. This enables an adjusted FFL to be determined in order to provide comparison to the modelled water levels. The adjustment to the FFL has been made as remodelling with incorporated surveyed terrain over 84 Townsend Road would likely result in unrealistically high-water depths across the property due to the interface between survey terrain and LINZ DEM.

Table 4: Comparison of Modelled Water Level and Finished Floor Level at 84 Townsend Road

	Dwelling 1	**Dwelling 2**
Predevelopment Modelled Water Level – upstream side of dwelling	25.29m	25.16m
Surveyed Finished Floor Level (LVD)	25.189m	24.648m
Adjustment to Surveyed FFL	+85mm	+100mm
Adjusted Finished Floor Level	25.27m	24.75m
Predevelopment Inundation Depth	20mm	410mm

Based on the modelled parameters, the table above shows that the finished floor level of Dwelling 1 and Dwelling 2 at 84 Townsend Road are inundated in the predevelopment scenario. The water level increase of up to 30mm as a result of the proposed development does not impact on the number of dwellings inundated during the modelled event at 84 Townsend Road.

The purpose of this modelling is for determining minimum development site levels and assessing the effects of the development on the surrounding network. It is considered that conservative parameters have been used, therefore this will be reflected within modelled water levels. Comparison of modelled water levels with existing finished floor levels are limited based on the modelled parameters.

4.7 Model Calibration/Verification

Model calibration was excluded from the scope; however, flood depths across the site have been compared against other previous modelling that has been completed, including:

- 200-year Ashley River breakout completed by Environment Canterbury.
- Flood hazard mapping.

Figure 8 and Figure 9 shows the depth maps for the Environment Canterbury 200-year Ashley River breakout flow (left) versus the modelling completed for the 200-year combined flood event (right). Although the modelling results include both the breakout flow and the rainfall, approximately 80% (approximately 5.9m^3/s of the total 7.2m^3/s) of the flow entering the site from Townsend Road is a result of the Ashley River breakout flow, whereas much a smaller flow enters from South Belt, where a total of approximately 1.7m^3/s enters from South Belt where approximately 20% is from the Ashley River breakout.

Figure 10 and Figure 11 shows the comparison of WDC hazard map (left) with the modelling completed for the 200-year rainfall only (right). The WDC hazard map shows both flood hazard and flood depth for a 200-year or 500-year storm event. A low to medium hazard is specified for depths between 0-1m depth, however, the parameters for the flood hazard are not defined.

The WDC flood hazard map has an interactive depth feature allowing specific depths to be queried. The high hazard area adjacent to Southbrook is a result of flood hazard rather than the flood depth, as the water depth south of Southbrook is generally less than 1m. Generally, the depths within the WDC interactive map are greater than the 200-year modelled results, this is likely to be due to the WDC maps reporting critical 500-year depths.

Although these maps show similar trends of flooding across the site, neither can be used as a direct comparison.

NIWA also publishes estimates of peak flood flows for waterways for a range of exceedance probabilities. NIWA estimates the peak flow of Southbrook adjacent to the site at approximately 30m^3/s to 50m^3/s which has been based on interpolation between the 100-year and 1000-year flows.

Models can be calibrated by varying of the Manning's roughness values, generally increasing the Manning's roughness will reduce the peak flow at the site. No calibration of the surface roughness values from Table 1 has been done. The modelled flow within Southbrook for the 200-year event is approximately 66m^3/s which is higher than the estimated NIWA peak flow of 30m^3/s to 50m^3/s. This flow is considered conservative in setting of finished floor levels.

Figure 8 and Figure 9: Comparison of ECan 200-year Ashley River breakout flow (left) and RILEY flood assessment modelling results of the 200-year combined flood event (right)

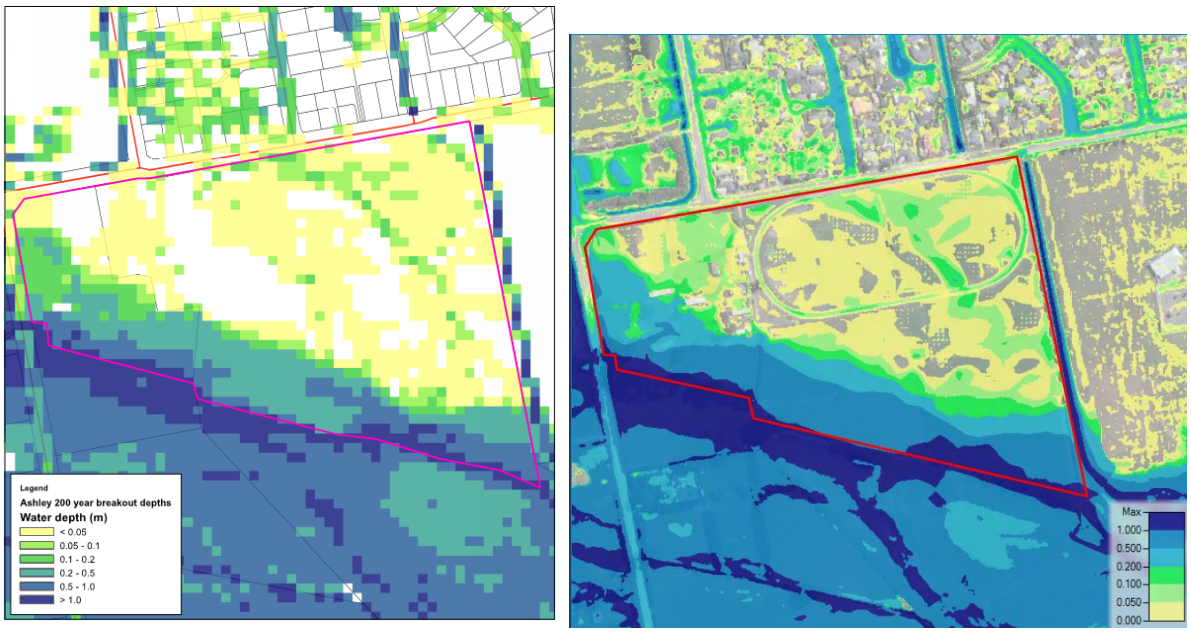


Figure 10 and Figure 11: Comparison of WDC hazard map (left) and RILEY flood assessment modelling results of 200-year combined flood event (right)

4.7.1 Finished Floor Levels

As the site is located within the flood hazard area affected by the 200-year rainfall flood event and also from the Ashley River breakout flow, minimum floor levels are required across the site to ensure dwellings are flood free.

There are no specific freeboard requirements specified for this site within the WDP, although it is expected a minimum freeboard requirement of 400mm will be required based on that specified within the south-west Rangiora Outline Development Plan, which requires:

- Within the south-west Rangiora Outline Development Plan area shown on District Plan Map 173 any dwelling/house shall have a minimum floor level of 400mm above the 0.5% Annual Exceedance Probability flood event.
- Within the south-west Rangiora Outline Development Plan area shown on District Plan Map 173 all residential allotments shall have a finished ground level that avoids inundation in a 0.5% Annual Exceedance Probability flood event.

Water levels vary across the site, therefore, RILEY Dwg: 170743-8 attached in Appendix E provides a summary of the water levels adjacent to the site based on modelling of the 200-year combined flood event.

4.8 High Hazard Flood Area

Review of the WDC flood hazard mapping shows a high hazard area to the south of the site. The high hazard area is defined where the flood hazard area is subject to inundation where the water depth times velocity is greater than or equal to 1, or where depths are greater than 1m in a 500-year flood event. This high hazard area is generally contained to the Esplanade Reserve. It is noted that this Flood Hazard Mapping was from work undertaken in 2014, where further development across the catchment has since occurred. The modelling undertaken by Fluent Solutions for the development of Townsends Fields showed a reduction of water depths across the site (104 Townsend Road), which would be expected based on the bund installed along the western boundary. No assessment of the 500-year event has been completed due to the high hazard mapping generally being contained within the Esplanade Reserve.

5.0 Summary

The site has been identified as being located within the flood hazard area as specified within the WDC District Plan based on a 200-year rainfall flood event and is also located within the Ashley River floodplain.

The combined 200-year flood event (local catchment plus Ashley River breakout) has been modelled to assess the effects of development of the site. The modelling indicates the predevelopment flows cause inundation across a large number of properties.

The model found that the earthworks required to achieve a flood free site in conjunction with auxiliary works along the site boundary can have a minimal impact on the existing properties adjacent to the site. The flood levels and flood extents as a result of development of the site can result in less than minor effect with appropriate design mitigation measures.

The modelling outcomes presented in this report are specific to the works outlined within Section 4.5, it is noted that similar outcomes may be achieved via different mitigation measures adjacent to the site such as widening of Southbrook. Therefore, during detailed design, it is recommended that the proposed earthwork surface is modelled to confirm the development effects on surrounding properties achieves a similar water level difference and the finished floor levels within the development site achieve 400mm freeboard to the modelled water levels.

The modelling demonstrates that the land subject to the plan change can achieve an outcome with no more than minor effects based on appropriate stormwater management solutions being implemented. It is also considered that similar measures to these would be required for other reasonable use of this land.

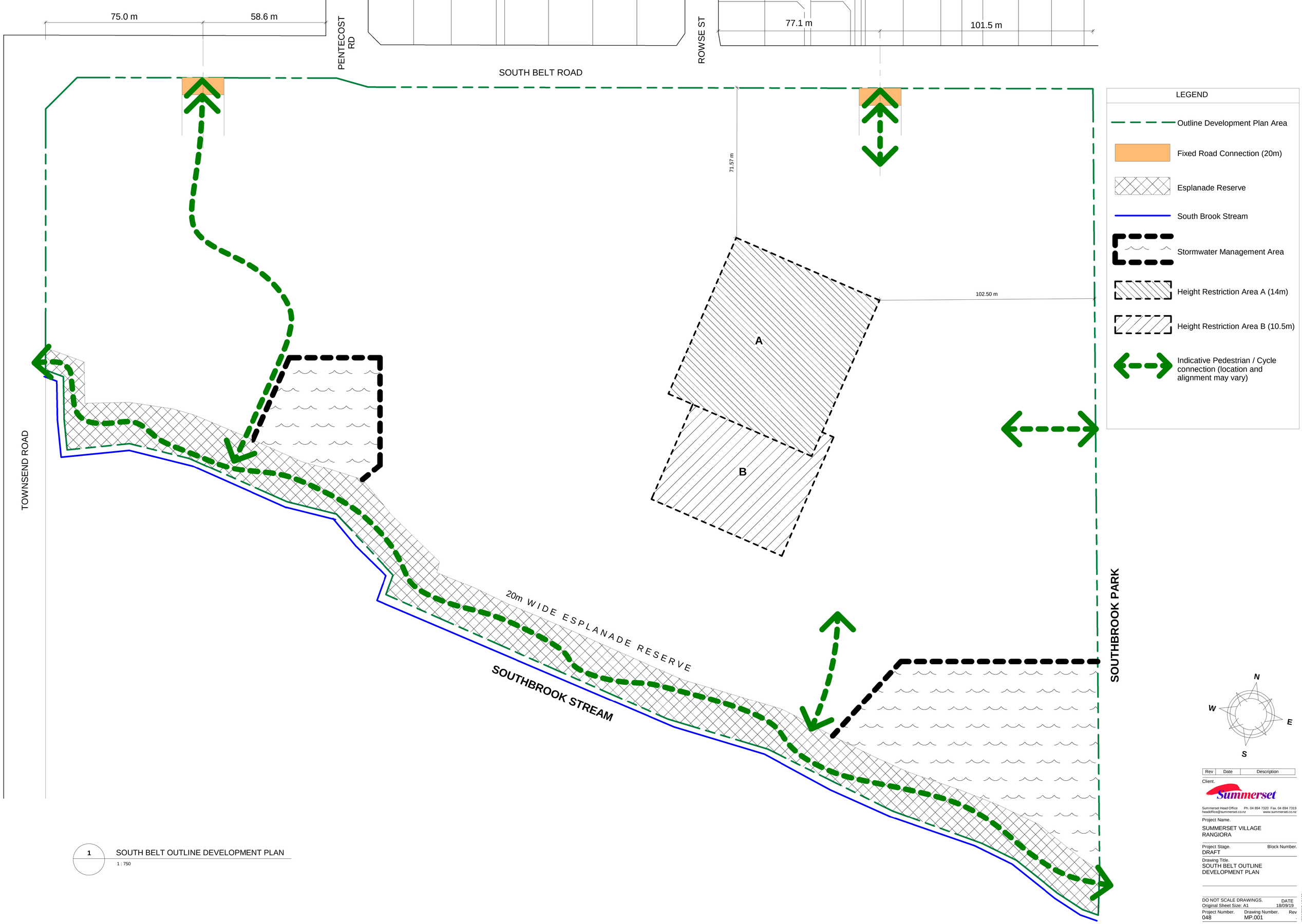
6.0 Limitation

This report has been prepared solely for the benefit of Summerset Villages (Rangiora) Limited as our client with respect to the brief and Waimakariri District Council in processing the Private Plan Change. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

The hydrological and hydraulic analyses and recommendations contained in this report are based on our understanding and interpretation of the available information. The recommendations are therefore subject to the accuracy and completeness of the information available at the time of the study. Should any further information become available, the analyses and findings of this report should be reviewed accordingly.

APPENDIX A

Outline Development Plan



1 SOUTH BELT OUTLINE DEVELOPMENT PLAN

1 : 750

Rev	Date	Description

Client.

Summerset

Summerset Head Office Ph. 04 894 7320 Fax. 04 894 7319
headoffice@summerset.co.nz www.summerset.co.nz

Project Name.

SUMMERSET VILLAGE
RANGIORA

Project Stage. DRAFT

Block Number.

Drawing Title.

SOUTH BELT OUTLINE
DEVELOPMENT PLAN

DO NOT SCALE DRAWINGS.
Original Sheet Size: A1

DATE 18/09/19

Project Number. 048

Drawing Number. MP.001

Rev

12/11/2019 4:24:36 p.m.

APPENDIX B

Model Results: Flood Extents

NOTES:

1. AERIAL IMAGE AND BOUNDARY INFORMATION SOURCED FROM LINZ.
2. SITE BOUNDARY LOCATION INDICATIVE.

FOR INFORMATION

REV	DATE	ISSUE	BY
3	29.11.19	REPORT ISSUE	LS
2	23.09.19	REPORT ISSUE	LS
1	04.09.19	REPORT ISSUE	LS

DESIGN	DES CHECK	APPROVED FOR ISSUE
LS	PR	DRAFT
DRAWN	CAD CHECK	
RBT	RBT	
DATE DRAWN		ISSUE DATE
04.09.19		/ /

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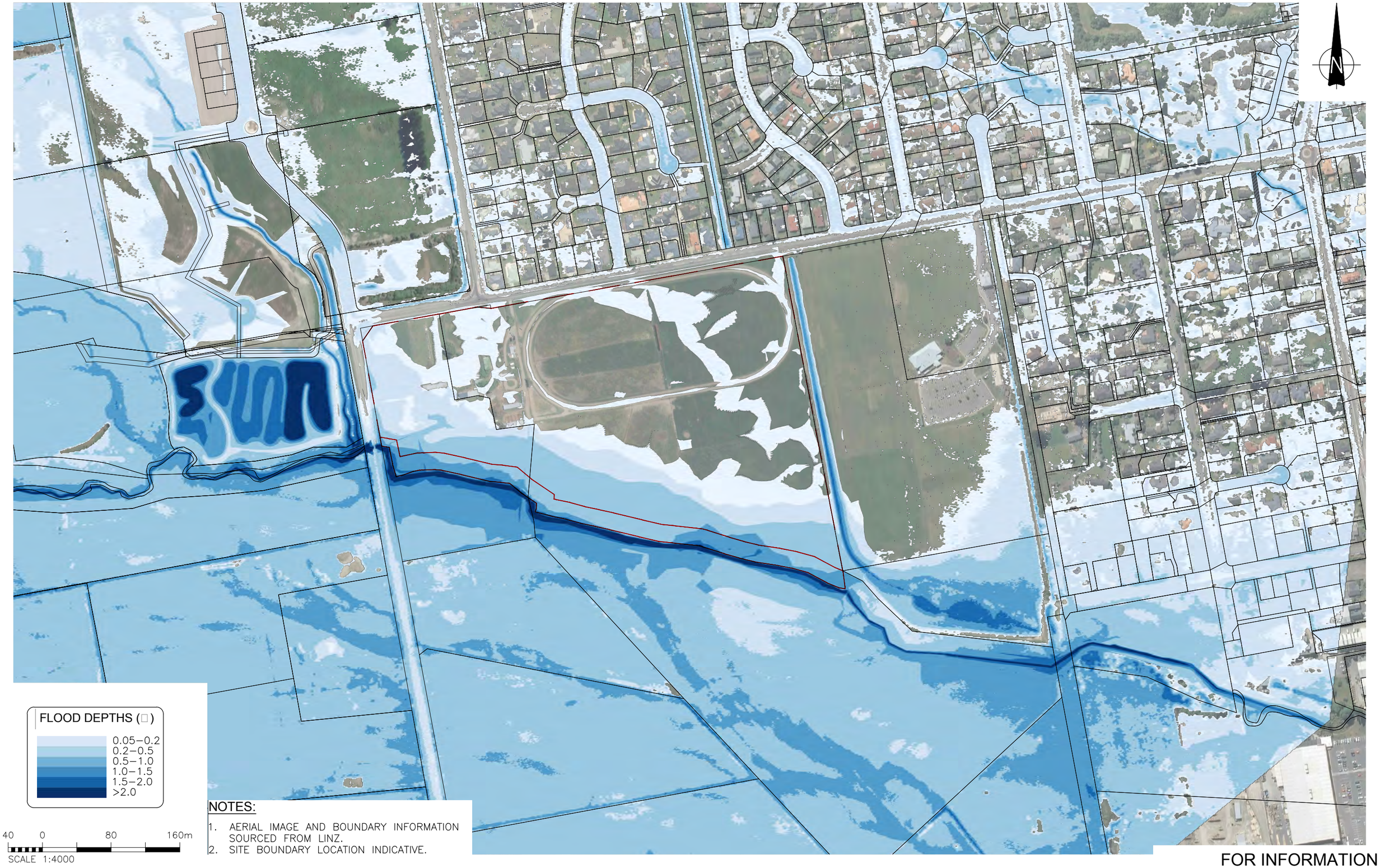
www.riley.co.nz

CLIENT	SUMMERSET VILLAGES (RANGIORA) LIMITED
ADDRESS	104 TOWNSEND ROAD & 141 SOUTH BELT, RANGIORA
PROJECT	SUMMERSET RANGIORA
SHEET TITLE	200 YEAR PRE-DEVELOPMENT FLOOD EXTENTS (RAINFALL ONLY)

ACENZ GCS

CADFILE	170743-4.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:30,000	A3
DRAWING No.	REV.
170743-4	3



NOTES:

1. AERIAL IMAGE AND BOUNDARY INFORMATION SOURCED FROM LINZ.
2. SITE BOUNDARY LOCATION INDICATIVE.

FOR INFORMATION

REV	DATE	ISSUE	BY
3	29.11.19	REPORT ISSUE	LS
2	23.09.19	REPORT ISSUE	LS
1	04.09.19	REPORT ISSUE	LS

DESIGN	DES CHECK	APPROVED FOR ISSUE
LS	PR	DRAFT
DRAWN	CAD CHECK	
RBT	RBT	
DATE DRAWN		ISSUE DATE
04.09.19		/ /

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ADDRESS	104 TOWNSEND ROAD & 141 SOUTH BELT, RANGIORA
PROJECT	SUMMERSET RANGIORA
SHEET TITLE	200 YEAR PRE-DEVELOPMENT FLOOD EXTENTS (COMBINED EVENT)

ACENZ GCS

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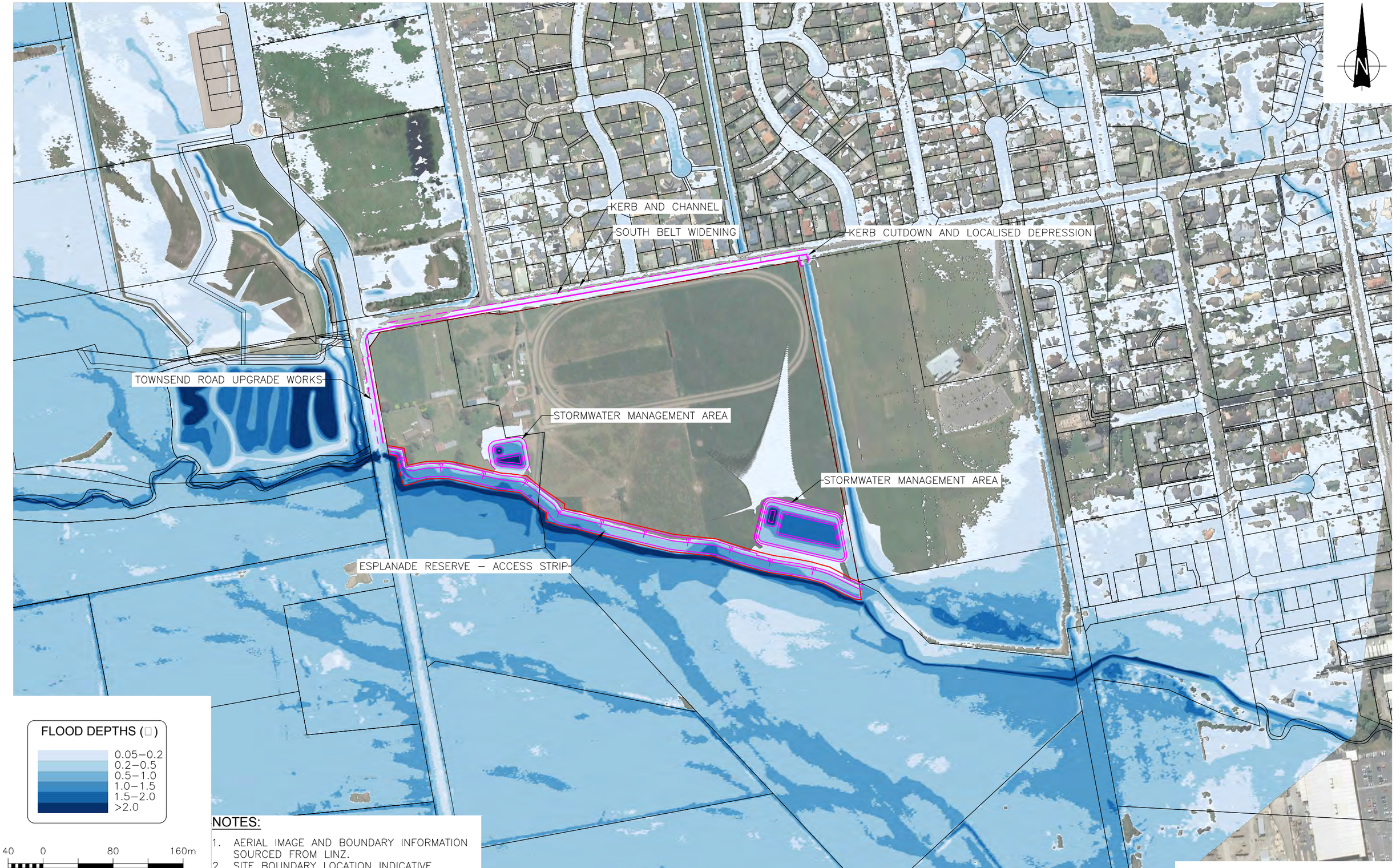
SCALE (A3)	1:4000
ORIG. SHEET SIZE	A3
DRAWING No.	170743-5
REV.	3



NOTES:

1. AERIAL IMAGE AND BOUNDARY INFORMATION SOURCED FROM LINZ.
2. SITE BOUNDARY LOCATION INDICATIVE.

FOR INFORMATION

REV	DATE	ISSUE	BY
3	29.11.19	REPORT ISSUE	LS
2	23.09.19	REPORT ISSUE	LS
1	04.09.19	REPORT ISSUE	LS

DESIGN	DES CHECK	APPROVED FOR ISSUE
LS	PR	DRAFT
DRAWN	CAD CHECK	
RBT	RBT	
DATE DRAWN		ISSUE DATE
04.09.19		/ /

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ADDRESS	104 TOWNSEND ROAD & 141 SOUTH BELT, RANGIORA
PROJECT	SUMMERSET RANGIORA
SHEET TITLE	200 YEAR POST-DEVELOPMENT FLOOD EXTENTS (COMBINED EVENT)

ACENZ
ISO 9001 CERTIFIED GCS

CADFILE	170743–6.dwg
SCALE (A3)	ORIG. SHEET SIZE
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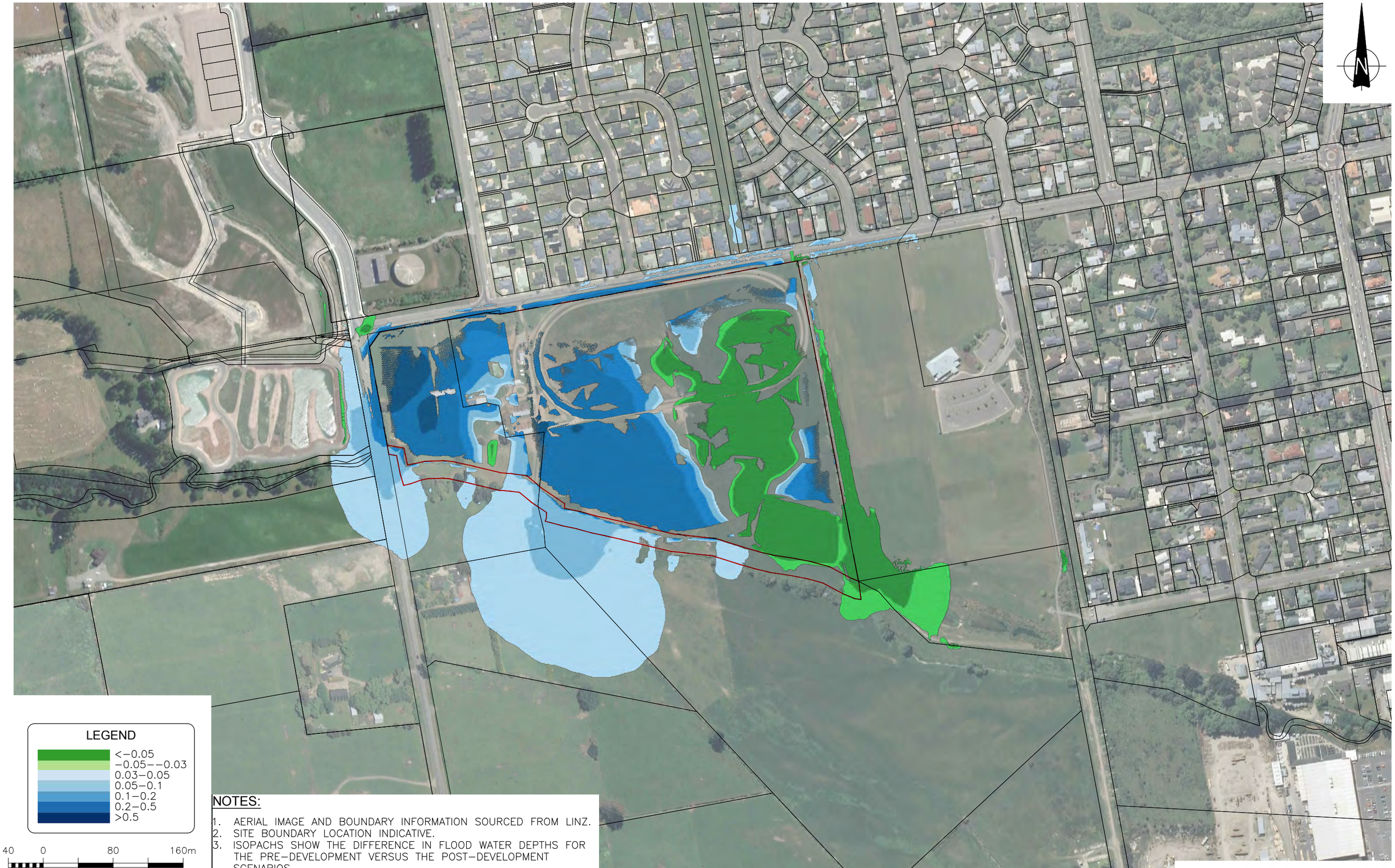
DRAWING No.	REV.
170743-6	3

APPENDIX C

Model Results: Isopach Map



NOTES:

1. AERIAL IMAGE AND BOUNDARY INFORMATION SOURCED FROM LINZ.
2. SITE BOUNDARY LOCATION INDICATIVE.
3. ISOPACHS SHOW THE DIFFERENCE IN FLOOD WATER DEPTHS FOR THE PRE−DEVELOPMENT VERSUS THE POST−DEVELOPMENT SCENARIOS

FOR INFORMATION

REV	DATE	ISSUE	BY
3	23.09.19	REPORT ISSUE	LS
2	23.09.19	REPORT ISSUE	LS
1	04.09.19	REPORT ISSUE	LS

DESIGN	DES CHECK	APPROVED FOR ISSUE
LS	PR	DRAFT
DRAWN	CAD CHECK	
RBT	RBT	
DATE DRAWN		ISSUE DATE
04.09.19		/ /

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CLIENT	SUMMERSET VILLAGES (RANGIORA) LIMITED
ADDRESS	104 TOWNSEND ROAD & 141 SOUTH BELT, RANGIORA
PROJECT	SUMMERSET RANGIORA
SHEET TITLE	WATER SURFACE ISOPACH MAP - PRE VERSUS POST DEVELOPMENT

ACENZ
GCS

CADFILE	170743−7.dwg
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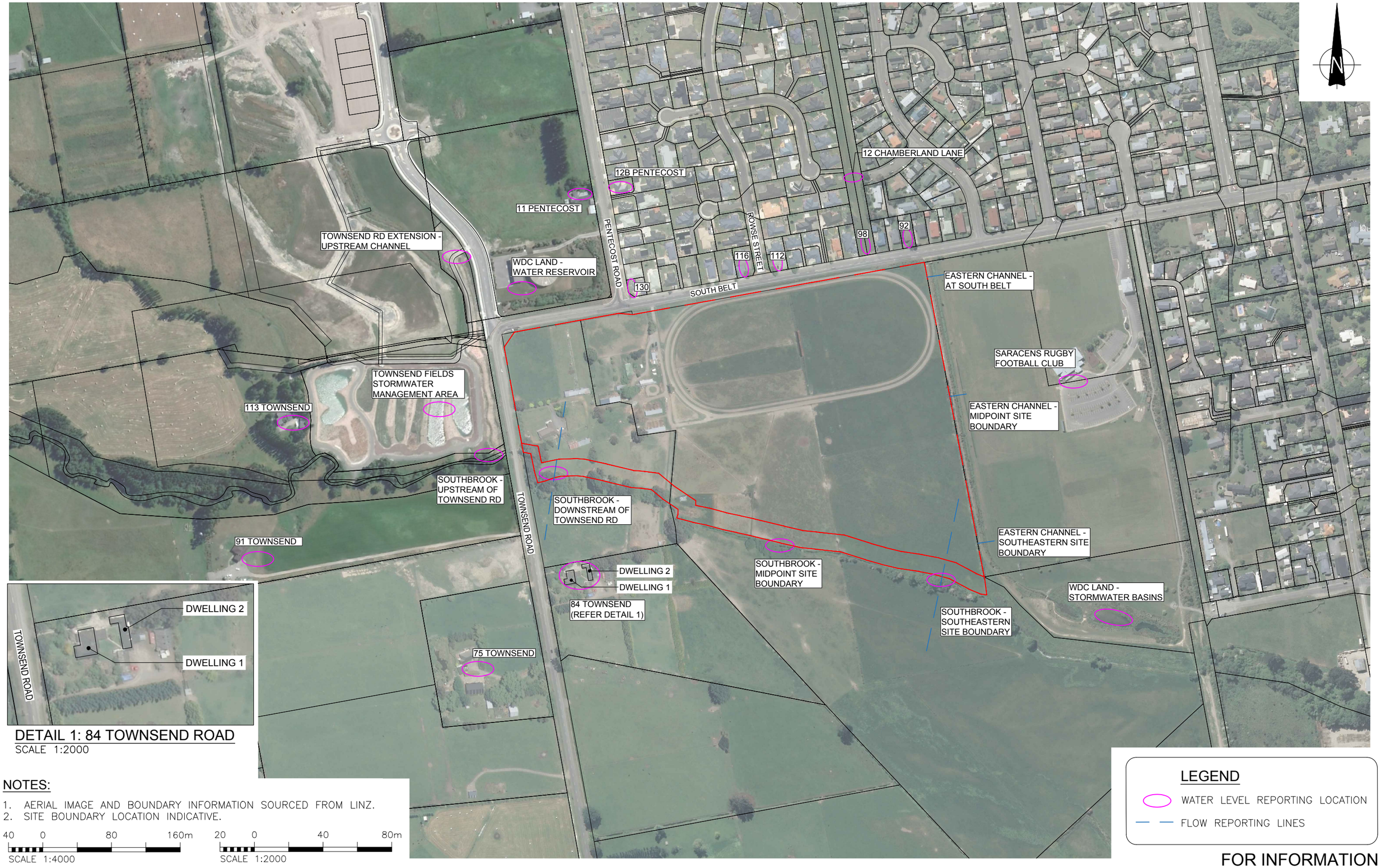
ORIG. SHEET SIZE	A3
DRAWING No.	170743-7
REV.	3

APPENDIX D

Location Map



DETAIL 1: 84 TOWNSEND ROAD
SCALE 1:2000

NOTES:

1. AERIAL IMAGE AND BOUNDARY INFORMATION SOURCED FROM LINZ.
2. SITE BOUNDARY LOCATION INDICATIVE.

40 0 80 160m
SCALE 1:4000

20 0 40 80m
SCALE 1:2000

LEGEND

WATER LEVEL REPORTING LOCATION

FLOW REPORTING LINES

FOR INFORMATION

REV	DATE	ISSUE	BY
2	29.11.19	DETAIL 1 ADDED	LS
1	04.09.19	REPORT ISSUE	LS

DESIGN	DES CHECK	APPROVED FOR ISSUE
LS	PR	DRAFT
DRAWN	CAD CHECK	
RBT	RBT	
DATE DRAWN		ISSUE DATE
04.09.19		/ /

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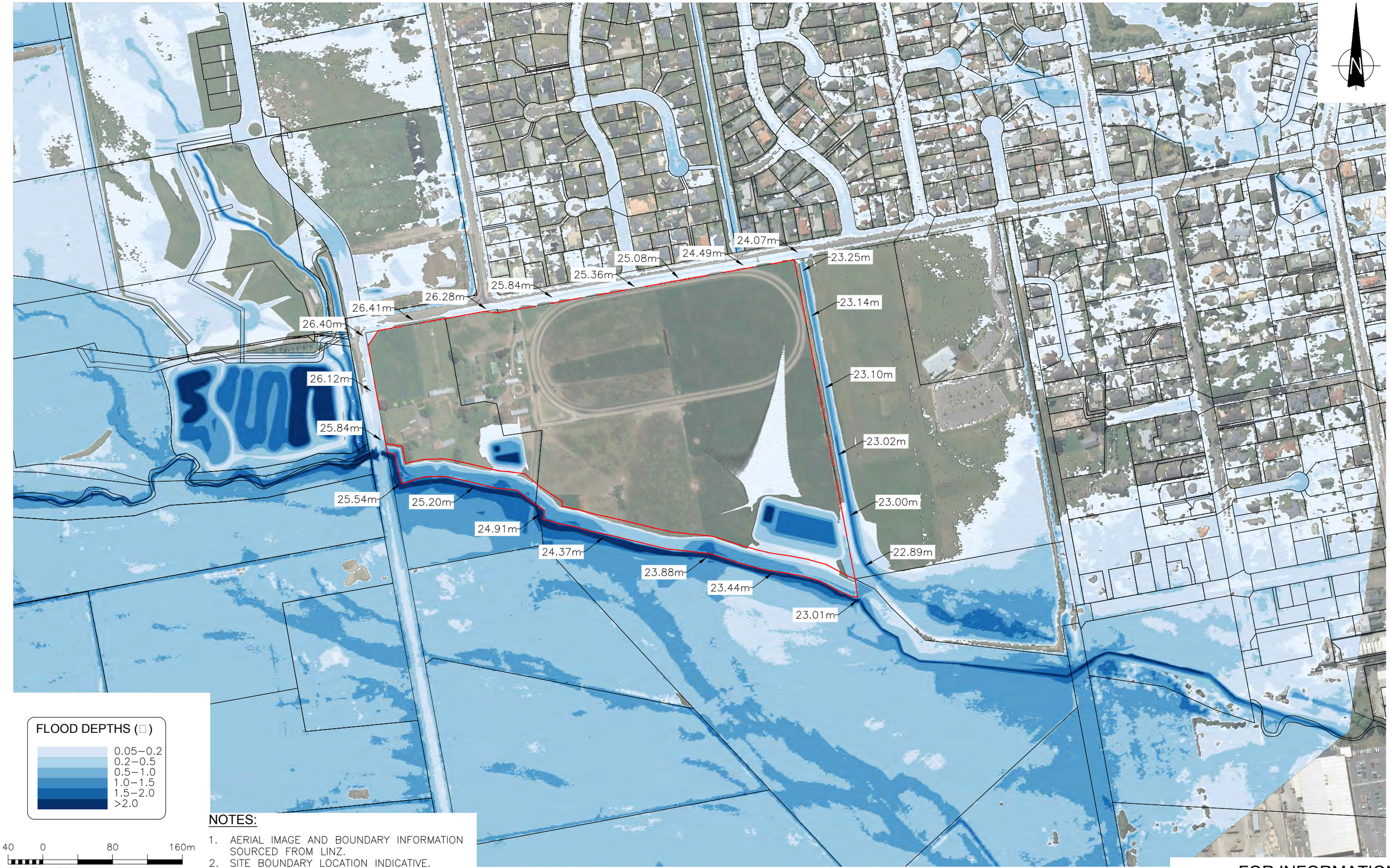
CLIENT	SUMMERSET VILLAGES (RANGIORA) LIMITED
ADDRESS	104 TOWNSEND ROAD & 141 SOUTH BELT, RANGIORA
PROJECT	SUMMERSET RANGIORA
SHEET TITLE	LOCATION MAP

ACENZ
ISO 9001 CERTIFIED GCS

CADFILE	170743-3.dwg
SCALE (A3)	1:4000
ORIG. SHEET SIZE	A3
DRAWING No.	170743-3
REV.	2

APPENDIX E

Model Results: Site Boundary Maximum Water Levels



NOTES:

1. AERIAL IMAGE AND BOUNDARY INFORMATION SOURCED FROM LINZ.
2. SITE BOUNDARY LOCATION INDICATIVE.

FOR INFORMATION

REV	DATE	ISSUE	BY
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1	04.09.19	REPORT ISSUE	LS

DESIGN	DES CHECK	APPROVED FOR ISSUE
LS	PR	DRAFT
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ADDRESS	104 TOWNSEND ROAD & 141 SOUTH BELT, RANGIORA
PROJECT	SUMMERSET RANGIORA
SHEET TITLE	200 YEAR POST-DEVELOPMENT FLOOD WATER LEVELS (COMBINED EVENT)

ACENZ
ISO 9001 CERTIFIED GCS

CADFILE	170743-8.dwg
SCALE (A3)	1:4000
ORIG. SHEET SIZE	A3
DRAWING No.	170743-8
REV.	2