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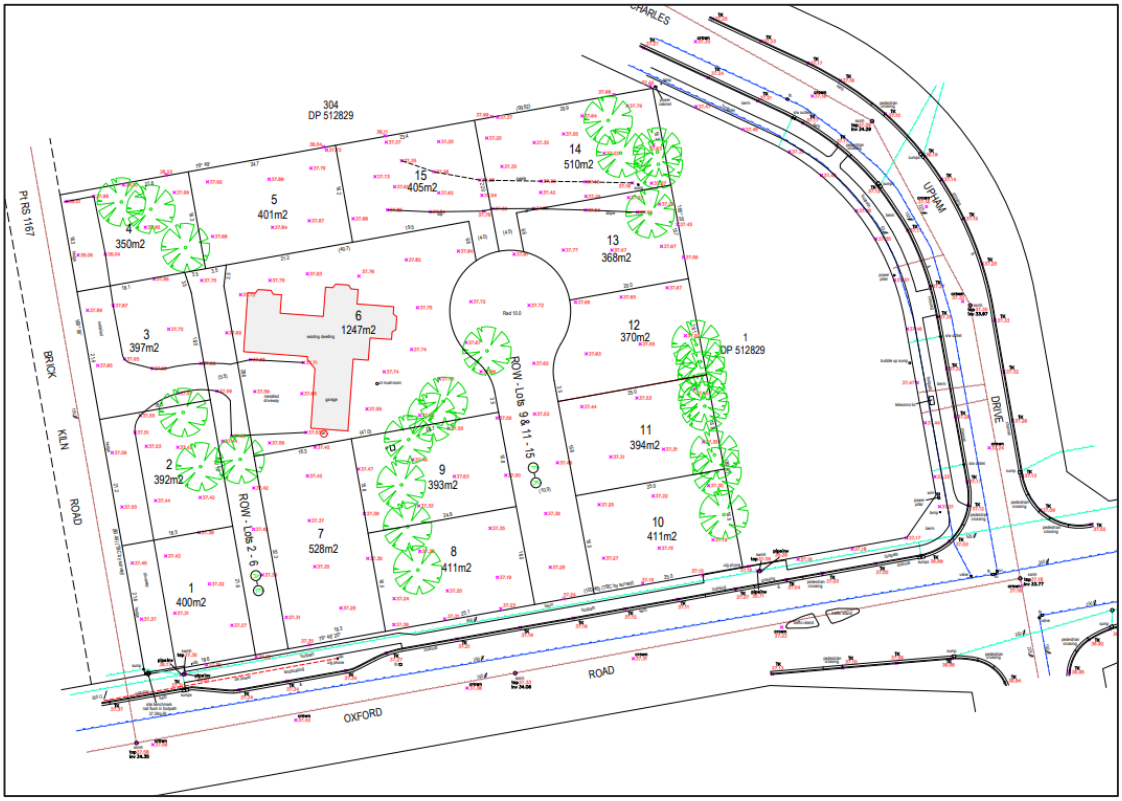
Flood Hazard Assessment Report

25 Ashley Gorge Road, Oxford

Prepared for Morgan McIntosh Limited

15742



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Flood Hazard Assessment Report

25 Ashley Gorge Road, Oxford

Prepared for Morgan McIntosh Limited

Project number: 15742

Quality Control Certificate

Survus Consultants

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Contents

1. Executive Summary **1**

2. Introduction **2**

2.1. Assessment Purpose 2

2.2. Assessment Scope 2

2.3. Assessment Method 2

3. Site Characteristics **3**

3.1. Location and Surrounds 3

3.2. Topography 3

3.3. Geology 5

3.4. Groundwater 6

3.5. Surface Water 6

4. WDC Flood Hazard Maps Assessment **7**

4.1. 0.5% AEP (200 Year ARI) Assessment 7

4.2. WDC Flood Hazard Requirement 9

4.3. Environment Canterbury Flood Hazard Requirements 10

5. HEC RAS Flood Modelling Analysis **10**

5.1. Design Parameters 10

5.2. Pre-Development Model 11

5.3. Post Development Model 1

5.4. Post Development Flood Analysis 2

6. 2% AEP (50 year ARI) Assessment **4**

7. Flood Risk Management Recommendations **5**

7.1. Culvert Design 5

7.2. Accessway and Road Design 5

7.3. Dwelling Finished Floor Levels 5

8. Section 106 Flood Hazard Assessment **5**

Disclaimer **7**

Appendices

Appendix A. Proposed Subdivision Scheme Plan

1. Executive Summary

Morgan McIntosh Limited proposes the rezoning of an approximate 49.70 ha area of land at 25 Ashley Gorge Road, Oxford.

The site is shown in the Waimakariri District Council (WDC) Flood Hazard Maps as being subject to inundation during the 0.5% Annual Exceedance Probability (AEP).

A flood hazard assessment has been carried out to assess the effects of flooding across the proposed plan change area and the effects of a potential development.

The flooding across the proposed plan change area is considered to be low risk with most of the flooding contained with the surface waters running through the site.

During future development works, stream upgrade measures (for increased conveyance capacity), the construction of stormwater basins, roading infrastructure, and the installation of adequately sized culverts will help aid the passage of flood waters through the site and most (if not all) future building platform locations will require none or minimal filling to achieve an acceptable finished floor level freeboard above the flood depth. Flood modelling (carried out as part of this assessment) indicates that a future development will have no effects on surrounding land areas and will be able to adhere with WDC design and construction requirements within flood prone areas.

Overall, it is considered that Section 106 of the RMA does not prevent the proposed re-zoning of the 25 Ashley Gorge Road land area, and subsequent future subdivision consents.

2. Introduction

2.1. Assessment Purpose

This Flood Hazard Assessment has been prepared in support of a submission by Morgan McIntosh Limited for the rezoning of an approximate 49.70 ha area of land from Rural to Large Lot Residential Zone (LLRZ), located at 25 Ashley Gorge Road, Oxford, as shown in Figure 1.

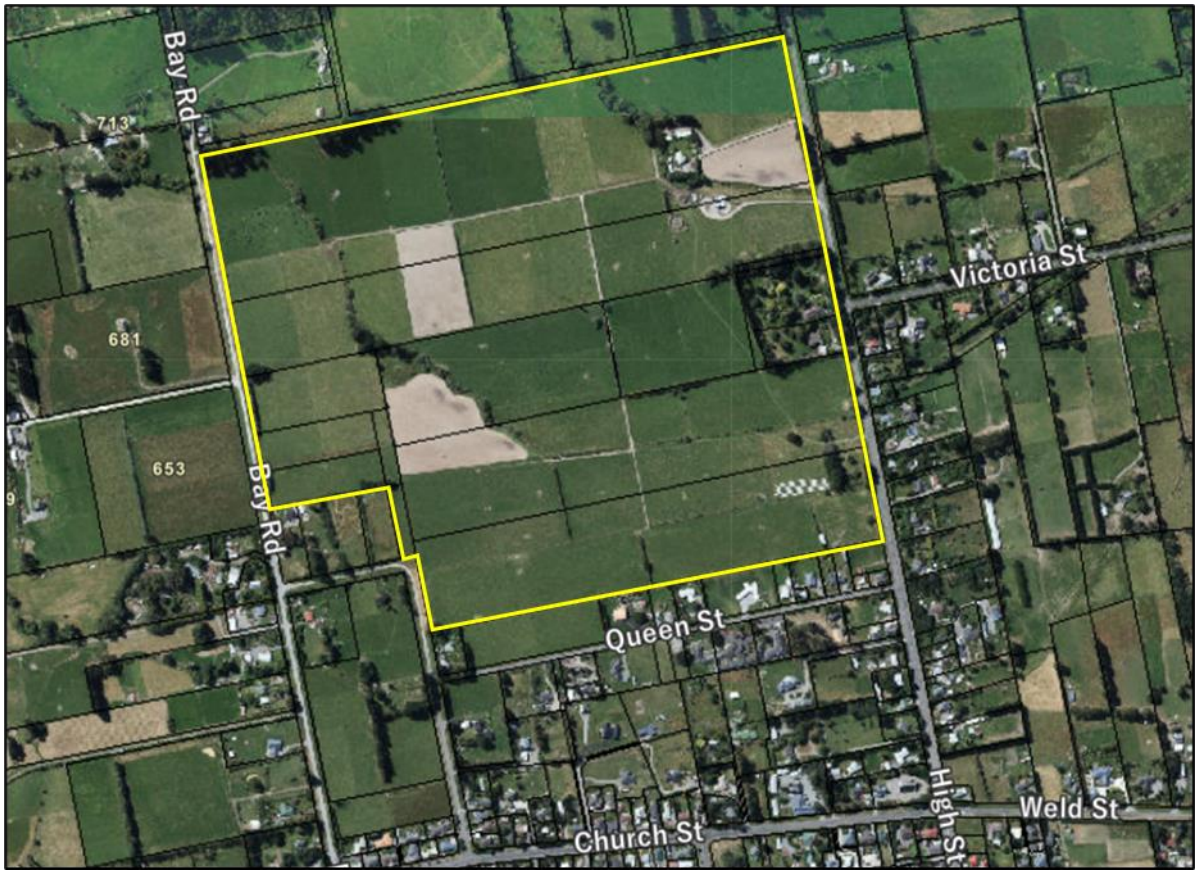


Figure 1. Plan Change Zone Boundary

2.2. Assessment Scope

This report addresses the existing 0.5% Annual Exceedance Probability (AEP), also referred to as the 200 year Annual Reoccurrence Interval (ARI), flood effects across the proposed plan change area, the effects of the development on the flood pattern and mitigation measures required to allow for development of the land area.

2.3. Assessment Method

The assessment has been carried out in two parts:

1. Review of Wiamakariri District Council (WDC) Flood Hazard Maps.
2. Hydrological and hydraulic flood modelling analysis.

The WDC flood hazard maps are provided online and are colour coded allowing for an assessment of flood depths and velocities; however, only provide a "snapshot" of the flood effects. The hydrological

and hydraulic flood modelling allowed for a more in depth analysis of the flood hazard risk and an assessment of the potential effects of a future development.

Appendix 1 provides the proposed Subdivision Scheme Plan.

3. Site Characteristics

3.1. Location and Surrounds

The plan change area is bounded by Bay Road to the west and High Street & Ashley Gorge Road to the east. The northern outskirts of Oxford Township borders the plan change area southern boundary and residential properties are also located to the west and east. Predominantly to the east, west and north of the site is rural pastureland.

Lots 1 & 2 DP 430450 are located centrally along the site eastern boundary and contain existing residential dwellings. An existing residential dwelling is also located near the northeast corner of the plan change area within RS 1391.

The site is currently pastureland, with scattered vegetation and shelterbelts. Frahams Creek (centrally located), an unnamed stream (northeast corner) and a farm drain (southern) traverse through the site.

3.2. Topography

3.2.1. Internal Site

The site is hilly in the northwest and then drops in elevation to a shallower slope. On average the site has a west to east grade of approximately 1 in 80. Generally, there is an approximate 10 m drop in elevation between the western and eastern boundaries.

Figure 2 shows the elevation profile across the site.

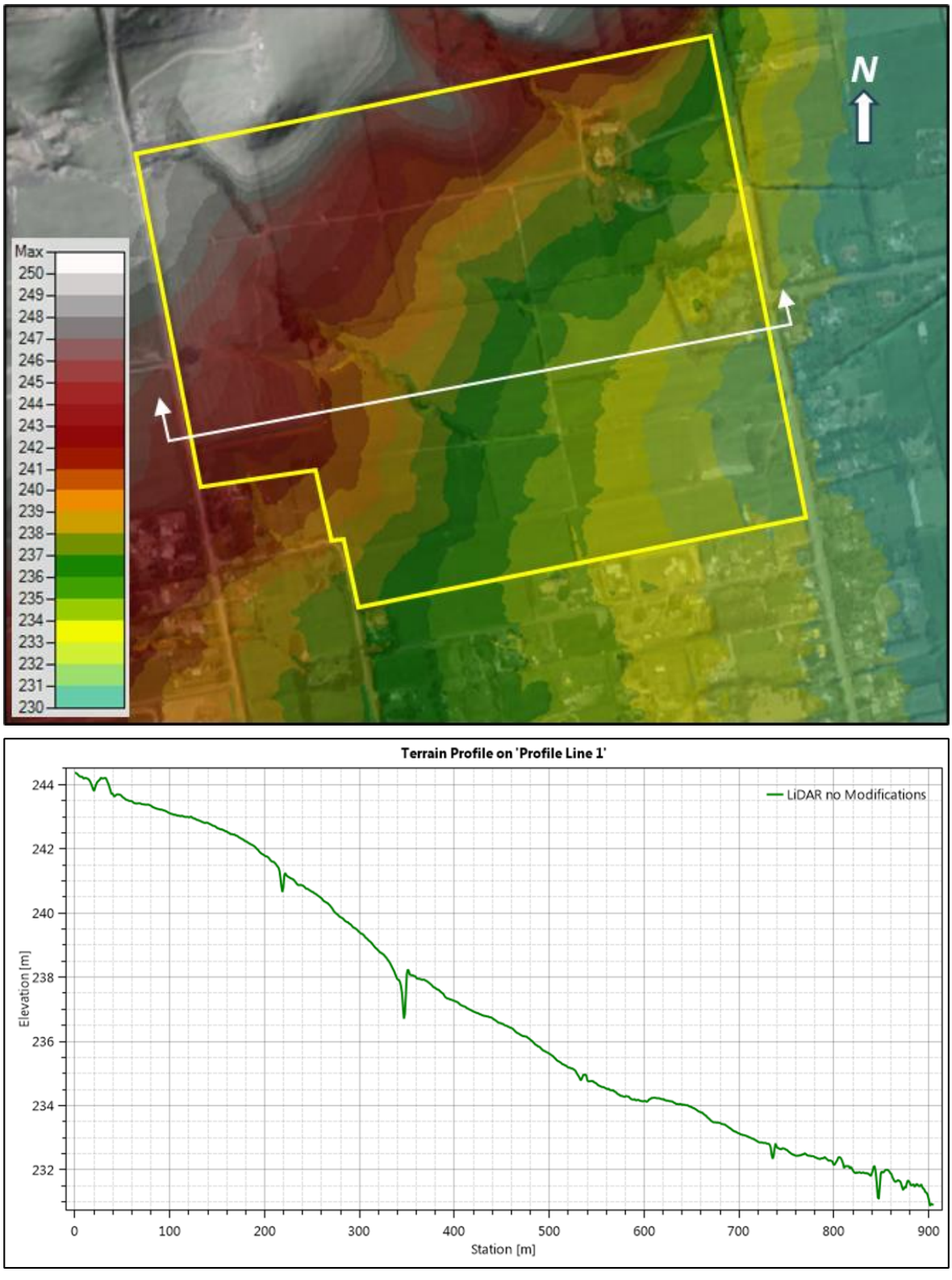


Figure 2. Topography and Elevation Profile

3.2.2. Upper Catchment

The catchment above the proposed plan change area is approximately 150 ha and discharges stormwater runoff into the site via the three main gullies, shown in Figure 3.

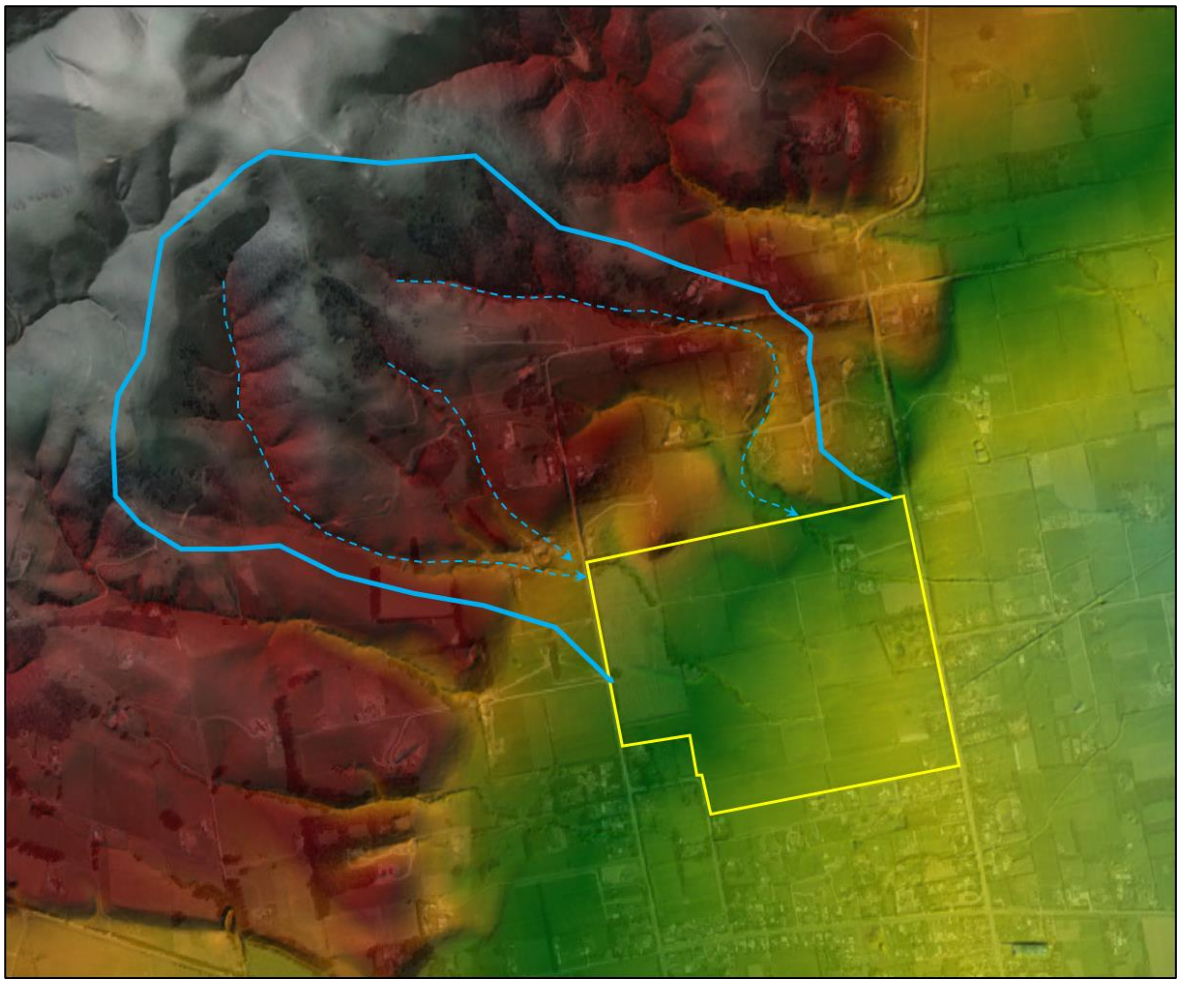


Figure 3. Upper Catchment

3.3. Geology

Landcare Research Soil Maps (2023) describe the soils as an imperfectly and poorly drained silt and silt over clay with the classification of argillic perch-gley pallic soil and argiliic orthic gley soil.

There is limited Canterbury Maps (2023) bore log data available. The well log soil information reviewed is as follows:

- Well L35/0369, located 680 m southeast of the plan change area, indicates a 0.5 m topsoil overlying a brown sandy gravel to a depth of 4.5 m below ground level (bgl), overlying a claybound gravel.
- Well L35/1059, located 770 m to the southeast, indicates a 0.3 m depth of topsoil overlying a claybound gravel.
- Well L35/0718, located 670 m to the south, indicates a 0.3 m topsoil, overlying a 1 m deep gravel, overlying a claybound silty gravel which extends to a depth of 7.4 m bgl.

The Landcare research soil maps indicate that to the southeast of the site the soil types change to more imperfectly drained and well drained, therefore the bore logs reviewed may not be representative of the soils types within the plan change area (which are expected to be poorly drained).

A geotechnical investigation would be required to confirm the exact soil types underlying the site.

3.4. Groundwater

3.4.1. Aquifer Type

The plan change area is located above the unconfined/semiconfined aquifer and piezometric contours indicate that groundwater generally flows to the southeast (Canterbury Maps, 2023).

3.4.2. Springs

There are no springs shown on Canterbury Maps within the plan change area or outlying vicinity.

3.4.3. Groundwater Depth

The closest groundwater monitoring well is L35/0023, located 40 m from the site eastern boundary (centrally). Groundwater records between 1952 to 1986 indicate a seasonal groundwater fluctuation of between 1.24 m to 3.61 m bgl with an average of 2.61 m bgl. Well records within the vicinity of the site also have recorded similar groundwater levels.

3.5. Surface Water

There are three main surface waters that traverse through the site, as shown in Figure 4.

1. Frahams Creek flows in a easterly directly through the centre of the site.
2. An unnamed stream flows across the site northeast corner.
3. A shallow farm drain runs along the south of the site.

It is assumed that the streams/drains are feed by rainfall runoff from the upper hill catchment and potentially a high seasonal groundwater (Canterbury Maps does not indicate a spring fed surface water network).

Survey data indicates that Frahams Creek, running through the centre of the plan change area, has a top of bank width ranging from 3 to 4.5 m (on average) and an average depth of approximately 1.0 m – 1.2 m. The stream running through the northeast corner has a variable top of bank width of 4 to 7 m and an average depth of approximately 0.8 m – 1 m.

The southern most drain is connected to the Bay Road drainage network but appears to be redundant (it is shallow and dry).

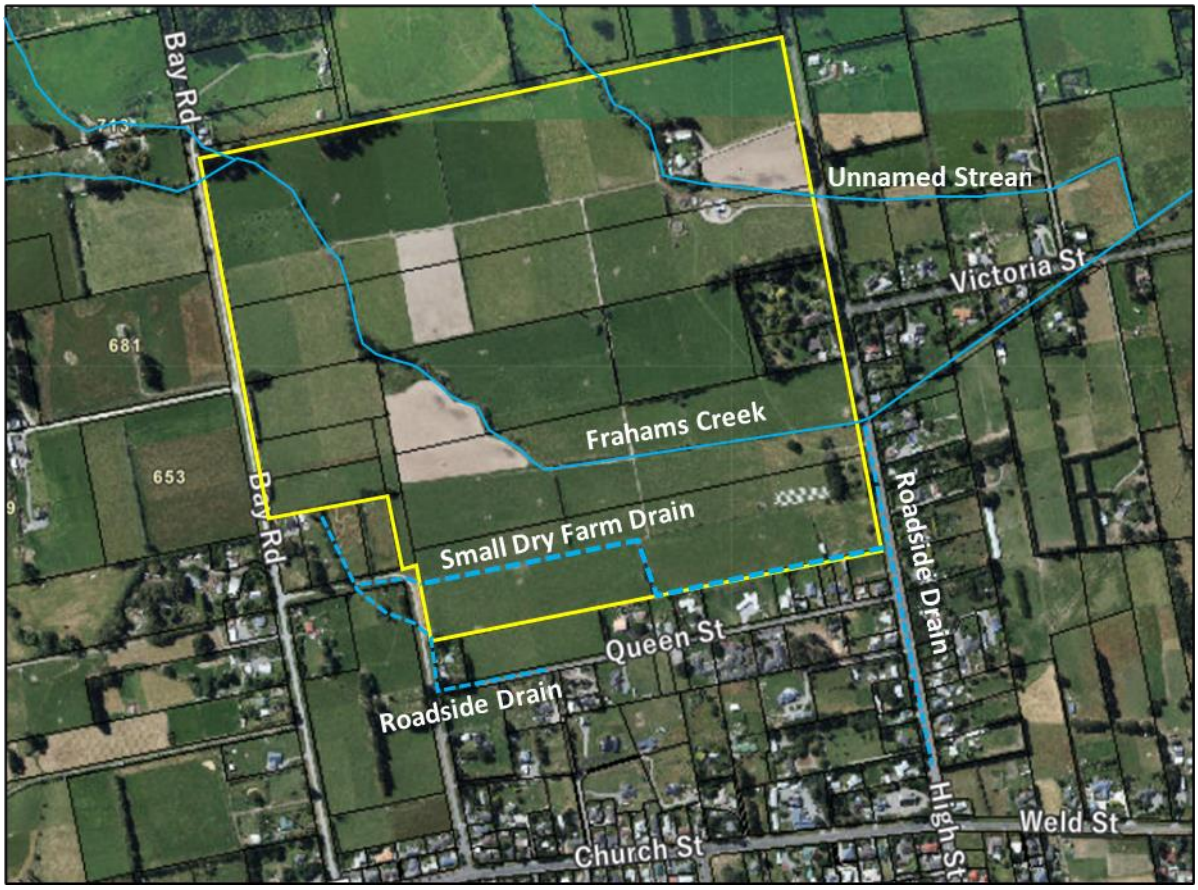


Figure 4. Surface Water Locations within the Plan Change Area

There are a number stormwater drainage channels within the locality, most notably is the open channel which runs down the western road verge of High Street and a second channel which runs adjacent to Bay Road and Queen Street.

4. WDC Flood Hazard Maps Assessment

4.1. 0.5% AEP (200 Year ARI) Assessment

The Waimakariri District Council (WDC) online Flood Hazard Maps (2023) identify the site as being subject to flood inundation during the 0.5% AEP rainfall event.

Figure 5, on the following page, shows the 0.5% AEP flood distribution and depth across the site.

Figure 6 shows the 0.5% AEP flood velocity across the site.

The majority of the site is subject to minor inundation resulting from localised ponding and the flood waters are generally contained within the surface waters crossing the site.

The two main areas of flooding are within the northwest of the site where the flood depth ranges from 0.1 m to 0.3 m. and within the southeast were the flood depth ranges from 0.1 m to 0.4 m (as highlighted in Figure 5).

The flooding is generally due to the surface waters not having sufficient capacity to convey the stormwater flow generated by the upper catchment and as a result water spills over onto the

surrounding land areas. The most significant flood effect is within the southeast where Frahams Creek and the High Street drain capacities are breached.

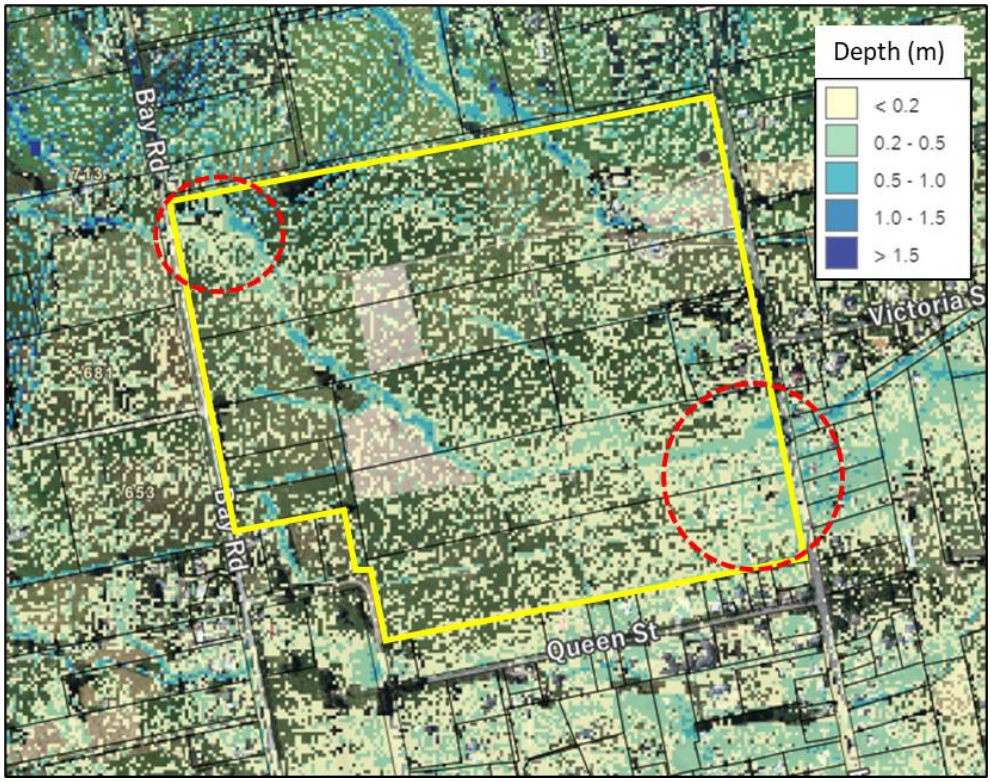


Figure 5. 0.5% AEP Flood Depth (WDC, 2023)

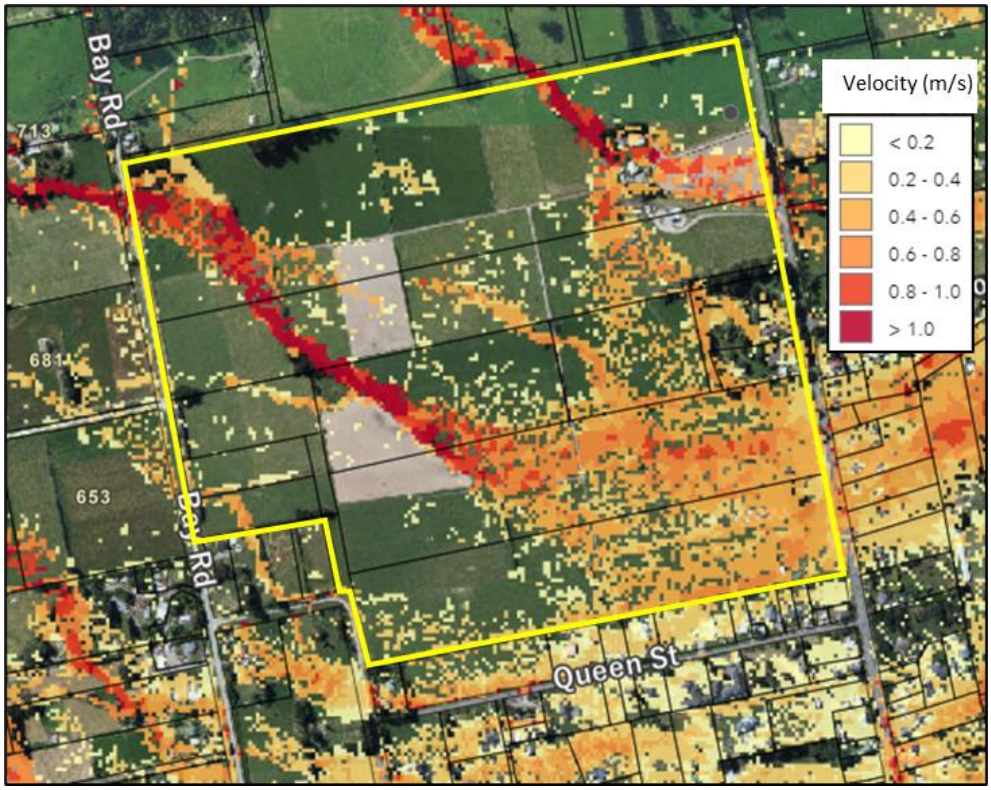


Figure 6. 0.5% AEP Flood Velocity (WDC, 2023)

The peak velocity within Frahams Creek ranges from 1.2 to 1.3 m/hr but is contained within the creek channel. The peak overland flow velocity within the southeast of the site ranges from 0.4 to 0.6 m/s.

The flood depth within the southeast ranges from 0.1 to 0.4 m and based on a velocity of 0.6 m/s equates to hazard range of 0.06 m^2/s to 0.24 m^2/s which is less than the 0.3 m^2/s Auckland Council allowance for safe pedestrian access. Therefore, the 0.5% AEP flood effects across the development are considered to be low hazard.

Figure 7 shows the WDC flood hazard risk category map. The majority of the site is low hazard with medium hazard zones confined to the surface water flow paths and a two small areas along the site southeast boundary.

Figure 7. Flood Hazard Risk Category (WDC, 2023)

4.2. WDC Flood Hazard Requirement

Waimakariri District Council has the following design requirements to ensure the passage through flood waters and the public safety risk is minimal.

- The accessway to a dwelling shall not be inundated in a 20% Annual Exceedance Probability (AEP, or 5 year Annual Reoccurrence Interval (ARI)) event.
- Culverts must be designed to have capacity to convey the 10% AEP (10 year ARI) flood event.
- Accessways must be passable in a 2% AEP (50 year ARI) flood event, with water depths to be no more than 300 mm.
- Culverts across overland flow paths or waterway should be designed so that if they are blocked, then the accessway is still passable with a flood depth of less than 300 mm.
- Flood waters must not be diverted as to have an adverse effect on neighbouring properties (e.g. increase in the flood depth). Generally, if the increase in flooding around a neighbouring dwelling is less than 20 mm it is considered "less than minor".

The 20%, 10% and 2% AEP flood hazard maps are not available online and have not been assessed. However, given the low hazard flooding across the site during the 0.5% AEP flood event, it is considered that during the future development design phase all WDC flood hazard requirements can be adhered

with; noting that as part of the site development the drains will most likely require widening in some areas and culverts maybe upgraded. Further, given the large lot sizes in comparison to a likely building footprint, it is unlikely there will be adverse effects on surrounding properties.

4.3. Environment Canterbury Flood Hazard Requirements

Policy 11.3.1 of the Canterbury Regional Policy Statement seeks to avoid new subdivision, use, and development in 'high hazard' areas. These are defined as areas where the water depth is greater than 1 m (or where the water depth (m) x velocity (m/s) is greater than 1) in a 500 year ARI flood event.

Policy 11.3.2. of the Canterbury Regional Policy Statement states that development should be avoided in areas subject to inundation in a 200 year ARI flood event unless the finished floor levels of new buildings are above the 200 year ARI flood level (and the area is not 'high hazard').

The overall plan change area is considered to be low hazard and generally most future dwelling finished floor levels would be above the 0.5% AEP flood level without the requirement for filling (raising the land elevation). During the detailed design phase additional flood modelling should be carried out to confirm if any lots (or building platforms within lots) maybe subject to a flood depth. Should some lots be subject to flooding it is not expected to be significant and the land elevation can be raised to achieve an acceptable finished floor level freeboard.

Overall, the proposed plan change area and future development can comply with Policy's 11.3.1 and 11.3.2.

5. HEC RAS Flood Modelling Analysis

Rain over grid hydrological and hydraulic flood modelling of the 0.5% AEP storm event of 24 hours in duration has been carried out using the U.S Army Corps of Engineers' Hydrologic Engineering Center (HEC) River Analysis System (RAS) software. The purpose of the modelling was to define likely effects of a future development within the proposed plan change area on the flood distribution and to identify and adverse effects on surrounding land areas.

5.1. Design Parameters

The 0.5% AEP 24 hour duration rainfall was based on HIRDS RCP 8.5 for the period 2081-2100 and the hyetograph rainfall distribution method was used with a peak twice that of the average at 70% of the storm duration, as recommended by the Christchurch City Councils (CCC) Waterways, Wetlands and Drainage Guide (WWDG).

The Flood Hazard Model Update Report (2020) prepared by DHI describes the WDC district wide flood modelling parameters and the nested rainfall distribution was used for the 24 hour duration district wide modelling. However, it is unknown what type of nested rainfall distribution was utilised and therefore for the purpose of the localised plan change area model, it was considered the hyetograph method was acceptable, provided it showed results similar to the flood hazard maps.

The pre and post development modelling was based on the following parameters:

- Grid size of 5 m^2 for the wider catchment and 2 m^2 within the approximate 50 ha plan change catchment.
- Manning's coefficient of 0.06 was used for the full catchment.
- The terrain was based on the most current LINZ LiDAR (2020-2022).

- The conceptual post development surface included the stormwater basins, surface water upgrades (some widening) and roading infrastructure. The post development surface can only be considered preliminary and was not prepared to a detailed design standard.
- Soils infiltration was accounted for by subtracting the Horton's infiltration value from the rainfall. The Horton's values were based on a poorly drained soils with an initial infiltration of 10 mm/hr, a final infiltration of 2 mm/hr and a Horton's decay rate of 5.4 (1/hr).

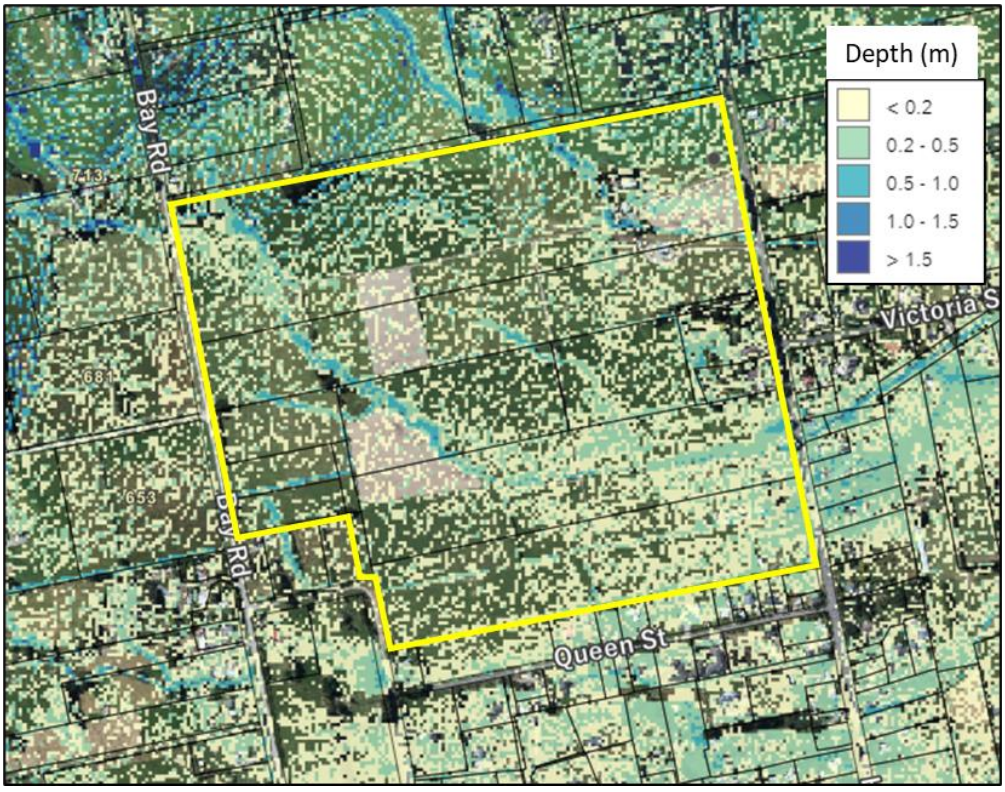
5.2. Pre-Development Model

The purpose of running a pre-development (site existing state) flood assessment on HEC RAS software was to allow a comparison against the post development (future development) model, also run on the same software. This allowed for a more accurate assessment between pre and post development conditions (rather than visually comparing the WDC Flood Hazard Map to the HEC RAS post development map).

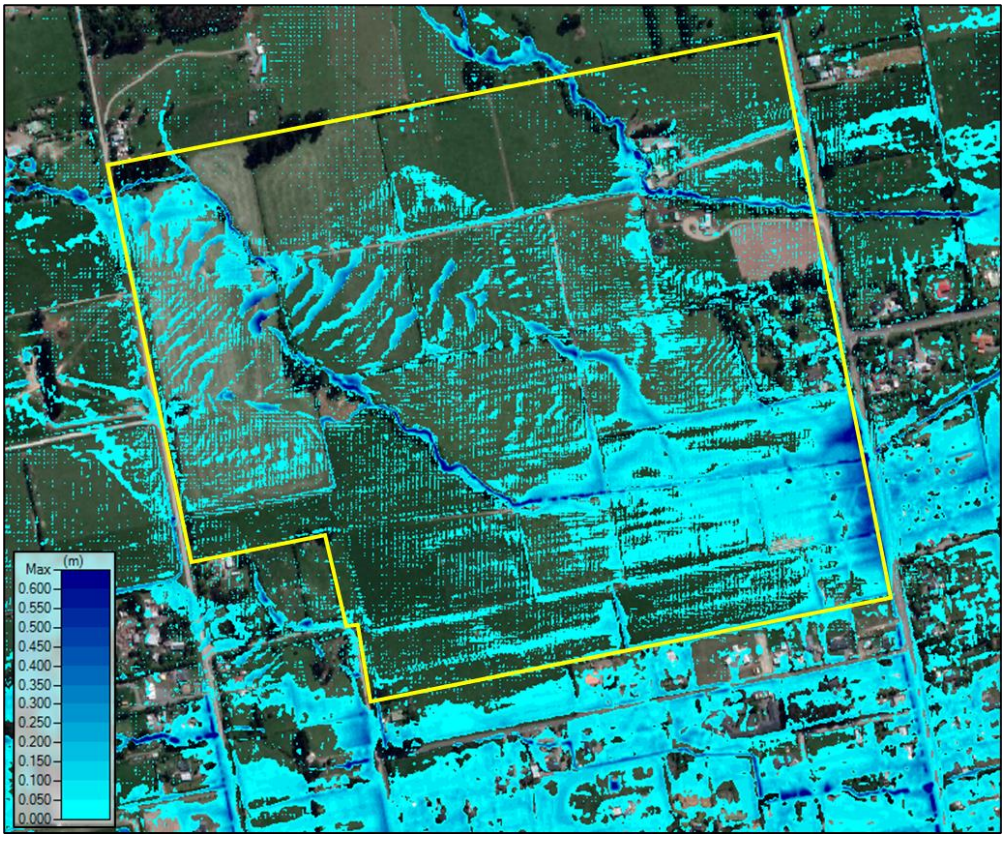
The HEC RAS pre-development flood map was visually compared to the WDC Flood Hazard Map for confirmation of the accuracy of the flood distribution and depth across the site.

Figure 8 provides a comparison between the HEC RAS pre-development model result and the WDC Flood Hazard Map.

There are moderate differences between the maps due to different grid sizes, age of LiDAR, roughness coefficients and rainfall distribution. However, overall both flood maps shows the same general flood distribution and depth across the site and therefore the HEC RAS pre-development model is considered acceptable.



(a) WDC 0.5% AEP Flood Hazard Map



(b) HEC RAS Pre-Development Flood Hazard Map

Figure 8. Comparison Between the WDC and HEC RAS Flood Hazard Maps

5.3. Post Development Model

The post development design surface was prepared by adjusting the HEC RAS terrain manually because at this early stage a detailed civil design surface has not been prepared. The post development surface included roads, marginal widening of the surface waters and the stormwater basins. Building platforms (dwellings) were not included the model.

Figure 9 shows the post development surface used for the modelling.

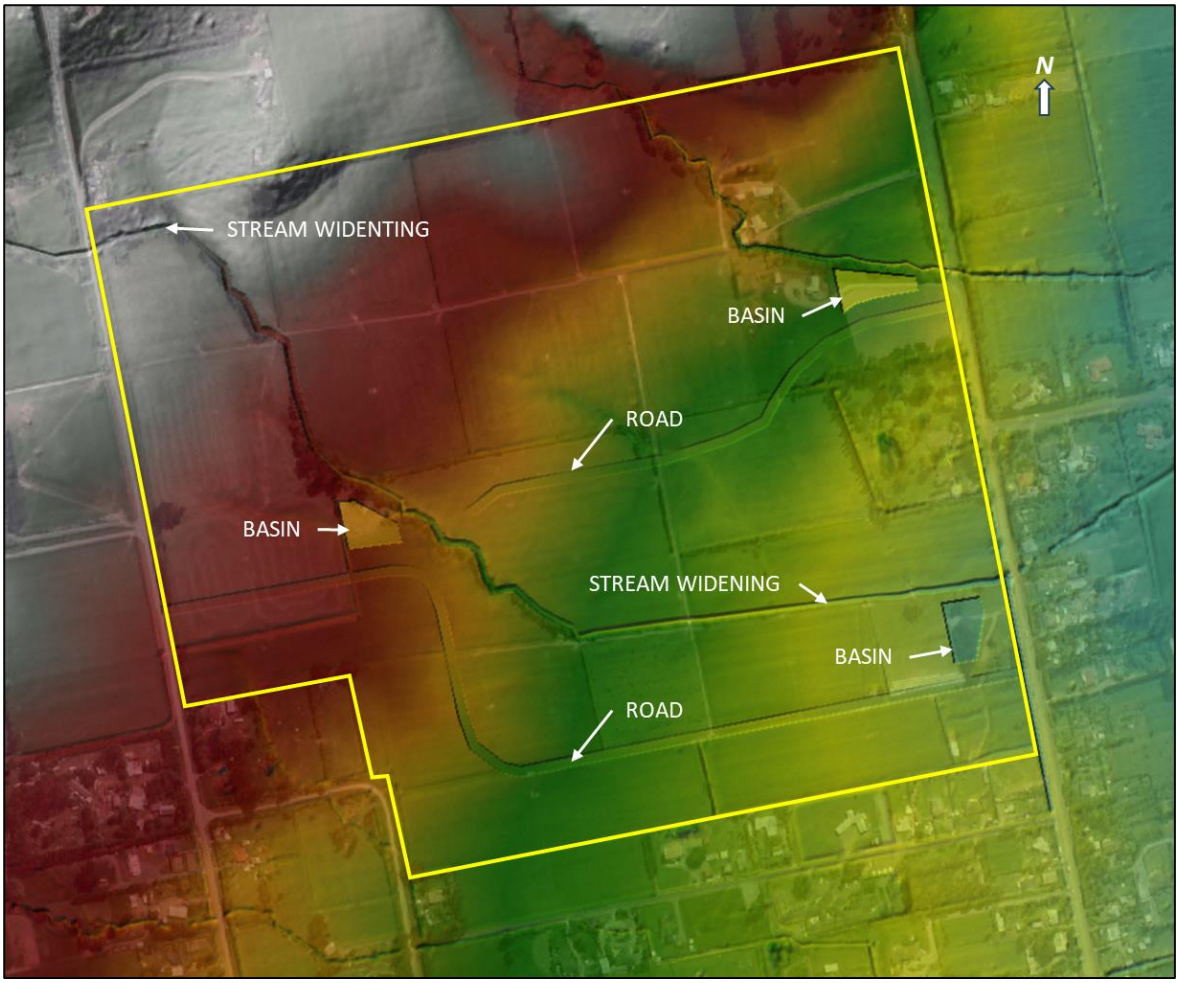


Figure 9. Post Development Design Surface

5.4. Post Development Flood Analysis

5.4.1. Flood Depth & Velocity

Figures 10 and 11 show the post development HEC RAS modelling depth and velocity results. Visually the maps indicate there is generally little change in the flood pattern and depths as a result of the proposed development across the plan change zone.

It should be noted that the post development design surface will have inaccuracies with regards to basin and road depths as the design terrain was manually adjusted. However, the modelling provides a preliminary overview of the potential effects of a development within the plan change area to an acceptable standard for the purpose of rezoning. Additional flood modelling should be carried out during the future detailed design stage.

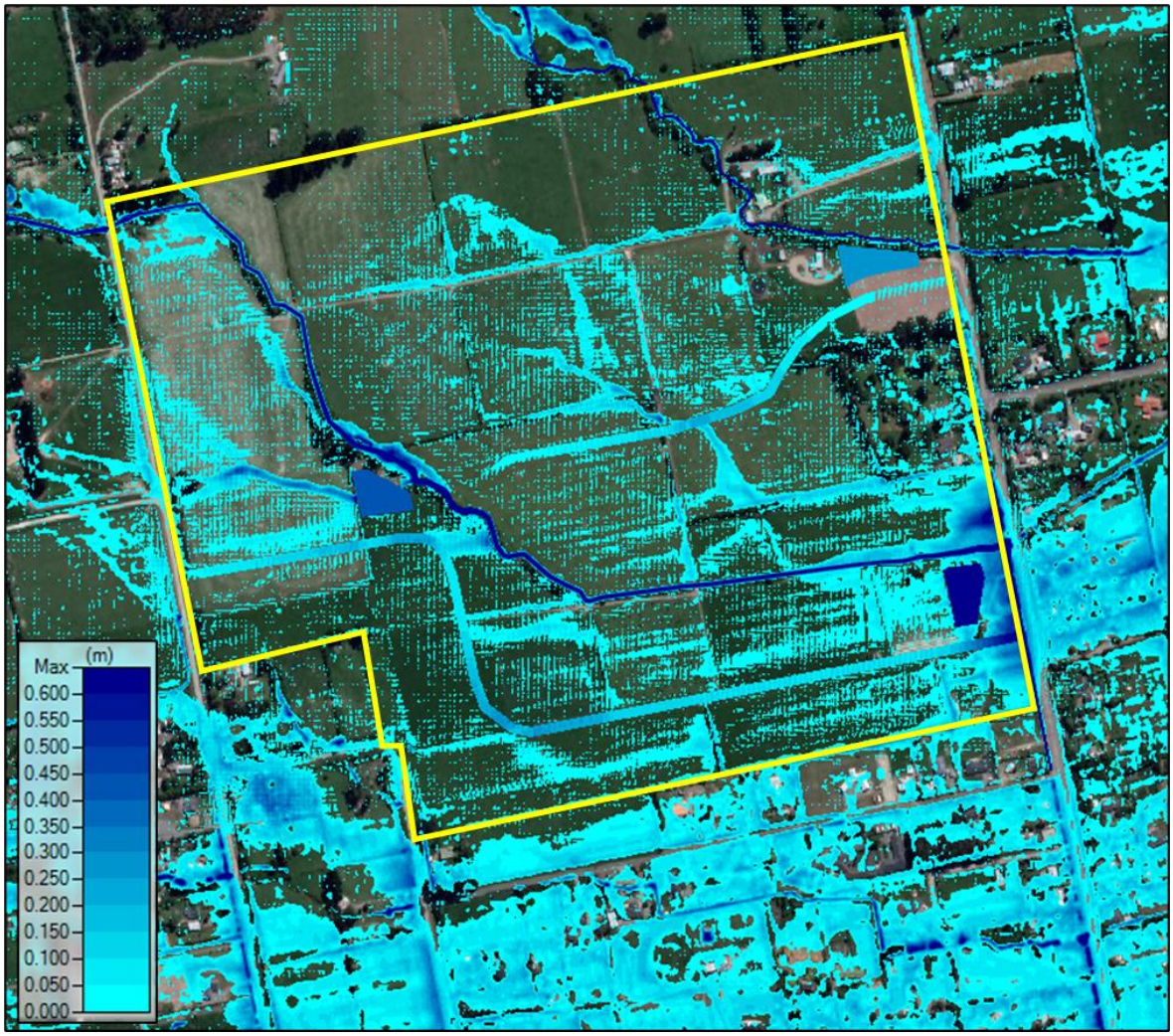


Figure 10. 0.5% AEP HEC RAS Post Development Model Flood Depths

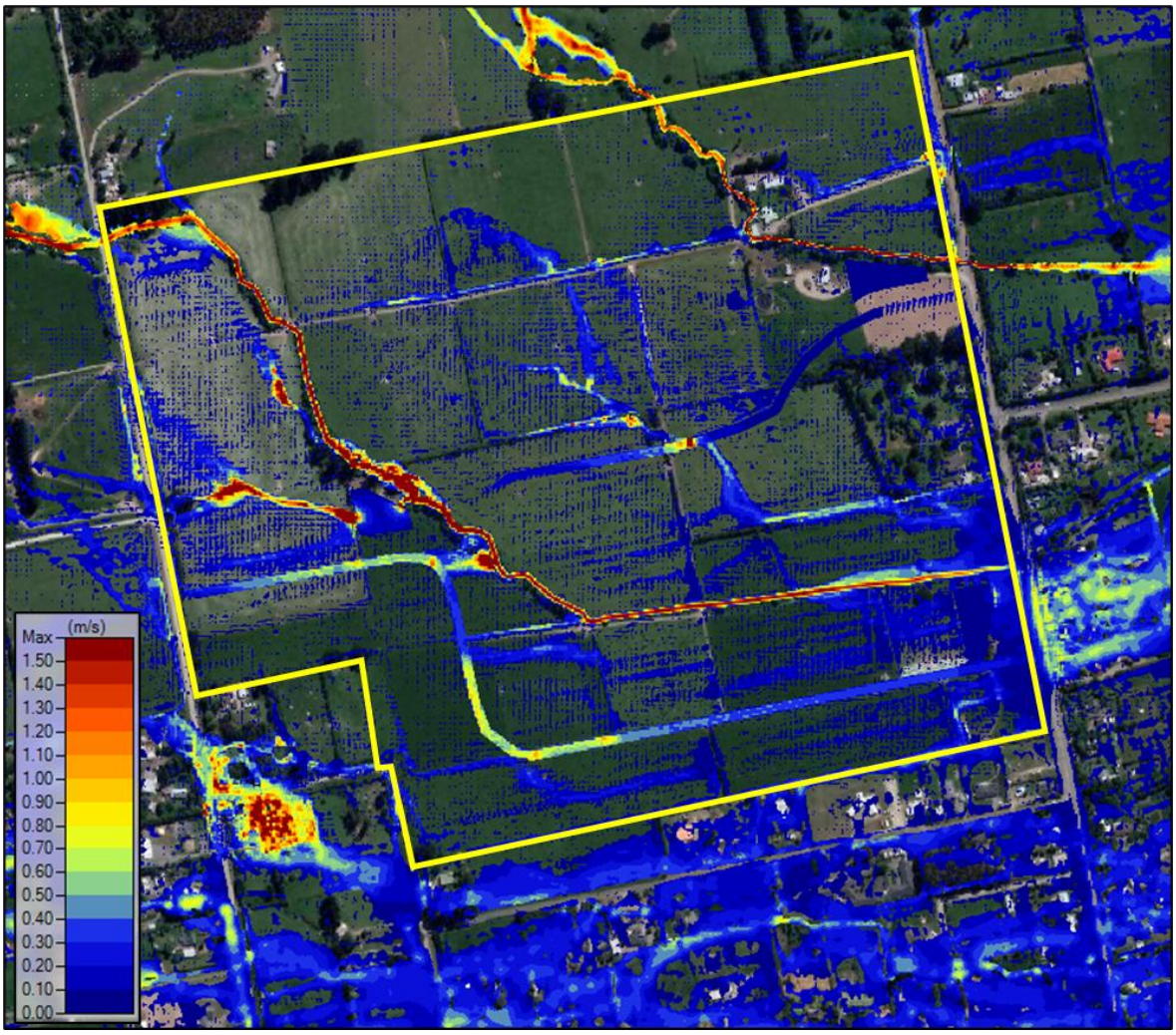


Figure 11. 0.5% AEP HEC RAS Post Development Model Velocities

5.4.2. Difference Between Pre and Post Development Flood Depths

Any future development within the proposed plan change area must not have an adverse effect on surrounding land areas, primarily dwellings and structures. Generally, an increase in flood depth around a dwelling exceeding 20 mm is considered by WDC to be an adverse effect.

Figure 12, on the following page, provides a "difference map" showing the difference in flood depth between the pre and post development HEC RAS modelling simulations (post development minus pre-development). Red indicates that the "post development" terrain results in a decrease in the flood depth and blue indicates an increase.

Overall, the modelling indicates that a future development (based on the current proposed scheme plan) may potentially result in a decrease in the flood depth within the plan change area and has no adverse effect on surrounding properties or infrastructure.

The decrease in flooding is potentially due to the widening of the surface waters in areas where there appeared to be a restriction and the stormwater basin capacities.

It must be noted that the post development model is preliminary and not detailed, however, has been used for the purpose of examining the possible effects of a development.

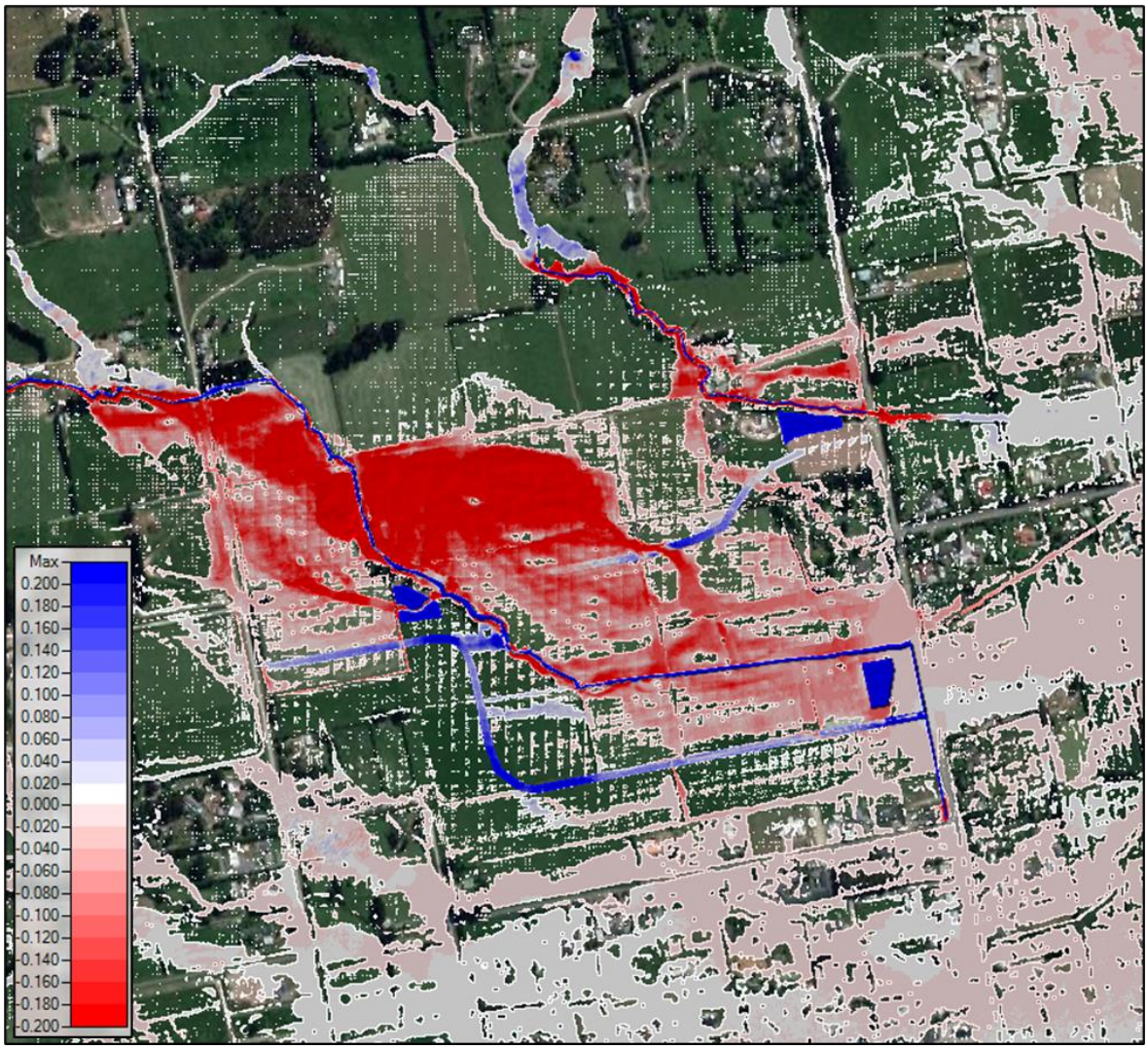


Figure 12. Difference Between Pre and Post Development Flood Depths (Post – Pre)

6. 2% AEP (50 year ARI) Assessment

The 2% AEP flood modelling maps are not available online and have not been requested from WDC, nor has the 2% AEP storm event been modelled on HEC RAS.

The 2% AEP storm will be smaller in magnitude than the 0.5% AEP, which is classed as a low hazard, and therefore the effects of the 2% AEP storm are likely to be minor (e.g. low hazard and will not prohibit development of the area). During future consenting and design stages the 2% AEP effects can be assessed and designed for. Based on the assessment and effects of the 0.5% AEP it is not considered that the 2% AEP will prohibit development.

7. Flood Risk Management Recommendations

7.1. Culvert Design

Culverts maybe required or existing culverts may need to be upgraded, especially at the High Street/Ashley Gorge Road site entrances. The culverts should be sized to accommodate the 10% AEP flow within any surface water, or it maybe considered more prudent to upsize a culvert for improved conveyance during a larger storm event.

7.2. Accessway and Road Design

Accessways and roads should be designed to ensure the flood depth during the 2% AEP is less than 300 mm to allow for the safe passage of vehicles. Any raised road or accessway must not exacerbate flooding around an existing dwelling.

The deepest flood waters are located in the southeast of the site, in close proximity to the access off High Street, however the flood depth in this location is not considered excessive and an engineering solution to ensure the flood depth is less than 300 mm should be achievable. Based on the WDC flood maps and modelling it is considered the velocity at the accessway locations will be low hazard.

7.3. Dwelling Finished Floor Levels

Building platform locations, within each lot, should be positioned away from any 0.5% AEP flood water if possible. Any dwelling located within an area subject to a 0.5% AEP flood flow/depth should have a finished floor level at least 400 mm above the flood level. WDC will need to confirm the required finished floor level in due course.

8. Section 106 Flood Hazard Assessment

Section 106 of the Resource Management Act (RMA, 1991) allows a consent authority to grant or refuse consent subject to the risk from natural hazards and subsequent proposed mitigation measures.

Table 1 provides an assessment of the site flood hazard risk against Section 106 of the RMA.

Clause	**Assessment**	**Compliance (Yes/No)**
1) A consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that – a) there is a significant risk from natural hazards; or b) [Repealed] c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.	The site is located with a predominantly low risk flood hazard environment with flood depths and velocities below what is considered a safety risk. Roads (access) points to the subdivision and individual lots will be designed and constructed to ensure there is no significant risk to people or property from a natural flood hazard.	Yes

1A) For the purpose of subsection (1)(a), an assessment of the risk from natural hazards requires a combined assessment of – a) the likelihood of natural hazards occurring (whether individually or in combination); and b) the material damage to land in respect of which the consent is sought, other land, or structures that would result from natural hazards; and c) any likely subsequent use of the land in respect of which the consent is sought that would accelerate, worsen, or result in material damage of the kind referred to in paragraph (b).	The likelihood of a flood hazard occurring, material damage and the effects of the proposed land use have been assessed. The site is within a predominantly low hazard flood zone and material damage to land and structures and the effects due to a future development are considered to be less than minor.	Yes
2) Conditions under subsection (1) must be – a) for the purposes of avoiding, remedying, or mitigating the effects referred to in subsection (1); and b) of a type that could be imposed under section 108.	Conditions can be placed on the proposed development defining the flood mitigation requirements in terms of the design of roads, accessways and building platforms (location and freeboard requirements).	Yes

Overall it is considered that Section 106 of the RMA does not prevent the proposed re-zoning of the 25 Ashley Gorge Road land area, and subsequent future subdivision consents.

Disclaimer

This report has been prepared by Survus Consultants Limited (Survus) only for the intended purpose as a Flood Modelling Assessment.

The report is based on:

- LINZ LiDAR (2020-2022).
- Waimakariri and Environment Canterbury online Flood Hazard Maps.
- HEC RAS modelling software.
- Photographs and aerial images of the plan change area.

It has been assumed that data supplied by external sources is correct unless otherwise stated. No responsibility is accepted by Survus for incomplete or inaccurate data supplied by other parties.

Whilst every care has been taken during our investigation and interpretation of available data to ensure that the conclusions drawn, and the opinions and recommendations expressed, are correct at the time of reporting, Survus has not performed an assessment of all possible conditions or circumstances that may exist at the site. Variations in conditions may occur between data sources and Survus has provided conclusions in this report based on the best available information at the time of writing. Survus does not provide any warranty, either express or implied, that all conditions will conform exactly to the assessments contained in this report.

The exposure of conditions or materials that vary from those described in this report may require a review of our recommendations. Survus should be contacted to confirm the validity of this report should any of these occur.

This report has been prepared for the benefit of Morgan McIntosh Limited and the Waimakariri District Council for the purposes as stated above. No liability is accepted by Survus or any of their employees with respect to the use of this report, in whole or in part, for any other purpose or by any other party.

Appendix A. Proposed Subdivision Scheme Plan

NOTES :

1. THIS SURVEY HAS NOT INCLUDED SITE MARKING OF THE BOUNDARY POSITIONS UNLESS OTHERWISE INDICATED.

2. NO UNDERGROUND SERVICE INFORMATION IS SHOWN ON THIS PLAN. THE LOCATION OF ANY SUCH SERVICES SHOULD BE CONFIRMED WITH THE RELEVANT LOCAL AUTHORITY OR UTILITY SERVICE PROVIDER.

3. THE SITE DATUM FOR THIS SURVEY IS:

   SEE PLAN FACE FOR 4 SITE BENCHMARKS
   DATUM: NZVD 2016

4. "SPOT HEIGHT" POSITIONS ARE SHOWN IN THE FOLLOWING FORMAT X AND ARE EXPRESSED IN METRES IN TERMS OF THE SITE DATUM FOR THE SURVEY. THE HEIGHTS OF THESE POSITIONS HAVE AN ACCURACY RELATIVE TO THE SITE DATUM AS FOLLOWS:

   × HARD SURFACES eg CONCRETE, ASPHALT +/- 0.030m @ 95% CONFIDENCE LEVEL.
   × SOFT SURFACES eg GRASS +/- 0.050m @ 95% CONFIDENCE LEVEL.

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TOLL FREE 0508 787 887 DARFIELD 03 318 8151

REV	DATE	REVISION DETAILS	
A	02/10/23	FOR SUBDIVISION CONSENT	SRS

DESIGNED | VERIFIED

APPROVED

DATE

PROJECT
MORGAN McINTOSH LTD - 25 ASHLEY GORGE ROAD, OXFORD

TITLE
PROPOSED SUBDIVISION OF RS's 1391, 1956 & 2405; PT RS 1560 AND PT's RS's 1561 & 1626
RT's CB17A/179, CB376/298, CB376/258, CB19B/73, CB19B/74 & CB20A/174; Deeds Index 9D234, 36D637 & 88D741

INFORMATION ONLY

PROJECT NO 15742

SCALE 1:2000 (A1) | SIZE A1

DRAWING NO SC-01 | REV A