Hastings District Council

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DOCUMENT 4

COMMISSIONER HEARING

Meeting Date:	**Wednesday, 30 May 2018**
Time:	**9.30am**
Venue:	**Council Chamber Ground Floor Civic Administration Building Lyndon Road East Hastings**

ITEM **SUBJECT** **PAGE**

Isthmus.

HASTINGS DISTRICT COUNCIL

PROPOSED DISTRICT PLAN VARIATION 4 - IONA RESIDENTIAL

URBAN DESIGN + LANDSCAPE DESIGN STATEMENT

Item 2

Attachment BQ

Client: Hastings District Council

Project: Iona Residential_Variation 4 Proposed Hastings District Plan

Code: 3776

Report: Urban Design + Landscape Design Statement

Status: Final

Date: 14 May 2018

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180514_3776_GL_ Iona Residential Variation 4 Hastings District Plan_Urban Design and Landscape Design Statement

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1 EXECUTIVE SUMMARY

1.1 This report explains the landscape and urban design for the Structure Plan – and related provisions – for the Iona Residential area (Variation 4 to the Proposed Hastings District Plan).

1.2 The design was developed through a workshop process involving representatives of the main landowner (Lowe family) and residents of the surrounding area, facilitated by design consultants and Council specialists. Such a process means the design has been tested through scrutiny by parties with different perspectives and competing interests.

1.3 The design is based around the following key elements:

- The main natural features: Bull Hill and the main valley and ridge – which are to form the reserves.
- Residential development assigned to three distinct neighbourhoods: a small number (20) of lots in the upper part of the site ('Plateau Neighbourhood'), and the remainder concentrated in the lower parts of the site in 'Iona Terraces Neighbourhood' and the 'Bull Hill Neighbourhood'.
- A street and path network that responds to natural features and Havelock North's characteristic street network.

1.4 The objective of accommodating 390-400 dwellings, while maintaining a quality of amenity in keeping with Havelock North's village character, is to be achieved by providing for a variety of lot size so as to promote a choice of housing type and cost – and a subsequent mixed community.

2 INTRODUCTION

2.1 This report explains the landscape and urban design behind the Structure Plan – and related provisions – for the Iona Residential area (Variation 4 to the Proposed Hastings District Plan).

2.2 The purpose of the Variation set out in the s32 Report is 'to make additional land available for greenfield housing development in the Iona Road area of Havelock North.' Most of the subject land has been earmarked for some time in the Heretaunga Plains Urban Development Strategy ('HPUDS') for future residential development. Development of the Iona area had previously not been identified as required within the life of the Proposed District Plan. However, an issue with reverse sensitivity on the priority area for green-fields development on the eastern side of Havelock North ('Arataki') meant that priority shifted to the Iona area to provide a necessary supply of residential sites.

2.3 The majority of the land covered by Variation 4 is owned by Graeme Lowe Properties Ltd and Lowe Family Holdings. In other words, the ownership lends the land to a coordinated development and a comprehensive design. Representatives of the family also expressed a desire to create a quality outcome for the land as a legacy.

2.4 However, there was a degree of contention about the form of development. Isthmus was engaged in January 2017 to facilitate a design through a workshop process involving representatives of the land owners and surrounding residents. The working group established a set of outcomes to direct the design process (see paragraph 4.1).

2.5 The Minister for the Environment subsequently directed Hastings District Council to enter into the Streamlined Planning Process. This direction included the Minister's expectation that the Variation should provide sufficient development capacity for a housing yield of at least 390-400 dwellings.

3 CONTEXT

The 'site'

3.1 Variation 4 covers land on the south-west outskirts of Havelock North at the toe of the 'Havelock Hills'. The focus of the design work for the Structure Plan was the Lowe family land and adjoining rural residential properties on the eastern boundary identified in the HPUDS as suitable for future greenfield development (collectively the site).

3.2 The site falls into three main areas:

- Flat land on the very edge of the Heretaunga Plains
- Rolling hills south of Iona Road
- A plateau at the 'back' of the land.

3.3 Particular features include the following:

- A **central ridge and valley** which cross diagonally across the upper part of the Variation area dividing the rolling hills from the upper plateau. The valley contains several ponds and areas of exotic and indigenous planting undertaken by some residents. The valley and main ridge is to be retained as a central reserve separating the 'Iona Terraces Neighbourhood' and the 'Iona Plateau Neighbourhood'.
- A small but **distinctive knoll (Bull Hill)** near the intersection of Iona and Middle Road, surmounted by a sculpture of a bull. The hill is to be retained as the centre-piece of a reserve, and has given its name to the 'Bull Hill Neighbourhood' on the flat land.
- Two **avenues of trees** lining the driveways to the Lowe homestead from Middle and Iona Roads.

3.4 Most of the site is currently grazed pasture surrounded by the following different landscape character types:

- To the north-west on the opposite side Middle Road is low-lying land that is contiguous with the intensively cultivated Heretaunga Plains.
- To the north-east is suburban Havelock North.
- To the south-east and south-west, surrounding the upper parts of the site, are rural residential properties accessed from Iona Road, Lane Road and Endsleigh Road.

Wider context

3.5 The site is at the toe of the Kohinurakau and Te Matā Ranges that form the backdrop to the Heretaunga Plains. To put the relative elevation in context, the flat land in the Bull Hill Neighbourhood is approximately 10m ASL, while the higher parts of the land (the main ridge and plateau) are approximately 40m – 45m ASL. The backdrop ranges typically rise to between 300m and 400m, with Kohinurakau (Mt Erin) rising to 490m.

3.6 Havelock North has a radial road pattern, two of which (Middle Road, Te Mata Road) follow the toe of the hills (the others radiating across the plains). The site is adjacent to Middle Road and therefore connected directly to Havelock North town centre. Iona Road is also a major cross connection traversing the lower hills. At local scale, the site is connected to Reynolds Road – the central street through the adjoining suburban area. In other word, the site is well connected to the rest of Havelock North.

3.7 The flatter land in Havelock North has a conventional suburban character. In contrast, the hill suburbs have a distinctive pattern of roads winding up spurs and valleys into the foothills. Over time, the lower sections of these roads have become suburbanised, although they still retain a relatively spacious and treed character, and a layout that reflects the underlying landform. The higher slopes near the ends of these roads are characterised by rural residential properties. This pattern was one of the design cues for the Structure Plan.

4 DESIGN

Design process

4.1 At the outset the working group set out the following outcomes:

- A place that adds value to Havelock North;
- Recognition that this is an opportunity to create innovative land development responses to this unique environment;
- A quality environment that reflects best practice urban design outcomes;
- Development provisions that shape the Iona Growth Area and seek to achieve HPUDS objectives – uses land efficiently, while creating a high quality residential community; and
- A structure plan that is developed in a collaborate manner and reflects the above objectives.

4.2 There was general consensus, at the start of the design process, that the flat land was suitable for urbanisation. Contention focused mainly on the form of development on the uphill side of Iona Road. The baseline was that this area – currently zoned rural residential – could be subdivided under existing provisions of the Plan into 1ha lots. Such development would likely be drawn to the ridges to take advantage of aspect and outlook over the plains – a common characteristic of the surrounding area. On the other hand, there was acknowledgement that some form of urban development was necessary to achieve the HPUDS objectives.

4.3 Such matters were discussed over five workshops, recorded in iterative sets of plans, diagrams and commentaries.

4.4 A key principle agreed through workshops – as a means to resolving these competing matters – was to work with the landscape by retaining the main ridge and valley and concentrating development on the lower parts of the site. The reason was two-fold: (i) to retain the ridge and valley as a community amenity, and (ii) to provide a buffer between development and surrounding areas. This essentially entailed a trade-off between avoiding the central ridge (which has the best potential house sites), and re-contouring (terracing) the rolling land north of the ridge to concentrate house numbers in this area instead.

4.5 Other matters explored through the workshops included the configuration of neighbourhoods, alignment of the spine road and street network, the interface with adjacent properties, and lot sizes.

Key elements of the design

4.6 The outcome of the design process – distilled in the Structure Plan – entails the following key elements:

- The main natural features as reserves: the central ridge and valley, and Bull Hill
- A road and street pattern based on a grid of streets on the flat land, and a rural character spine road in the hill section.

- Three distinct 'neighbourhoods' in response to topography:
  - 'Iona Terraces Neighbourhood' (rolling hills)
  - 'Iona Plateau Neighbourhood' (upper plateau)
  - 'Bull Hill Neighbourhood' (flat land)

Reserves based on natural features

4.7 The central valley and ridge are the most prominent features. A reserve incorporating the valley, ridge, and southern hillside are to be the main natural elements of the design:

- The ridge has a distinctive profile that captures an element of the 'sense of place' of the Havelock North hills. It will help separate the more intensive residential development north of the ridge from the rural-residential area to the south and west.
- The valley contains ponds and plantings of both exotic and indigenous vegetation that forms a foundation for the reserve (adjoining residents indicated a desire to be involved in further natural restoration). It is connected to the surrounding are: an access lot connects to Lane Road at the head of the valley, and the lower reserve fronts Middle Road.

4.8 Bull Hill also recommended itself as a reserve: it is a distinctive symmetrical knoll surmounted by a sculpture of a bull (commissioned by the Lowe family).

4.9 Walking routes along the central valley and ridge connect to Middle Road and Lane Road at each end, thereby providing circular routes and access to the wider community. There are frequent connections between the Neighbourhoods and these routes.

Road and street pattern

4.10 The road and street pattern comprises the following:

- A rectangular grid of streets on the flat land in Bull Hill Neighbourhood.
- A winding spine road serving the hillier land above Iona Road (i.e. Iona Terraces and Iona Plateau Neighbourhoods).

4.11 This design took its cue from Havelock North's historic street pattern. The outcome sought is that the spine road echo characteristics of the rural roads winding into the hills. The alignment depicted on the Structure Plan responds to the topography. Criteria against which the detail design will be assessed list such characteristics as (i) grassed swales rather than kerb-and-channel (ii) a footpath on one side only, aligned to fit topography, and a material compatible with rural character (iii) no on-street parking – which allows for a narrower carriageway (iv), street lighting only at intersections, (v) informal arrangement of street trees, (vii) a widened and sloping berm at the mid-point opposite 50 Lane Road (where it adjoins a rural residential property).

Three neighbourhoods

4.12 Aspects of the design for the **Iona Terraces Neighbourhood** include:

- As discussed, the alignment and form of the spine road is designed to echo rural characteristics rather than a conventional suburban street.
- Each cul-de-sac off the spine road is open at the end to ridge/reserve so that there will be visual and physical connections to the central reserve. The reserve will form part of the character of these 'lanes'.
- The land is to be re-contoured to a series of north-facing terraces to accommodate the necessary development. The terracing will sit just below main ridge, which will soften views of the development from areas to the south and west.
- The neighbourhood has a moderate density, with lots averaging 880m^2.

4.13 Aspects of the design for the **Iona Plateau Neighbourhood** include:

- The valley sides around the plateau are to be replanted in indigenous bush. The purpose includes providing a buffer to adjacent properties, softening views of houses, emphasising the natural landform, and improving natural processes (water and wildlife).
- The house platforms are located so as to cluster development to the relatively flat plateau. Houses will be sandwiched between the revegetated perimeter scarp and trees along the spine road. Exotic trees are recommended for the road because such trees are part of Havelock North's 'sense of place', and to provide scale to anchor the houses.
- The spine road is to continue the rural character except that will not have any street lighting in this area.
- Lots 1 and 20 are restricted to single-storey houses to minimise any dominance of the central reserve.
- Lots 13, 14 and 15 also have specific restrictions on height and location to minimise potential effects on the amenity of neighbours.

4.14 Aspects of the design for the **Bull Hill Neighbourhood** include:

- Centring a reserve around Bull Hill as a focal point for both the Bull Hill Neighbourhood, and for the Structure Plan area as a whole. The hill will terminate views along both Reynolds Road extension and the Spine Road. The street south-west of Bull Hill is similarly aligned on the hill so as to connect it with the central valley reserve. In other words, Bull Hill will be a landmark junction between the precincts street network and walking routes.
- Aligning streets around the edges of both the Bull Hill Reserve and the Central Reserve for maximum visibility and access, and so that houses 'front' these open spaces.
- Aligning an internal street so as to incorporate the Lowe homestead driveway avenues within an internal street.

Density and variety

4.15 The **density** varies between the neighbourhoods in response to context:

- The Iona Plateau Neighbourhood is limited to 20 lots with specific house platforms. Lots have an average size of approximately 3000m^2, which can be characterised as 'large lot residential', but this should also be seen in context of the large central reserve which also forms part of the visual catchment.
- The Iona Terraces Neighbourhood is to have an average lot size of 800m^2, which is a reasonably spacious conventional suburban density (with the exception of Area D with a 1000m^2 minimum lot size discussed below).
- The Bull Hill Neighbourhood is to have a maximum yield of 17 dwellings ha net (approximately 590m^2 average).

4.16 Importantly, the design also promotes **variety** of lot sizes – and housing types – within the lower two neighbourhoods.

- The Iona Terraces Neighbourhood provides for a minimum lot size of 350m^2, although the number is limited and proportioned to each 'terrace'.
- The Bull Hill Neighbourhood has a 400m^2 minimum lot size as a development standard, but allows for smaller lots (to 250m^2) as part of a Comprehensive Residential Development.

4.17 The reasons for such variety are to (i) enhance amenity by avoiding monotony (ii) providing choice of housing type and cost and (iii) delivering greater numbers of dwellings than would otherwise be the case with a conventional pattern of standard lot sizes. I consider such variety and mix is also in keeping with a 'village' character which is an aspect of Havelock North's sense of place.

Lane Road and properties on the eastern boundary

4.18 Lane Road runs along the next valley east of the site (it climbs to a spur further south). The valley has a relatively rural character with houses are typically set back from the road amongst trees. A principle of the design is that the Iona Residential area should not encroach on the character of Lane Road,.

4.19 A nuanced approach was taken to the land between the Lowe family land and the ridge dividing the catchment from Lane Road. The boundary was determined in relation to topography, the cadastral boundaries – which don't follow the topography – and on maintaining amenity for those residential properties on the ridge that might wish to retain a rural residential amenity. The properties included in this area that are included in the Iona Terraces Neighbourhood have a 1000m^2 minimum lot size to provide a buffer with adjoining properties.

4.20 The main consideration of alternatives then focused around the street network, number of dwellings, and specific details. Such matters were discussed over five workshops, recorded in iterative sets of plans, diagrams and commentaries.

5 OUTCOMES

5.1 In summary, I consider the Structure Plan will give effect to the following outcomes:

Collaborative design process

5.2 The Structure Plan is the outcome of a collaborative design process between representatives of the main landowners, residents of the surrounding area, and Council staff. In my view, the design successfully resolves competing matters which is reflected by the general support for the Variation from both the landowners and surrounding residents.

Natural and human context

5.3 While the area is to be urbanised, it will incorporate the main natural features as central elements: (i) Bull Hill, (ii) the central ridge and valley – including the ponds and tree planting, and (iii) the landforms of the upper plateau area.

5.4 The road and street pattern will also reflect characteristics of Havelock North.

Connectivity

5.5 The variation will have good connectivity including (i) connection to the existing suburban area via a logical extension of Reynolds Road, (ii) direct connections to arterial routes to Havelock North town centre, (iii) a spine road that echoes the pattern of such roads in Havelock North, (iv) the centring of roads and paths on Bull Hill which will assist legibility, (v) street frontages to reserves, and (vi) a network of paths through Bull Hill reserve and the central reserve with frequent connections to local streets.

Residential capacity and choice

5.6 The Variation will provide for new dwellings at a reasonable density, with both minimum and maximum number of dwellings per ha. The controls providing for a variety of lot size should provide choice of housing type and cost.

Internal amenity

5.7 The combination of the factors listed above should provide good amenity within the Structure Plan area. In summary, they should lead to (i) a mixed community, (ii) varied streetscapes, (iii) a strong presence of natural features, (iv) ready access to a connected reserve network, (v) connectivity to the surrounding areas and Havelock North town centre, and (vi) a distinct identity.

External amenity

5.8 Amenity for surrounding rural residential properties, and adjoining suburban properties, will be retained by the following:

- The retention of the main ridge and valley to separate the main concentration of development from properties on Endsleigh Road and Lane Road.
- Revegetated hillsides around the plateau, and the small ridge in the south-west corner of the plateau, to soften outlook to the Plateau Neighbourhood from properties on Endsleigh Road and Lane Road
- The larger lots in Area D to the east of the spine road to provide a buffer to properties on Lane Road.
- Specific measures (house platform location, single-storey houses, no-building zones) to address outlook from 142 and Lane Road.
- A buffer of 700m^2 lots where the Bull Hill Neighbourhood is adjacent to other zones (i.e. the suburban housing in the Reynolds Road area, along Middle Road, and opposite rural residential properties along Iona Road).

5.9 For the reasons above, I consider the Structure Plan, and the process by which it was arrived at, achieves the '7 Cs' of the New Zealand Urban Design Protocol: Character, Connections, Custodianship, Collaboration, Creativity, Choice and Context.

Gavin Lister
14 May 2018

APPENDIX ONE: QUALIFICATIONS AND RELEVANT EXPERIENCE

1 My name is Gavin Lister. I am a founder of Isthmus, a specialist landscape architecture, urban design, and architecture practice.

2 I am qualified in urban design and landscape architecture, including a Bachelor of Arts (Auckland University), Post-graduate Diploma in Landscape Architecture (Lincoln College), and Masters of Urban Design (Sydney University). I am a Fellow of the New Zealand Institute of Landscape Architects and a member of the Urban Design Forum.

3 I have 30 years' experience throughout New Zealand in a range of project types including infrastructure and energy projects, housing and land development masterplanning, public places and streetscape design, and guidelines and policy work. I played a key role in the overall master-planning of Hobsonville Point development, and prepared the urban design controls for the 'Vinegar Lane' proposed development in Ponsonby. I was a member (including chairperson) of Auckland Council's Urban Design Panel between 2007 and 2017. Specifically,

4 I am familiar with the area. I grew up in Hawkes Bay and have carried out work within the District, for Hastings District Council and other clients, since 1995.

5 I understand resource management processes as they apply to landscape and urban design matters. I have prepared guidelines for carrying out landscape, visual and urban design assessments. I regularly provide evidence to Council Hearings, the Environment Court and Boards of Inquiry. I have completed the Ministry of the Environment 'Making Good Decisions' courses and am a regular member of Auckland Council's Panel of Independent Commissioners.

6 I have worked for applicants and opponents of projects, provided peer reviews and advice to consenting authorities, and acted on design panels. I therefore consider I have a perspective on different roles in the development process.

Stantec

15 May 2018

Hastings District Council
Private Bag 9002
Hastings

Attention: **Anna Sanders**
Senior Environmental Planner Policy (Special Projects)

Dear Anna,

Response to Transportation Related Submissions to the Proposed Iona Urban Growth Area

This letter outlines our response to the transportation related submissions relating to the proposed Iona Urban Growth Area. The structure of this letter is in a manner that provides a response to each submission in the chronological order that they were put forward.

Note that the following submissions did not include any issues relating to the transportation effects:

- Submission No.1 – Tom Harper.
- Submission No.4 – Stuart Rattray.
- Submission No. 7 – Pete Wynn Lewis.
- Submission No.8 - Thomas Allen and Karen Fay.
- Submission No.10 – Brian and Jackie Mills.
- Submission No.11 – Peter Maidens.
- Submission No.13 – Jamie Wilson.
- Submission No.14 – Geoff Gage.
- Submission No.18 – Brian Rickard.
- Submission No.19 – Barry and Tanja Huxford.
- Submission No.20 - Hawkes Bay Mountain Bike Club and Bennelong MTB Club.
- Submission No.22 – David Oliver.
- Submission No.23 – Jeremy Cranswick.
- Submission No.24 – Josephine and Simon Beamish.
- Submission No.25 – David and Elizabeth Ashby.
- Submission No.26 – Christopher Mills.
- Submission No.27 – William Davidson.
- Submission No.28 – Hawkes Bay District Council.
- Submission No.29 - Tahimana Private Residences Ltd.
- Submission No.30 - Malcom and Michelle Hart.

The following submissions refer to decisions regarding the nature of the internal development roads, for which we would refer to the evidence of HDC's Planning and Roading specialists.

- Submission No.6 - David MacCallum.
- Submission No.12 - Phillip Michael Appleford.
- Submission No.16 - Peter and Lois Rutter.
- Submission No.21 – Matt and Rozie Dixon.

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Submission No.2 – Vicki Gold

Comment

Parking in Havelock North is inadequate now, without the addition of 400+ families in the new development. I request that a comprehensive plan is established to address the increase in traffic in the Village.

Response

Covered as part of HDC's Planning Team's response, in conjunction with Council's Parking Manager.

Submission No.3 - Edward Hamilton

Comments

A. The proposal will increase traffic through Havelock North, which is already congested at times.

B. Gilpin Road will become busy and possibly dangerous.

Response (Comment A)

Existing Traffic Volumes and Growth

Peak hour and average daily traffic (ADT) data for roads that will see a rise in traffic following the completion of the Iona Urban Growth Area has been obtained from the RAMM database[1]. This data is summarised below.

Table 1: Recent Traffic Counts (Combined Directions)

Road	Section	Value	Year						Typical Annual Traffic Growth
			2013	2014	2015	2016	2017	2018	
Breadalbane Road	Reynolds Road to Iona Road	Peak Hour	-	150	-	150	-	-	0%
		ADT	-	1,290	-	1,240	-	-	-2%
Havelock Road	Porter Drive to Bridge	Peak Hour	1,210	1,200	-	1,180	1,370	-	3%
		ADT	11,100	10,960	-	11,880	12,830	-	4%
Gilpin Road	Te Aute Road to Middle Road	Peak Hour	-	109	-	-	-	-	-
		ADT	-	738	-	-	-	860	4%
Middle Road	Exmoor Street to Palmerston Road	Peak Hour	530	490	-	520	-	-	-1%
		ADT	4,670	4,540	-	4,560	-	-	-1%
Karanema Drive	Napier Road to Martin Place	Peak Hour	-	-	-	-	-	-	-
		ADT	-	9,100	-	-	-	-	-
Te Aute Road	Porter Drive to Mangarau Crescent	Peak Hour	-	710	-	700	-	-	-1%
		ADT	-	5,870	-	6,370	-	-	4%

Since the delivery of the Transport Assessment (April 2016) the only RAMM traffic count undertaken has been along Havelock Road. This road saw a jump in traffic from 2016 to 2017 with an additional 1,000 vehicles per day (200 in the peak hour for combined directions).

For all other roads, including Gilpin Road, traffic growth is likely to have been low.

Havelock North Village Impact

A high proportion of the trips created by the Iona Urban Growth Area are likely to travel to or through the Havelock North Village (assumption = 85%). From an operational perspective, the biggest impact would be at:

- Middle Road / Porter Drive (give-way control).
- Te Aute Road / Porter Drive (roundabout).
- Havelock Road / Porter Drive (roundabout).
- Havelock Road / Karanema Drive (roundabout).

Analysis of the potential impact on these intersections follows.

[1] *estimate

Middle Road / Porter Drive

To address previously stated concerns relating to the operational impact of the Middle Road / Porter Drive intersection, additional modelling (using SIDRA 7) was undertaken by HDC (Memorandum, 05 February 2018). The assessment used the base assumptions outlined within the Transport Assessment (MWH, 2016).

The modelling showed that the worst level of service (LOS) experienced at the Middle Road / Porter Drive intersection would be for the right turners from the Middle Road approach (LOS B) and that the intersection would not suffer any appreciable reduction in LOS even with the development traffic. Generally LOS D for a minor road approach during peak hours is considered to be acceptable; as such, even on the basis of a higher proportion of development trips using this intersection, we would expect the intersection to continue to operate well.

Roundabouts

Analysis of traffic data has identified that, in order, the busiest roundabouts on the Iona Urban Growth Area to Hastings route are:

1. Havelock Road / Karanema Drive (roundabout).
2. Havelock Road / Porter Drive (roundabout).
3. Te Aute Road / Porter Drive (roundabout)[2].

Indeed, HDC surveys undertaken in 2017 identified that the total volume of traffic passing through the Karanema Drive roundabout is almost double that passing through the Porter Drive roundabout[3].

To understand the current levels of operational efficiency, HDC undertook traffic modelling assessments for the Havelock Road / Karanema Drive and the Havelock Road / Porter Drive roundabouts. Given that the Te Aute Road / Porter Drive roundabout is geometrically similar to the Havelock Road / Porter Drive roundabout, and the volumes are likely lower, we have assumed that the Te Auta Road / Porter Drive roundabout would operate better than the Havelock Road / Porter Drive roundabout.

A summary of the modelling results is provided within Table 2.

Table 2: Havelock Road Roundabouts – Existing Performance

Roundabout	Peak	Degree of Saturation	Level of Service		95th Percentile Queue (m)
			Intersection	Worst Movement	
Havelock Road / Karanema Drive	AM	0.908	B	D	53 m (Havelock Rd – SE)
	PM	0.964	B	D	115 m (Karanema Drive)
Havelock Road / Porter Drive	AM	0.446	A	A	3 m (Porter Drive – SE)
	PM	0.506	A	A	4 m (Havelock Road – NW)

The results show that both roundabouts are currently operating within capacity, recognising that there may be isolated periods when queues (particularly along Karanema Drive during the PM peak) extend beyond 10 vehicles. Notwithstanding, we have undertaken further assessments to understand the potential impact of the Iona Urban Growth Area upon these two roundabouts. The underlying assumptions of the assessments are:

- As per the TIA, 85% of development trips will head towards Havelock North. Of these trips 30% will travel via Iona Road and 70% via Middle Road (again, as per the original assumptions of the TIA).
- 75% of all the trips heading towards Havelock North will pass through the Village and continue through to Hastings. The destination for the remaining trips is the Village itself. In effect, the assumption is that 60% (85% x 70%) of development trips will pass through the Havelock Road / Karanema Drive and the Havelock Road / Porter Drive roundabouts and continue through to Hastings.

Table 3 provides a summary of the results for this 'with Iona Urban Growth Area trips' scenario.

[2] Surveys not undertaken for the Te Aute Road / Porter Drive roundabout. Assumption made based upon review of RAMM data counts.
[3] Two hour volume for Havelock Road / Karanema Drive roundabout = 3,800 vehicles (AM) and 5,100 vehicles (PM). Two hour volume for Havelock Road / Porter Drive roundabout = 2,000 vehicles (AM) and 2,800 vehicles (PM).

Table 3: Havelock Road Roundabouts – Existing Performance + Iona Urban Growth Area Trips

Roundabout	Peak	Degree of Saturation	Average Delay (sec) / Level of Service		95th Percentile Queue (m)
			Intersection	Worst Movement	
Havelock Road / Karanema Drive	AM	1.277	F	F	324 m (Havelock Road - SE)
	PM	1.016	C	F	183m (Karanema Drive)
Havelock Road / Porter Drive	AM	0.611	A	A	37 m (Porter Drive – SE)
	PM	0.608	A	A	38 m (Havelock Road – NW)

The results show that the effect of the Iona Urban Growth Area development trips upon the efficiency of the Havelock Road / Porter Drive roundabout would be relatively low. However, the additional trips generated by the Iona Urban Growth Area may push the performance of the Karanema Drive beyond the standard limits of acceptability (LOS E for the worst movement).

Notwithstanding, regardless of whether the Iona Urban Growth Area is introduced, general background traffic growth driven by other local housing and business developments is likely to mean that this intersection will require some form of upgrade within the next few years.

We understand that a review of the functionality of the roundabout is being planned by the HDC road asset department. Further to this, we would also recommend that HDC undertake a business case to determine how any upgrade to the Karanema Drive roundabout would fit into a wider transport solution for Havelock North.

Response (Comment B)

Traffic Volume Rise along Gilpin Road:

The Structure Plan does not propose any direct connection onto Gilpin Road and the road does not form part of the shortest or quickest route between the Iona Urban Growth Area and Hastings or Havelock North Village. For these reasons the TIA assumed that only 10% of the development traffic would use this road.

For the majority of the day we would not expect traffic volumes along Gilpin Road to notably rise. However, we understand that recently Gilpin Road is being used more as a rat-run to avoid congestion (particularly around school close time) along Heretaunga Street East. Should this Heretaunga Street East be upgraded (and travel times become shorter and more reliable) we would expect the rat-running effect along Gilpin Road to subside.

However should issues along Heretaunga Street East remain, the number of trips from the Iona Urban Growth Area heading along Gilpin Road may be higher than the assumed 10% (during peak times at least). If this scenario eventuates then HDC may need to consider minor safety works for the whole of Gilpin Road and its intersections with Middle Road and Te Aute Road. Operationally we would still expect both intersections with Gilpin Road to work well with low levels of delay.

Safety along Gilpin Road:

To understand the safety implications of the development upon Gilpin Road, the most recent crash history records from the NZ Transport Agency's CAS database have been reviewed. Over the last full five year period (2012-2017) there have been three crashes along Gilpin Road, of which two were caused by an intoxicated driver. The other crash occurred late at night as a result of a driver following too closely. The nature of these accidents do not suggest any significant safety issue along Gilpin Road that would be exacerbated through the addition of only a small amount of extra traffic (in the region of 10% of the total development trips).

However as above, if traffic does rise, we would recommend that HDC consider minor safety improvements for the whole of Gilpin Road between Te Aute Road and Middle Road (inc. the intersections).

Submission No.5 - David and Colleen Youngquest

Comments

A. There is potential for traffic along Middle Road and through the Middle Road/Porter Drive intersection to increase.

B. We consider that improvement to public transport, cycle lane provisions and reduced speeds are important.

C. Increased traffic and speed along Margaret Avenue.

D. Heavy traffic restrictions along Iona Road during development construction.

Response (Comment A)

See response to Submission No.3. Traffic modelling has indicated that the efficiency of Middle Road or at the Middle Road/Porter Drive will not be notably affected by development of the Iona Urban Growth Area.

Response (Comment B)

We agree that accessibility to public transport and provisions for cyclists are important features which help reduce the reliance on the private car and as a consequence reduce congestion and improve amenity. Currently no bus routes pass by the proposed growth area. However we understand that HDC will work with Hawkes Bay Regional Council to identify the benefits of providing bus routes that would serve the area at an appropriate time. We also understand that Palmerston Road, which will be connected to the Iona Urban Growth Area via the extension of Reynolds Road is proposed to be upgraded to include improved cyclist facilities (i-way map).

Upgrades are also planned on both Iona and Middle Roads to ensure that levels of service are maintained as the areas develops from a rural and rural-residential area to an urban residential area. Following the development, speed reductions to 50kph for Middle Road and Iona Road will be considered by HDC, extending out to the Gilpin Road intersection.

Response (Comment C)

The development being planned has no connection with Margaret Avenue. Any rise in traffic along Margaret Avenue would relate to short distance trips from resident dwellings and the Iona Urban Growth Area (potentially say to a Dairy if one were introduced). Any consequential traffic rise would be negligible and within the range that would be similar to the daily fluctuation of traffic (+/- 5%).

Response (Comment D)

In order to minimise any adverse impacts associated with the works, a Traffic Management Plan should be developed by the contractor to the full satisfaction of HDC. The Plan should define the following minimum requirements:

- As far as practicable, heavy vehicle movements should avoid passing by schools during the opening and closing times.
- All construction personnel parking shall be accommodated in defined areas on site with little or no overspill onto the surrounding local roads.
- All vehicles transporting cut and fill should have adequate damping and cover to avoid dust impacts on adjacent properties.
- The Contractor shall use Variable message Signs (VMS) boards and approved notification signage to Auckland Transport / NZTA standards to provide early as well as on-going warning to all road users and the public of upcoming changes to road usage.
- The Contractor shall provide letter drops to all properties within and around the construction area warning them of upcoming changes to road usage.

These are however general considerations and we refer to the evidence of HDC in regard to the likely construction methodology.

Submission No.9 - Robert and Nicky Gardner

Comments

A. Gilpin Road is not adequate to cope with the volumes of traffic that the subdivision will create. It is already difficult to pass when cars are travelling each way.

B. Concern regarding how the traffic will impact movement through the Village.

Response

See response to Submission No.3. We consider that the additional traffic created by the development and travelling along Gilpin Road will not generate any significant operational or safety issue.

Submission No.15 - Dale Prebble

Comments

The transport assessment (*HDC Memo*) needs to be re-visited and include the build-up of traffic on the three roundabouts between the end of Middle Road and the bridge over the Karamu Stream.

Response

See response to Submission No.3.

Submission No.17 - Noel Martin-Smith

Comments:

A. The opening up of Reynolds Road to create a "spine road" for the proposed subdivision will result in unacceptably high traffic volumes on Reynolds Road and Breadalbane Road.

B. The TIA ignores the impact of the proposed development on Reynolds Road or Breadalbane Road (the most direct route to Reynolds Road).

C. The TIA does not consider the likely impact on roading of the proposal to alter the "Special Character" zoning to allow the building of an additional 54 dwellings on Breadalbane Avenue.

D. The TIA references outdated or estimated traffic counts. Further a 'traffic count' on Middle Road on one day for a period of nine hours on one road in a single day is, in statistical terms, totally irrelevant.

Response (Comment A):

The average daily traffic (ADT) volume along Breadalbane Road is around 1,300 to 1,500 vehicles. The ADT along Reynolds Road is likely to be in the region of 200 to 300 vehicles[4]. The predominant destination from the Iona Urban Growth Area is likely to be the Havelock North Village (or through to Hastings).

For trips from the Southern part of the Iona Urban Growth Area (south of Iona Road), the journey distances to the Village Centre are as follows:

- Via Iona Road and Lucknow Road – 2.9km
- Via Iona Road, Breadalbane Road and Middle Road – 2.4km
- Via Middle Road – 2.2km

The shortest route between the Iona Urban Growth Area (south of Iona Road) is via Middle Road (avoiding Breadalbane Road).

For the northern part of the Growth Area, where the new 'spine road' is proposed, three access points onto Middle Road are proposed which would serve a high proportion of residents Breadalbane Road meaning that Reynolds Road would not form part of any major route to/from Havelock North Village for these people.

Notwithstanding, we recognise that there will inevitably be some rise in traffic along Breadalbane Road and Reynolds Road. As such, we recommend that following the introduction of the development that traffic volumes along these roads are closely monitored to ensure that safety for future and existing residents is not compromised. If traffic volumes and speeds rise to undesirable levels, HDC may wish to consider implementing traffic calming measures to ensure that Middle Road and Iona Road function as the primary collector roads and that Breadalbane and Reynolds Road retain the feel and function of local roads.

Response (Comment B and C)

HDC have confirmed that there are no proposed developments on Reynolds Road or Breadalbane Road. The new Iona Urban Growth Area will result in an extension of Reynolds Road into this development area terminating at the Bull Hill Reserve as shown on the Structure Plan. Breadalbane Avenue is within the proposed Special Character Zone and is part of the proposed Iona Urban Growth Area. This specific area has an expected yield of approximately 30-40 dwellings - however this yield is accounted for in the overall Iona Urban Growth Area Development capacity of 390-400 dwellings.

Further, any other proposed (and yet uncommitted) future developments are subject to separate resource consent applications with separate Transport Impact Assessments. Those applications will however have to take account of the Iona Urban Growth Area (should resource consent be granted).

[4] Based on 2009 count of 180 vehicles per day.

Response (Comment D)

The traffic modelling used volumes that were derived using the following process:

1. Gathering recent traffic data (as shown in Table 1) from the RAMM database for Middle Road, Iona Road and Gilpin Road.
2. Identifying the historic annual traffic growth percentages.
3. Applying growth to the most recent available traffic count to obtain an estimate for 2016. For example, if the most recent data available was for 2014 and uplift factor was applied to capture two year growth based on historic trends.
4. Undertaking a turning movement survey for the Middle Road/Iona Road/Gilpin Road intersection.
5. For each approach, comparing the two-way volumes from the traffic surveys and the RAMM database.
6. Applying an uplift factor to the turning movement counts.

Thus whilst a turning movement survey was undertaken for one day, the primary purpose of the survey was to understand the distribution of turning movements. Thus, the modelling represents typical weekday traffic, not an isolated day.

Matt Soper

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TE KAUNIHERA O HERETAUNGA

MEMORANDUM

File Ref Record Number

To: Anna Sanders
From: **Matthew Kneebone**
Copy to: Rowan Wallis
Date: 14 May 2018
Subject: Iona-Middle Housing Development – Response to Stormwater Submissions

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Introduction/background

- Area is part of wider HPUDs land development strategy.
- There area is outside of an HDC stormwater system.
- The catchment is currently serviced via a rural drainage system, comprising of roadside drains and open drains across private land.
- The receiving environment is the Karamu Stream, approximately 700m to the north-west of the proposed development area.
- Runoff from the Iona hills passes through multiple properties which are privately owned.
- The ownership and responsibility of the open drainage network is a mixture of privately maintained drains and formal HBRC flood protection schemes.
- HBRC have a maintenance programme in place for a number of the drains below Middle Rd.

Development proposal/mitigation measures

- Stormwater management is required where there is a significant change in the landform. In converting pastoral land (pre-developed state) into residential properties (post-development state) there is an increase of impervious surfaces – rooves, roads, driveways etc and less pervious (grass) areas to absorb rainfall.
- This type of change in land use, results in a change to runoff rates – less rain is absorbed and moves faster in an urban environment (via pipes/roads).
- As part of the structure planning for new developments such as this, a stormwater management plan needs to quantify the difference between the pre-development runoff rates and the post-development runoff rates. This becomes the basis for determining any mitigation solutions.
- The development is to be hydraulically neutral from a stormwater perspective – that is there shall be no increase in peak runoff as a result of the residential development. In other words, there should be no significant effect on downstream properties.
- The developer has produced a stormwater assessment report, detailing the contributing catchments, flow paths and pre/post-development runoff rates.
- This assessment has been used to identify potential stormwater mitigation options, for quantity management (volume controls) and quality improvements (contaminant capture).

- The concept of mitigation in this proposal involves the construction of storage ponds within the development and land owned by the developer, to capture runoff and slow the flow to predevelopment rates.
- The mitigation measures proposed include detention ponds, roadside swale drains and wetlands to manage quantity and quality aspects.
- The mitigation measures proposed are specific to the individual catchments – the size and scale of the mitigation proposed is directly related to the size of the contributing catchments.

Comments on submissions received

<u>Edward Hamilton</u>

1. Opposes the residential development and questions the need for additional dwellings.
2. Concerned about stormwater runoff from development.
3. Concerned about ongoing maintenance of the Gilpin Rd roadside drain.

Response to matters raised

1. Planning issue, not directly related to stormwater.
2. Developer has produced a detailed stormwater report assessing both pre and post development scenarios, and provided mitigation options to reduce the impact of the urban development.
3. Council has set aside funding for stormwater improvements to the drain along Gilpin Rd as part of the Iona-Middle housing development. In the interim frequency of open drain maintenance will be reviewed based on the submissions made.

<u>Thomas and Karen Dear</u>

1. Stormwater management, with a particular focus on Outlet I.
2. Historic ponding issues on site, creation of land drainage across property. Wants piping of open drainage network through their property.
3. Lower housing density.
4. Structure planning for wider area.

Response to matters raised

1. Details of stormwater management contained in the T&T stormwater assessment. The report shows a reduction in the size of the catchment area draining to Outlet I. The predevelopment catchment area draining to Outlet I is 4 hectares, post development the catchment area is reduced to 2 hectares. The report identifies a corresponding reduction in peak flows to Outlet I in the post development - mitigated scenario.
2. The development is required to be hydraulically neutral and with mitigation there is a reduction in peak flow rates for a range of design storms. There is no proposal to pipe any of the downstream drainage network. When an open drainage network is piped, the capacity of the pipe can often be less than the capacity of an open drain. There will still be a need for some secondary flowpath through the land, so there will still be a need for an open channel network across the property.
3. Planning issue – no stormwater comments.
4. Planning issue – no stormwater comments.

Robert and Nicky Gardner

1. Stormwater management, with a particular focus on Outlet G, Bull Hill and Breadalbane Ave.
2. Historic ponding issues on site, creation of land drainage across property. Wants piping of open drainage network through their property.
3. Raised concerns regarding ongoing maintenance of open drainage network through their property.
4. Traffic volumes along Gilpin Rd and wider infrastructure needs – supermarket, schools etc.

Response to matters raised

1. **Outlet G:** A large stormwater detention pond is proposed to be constructed at the location of Outlet G, as shown in the stormwater assessment report. This storage pond will be sized to detain the increase in peak runoff from the post development catchment draining to Outlet G. The existing land above Outlet G will be modified and new drainage paths created through the urban development – via pipes and roads. This storage pond will release water at a rate no greater than the predevelopment runoff rates.

   Outlet E/Bull Hill: A storage pond similar to that proposed at Outlet G is to be formed around the lower lying land of the Bull Hill reserve area. This storage pond will store and slowly release runoff via Outlet E. The existing land above Outlet E will be modified and will result in a decrease in the catchment area draining to Outlet E. The catchment area will reduce by 4 hectares, from 36 to 32 hectares. The effect of this area reduce and the mitigation proposed will reduce the peak flow rates discharging into Outlet E.

   Breadalbane Avenue: Any development in the Breadalbane Ave area will be subject to the same stormwater requirements as the Iona-Middle development - that is hydraulic neutrality is to be achieved, such that the post development runoff is no greater than pre-development flow rates. In addition, the runoff from Breadalbane Rd will pass through the storage pond at Outlet E before being discharged into the land below Middle Road.
2. The development is required to be hydraulically neutral and with mitigation there is a reduction in peak flow rates for a range of design storms. There is no proposal to pipe any of the downstream drainage network. When an open drainage network is piped, the capacity of the pipe can often be less than the capacity of an open drain. There will still be a need for some secondary flowpath through the land, so there will still be a need for an open channel network across the property.
3. There is an HBRC drainage scheme servicing this property and the catchment above Middle Rd. The HBRC Works Group currently carries out drain maintenance – spraying, mowing and drain cleaning on this property.
4. Planning issue.

William Davidson

1. Stormwater management with a particular focus on Outlets D, E, F & I.
2. Historic ponding issues on site, creation of land drainage across property. Wants piping of open drainage network through their property.
3. Concerned the structure plan does not include drainage improvements on the Davidson land.
4. No increase in the catchment area draining to Outlet E.
5. No flooding to occur on land in the future.

Response to matters raised

1. The T&T stormwater report outlines the mitigation measures proposed across the development area and includes significant storage pond in both the upper and lower parts of the catchments draining to Middle Rd. These storage ponds will be sized to detain the increased in runoff from the developed catchment to ensure that peak flow rates are not significantly increased as a result of the housing residential housing development.

   The report has identified the existing flowpaths through the development area and their outlet locations along Middle Rd.

   Outlet D: This outlet under Middle Rd is 1500mm in diameter and services a large rural catchment of 146 hectares. A large storage pond will be created in the upper part of the catchment to buffer the flow from the catchment area above the housing development. As part of the earthworks and internal roading network, there is proposed to be a slight increase in the size of the catchment discharging to Outlet D, from 146 to 149 hectares. This will divert some of the runoff from Outlet E to Outlet D, reducing the runoff into the Davidson land. Council is working with the developer on options in the lower catchment to provide mitigation just upstream of Outlet D.

   Outlet E: This outlet is located at the base of the Bull Hill and discharges under Middle Rd into the Davidson land. A storage pond will be created at the base of the Bull Hill to provide mitigation of post-development flows and the post-development catchment will reduce by 3 hectares.

   Outlet F: This outlet is the discharge point from a gully running from above Lane Rd towards the Bull Hill. This outlet point is not piped under Middle Rd and runs along the Middle Rd roadside drain, connecting into the piped culvert under Middle Rd referred to as Outlet E.

   Outlet I: Is located between the existing development called Stapleford Park and the main entrance to the Lowe residence. A reduction in the size of the catchment discharging to Outlet I is proposed.
2. The Davidson properties receive runoff from the catchments above Middle Rd, from two piped outlets – Outlets E & I (outlet F is conveyed along Middle Rd to Outlet E). There are a number of open drains through the Davidson land, conveying runoff to Gilpin Rd. In some areas it appears that modification of the land over time has either blocked runoff along natural gullies and channels or redirection has occurred resulting in additional open drains being created to assist with drainage.
3. The open channel network across the Davidson properties is not part of the HBRC maintained network and remains in private ownership.

   This residential development may provide an opportunity for the Hastings District Council, Hawkes Bay Regional Council and affected landowners to collectively work together to improve the overall efficiency of the land drainage network.
4. The developer is proposing to reduce the size of the catchment draining to Outlet E and also provide a storage pond for mitigation of post development runoff.
5. The stormwater network and associated infrastructure to be provided by the developer is designed in accordance with the HBRC Waterway Guidelines, which provide a range of options to provide for quality and quantity management of stormwater for a range of developments. These guidelines require the developer to reduce the runoff from a developed catchment to 80% of the predevelopment scenario in a 1 in 100 year design storm. However there is always the potential for a storm larger than the 1 in 100 year design event to occur and given the low lying nature of the land below Middle Rd, there will always be some risk of flooding.

Hawkes Bay Regional Council

1. Further assessment of mitigation at Outlet D.
2. Variation 4 be approved, subject to outcome of assessment at Outlet D.
3. HBRC and HDC continue a collaborative approach to assess this development.

Response to matters raised

1. HDC agree that further work is required to assess and confirm mitigation requirements related to the stormwater discharge to Outlet D.
2. Also agree with this approach.
3. HDC and HBRC have been working with the developer to date and will continue to collaborate to reach agreement on an appropriate stormwater solution for this development.

Graeme Lowe Properties Ltd & Lowe Family Holdings

1. Reduction in the size of the detention pond at Outlet G.
2. No mitigation of runoff in the lower catchment above Outlet D.
3. Ownership of stormwater management areas and open space.

Response to matters raised

1. The structure plan has highlighted an area larger than that identified in the T&T report. This is due to the conceptual nature of the stormwater mitigation solutions proposed for this development. It is expected that during the detailed design of any future detention ponds that changes will occur to the indicative size and shape of the pond proposed.
2. Both HBRC and HDC are concerned about the approach to no mitigation being provided in the lower reaches of the catchment above Outlet D. Any runoff from the lower portion of this catchment will be conveyed through the 1500mm diameter culvert under Middle Rd without any form of mitigation. The developer is proposing to provide offset mitigation in the upper reaches of the catchment, as a way of reducing the overall runoff from the entire catchment to Outlet D.
3. It was expected that the developer would vest to Council the areas set aside for stormwater management and that Council would maintain these facilities on behalf of the community. If the land were to be retained in private ownership the on-going maintenance requirements would need to be undertaken by the landowner.

Matthew Kneebone
Stormwater Manager
matthewk@hdc.govt.nz

REPORT

Tonkin+Taylor

Middle and Iona Road Proposed Development, Havelock North

Stormwater Flood Effects Assessment

Prepared for
Lowe Corporation Ltd

Prepared by
Tonkin & Taylor Ltd

Date
October 2017

Job Number
1003185.v3

Exceptional thinking together

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1 Introduction

Tonkin and Taylor Ltd (T+T) have been engaged to carry out an assessment of stormwater requirements for the proposed Iona Road development in Havelock North, Hawkes Bay by the Lowe Corporation Ltd (LCL).

We understand that the Hastings District Council (HDC) is planning for a new residential development in the Iona area on the south-west side of Havelock North. The area is referred to as the Iona residential growth area and is made up of land between Middle and Iona Road, land on the hills on the south side of Iona Road and some lower hill land accessed off Breadalbane Ave. A significant portion of this area is owned by LCL.

Mitchell Daysh are providing project management and planning advice to the client LCL with regard to the overall development and consenting process. Isthmus have provided conceptual plans of the entire proposed development, part of which is located on land owned by LCL.

The proposed development is identified within the Heretaunga Plains Urban Development Strategy (HPUDS). HPUDS is a sub-regional urban growth strategy developed by HDC, Napier City Council (NCC) and Hawkes Bay Regional Council (HBRC).

This assessment only considers the effects of the proposed development located on land owned by LCL. It does not considered the effects of the entire HPUDS area.

This assessment is made up of the following sections:

Section 2 - Scope of works

Section 3 - Regulatory requirements

Section 4 – Existing site description

Section 5 – Proposed development

Section 6 - Methodology

Section 7 - Hydrological assessment of the existing site

Section 8 - Hydrological assessment of the proposed site without mitigation

Section 9 - Development of hydrological mitigation options

Section 10 - Hydrological assessment of the proposed site with mitigation

Section 11 - Downstream flood effects assessment

Section 12 - Further design considerations

Section 13 - Conclusion

2 Scope

The key objective for this stormwater assessment is to demonstrate that the proposed development can meet the requirements in the HBRC Waterway Guidelines Stormwater Management (WGSM). This is to ensure that as a result of the proposed development, the downstream hydrological environment is unchanged or alternatively, the impacts on the downstream system are negated via improvements or mitigation works.

The scope of works required to achieve the key objectives are as follows:

- Undertake a hydrological assessment for the present day (2017) land use
- Undertake a hydrological assessment for the proposed situation (which includes future development) without mitigation
- Determine mitigation measures required to adequately address all potentially adverse stormwater effects
- Determine whether stormwater can be managed within the development to ensure no downstream adverse effects
- Undertake a concept design for flood management and stormwater quality controls within the proposed development
- Undertake hydrodynamic modelling to determine downstream flood effects that would occur as a result of the proposed development with mitigation controls in place
- Assess the effects of stormwater runoff from the proposed development with mitigation in place and demonstrate how the proposed mitigation works are able to adequately address adverse effects.

3 Regulatory requirements

Stormwater management for the proposed development has been aimed at compliance with the following documents:

- HBRC Waterway Guidelines Stormwater Management (May 2009) (WGSM)
- HDC Engineering Code of Practice 2011
- Heretaunga Plains Urban Development Strategy (HPUDS)
- NZS 4404:2010 – Land Development and Subdivision Infrastructure

HBRC's Waterway Guidelines have the following recommendations for development stormwater runoff effects:

Storm peak discharge control

- Where there are existing flooding sensitivities downstream it is recommended that the post-development peak discharge for the 100 year storm for a new project be limited to 80% of the pre-development peak discharge
- That the 2 and 10 year post-development peak discharges not exceed the 2 and 10 year pre development peak discharges
- The rainfall data for the 2, 10 and 100 year storms should be increased to allow for predicted climate change effects

Stream erosion control

- To mitigate against stream erosion, 1.2 times the water quality volume should be live storage provided within the stormwater management systems to be infiltrated or released over a 24-hour period

Water quality control

- The 90% storm map (Figure 6-5 in the HBRC's WGSM) is to be used for determining water quality treatment volumes and flow rates in sizing stormwater management practices
- The proposed treatment system is to remove 75% of total suspended sediment on a long-term average basis

4 Existing site description

The existing subject site is the land owned by LCL that is being considered for development. The subject site is located south west of Havelock North, Hawkes Bay and is made up of two distinct areas;

- The Iona Triangle site (referred to as 'Triangle site')
- The Iona Hill site (referred to as 'Hill site')

The subject site is shown in Figure 1 below.

Figure 1 - Aerial image of the subject site (Aerial image from HDC online map viewer, Imagery 2017 Urban layer)

The Triangle site and Hill site are located on land owned by LCL and there are additional areas contained within the HPUDS area owned by a number of other private owners. The LCL land and the additional HPUDS area is discussed further in Section 5.

4.1 Triangle site description

4.1.1 Land use and character

The Triangle site has an approximate area of 17 ha and is bounded by Middle, Iona and Breadalbane Roads. The parcels of land at the eastern and western ends of the Triangle are used for grazing where the middle section contains lifestyle sections with mature trees and gardens. The Triangle site has a flat to gentle sloping topography with a hill approximately 20 m high in the western parcel.

Figure 2 shows the aerial image of the Triangle site and its key drainage features.

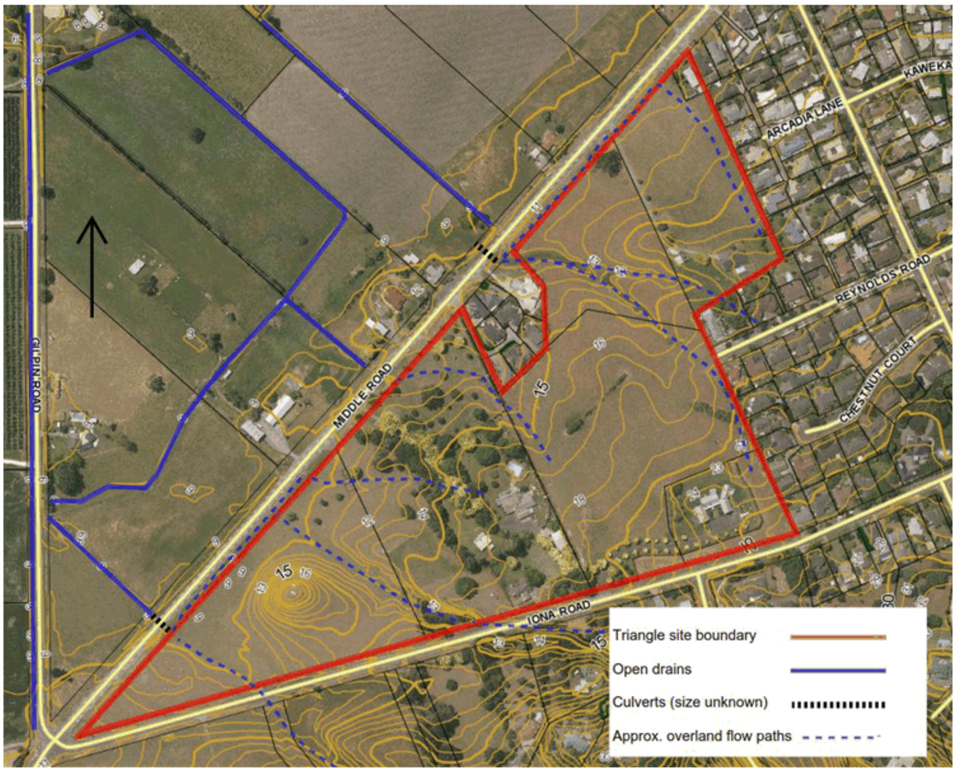

Figure 2 - Aerial image showing Triangle site and drainage features (Aerial image from HDC online map viewer, Imagery 2017 Urban layer)

As part of the development it is proposed to rezone the land residentional subject to compliance with the structure plan developed specifically for the Iona area.

4.1.2 Drainage and receiving environments

The Triangle site is not currently part of the urban stormwater network. Stormwater runoff generated on the site and from upstream catchments discharges to three locations along Middle Road. Runoff at these locations is conveyed beneath Middle Road via culverts and discharges to open 'farm' drains on the north western side of Middle Road, as shown in Figure 2. The Karamu Stream is the final receiving water body for the open drains from the site.

It is understood that there is stormwater ponding after heavy rainfall events in the low lying areas between the Karamu Stream and Middle Road (i.e. north west of Middle Road).

4.2 Hill site description

4.2.1 Land use and character

The Hill site has an approximate area of 27 Ha and is located on the south side of Iona Rd, between Lane and Endsleigh Roads. The topography of the site is a series of valley and ridgelines that are orientated towards Iona Road and form part of the lower Havelock Hills (Kohinuraukau Range). Within the main valley is a series of manmade ponds that are planted in both native and exotic species. The ponds are fed by groundwater and surface runoff from upstream catchments, outside the site boundary. It appears from historic photos that the south eastern pond was created prior to 2004 while the remainder of the ponds were created sometime between 2004 and 2008.

Refer to Figure 3 showing the aerial image of the Hill site and key drainage features.

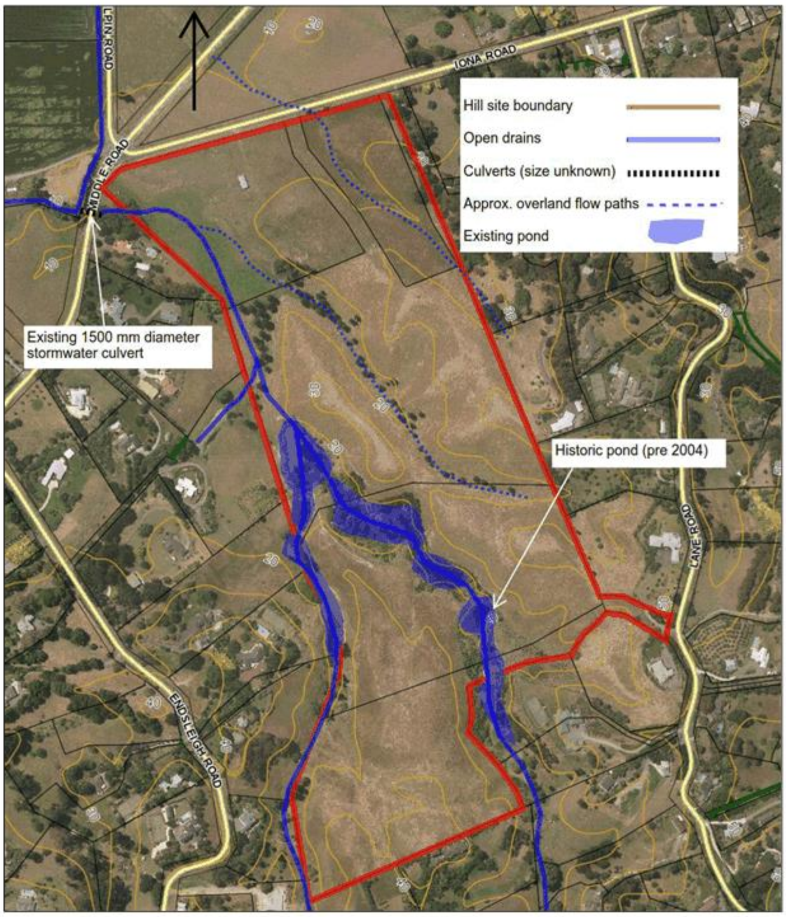

Figure 3 - Aerial image showing Hill site and drainage features (Aerial image from HDC online map viewer, Imagery 2017 Urban layer)

The Hill site is currently zoned as Rural Residential under the Proposed Hastings District Plan. As part of the development it is proposed to re-zone the land residential subject to the Iona Structure Plan.

4.2.2 Drainage and receiving environments

The Hill site is not currently part of the urban stormwater network. The majority of the stormwater runoff generated on the site and from upstream catchments is conveyed via natural channels within the valley and also passes through a series of ponds, as described in Section 4.2.1. Runoff within the main channel is conveyed beneath Middle Road via a 1500 mm diameter culvert and into an open drain on the western side of Middle Road. This open channel appears to diverge to two road side channels along Gulpin and Richard Road and finally discharges into the Karamu Stream. The area in the north eastern corner of the Hill site discharges into the Triangle site.

Figure 3 shows the location of the drainage features and downstream receiving waterbodies.

5 Proposed development

The proposed development consists of the three main areas as indicated in Figure 4 below. The Triangle site and Hill site are located on land owned by LCL while the remaining HPUDS area is held by a number of private owners.

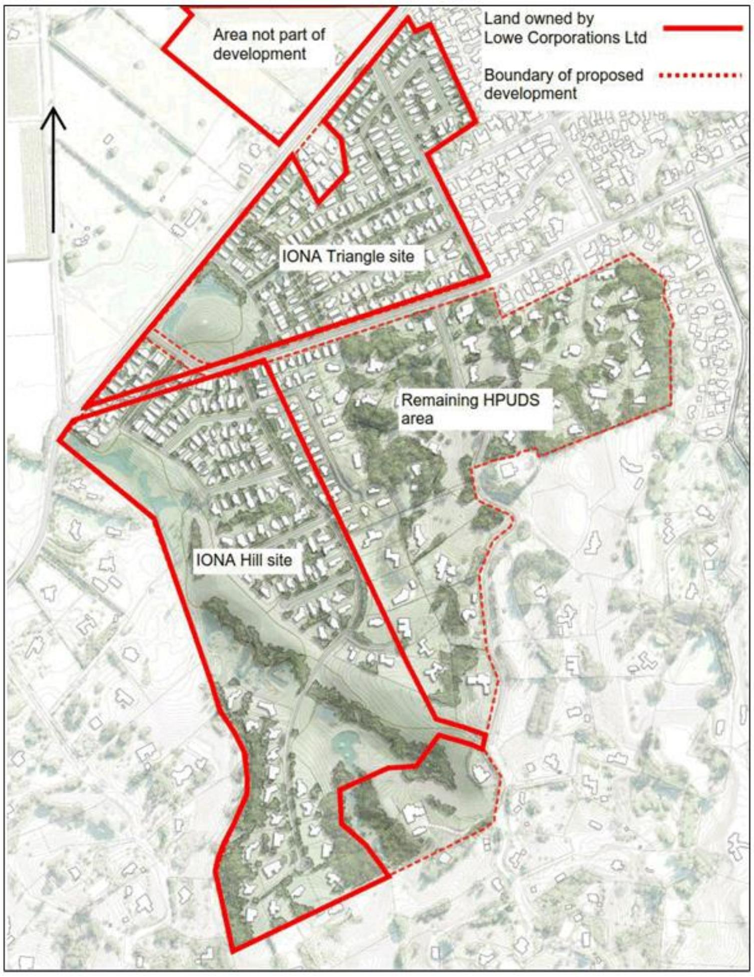

Figure 4 - Plan of proposed development. Aerial from "IONA – Working Group – Presentation 3 – Masterplanning Document – Indicative MasterPlan – Option 3" by Isthmus, dated 17/03/2017

This assessment is based on the masterplan of the proposed development which was completed by Isthmus on 17 March 2017 and is titled "IONA – Working Group – Presentation 3 – Masterplanning Document". In particular, our assessment is based on the Indicative Masterplan - Option 3 which is the most intensive of the options. This option includes a total of 366 new lots with a range of sizes from 300 – 7400 m^2 and an average size of 795 m^2.

The Iona Hill site consists of smaller to medium sized lots between 300 – 1300 m^2 in middle and lower hills and larger sized lots between 2,000 – 7,400 m^2 in the upper plateau to the south. The existing valley in this north eastern area is being filled in to allow for the development while the larger of the valleys is remaining in its existing form, containing several ponds. There is a proposed 'spine' road from Iona Road, crossing the larger valley to service the lots at the southern end of the development.

The Triangle site is made up of smaller lots between 420 – 800m^2. Access to the Triangle site can be either from Iona or Middle Road. The hill in the western corner is proposed to be left as a reserve referred to as the 'Bull Knoll Reserve".

The remaining HPUDS area, outside the Lowe Development Ltd land, is proposed to consist of larger lots with sizes between 1,900 – 7400 m^2.

At this stage the carriageways are proposed to be narrow with no parking lanes, minimal kerbs, footpaths on only one side, sloping berms and informal groups of trees consistent with a country style avenue. An indicative sketch of the proposed carriageways is shown in Figure 5 below.

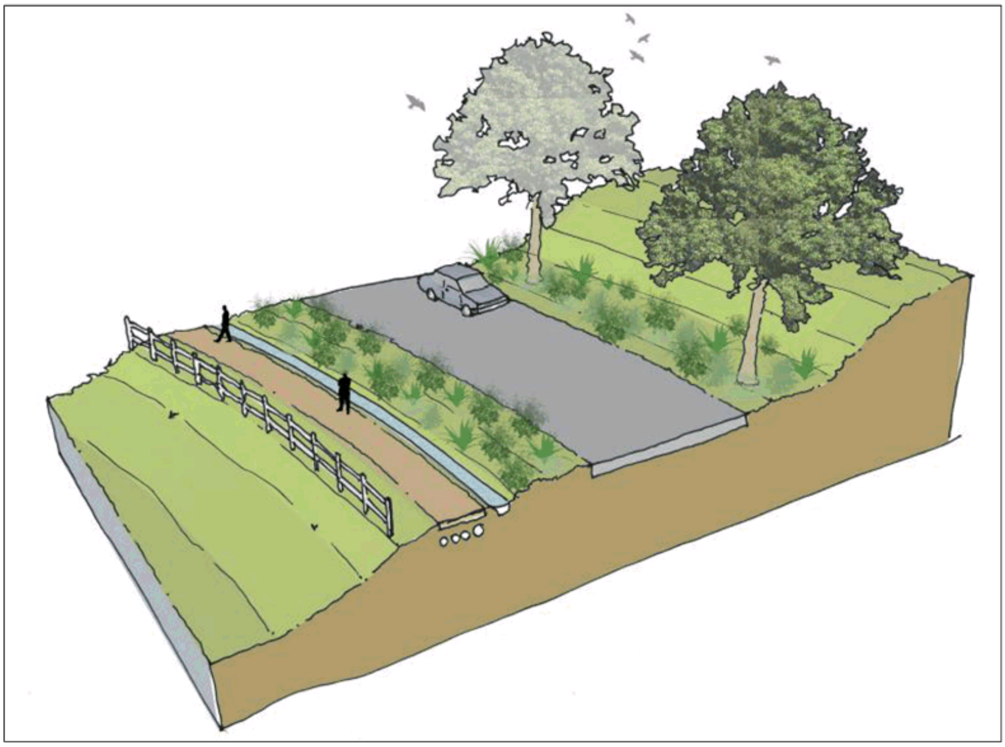

Figure 5 - Proposed carriageway for the Iona development, Reprinted from "IONA – Working Group – Presentation 3 – Masterplanning Document – Carrageway Character" by Isthmus, dated 17/03/2017.

6 Methodology

The methodology of assessment comprises:

1 A hydrological assessment to determine changes in discharge as a result of the proposed development for a range of design rainfall events.

2 A hydraulic assessment of the area downstream from the proposed development to determine the effects of the changed hydrology.

The landuse, hydrological changes and effects of the mitigation are discussed in Sections 7 to 11 of this report, and the hydraulic effects of the hydrological changes are assessed in Section 12.

6.1 Hydrological assessment

6.1.1 Hydrological model

HEC-HMS V4.2 produced by the USACE was used for rainfall-runoff simulation for all catchment areas upstream, and including, the subject site.

6.1.2 Hydrologic design method

The hydrological design method that has been used for this assessment is the SCS Runoff Curve Number method which can be applied to both rural and urban catchments. It is the preferred approach for this assessment given the large catchments, low impact design and design of retention structures required for the proposed development.

The SCS Runoff Curve Number method is further described in the Technical Report "Urban Hydrology for Small Watersheds – TR 55" by the United States Department of Agriculture dated June 1986 (TR 55).

Furthermore, the SCS method is known to be well-suited to assessment of mitigation requirements where the catchment time of concentration is markedly changed as a consequence of development. The method is preferred over the Rational Method approach as the Rational Method approach only allows for estimation of peak discharge in response to rainfall of duration exactly equal to catchment time of concentration. Provision of mitigation often involves changes to the catchment response by provision of storage, and under such situations the Rational Method cannot be used.

The SCS approach allows for estimation of the complete rainfall-runoff response hydrograph, with or without attenuation (i.e. can be used to simulate both).

6.1.3 Initial loss

Initial loss (I) is all losses before runoff begins. It is calculated using the formula I = 0.2S.

Where:

$$S = \frac{1000}{CN} - 10$$

6.1.4 Time of Concentration

To calculate time of concentration we have used the method in the NZ Building Code: Surface Water Clause E1. The method considers the time of entry and time of network flow which is appropriate for determining time of concentration within the development, as it has varying surfaces (i.e. swales, roads, pipes etc). We have used this method for the existing undeveloped situation for consistency when comparing the effects of the development.

The slope of the catchment has been calculated by using the equal areas method.

The SCS lag time for HEC HMS has been calculated as the time of concentration multiplied by 2/3.

6.1.5 Baseflow

There was no allowance for baseflow in the hydrological modelling of all pre development and post development scenarios.

6.1.6 Design rainfall

The design rainfall values used in this assessment have been generated using the HIRDS (High Intensity Rainfall Design) software V3 available from NIWA.

As the catchment is relatively large, there is some variance in rainfall distribution between the front (at Iona Rd) and back of the catchment (end of Endsleigh Dr). The rainfall is higher in the upstream parts of the catchment. For the purposes of this assessment we have taken the average rainfall depth over the locations. The two locations for which HIRDS data were obtained, together with the 48-hour rainfall totals for relevant recurrence intervals are shown in Table 1.

Table 1: HIRDS Rainfall Locations

	NZMG		48-hour rainfall depth (mm)		
Location	**Easting**	**Northing**	**2-year ARI**	**10-year ARI**	**100-year ARI**
Iona Road	2841177	6161666	90.5	134.6	220.7
Endsleigh Dr	2841320	6159539	99.6	148.1	242.7

The averaged rainfall depths for each combination of return period and duration are shown in Table 2.

Table 2 - HIRDS V3 average rainfall depths from front and back of the catchment

ARI	10m	20m	30m	60m	2h	6h	12h	24h	48h
2	5.7	8.7	11.1	16.8	23.9	41.7	59.3	84.3	94.9
5	7.8	11.9	15.2	23.1	32.2	54.8	76.5	107.0	120.5
10	9.7	14.7	18.7	28.4	39.3	65.6	90.6	125.3	141.1
20	11.8	17.9	22.9	34.8	47.5	78.0	106.6	145.7	164.2
50	15.3	23.2	29.7	45.1	60.8	97.5	131.5	177.3	199.7
100	18.5	28.2	36.0	54.8	73.1	115.4	153.9	205.3	231.3

A design rainfall hyetograph was developed using a nested storm approach. The nested storm approach creates a hyetograph which contains rainfall bursts of differing durations, all of which have the same return period. This has been selected as it removes the need for multiple simulations to cover rainfall events of differing duration. This approach has been well proven for assessment of mitigation requirements for urban developments. The nested storm hyetograph used includes all rainfall durations up to 48 hours.

Climate change effects

To allow for the effects of climate change, the HBRC's SWG recommends that the average rainfall depths for present day are adjusted by the percentages in Table 3 (taken from Table 6-2 in the HBRC's WGSM) multiplied by 2.1.

Table 3 - Percentage adjustments for climate change allowance (from HBRC's WGSM)

Table 6-2 Factors (percentage adjustments) for Use in Deriving Extreme Rainfall Information for Screening Assessments (Table 5.2 from MfE, 2008)

ARI (years)→ Duration↓	2	5	10	20	30	50	100
< 10 minutes	8.0	8.0	8.0	8.0	8.0	8.0	8.0
10 minutes	8.0	8.0	8.0	8.0	8.0	8.0	8.0
30 minutes	7.2	7.4	7.6	7.8	8.0	8.0	8.0
1 hour	6.7	7.1	7.4	7.7	8.0	8.0	8.0
2 hours	6.2	6.7	7.2	7.6	8.0	8.0	8.0
3 hours	5.9	6.5	7.0	7.5	8.0	8.0	8.0
6 hours	5.3	6.1	6.8	7.4	8.0	8.0	8.0
12 hours	4.8	5.8	6.3	7.3	8.0	8.0	8.0
24 hours	4.3	5.4	6.3	7.2	8.0	8.0	8.0
48 hours	3.8	5.0	6.1	7.1	7.8	8.0	8.0
72 hours	3.5	4.8	5.9	7.0	7.7	8.0	8.0

The rainfall depths adjusted for climate change that are used in this assessment are shown in Table 4 below.

Table 4 - HIRDS V3 rainfall depths (adjusted for climate change)

ARI	10m	20m	30m	60m	2h	6h	12h	24h	48h
2	6.7	10.1	12.8	19.2	27	46.4	65.3	91.9	102.5
10	11.3	17.1	21.7	32.9	44.2	75.0	102.6	141.8	159.2
100	21.7	32.9	42.1	64.0	85.3	134.7	179.8	239.8	270.2

A plot of the design rainfall hydrographs used in this assessment for the 2, 10 and 100 year ARI event adjusted for climate change are shown in Figure 6, Figure 7 and Figure 8 respectively.

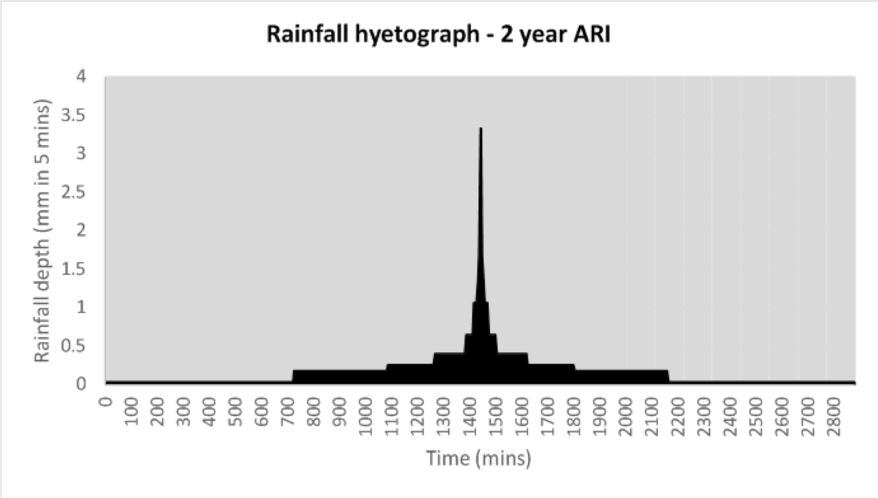

Figure 6 - 2 year ARI design rainfall hyetograph

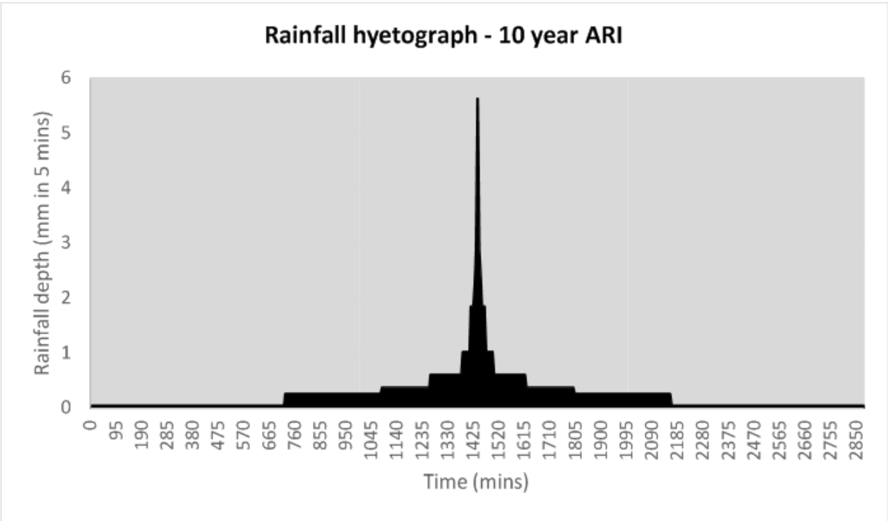

Figure 7 - 10 year ARI design rainfall hyetograph

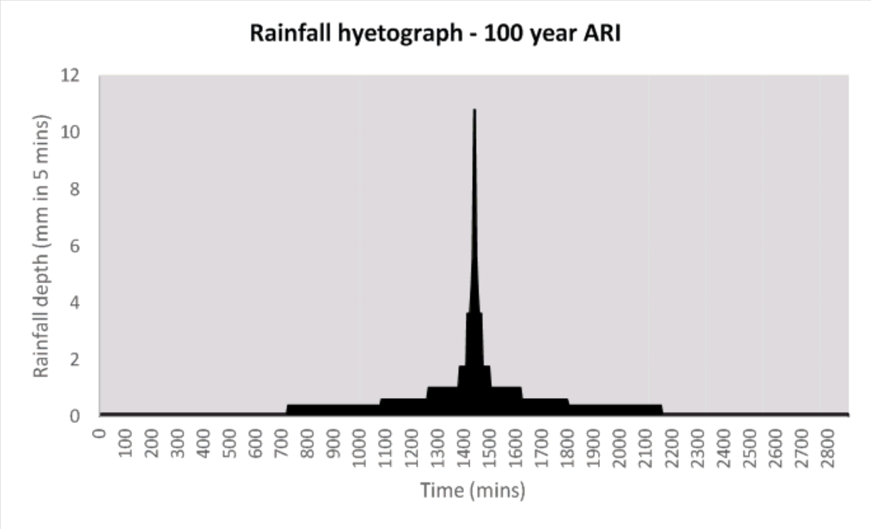

Figure 8 - 100 year ARI design rainfall hyetograph

6.1.6.1 Water quality design rainfall

The HBRC's WGSM recommend that the rainfall depth for the 90% storm is used for determining water quality treatment volumes and flow rates in sizing water quality treatment devices. The 90% storm values provided in Figure 6-5 of the HBRC WGSM are shown in below.

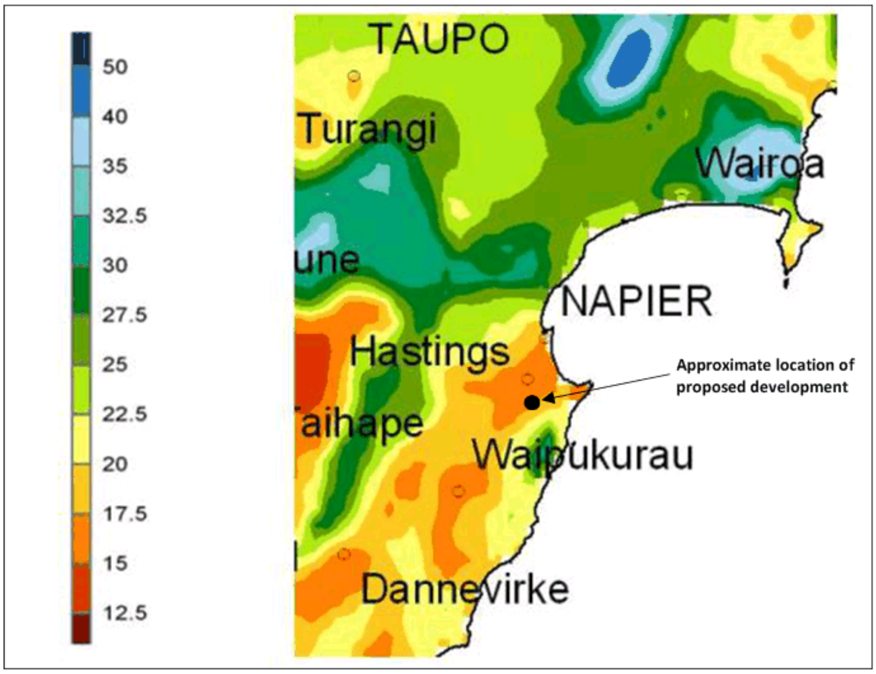

Figure 9 - 90% rainfall event depth for the Hawkes Bay Region (from Figure 6-5 in the HBRC's WGSM)

We have used a rainfall depth of 20 mm for the water quality design storm. The water quality volume has been calculated using the method in Section 6.3.4 of the HBRC's WGSM.

6.2 Hydraulic assessment of downstream area

To assess the downstream effects of the IONA development, a two dimensional hydraulic model was configured to calculate water levels for Pre-development and Post-development scenarios.

A MIKE21 (2014) model was constructed using a 6m x 6m "classic grid" (i.e. square) which was configured to assess the relative difference in water levels in the area downstream from where hydrographs will be discharging.

The grid resolution was selected to represent the general topography downstream. Features at a finer resolution than the resolution may not be represented accurately, however the resolution is considered appropriate for the purposes of this assessment.

6.2.1 Bathymetry

The extent of the available LiDAR data and model extent are shown in Figure 10.

The model extent was significantly trimmed (in comparison to the available LiDAR) to reduce the number of computational cells and subsequently run times.

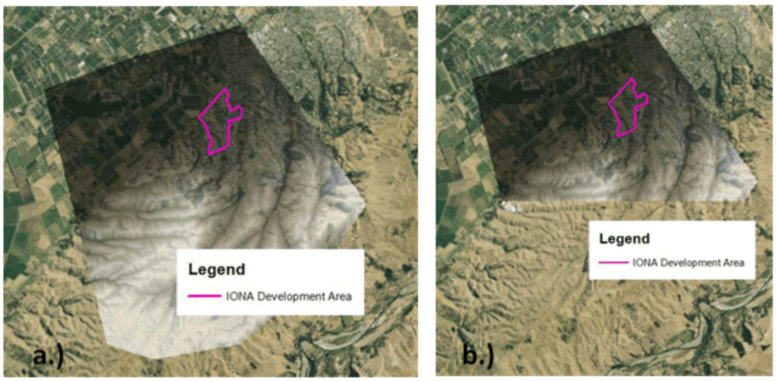

Figure 10 Area covered by LiDAR data [a.) available LiDAR data, b.) 2d model extent]

6.2.2 Inflows

Inflows to the model were loaded from the proposed development site at the discharge locations from the proposed development.

A review of the topography of the area revealed that flow from the Louisa stream (see Figure 11) approaching the area from the west could potentially have an effect on the flood levels and extent of flooding immediately downstream of the IONA development. To account for this potential effect, inflow from the Louisa stream was therefore included as a source point onto the 2d surface.

The locations of the inflows are shown in Figure 11. Inflows labelled D, E, F, I and G represent the hydrographs emanating from the IONA development.

The Louisa Stream source point and the pertinent catchment parameters are summarised in Table 13.

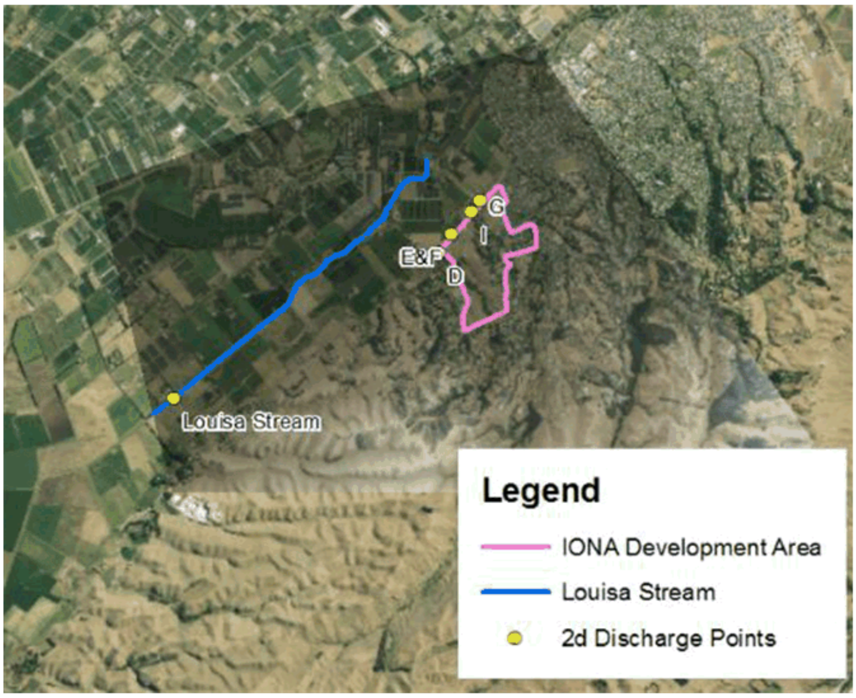

Figure 11 Location of source point inflows

6.2.3 Downstream boundary conditions

The downstream boundary condition was set at a constant 19.2 m RL on the northern and western boundaries of the 2d extent. This is an estimated value, but the boundary is located sufficiently far away from the area of interest to not have an effect on the results. The downstream boundary level remained the same for all the scenarios.

6.2.4 Simulations completed

Table 6 presents the scenarios represented in the hydraulic model.

Table 5 Hydraulic model scenarios

	48hr duration storm			Water Quality Storm
	2yr ARI+CC	10yr ARI+CC	100yr ARI+CC	
Pre-Development	X	X	X	X
Post- Development (with mitigation)	X	X	X	X

7 Hydrological assessment of existing site

A hydrological assessment of the pre development site using current land uses has been undertaken. The peak flows from this assessment have been used to set the target peak flows for the proposed development.

7.1 Catchment delineation

The stormwater catchments draining to the Triangle and Hills sites have been delineated from a DEM based on LiDAR data provided by HBRC. For the purpose of this assessment the catchments have been split into subcatchments based on the proposed development boundaries and key downstream drainage features such as road culvert crossings and ponds. Figure 12 shows the delineated pre development catchments.

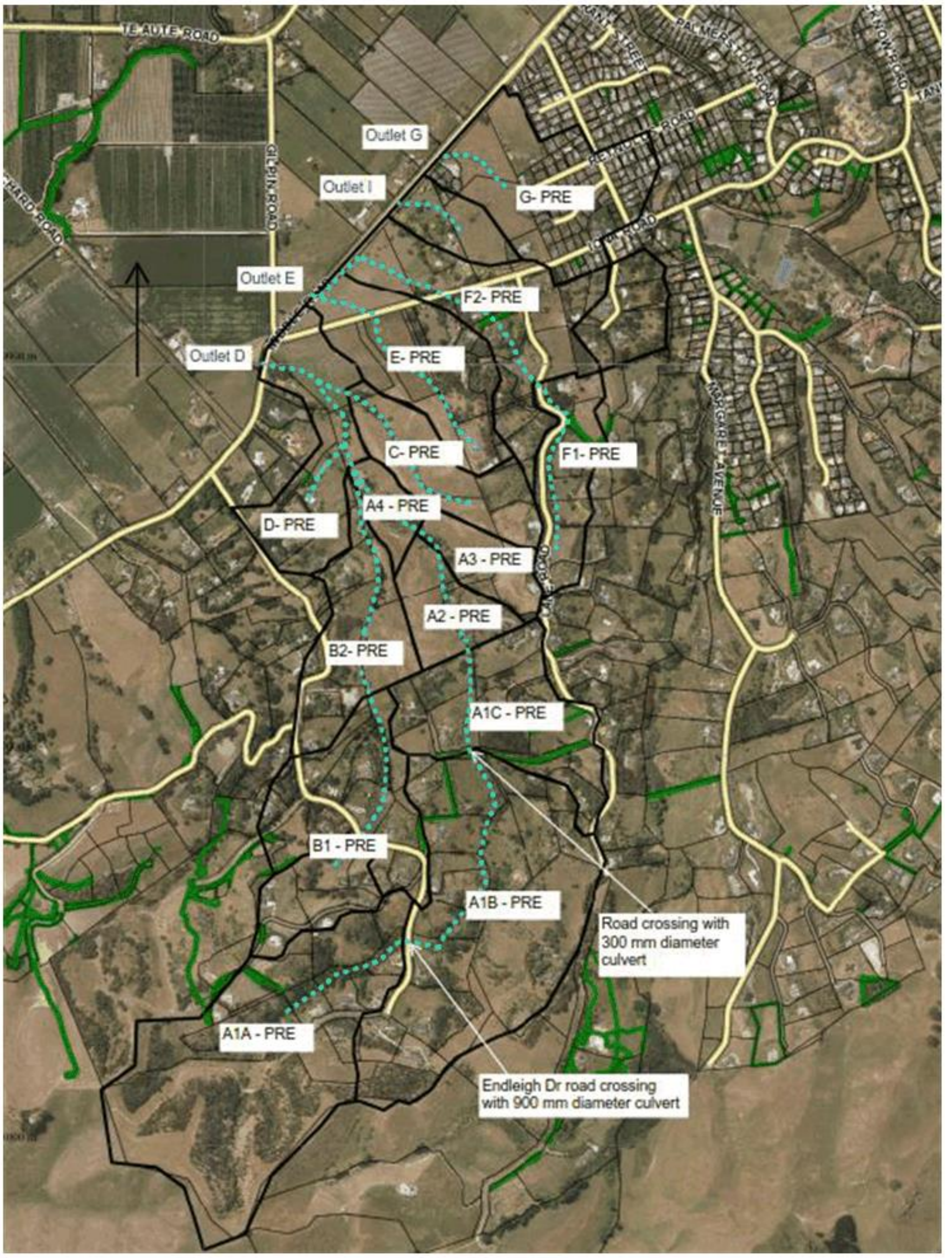

Figure 12 - Pre development catchment and subcatchment delineation (Aerial image from HDC online map viewer, Imagery 2017 Urban layer)

7.2 Soil types

The Landcare Research Soil Maps (LINZ) shows that surface soils at the site are typically poorly drained. The Triangle site and the gullies of the Hill site and upstream catchment have a soil type of silty loam that is poorly drained. The surface soils in the hill areas within the Hill site up to Endsleigh Rd consist of a loam that is imperfectly drained while the hill areas toward the back of the catchment are moderately well drained. The soil drainage characteristics from the LINZ maps are shown below in Figure 13 for the subcatchments.

Hydrological soil groups for the TR 55 method have been assigned based on the LINZ surface soil descriptions. The hydrological soil groups used in this assessment range from B – D with group B for moderately well drained areas, group C for imperfectly drained areas and group D for poorly drained areas. This is consistent with the specific soil maps reports for the various types of soils within the catchment.

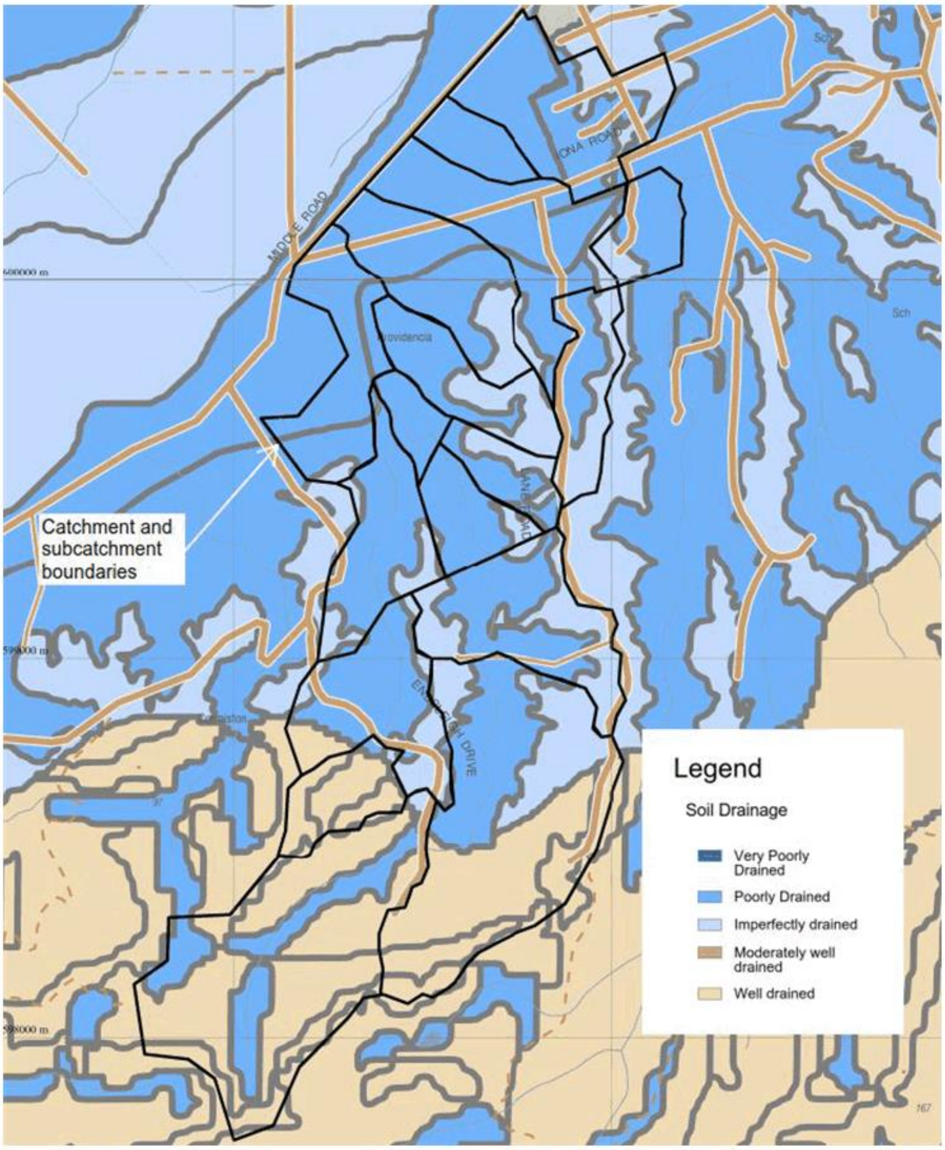

Figure 13 - Hydrological soil groups from LINZ

7.3 Hydrological model inputs

The following subsections provide the hydrological model inputs for the existing site (the proposed site is discussed in Section 8).

7.3.1 Runoff curve numbers

The curve numbers are used to represent the Hydrologic Soil Group (see previous section) and land cover. We have assumed the type of cover to be "Pasture, grassland, or range – continuous forage for grazing" and of good hydrologic condition which is based on >75% ground cover that is lightly or only occasionally grazed (TR55). We have assumed no impervious areas for the pre development situation.

The curve numbers used in the Pre Development model are 61 for hydrological soil group B, 74 for C and 80 for D.

7.3.2 Time of Concentration

The Time of Concentration for the pre development subcatchments have been calculated using the formula from Section 2.3.2 bi) in the NZ Building Code: Surface Water Clause E1. This formula takes into account the Manning's 'n' roughness coefficient. A Manning's number of n = 0.045 has been used which is consistent with the gully streams and flow paths as a "*Winding natural stream with irregular cross-section and some obstruction with vegetation and debris*"[1].

7.3.3 Road crossings

There are two main road crossings identified within the subcatchments A1A and A1B (shown in Figure 12) that likely detain upstream flows and therefore affect peak flows in the lower catchment. These have been modelled as storage nodes in the HEC-HMS model with culvert outlets at the invert of the gully. The elevation storage relationship for the node was obtained from contours developed from the LiDAR data.

7.3.4 Existing ponds

For the pre development situation we have only considered the pond that was present prior to 2004. We understand there is no formal discharge structure at the downstream end of this pond and that flow is conveyed by overtopping the pond.

We have not included this pond in the predevelopment model as we consider its available storage volume to attenuate flows to be minimal and unlikely to have a significant effect on peak flows.

7.4 Model layout (pre development)

A model schematic layout for the pre development situation is shown in Appendix A.

7.5 Model results (pre development)

The hydrological model was run for the 48 hour duration storm using the temporal pattern and intensities referred to Section 6.1.6 of this report. Although the response time for the development and upstream catchments are significantly shorter than 48 hours, we have modelled a longer duration event to coordinate with downstream flooding and ensure critical durations are covered.

[1] Definition in Table 3 of the NZ Building Code: E1 Surface Water

Table 6 below shows the model results for the peak discharges at the main outlet locations at the Triangle and Hill site (refer Figure 12 for outlet locations).

Table 6 - Pre development peak flows at the outlet locations

	Pre Development peak discharge (m^3/s)			
Outlet locations	Water Quality Storm (20mm over 24hrs)	2 Year ARI (CC)	10 Year ARI (CC)	100 Year ARI (CC)
Outlet D	0.18	1.90	4.16	10.63
Outlet E	0.08	0.91	1.98	4.52
Outlet I	0.01	0.14	0.29	0.65
Outlet G	0.05	0.66	1.29	2.71

7.6 Model result checking using Rational Formula

This Rational Formula is a valid estimation of peak discharge in response to average rainfall intensity over a duration equal to catchment time of concentration, and only in catchments where storage is negligible.

Due to the shape of the upstream catchments (long and thin) it has been necessary to split the catchments into a large number of smaller catchments. The Rational Method can be used to assess the peak discharge for each of the sub-catchments but care should be taken in applying the method at outlet locations due to the large number of sub-catchments upstream (each with differing times of concentration).

For example, considering subcatchment labelled A3-pre, the following comparisons may be made. Note that full subcatchment details and modelled peak discharge in response to the three rainfall events considered are provided in Appendix B of this report.

Subcatchment A3-pre

- Catchment area: 4.6 hectares
- Time of concentration: 59 minutes (taken as one hour)
- 2-year ARI rainfall intensity: 19.2 mm/h (from Table 4)
- 10-year ARI rainfall intensity: 32.9 mm/h
- 100-year ARI rainfall intensity: 64.0 mm/h

Using a Rational Coefficient of 0.4 (as an illustrative example), yields the discharge estimates provided in Table 7. What can be seen is that the runoff coefficient of 0.40 yields peak discharge estimates lower than what have been derived from the model. In order to achieve agreement between the Rational Method and the model that has been used, the effective runoff coefficient required has been calculated. This varies from 0.53 for the 2-year ARI rainfall event, to 0.67 for the 10-year and to 0.79 for the 100-year rainfall event. This compares favourably with industry practice, such as the Christchurch City Council Waterways, Wetlands and Drainage Guide which shows the runoff coefficient doubling from a 5-year ARI event to a 50-year ARI rainfall event for most landuses. This is indicative of a higher portion of rainfall being able to concentrate and collect in higher intensity rainfall events.

Table 7: Rational Formula Comparison for subcatchment A3-pre

	Peak discharge from model (m^3/s) (summary table in Appendix B)	Peak discharge from Rational Method (m^3/s) for C = 0.40	Effective runoff coefficient to achieve model peak discharge
2-year ARI	0.13	0.10	0.53
10-year ARI	0.28	0.17	0.67
100-year ARI	0.65	0.33	0.79

A similar result was obtained for comparisons for other subcatchments.

As the modelled approach makes use of a nested rainfall profile, a volumetric runoff comparison between the two methods is meaningless. The volume of runoff from a 48-hour nested rainfall event will be far in excess of the volume of runoff resulting from a one-hour event, even with the same average recurrence interval. Of significance, however, is that the use of the nested profile takes account of the likely change in catchment response following both development and mitigation for that development (i.e. the time of concentration and rainfall duration are specifically included). In undertaking comparative assessments between the state of development (e.g. pre to post development), the required attenuation volume can be accurately assessed.

8 Hydrological assessment of proposed site (without mitigation)

A hydrological assessment of the post development situation has been undertaken without any mitigation. This was done to develop the required mitigation solutions.

Note that the soil types and model inputs for subcatchments outside the proposed development have not changed from the pre development model.

8.1 Catchment delineation

The subcatchments within the Triangle and Hill sites have been delineated from the proposed post developed contours indicated on the Masterplan and from discussions with the project team. Refer to Figure 14 below showing the delineated post development catchment. Note that the overland flowpaths indicated in the figure are indicative where final developed contours and overland flowpaths have not been finalised.

Subcatchments C1, C2 and E which form the Middle and Lower Ridge neigbourhoods, are being created by filling in existing gully areas. It is understood that subcatchments C1 and C2 can be formed so that the majority of piped and overland stormwater flows can be discharged to the western gully (i.e. to Outlet D). It is further understood these two subcatchments (C1 and C2) can be serviced by a centralised gravity wastewater system without the requirement for pumping.[2] This increases the catchment area draining to Outlet D from the pre-developed situation. This was done because sufficient attenuation volume was able to be made available in the gully upstream of Outlet D.

[2] This was discussed with the project team of Strata Group and Mitchell Daysh on 24 October 2017.

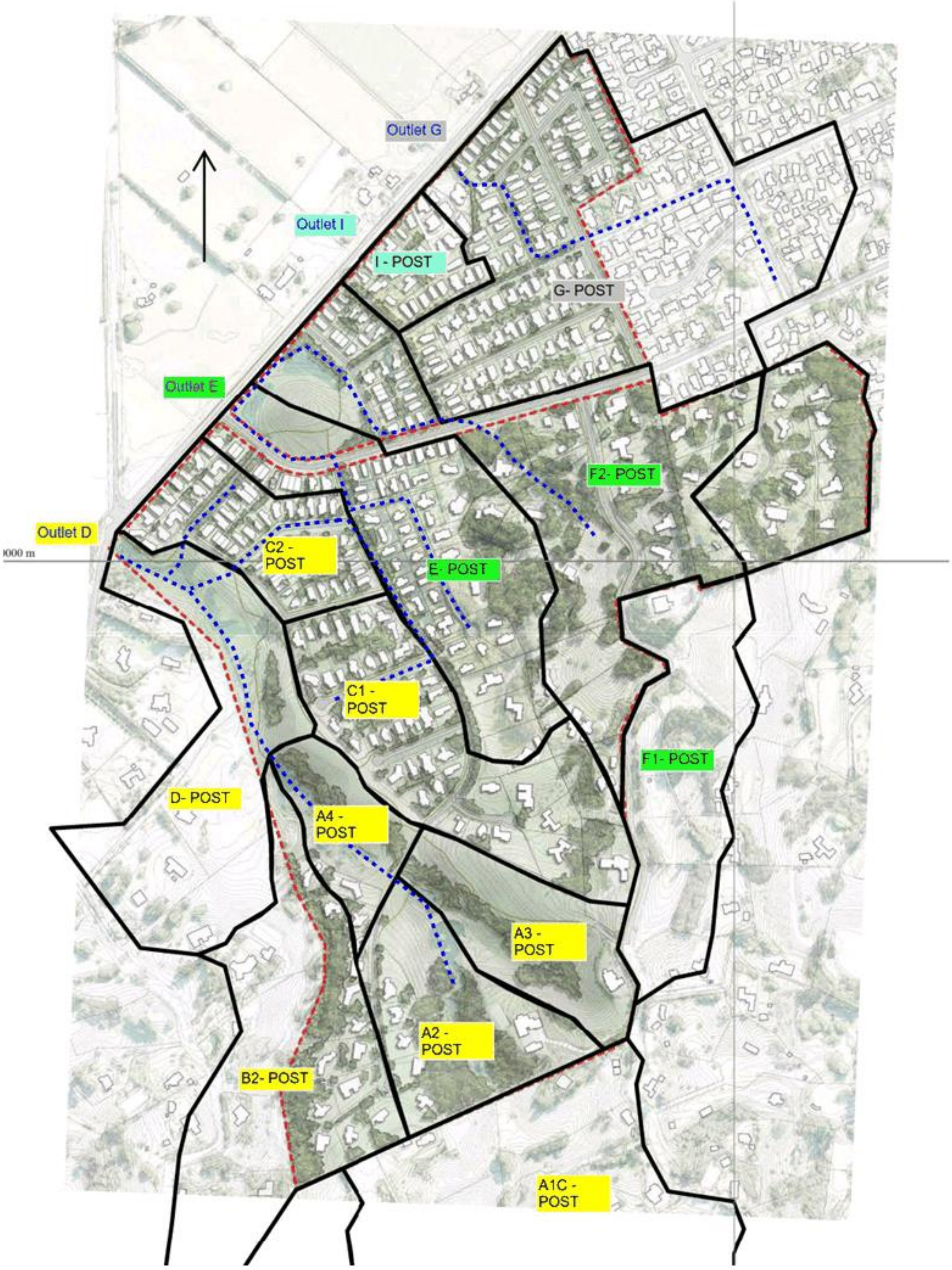

Figure 14 - Post development (unmitigated) catchment and subcatchment delineation

8.2 Hydrological model inputs

Hydrological model inputs for each subcatchment can be found in Appendix B.

8.2.1 Runoff curve numbers

For the purposes of this assessment we have assumed that the developed land is zoned General Residential.

Maximum building coverage as per the "Proposed Hastings District Plan as Amended by Decisions on Submissions – September 2015" Section 8.2.5F is 45% of net site area. As the district plan does not appear to state the maximum impervious surface area (which includes building coverage and road) we have assumed this to be 60%. This is consistent with the Auckland Unitary Plan for mixed housing urban.

Option 3 from the indicative Masterplan indicates lot sizes between 300 – 7400 m^2 with an average lot size of 750 m^2. For the purpose of this assessment we have split the areas up into four main categories with corresponding maximum impervious areas and curve numbers. The curve numbers for all lots sizes and the impervious areas for the Medium to Extra Large lots are based on Table 2-2a of TR 55 for urban areas. The impervious areas and runoff curve numbers are shown in Table 8 below:

Table 8 - Impervious areas for lot sizes within proposed IONA development

	Lot size (m2)	Impervious Area	Curve numbers for hydrologic soil groups			
			A	B	C	D
Small lots	300 – 1000	60 %	74	83	88	91
Medium lots	1000 - 2000	25%	54	70	80	85
Large lots	2000 - 4000	20%	51	68	79	84
Extra Large lots	4000 +	12%	46	65	77	82
Pre developed	N/A	0%	39	61	74	80

Refer to Figure 15 below showing a breakdown of lot sizes used for calculating runoff curve numbers for subcatchments.

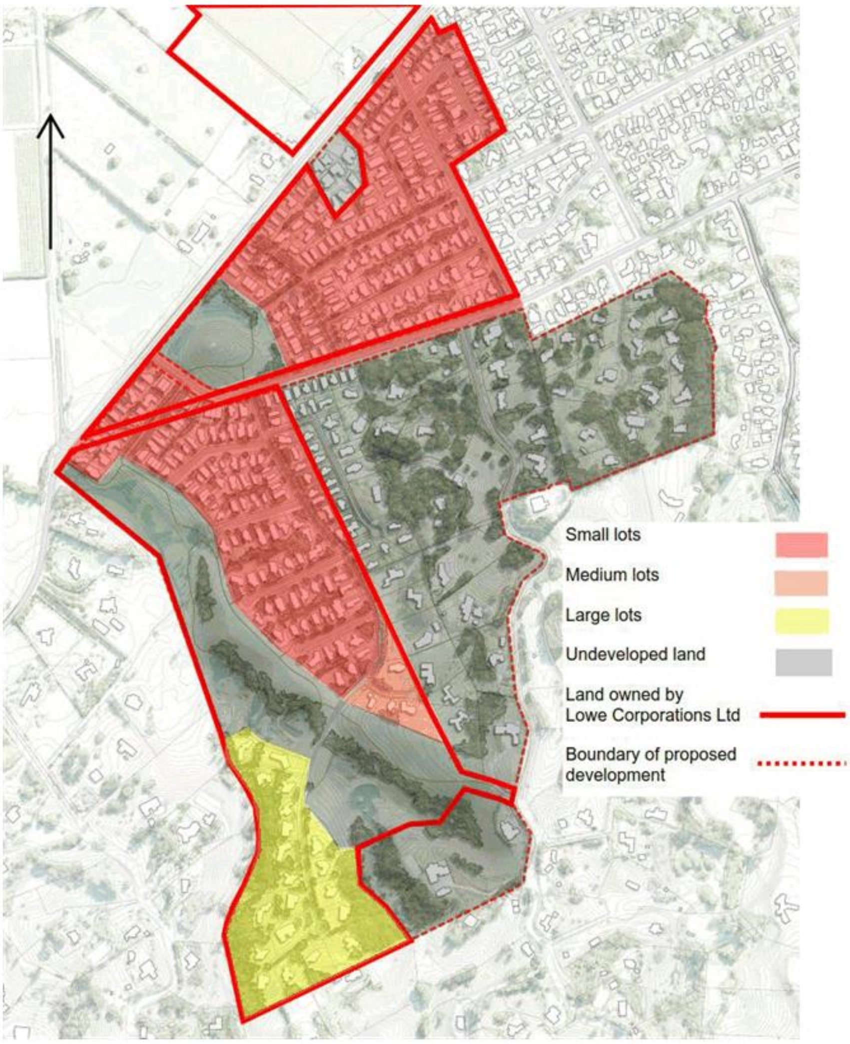

Figure 15 - Plan showing breakdown of lot sizes used for calculating runoff curve numbers

8.2.2 Time of Concentration

For the developed areas the Time of Concentration has been calculated using the general formula from Section 2.3 in the NZ Building Code: Surface Water Clause E1. The formula allows for a time of entry (t_e) as well as a time of network flow (t_f).

We have used a time of entry of 7 minutes for developed areas with small lots and a time of entry of 10 minutes for developed areas with lots medium to large lots. To calculate the time of network flow we have assumed that all flows are conveyed within a road channel or pipe.

8.2.3 Ponds

Although there are a number of existing ponds, similar to the pre development situation we have not included the ponds in the post development model as we consider their available attenuation volume to be minimal and unlikely to have a significant effect on peak flows.

8.3 Model layout (unmitigated post development)

A model schematic layout for the unmitigated post development situation is shown in Appendix A.

8.4 Model results (unmitigated post development)

The hydrological model was run for the Water Quality Storm (WQS), 2, 10 and 100 year ARI events.

Table 9 below shows the peak discharges at the main outlet locations at the Triangle and Hill site. We have included the pre development peaks for comparison and discussion. Notet that “CC” denotes Climate Change, meaning that post development flows have been calculated taking CC into account.

Table 9 - Post development (unmitigated) peak flows at the outlet locations

			Post Development (unmitigated) peak discharge (m^3/s)			
Outlet locations	**Scenario**	**Total catchment area (ha)**	**Water Quality Storm (20mm over 24hrs)**	**2 Year ARI (CC)**	**10 Year ARI (CC)**	**100 Year ARI (CC)**
Outlet D	Pre developed	146	0.18	1.90	4.16	10.63
	Unmitigated post development	149	0.21	2.03	4.33	10.72
Outlet E	Pre developed	36	0.08	0.91	1.98	4.52
	Unmitigated post development	32	0.07	0.87	1.83	4.07
Outlet I	Pre developed	4	0.01	0.14	0.29	0.65
	Unmitigated post development	2	0.01	0.13	0.23	0.47
Outlet G	Pre developed	16	0.05	0.66	1.29	2.71
	Unmitigated post development	19	0.07	1.26	2.30	4.61

8.5 Discussion of unmitigated hydrological effects

The proposed development results in an increase in impervious area causing higher volumes of runoff and higher peak flows due to faster hydrological response times that the existing situation.

There are also some changes in the post developed catchment areas from pre developed due to changes in ground profile, particularly with the filling of gully areas. This will result in an increase or decrease in runoff peak flows and volumes to some outlets.

Table 9 above shows a 2% increase in catchment area for Outlet D in the post developed situation, a 10% decrease for the Outlet E catchment, 50% decrease for the Outlet I catchment and a 20% increase for the Outlet G catchment.

Table 9 above shows a relavitly small increase in peak runoff at Outlet D. Although there is some development in the lower parts of this catchment (i.e. subcatchments C1 and C2), it is a relatively small area compared with the total catchment area.

Although a small part of the Outlet E catchment is being developed (i.e. lower parts of subcatchment E and F2) some of the lower portion of the Outlet E pre developed catchment now drains to Outlet D and Outlet G in the post developed scenario. The result is an overall reduction in peak flows for the unmitigated post development scenario.

There is a significant increase in peak flow rates at Outlet G due to the entire subcatchment area being developed with smaller higher density lots. The subcatchment area is also increased in the post development scenario as the formation of the road network within the Triangle site is likely to divert the upper section of the pre developed subcatchment I to Outlet G. Although Catchment I is being developed with high density lots, the peak flows at Outlet I are still reduced in the post development scenario due the upper section of the pre development catchment being diverted to Outlet G as discussed above.

9 Development of hydrological mitigation options

9.1 Water quantity requirements

In order to meet the recommendations for peak discharge control in the HBRC's WGSM post development peak discharge. Stormwater from the proposed development is to be managed to ensure the downstream receiving environment is unchanged or the impacts on the downstream system are negated through improvements or mitigation works.

The water quantity target peak flow rates are based on recommendations in the HBRC's WGSM and are shown in Table 10 below.

Table 10 - Water quantity requirements based on recommendations in the HBRC's WGSM

		Post Development (unmitigated) peak discharge (m^3/s)			
Outlet locations	**Scenario**	**Water Quality Storm (20mm over 24hrs)**	**2 Year ARI (CC)**	**10 Year ARI (CC)**	**100 Year ARI (CC)**
Outlet D	Unmitigated post development	0.21	2.03	4.33	10.72
	Target peak flow	NA	1.90	4.16	10.38
Outlet E	Unmitigated post development	0.07	0.87	1.83	4.07
	Target peak flow	NA	0.91	1.98	3.62
Outlet I	Unmitigated post development	0.01	0.13	0.23	0.47
	Target peak flow	NA	0.14	0.29	0.52
Outlet G	Unmitigated post development	0.07	1.26	2.30	4.61
	Target peak flow	NA	0.66	1.29	2.17

The target peak flows in Table 10 above for the 2 and 10 year ARI storm events is 100% of the pre development peak flows. For the 100 year ARI storm event the requirement to attenuate to 80% of pre development peak flows is considered appropriate for the Outlet I and G catchment which is proposed to be fully developed.

Only a small portion of the Outlet D catchment is proposed to be developed (i.e. less than 10%). It is therefore appropriate that only the developed area is subject to a reduction in peak flow rate to achieve 80% of pre development flows for the 100 year ARI storm event. To obtain a target flow we have reduced the pre developed peak flow at Outlet D by 20% of the peak flows from the pre developed area being developed only (i.e. peak flows from subcatchments C1 and C2).

Although only a small part of the Outlet E catchment is being developed (i.e. less than 15%) we have targeted a peak flow of 80% of total catchment pre developed flows for the 100 year ARI storm event given the sensitive receiving environment.

Note that the table does not include a target peak flow for the Water Quality Storm event. There is no specific district or regional target peak flow for storm events other than a 2, 10 and 100 year ARI event.

9.2 Water quantity mitigation options

9.2.1 General

In developing stormwater mitigation options we have considered the following goals:

- Utilise available space within LCL owned land on north western side of Middle Road by diverting runoff to Outlet G;
- Utilise available space within the 'Bull Knoll' site near Outlet E;
- Utilise main gully as there is available space for water quantity controls, particularly in the upper regions, as well as a better defined downstream channel network; and
- Avoid 'online' treatment controls within main gully if possible. The main gully will be subject to large undeveloped flows that will reduce residence time within treatment ponds and potentially causing maintenance issues.

9.2.2 Mitigation for Outlet D catchment

To mitigate the increase in peak runoff the inlet to the proposed culvert below the 'spine' road can be used to attenuate flows within the upstream pond network. Providing attenuation higher in the catchment will allow peak flows from the larger upstream portion of the catchment to lag further behind the smaller peaks from the smaller proposed developed area, thus reducing overall peak flows leaving the site for flood events.

To provide the sufficient attenuation to meet target peak flow rates, preliminary calculations indicate a volume of 7,000 m^3 is required, which equates to a 2.5 m water depth at the culvert inlet. The approximate extent of a 2.5 m depth of storage during a 100 year ARI event is shown on Figure 16 below which is delineated by the 29.75 mRL contour. The 100 year ARI flood extent is also within the LCL owned land. As the full volume will only be utilised for a matter of hours once in a 100 year period, we do not envisage any adverse effects. This will be addressed in more detail during subsequent design stages.

An inlet structure, separate to the culvert, is the preferred option to attenuate the flows as opposed to attenuating flows at the culvert entrance itself. An inlet structure will provide more flexibility if the level of attenuation requires adjustment.

We have also explored the option to include a stormwater detention pond within the lower gully section of Catchment D to attenuate flows from the Middle and Lower Ridge neighbourhood. An 'offline' pond would be preferable to avoid mitigating and conveying the entire catchment flows. To accommodate the area for an 'offline' pond the existing stream would need to be diverted west, close to the boundary of the LCL owned land. There would be limited detention volume available within this low lying area unless a significant embankment was formed around the pond to enable a volume to be stored. It is likely that this low lying area serves as a floodplain during storm events and therefore any filling of this floodplain (i.e. by forming a detention pond) may result in increased flooding on neighbouring properties. This option can be explored further during subsequent design stages, however we do not see the requirement for additional attenuation at this stage.

It is therefore more suited to provide some treatment through wetland planting rather than attenuation of peak flows within this area of the gully.

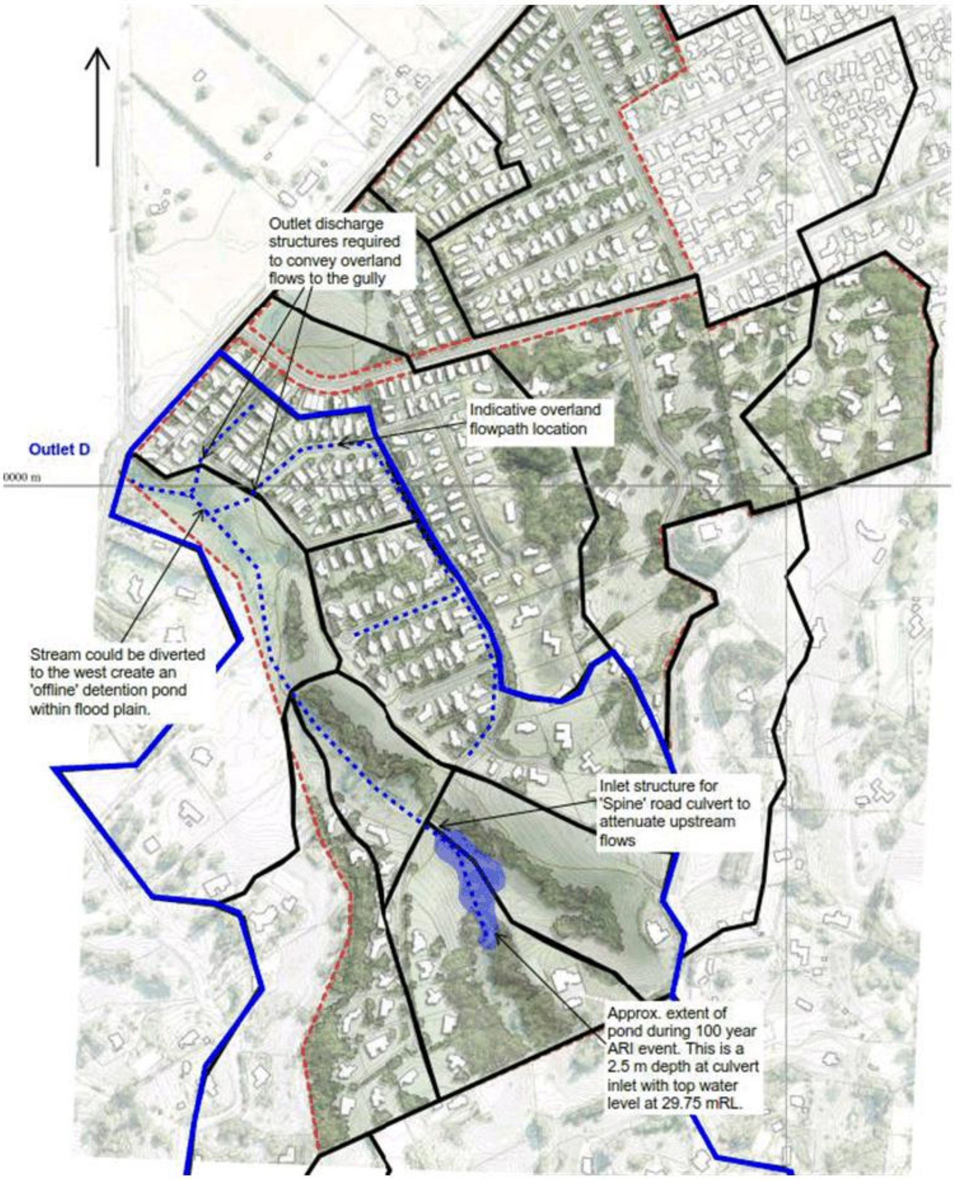

Figure 16 - Proposed mitigation options for Outlet D catchment

9.2.3 Mitigation for Outlet E catchment

For stormwater quantity and quality control a stormwater wetland is proposed due to the requirement to attenuate (i.e. the 100 year ARI event) and treat runoff from this portion of the development.

The wetland for this option is to be located within the Bull Knoll reserve at the downstream end of the Outlet E catchment. The area is relatively low lying in comparison to the invert of the receiving channel (IL of 18.5 mRL) and therefore a very shallow wetland has been adopted (i.e. 1 m 100 year depth)

The proposed design of the wetland is based on the HBRC's WGSM with the following objectives and characteristics:

- Reduce the 100 year ARI storm to 80% of the pre development peak discharge
- Water quality control volume based on 20 mm of runoff from catchment impervious areas. It should be noted that the pond also allows for the treatment of the existing developed area draining into it.
- Water quality volume is 530 m^3 and Extended detention volume is 630 m^3
- 50% of the water quality volume is allocated to permanent storage at a depth of 200 mm.
- 1.2 times the water quality volume to be released as extended detention over 24 hours
- Pond area of approximately 0.7 Ha to the crest
- 100 year depth within the wetland of 1 m
- Side slopes of 1V:5H with a 3 m wide safety bench.

To maximise the available space for the wetland it is likely that some low retainining (i.e. 1 m height) will be required around the knoll side of the wetland. An outlet pipe sized to convey the attenuated 10 year flow will be required to connect into the existing culvert crossing Middle Road.

Refer to Figure 17 showing the proposed mitigation option for the Outlet E catchment.

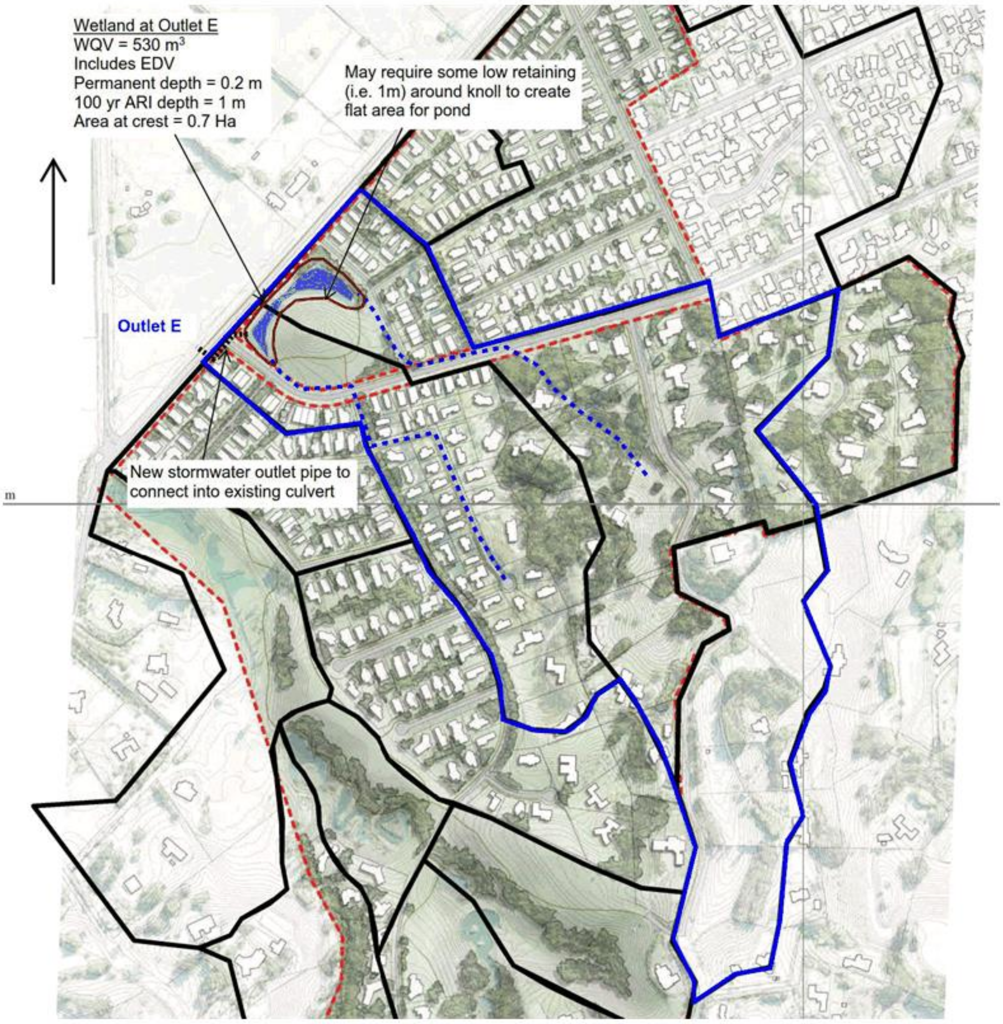

Figure 17 - Proposed mitigation option for Outlet E Catchment

9.2.4 Mitigation for Outlet G catchment

Similar to the Outlet E catchment a stormwater wetland is proposed for Outlet G. Its proposed location is on the western side of Middle Road. The area where the wetland is proposed is slightly elevated from the land further to the northwest ensuring it is removed from any potential floodplain (refer to results of flood effects assessment in Section 11 and the flooding depth and extent plots in Appendix D showing floodplain extent). It has been designed to be shallow in depth (i.e. 1.6 m 100 year depth) to ensure it is able to drain to the receiving channel.

The proposed design of the wetland is based on the same objectives as that for the Outlet E wetland with the following characteristics:

- Water quality volume is 2,300 m^3 and Extended detention volume is 2,800 m^3
- A permanent depth of 200 mm to store 50% of the water quality volume.
- Pond area of approximately 1.4 Ha to the crest

- 100 year depth within the wetland of 1.6 m
- Side slopes of 1V:5H with a 3 m wide safety bench.

The area is relatively large due to the shallow depth of the receiving channel and therefore the requirement for the pond to also be shallow. An access and maintenance track will also need to be constructed around it.

To ensure overland flow drains to the proposed wetland within the road carriageway the current road layout as indicated in the MasterPlan will need to be re-contoured. A short section of open channel may be required along the boundary of Stapleford Park to convey overland flows from the road network to a new culvert beneath Middle Road. The channel top width would likely be between 5 – 10 m wide dependent on its side slopes (1V:2H – 1V:4H). The new culvert would need to be of sufficient capacity to convey the unmitigated post development 100 year ARI peak flow. It is estimated that a 1 m x 2 m box culvert would suffice. Further detail will be provided in subsequent design stages.

Refer to Figure 18 showing the proposed mitigation options for the Outlet G catchment.

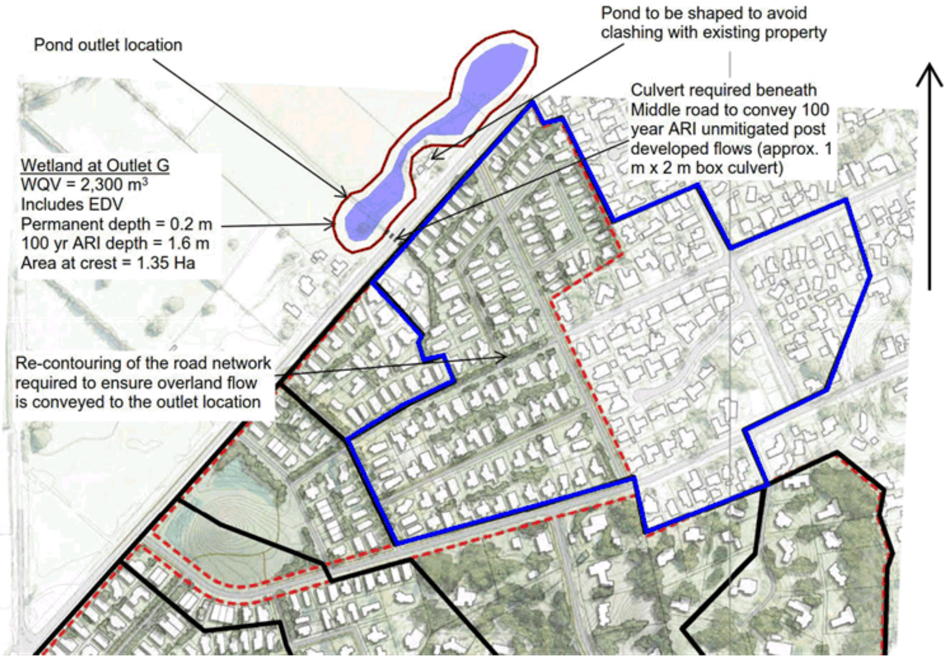

Figure 18 - Proposed mitigation options for Outlet G catchment

9.2.5 Mitigation for Outlet I catchment

No mitigation required for Outlet I as the post developed catchment area has decreased from the pre developed area for this option such that peak flow response has also decreased, in spite of the proposed development. Refer to Table 11 below.

9.3 Water quality mitigation

Stormwater quality controls have been proposed in accordance with the HBRC WGSM.

The proposed carriageway for the development, as shown in Figure 5, indicates a wide planted berm that could be utilised for stormwater treatment. It is proposed that the majority of the water quality treatment for Outlet D catchment is achieved within the carriageway through swales and raingardens. Incorporating swales into the development will also reduce the need for pipes. The swales will need to be culverted for access to properties.

The existing ponds within the main gully in their current form will also provide some settling of contaminants and removal via contact with vegetation for upstream developed areas. There is also an option to plant the existing stream upstream of Outlet D to encourage additional treatment through with vegetation.

Runoff from Outlet E and G catchments is treated through the proposed wetlands.

There are a number of options to treat stormwater runoff from Catchment I. Swales could be provided along the carriageway with the option of on-site treatment through raingardens or similar devices. There is also the option to install proprietary devices such as Stormfilters to minimise the treatment device footprint.

Figure 19 below shows proposed water quality controls that could be adopted for the catchments.

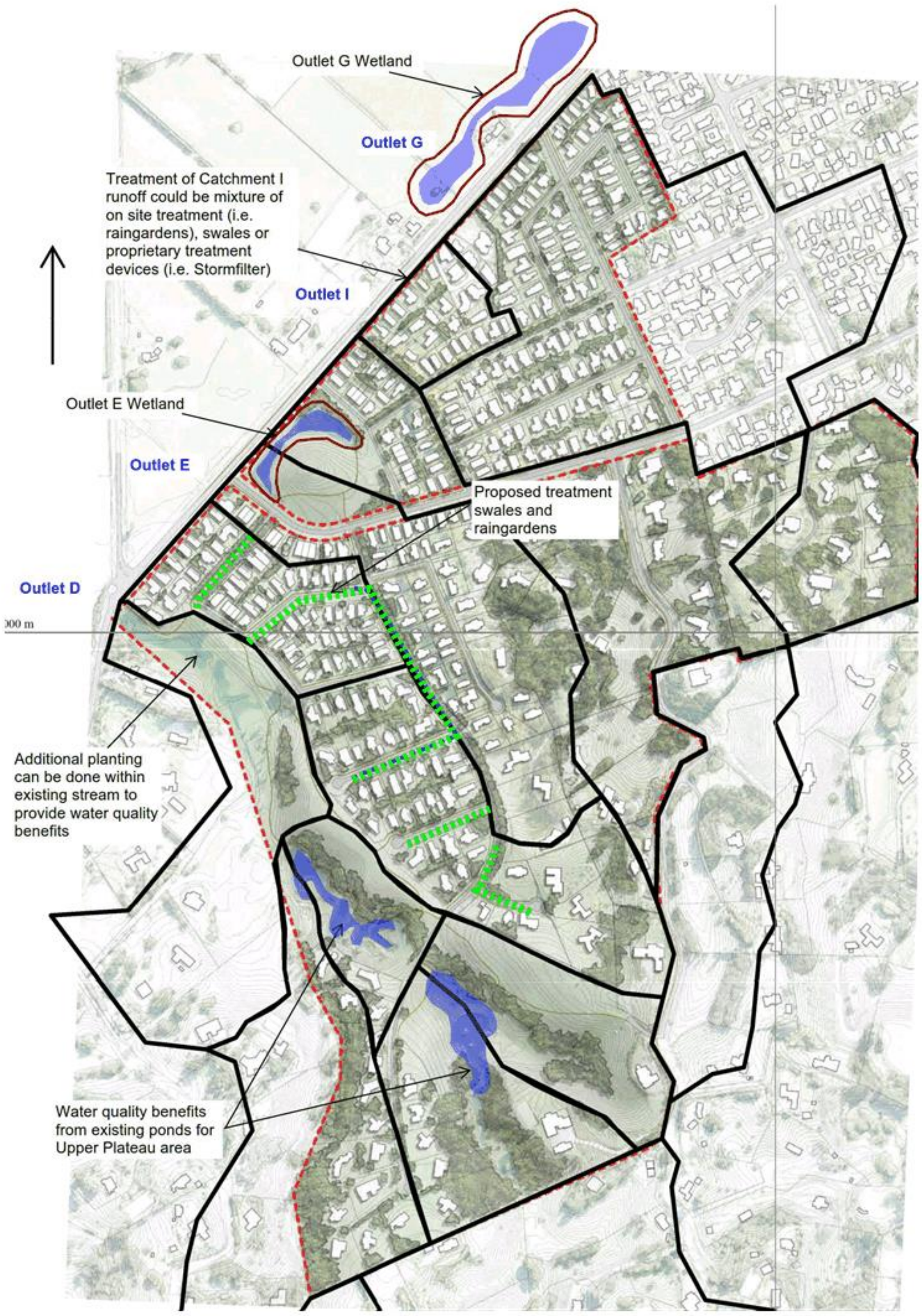

Figure 19 - Proposed water quality controls for catchments

10 Hydrological assessment of proposed site (with mitigation)

A hydrological assessment has been completed of the post development situation with the mitigation options described in Section 9 having been undertaken.

The results of the hydrological model for the post development situation with mitigation has been compared to the pre development peak flows in Table 11 below.

The resultant hydrographs showing the pre development and the mitigated post development flows at the outlet locations can be found in Appendix B.

Table 11 - Results of the stormwater assessment of the proposed site (with mitigation)

		Post Development (mitigated) peak discharge (m^3/s)			
Outlet locations	**Scenario**	**Water Quality Storm (20 mm over 24hrs)**	**2 Year ARI (CC)**	**10 Year ARI (CC)**	**100 Year ARI (CC)**
Outlet D	Pre developed	0.18	1.90	4.16	10.63
	Target peak flow	NA	1.90	4.16	10.38
	Post developed (with mitigation)	0.18	1.85	4.04	9.70
Outlet E	Pre developed	0.08	0.91	1.98	4.52
	Target peak flow	NA	0.91	1.98	3.62
	Post developed (with mitigation)	0.06	0.68	1.55	3.56
Outlet I	Pre developed	0.01	0.14	0.29	0.65
	Target peak flow	NA	0.14	0.29	0.52
	Post developed (with mitigation)	0.01	0.13	0.23	0.47
Outlet G	Pre developed	0.05	0.66	1.29	2.71
	Target peak flow	NA	0.66	1.29	2.17
	Post developed (with mitigation)	0.04	0.46	0.99	2.12

The proposed mitigation achieves the target peak flows for the development.

11 Downstream flood effects assessment

The 2D model build was detailed in Section 6 of this report. This section provides additional information regarding hydraulic model parameters, and the results of the flood effects assessment.

11.1 Model parameters

11.1.1 Inflows

The inflows to the hydraulic model were determined from the mitigated hydrological model options. In addition to the discharge from the proposed development, the downstream inflows from the Lousia Stream catchment were estimated. The locations of the Louisa Stream modelled source point is provided in Section 6.

It is noteworthy that a detailed assessment of the Louisa Stream hydrology is unnecessary because it is not affected by the proposed development. It's inclusion in the assessment is provided to represent additional stormwater flows on the downstream catchment.

The catchment area upstream of the Louisa Stream source point was calculated at 24.43 km^2 (refer Figure 20). Based on the topography it was expected that the flood peak will already be significantly attenuated due to storage and that the inflows at the Louisa Stream discharge point would be a conservative estimate at that point.

The rainfall was determined and represented in the same manner as described for the proposed development site, with revised HIRDS (v3) that were representative for the Louisa Stream. Rainfall depths for the Louisa Stream for the 2, 10 and 100 year ARI including climate change are shown in Table 12 (Easting : 1925732, Northing : 5593747 in NZTM2000 co-ordinate system).

Table 12 Rainfall depths (with climate change) for Louisa Stream catchment

Average Recurrence Interval (ARI)	Rainfall Depth (mm) 48hr duration storm
2	115.9
10	172.0
100	304.4

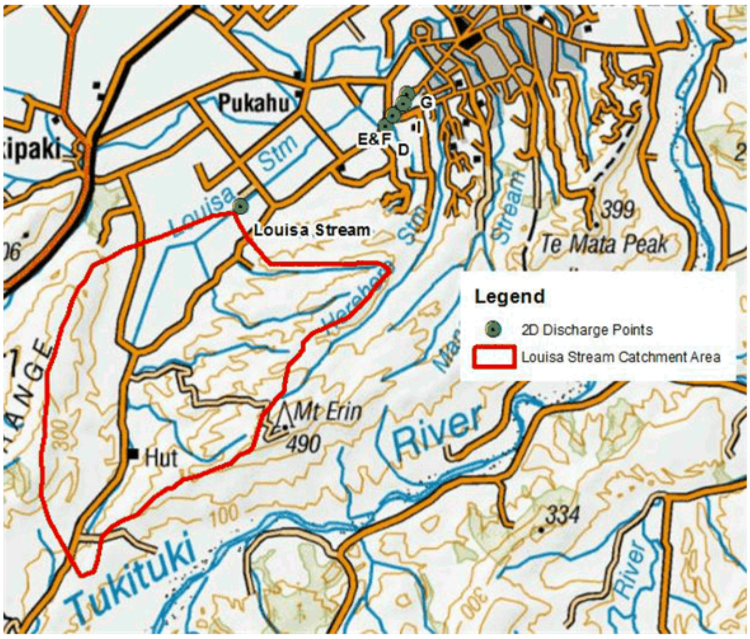

Figure 20 Catchment area for Louisa Stream inflow

The hyetographs for the 48hr duration storm is shown in Figure 21.

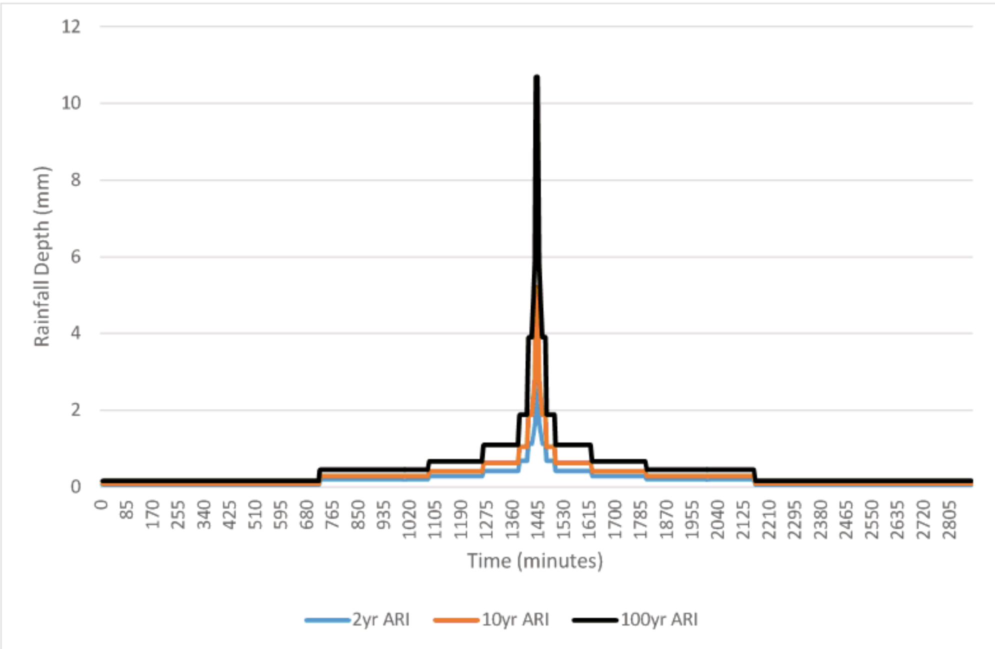

Figure 21 Hyetographs for the 48hr duration storms in the Louisa Stream catchment

HEC-HMS V4.2 produced by the USACE was used for rainfall-runoff simulation of the areas upstream of the Louisa Stream source point and the pertinent catchment parameters are summarised in Table 13.

Table 13 Catchment parameters used for Louisa Stream catchment

Catchment parameter	Value
Catchment Area (km^2)	24.43
Impervious area Curve Number (CN)	73
Imperviousness (%)	0
Initial abstraction (mm)	15
Slope (m/m)	0.01
Longest stream length (km)	8.25
Lag time (minutes)	97

The hydrographs produced based on the hyetographs and the catchment parameters are shown in Figure 22.

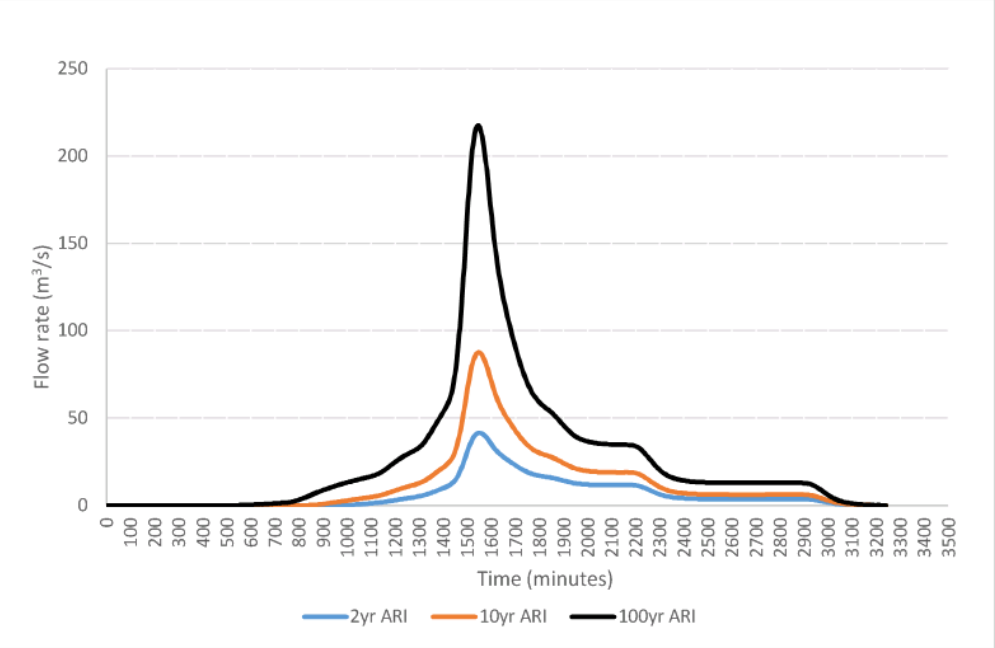

Figure 22 Hydrographs for the Louisa stream including climate change - 48hr storm duration

11.2 Results

The points of interest downstream of the IONA discharges were selected to correspond with properties which could potentially be affected by the development. Their locations (and location ID's) are provided in Figure 23 and were identified from aerial photography.

Comparisons of flooding depths for 2 year ARI, 10 year ARI, 100 year ARI storm events are provided Table 14 below. For the water quality (WQS) none of the points of interest were inundated and results for this case are therefore not reported.

The pre and post development flood depths, water level difference plots and flood extents for the WQE, 2, 10 and 100 year ARI events are shown in Appendix D.

It is noteworthy that the resolution of the 2D model does not provide detailed representation of the minor drains connecting the Iona site to the Louisa Stream. This has the effect of underestimating the outflows from the floodplains which could overestimate the flood levels in the floodplain and increase the duration of flooding. Long durations of flooding are consistent with anecdotal flood reports from this area. The effect of this is unlikely to affect the conclusions of this report, since the flood depths shown at the locations of interest are low and the number of potentially flooding properties would reduce if the flood extents reduced.

Figure 23 Points of Interest for comparison of water depths

Table 14 - Water depths at the points of interest

POI	Water Depth (m)					
	2 year ARI including CC		10 year ARI including CC		100 year ARI including CC	
	Pre-Development	Post-Development (with mitigation)	Pre-Development	Post-Development (with mitigation)	Pre-Development	Post-Development (with mitigation)
1	**0**	0	**0**	0	**0**	0
2	**0**	0	**0**	0	**0**	0
3	**0**	0	**0.24**	0.25	**0.29**	0.30
4	**0**	0	**0**	0	**0.21**	0.23
5	**0**	0	**0**	0	**0.27**	0.28
6	**0**	0	**0**	0	**0**	0
7	**0**	0	**0**	0	**0**	0
8	**0.25**	0.26	**0.28**	0.29	**0.3**	0.3
9	**0**	0	**0**	0	**0**	0
10	**0**	0	**0**	0	**0**	0
11	**0**	0	**0**	0	**0**	0
12	**0**	0	**0**	0	**0.24**	0.25
13	**0**	0	**0**	0	**0**	0
14	**0**	0	**0**	0	**0**	0

0 = No water depth simulated in model

Based on the aforementioned results of downstream flood assessment effects, the following observations are identified:

- The Louisa Stream peak flows are significantly attenuated before reaching the area of interest. The stream does not appear to have an important effect on the flood water levels in the area of interest.
- The maximum pre developed flood depth at the downstream points of interest (POI) is 300 mm during the 100 year ARI flood event.
- In the mitigated post developed scenario there are the following minor increases in flood depths:
  - 2 year ARI event - a 10 mm increase in flood depth at POI No. 8
  - 10 year ARI event - a 10 mm increase in flood depth at POI No. 3 and 8
  - 2 year ARI event - a 10 mm increase in flood depth at POI No. 3, and 12 and a 20 mm increase in flood depth at POI 4
- The pre and post developed flood depth plots in Appendix D show no increase in the extent of flooding as a result of the development. The lower lying areas appear to flood during events larger than the WQS and is not exacerbated by the proposed development and mitigation measures.
- As the peak flows for the mitigated post developed scenario have been reduced below pre development levels, the minor increase in flood depths is likely a result of the increased volume of runoff generated from the proposed development as opposed to peak flows.

12 Further design considerations

Provided in this assessment is a concept design of stormwater mitigation works for consenting purposes. A detailed design phase (in accordance with conditions of consent) is required after the consenting phase. A diagram of the subsequent phases in design development is show in Figure 24 below.

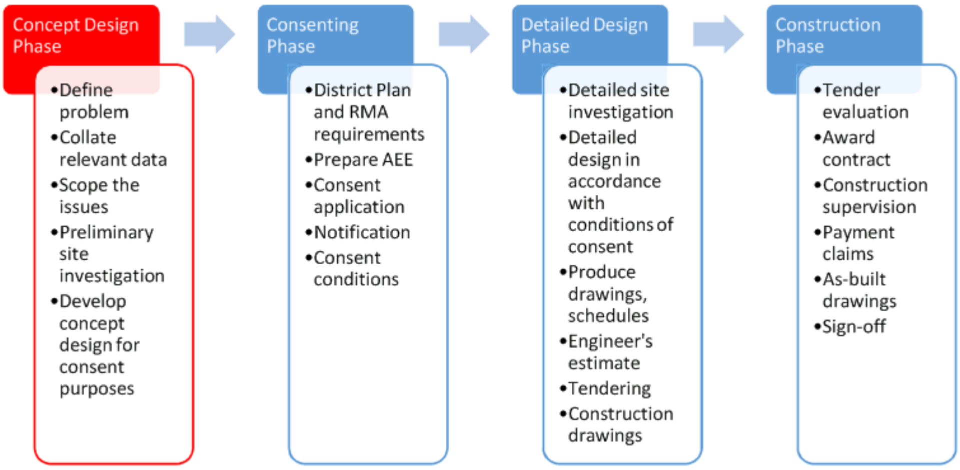

Figure 24 – Iona stormwater mitigation design phases

13 Conclusion

The aim of this assessment was to assess the potential stormwater effects caused by the proposed development and identify mitigation options to adequately address these adverse effects.

The proposed development has the potential, without mitigation, to increase peak runoff from site due to the increase in impervious area and proposed recontouring. The increase was particularly significant at the outlet locations in the southern corner of the Triangle site (Outlets D and E) due to downstream ponding issues and at the northern section of the Triangle site (Outlet G) due to large increases in peak flows.

Mitigation options have been considered that will meet the performance guidelines from HBRC WGSM for water quantity. That is, the post development peak discharges can be limited to 80% of the pre-development peak discharge and the post-development discharges do not exceed the 2 and 10 year ARI pre-development peak discharge.

The proposed mitigation options for water quantity and water quality include:

- A wetland to the north west of the development, on the western side of Middle Road, to treat and attenuate flows from the Outlet G catchment
- A wetland upstream of Outlet E, within the proposed development, to treat and attenuate flows from the Outlet E catchment
- Attenuation of flows upstream of the 'Spine' road culvert through an inlet structure and availablility of an upstream ponding volume
- Treatment swales within the carriageway verges, particularly in the proposed southern developed areas
- Facilitate the conveyance of runoff into existing ponds to enable additional water quality treatment

The mitigation options proposed achieves the target peak flows for the development.

The downstream effects assessment showed a 10 – 20 mm increase in flood depths in some downstream properties as a result of the mitigated proposed development. These increases are considered minor and likely a result of the increase in runoff volume from the proposed development being spread over the downstream flood plain.

The mitigation options proposed are conceptual to assist with the consent application for the proposed development. The detailed design of the mitigation options in accordance with consent conditions will be completed during the detailed design phase of works.

14 Applicability

This report has been prepared for the exclusive use of our client Lowe Corporation Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

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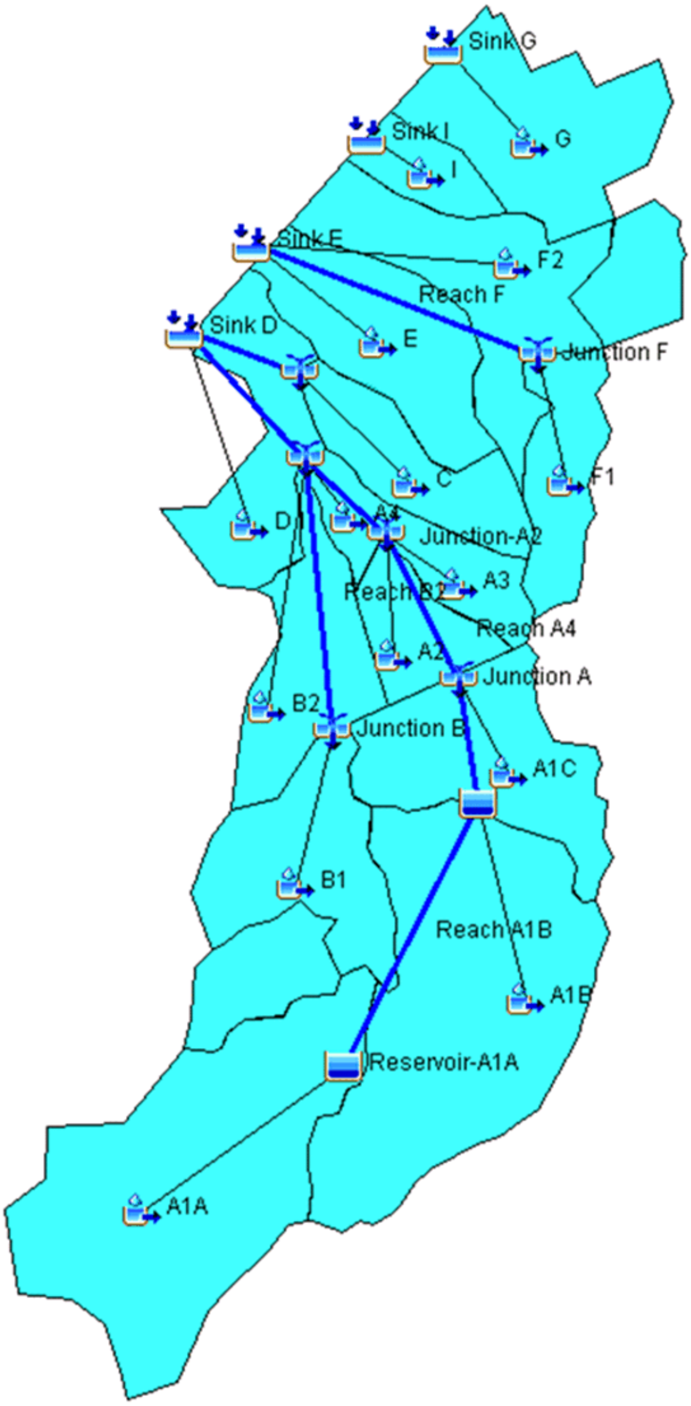
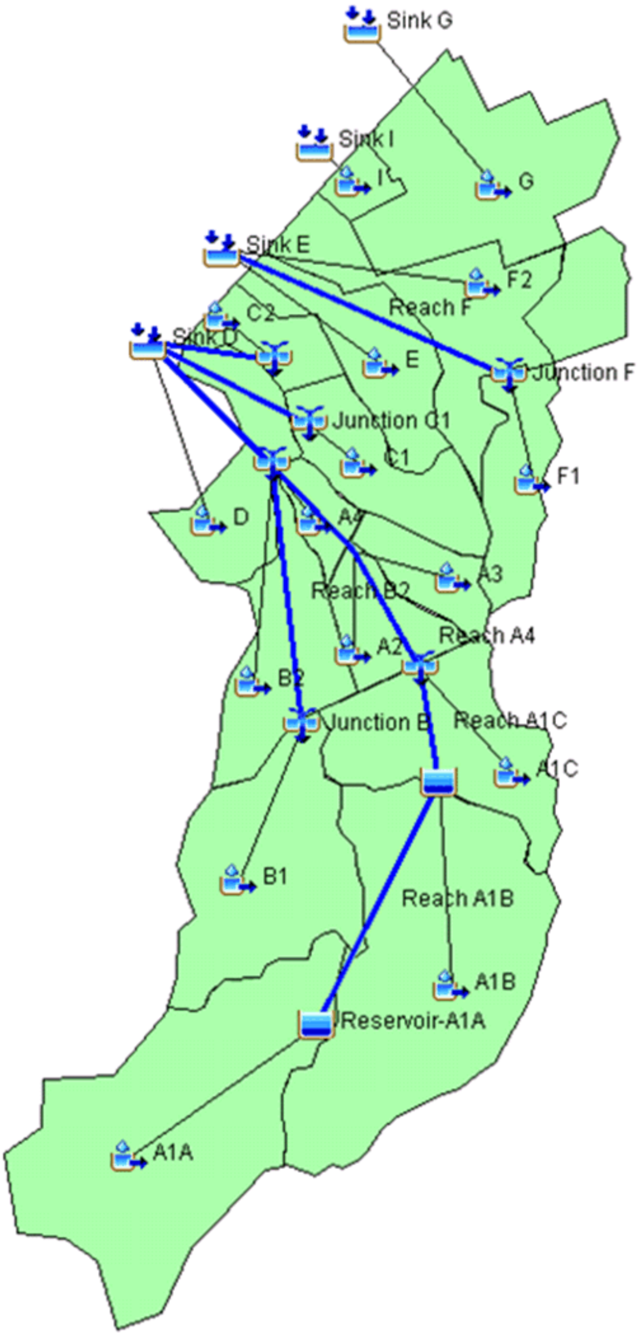
Appendix A: HEC-HMS model layout

- Pre development model
- Post development model – Without mitigation
- Post development model – With mitigation

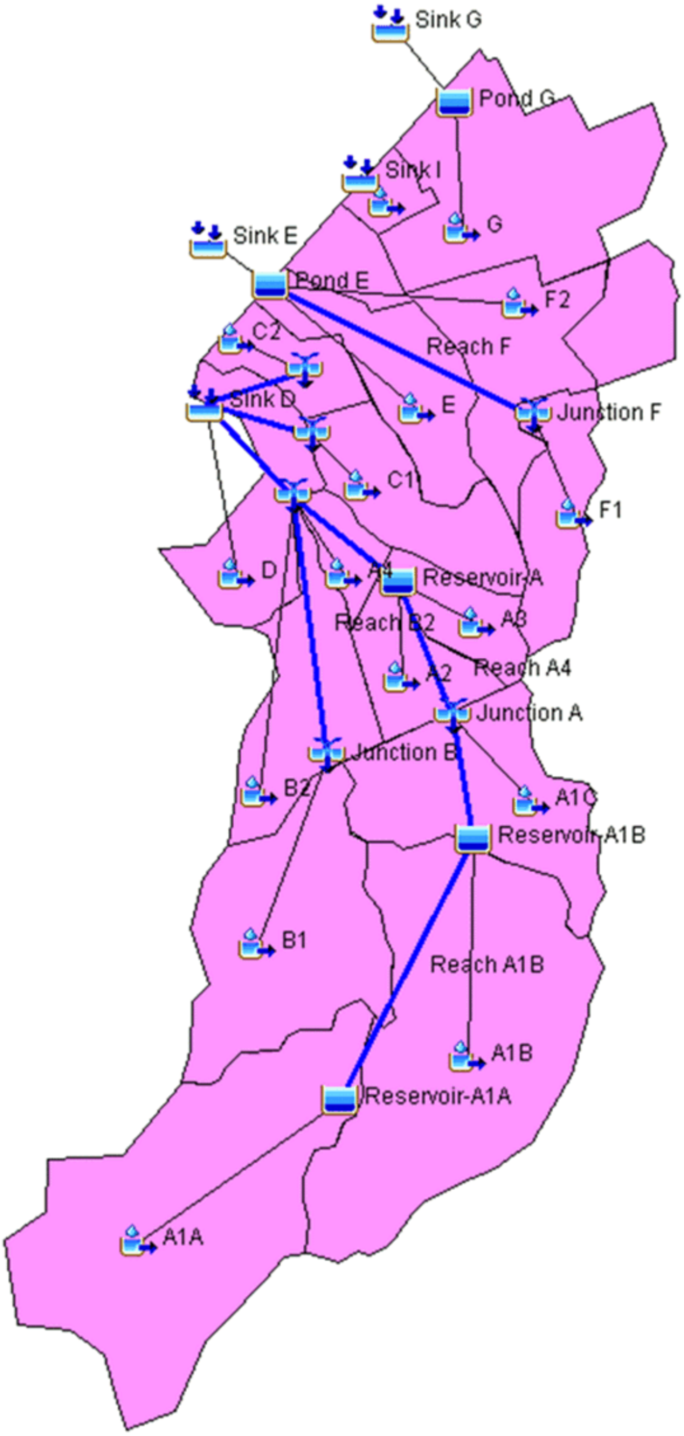
IONA Pre development HEC HMS Model Layout



IONA Post development (without mitigation) HEC HMS Model Layout



IONA Post development (with mitigation) HEC HMS Model Layout

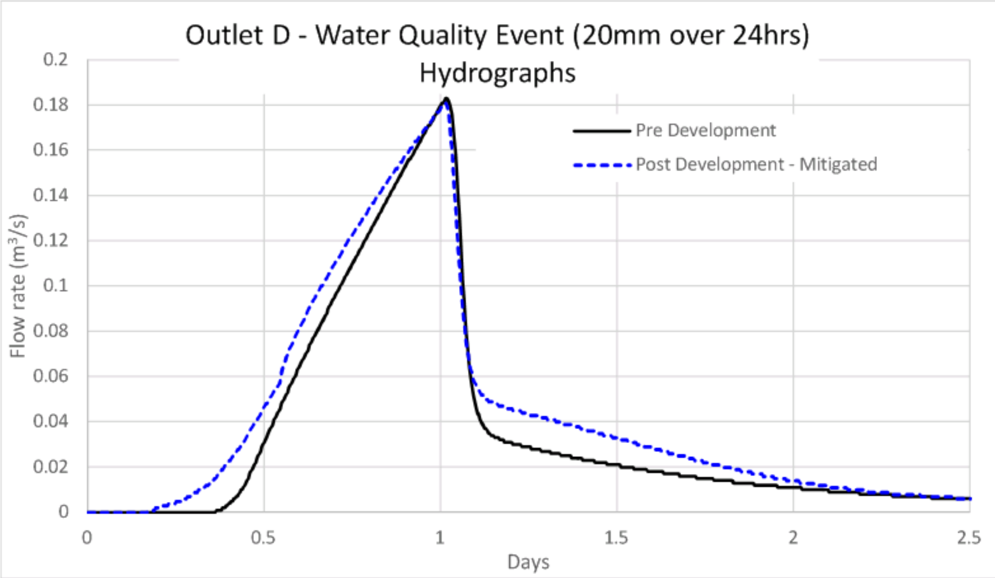


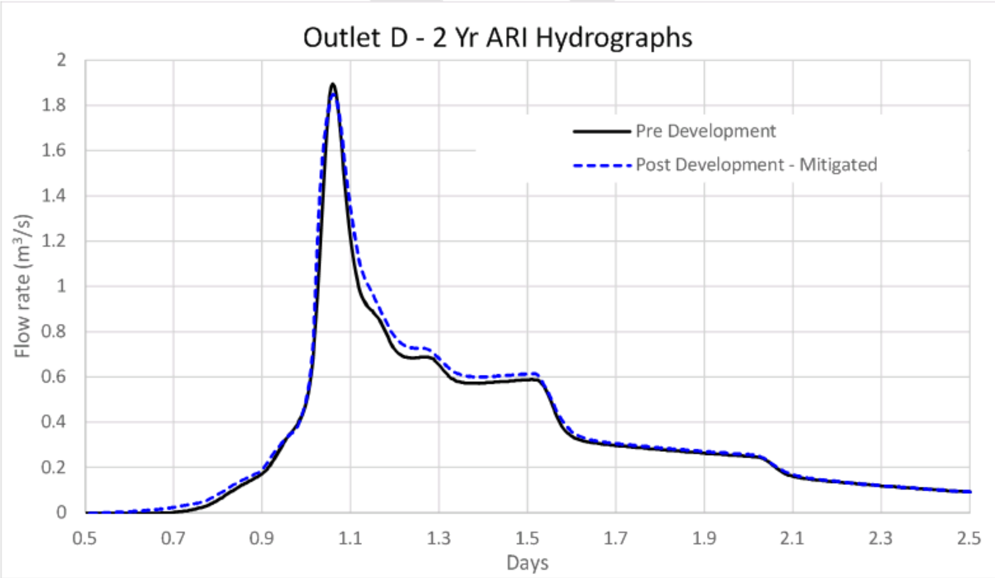
Appendix B: Summary table of catchments and peak flows (48hr duration)

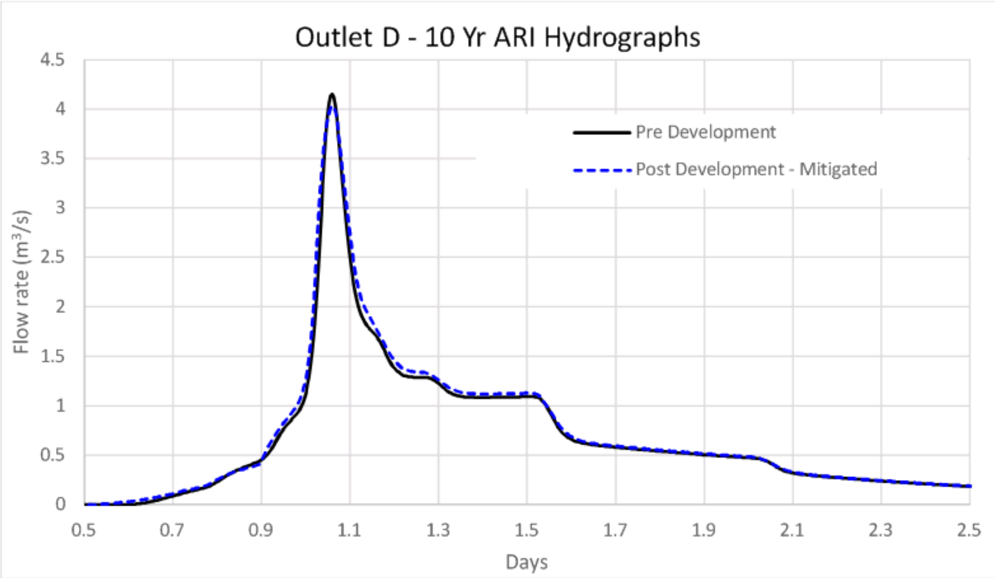
Catchment	Area (ha)	% Impervious	Curve Number	Tc (mins)	2 yr Peak (m^3/s)	10 yr Peak (m^3/s)	100 yr (m^3/s)
Pre development							
A1A - Pre	34.4	0	71	67	0.64	1.61	4.10
A1B - Pre	34.4	0	76	77	0.79	1.77	4.17
A1C - Pre	14.8	0	78	71	0.38	0.83	1.92
A2 - Pre	5.7	0	79	66	0.16	0.34	0.77
A3 - Pre	4.6	0	77	59	0.13	0.28	0.65
A4 - Pre	2.8	0	80	57	0.09	0.18	0.42
B1 - Pre	18.9	0	77	66	0.48	1.08	2.50
B2 - Pre	10.9	0	79	82	0.28	0.59	1.34
C - Pre	8.6	0	77	56	0.24	0.53	1.23
D - Pre	11.1	0	80	86	0.28	0.60	1.34
E - Pre	13	0	79	74	0.34	0.74	1.67
F1 - Pre	7.5	0	76	74	0.18	0.40	0.93
F2 - Pre	15.7	0	79	68	0.44	0.94	2.12
G - Pre	15.6	35	86	30	0.66	1.29	2.71
I – Pre	3.9	3	80	44	0.14	0.29	0.65
Post development							
A1A - Post	34.4	0	71	67	0.64	1.61	4.10
A1B - Post	34.4	0	76	77	0.79	1.77	4.17
A1C - Post	14.8	0	78	71	0.38	0.83	1.92
A2 - Post	5.7	8	81	66	0.17	0.36	0.79
A3 - Post	4.6	0	77	59	0.13	0.29	0.65
A4 - Post	2.8	5	81	57	0.09	0.19	0.42
B1 - Post	18.9	0	77	66	0.48	1.08	2.50
B2 - Post	10.9	9	81	82	0.30	0.62	1.37
C1 – Post	9.0	35	84	40	0.38	0.75	1.61
C2 – Post	4.37	60	91	37	0.23	0.42	1.86
D - Post	9.4	0	80	86	0.24	0.51	1.14
E – Post	8.3	10	81	47	0.36	0.74	1.63
F1 - Post	7.5	0	76	74	0.18	0.40	0.93
F2 – Post	14.0	8	81	66	0.42	0.89	1.96
G - Post	19.1	60	91	21	1.26	2.29	4.61
I – Post	2	60	91	22	0.13	0.23	0.47

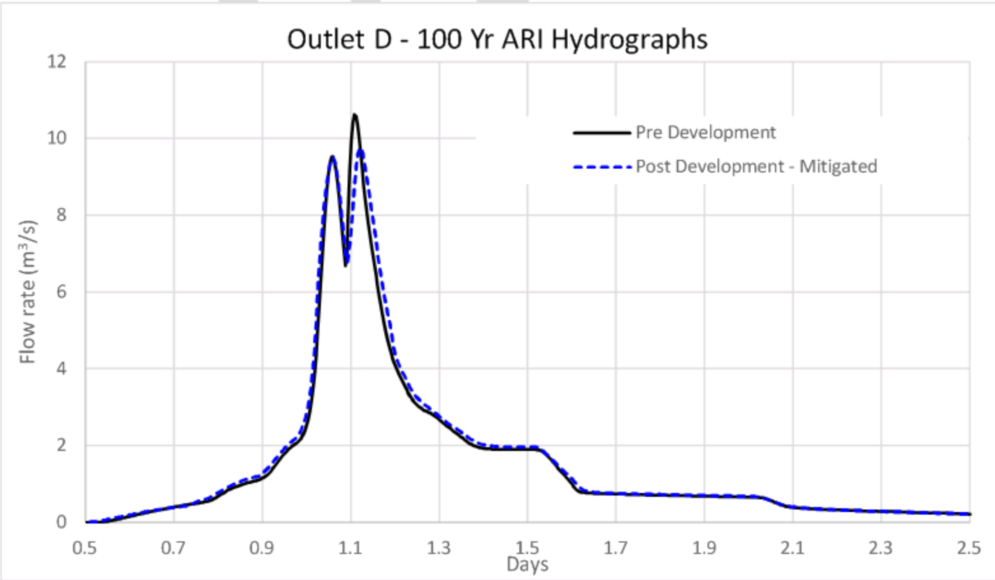
Appendix C: HEC-HMS – result hydrographs

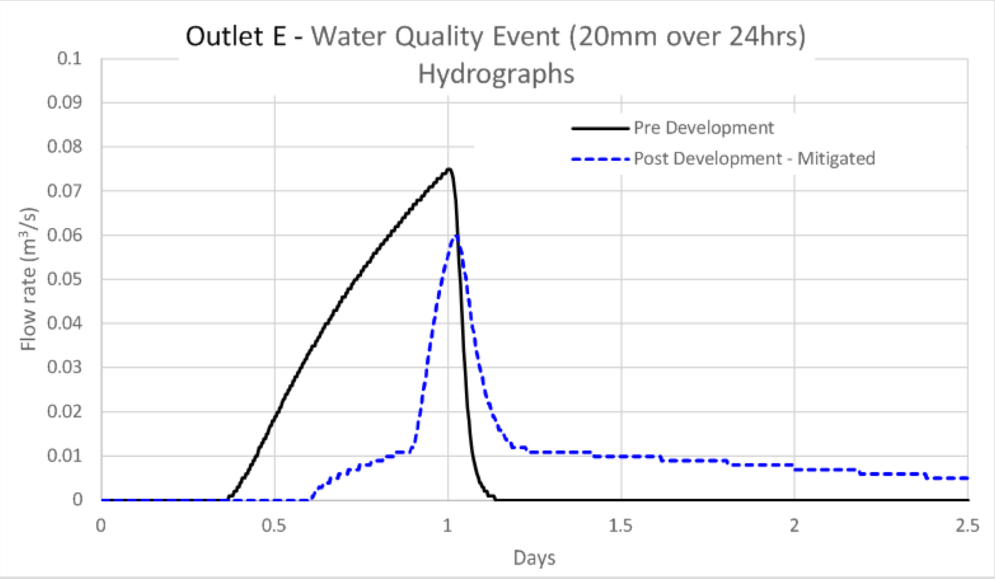
- Outlet D – WQE, 2, 10 and 100 year hydrographs comparing pre and post development flows
- Outlet E – WQE, 2, 10 and 100 year hydrographs comparing pre and post development flows
- Outlet I – WQE, 2, 10 and 100 year hydrographs comparing pre and post development flows
- Outlet G – WQE, 2, 10 and 100 year hydrographs comparing pre and post development flows

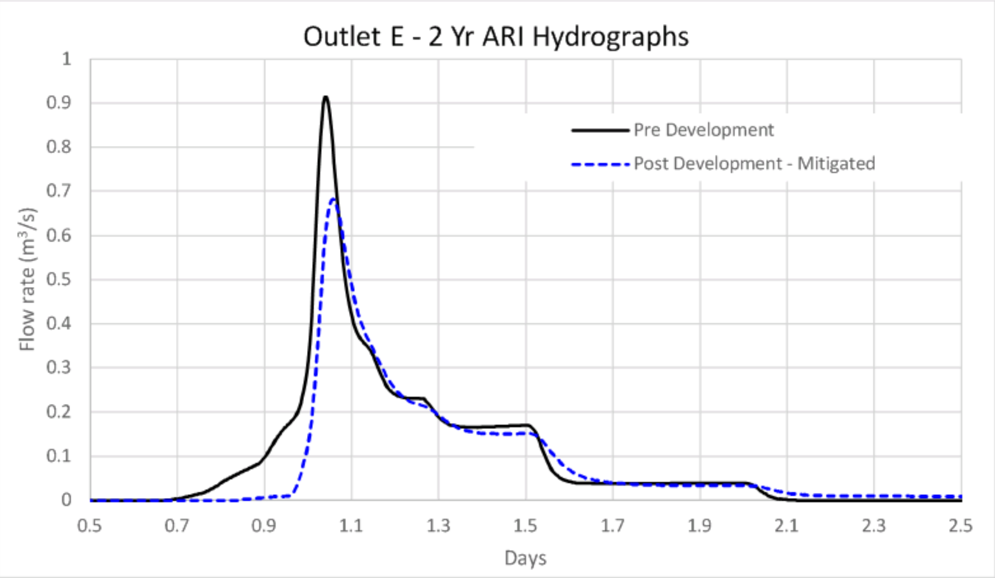

Outlet D - Water Quality Event (20mm over 24hrs) Hydrographs
Pre Development
Post Development - Mitigated
Flow rate (m3/s)
Days
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0
0.5
1
1.5
2
2.5

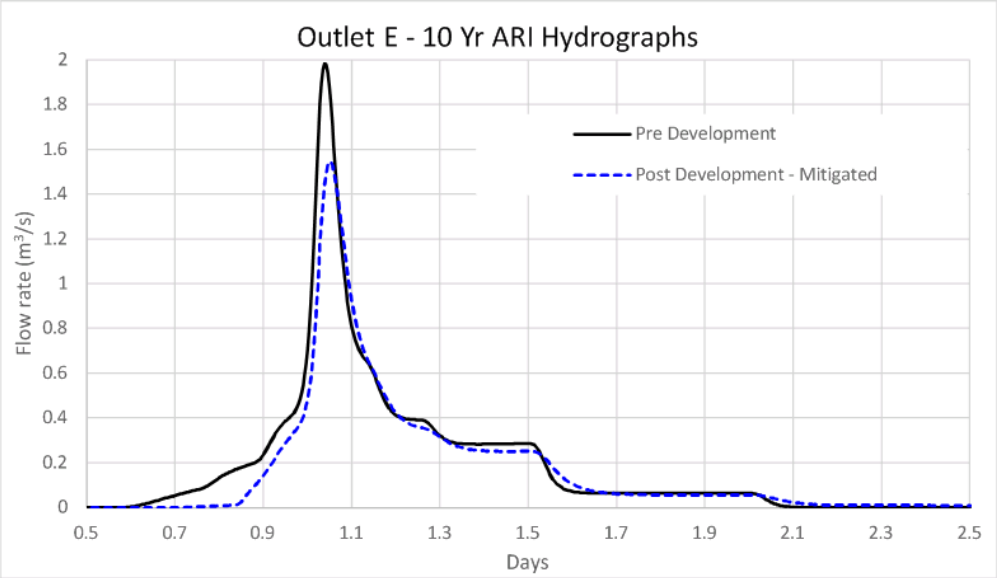

Outlet D - 2 Yr ARI Hydrographs
Pre Development
Post Development - Mitigated
Flow rate (m3/s)
Days
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5

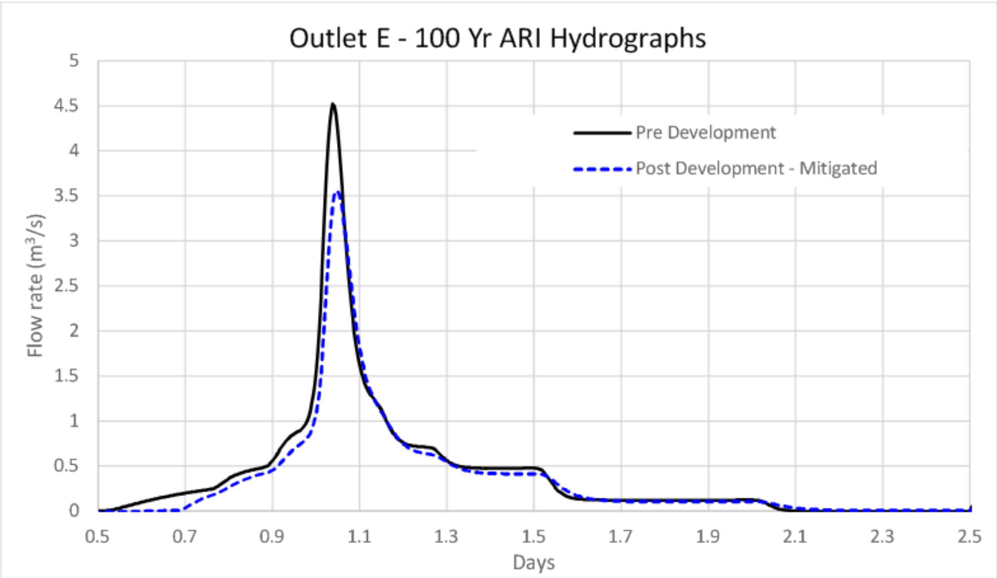

Outlet D - 10 Yr ARI Hydrographs
Pre Development
Post Development - Mitigated
Flow rate (m³/s)
Days
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5

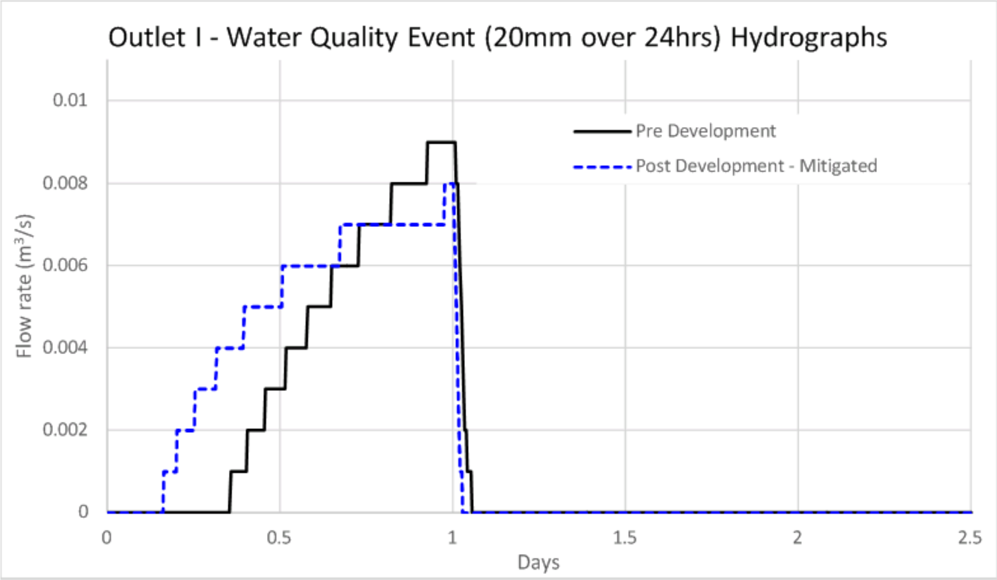

Outlet D - 100 Yr ARI Hydrographs
Pre Development
Post Development - Mitigated
Flow rate (m³/s)
Days
0
2
4
6
8
10
12
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5

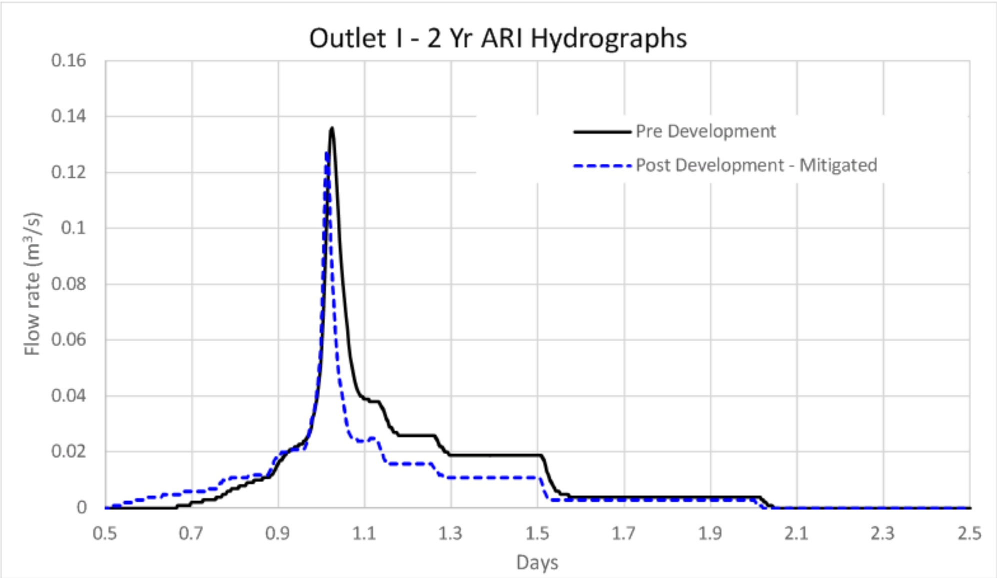

Outlet E - Water Quality Event (20mm over 24hrs) Hydrographs
Pre Development
Post Development - Mitigated
Flow rate (m³/s)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
0.5
1
1.5
2
2.5
Days

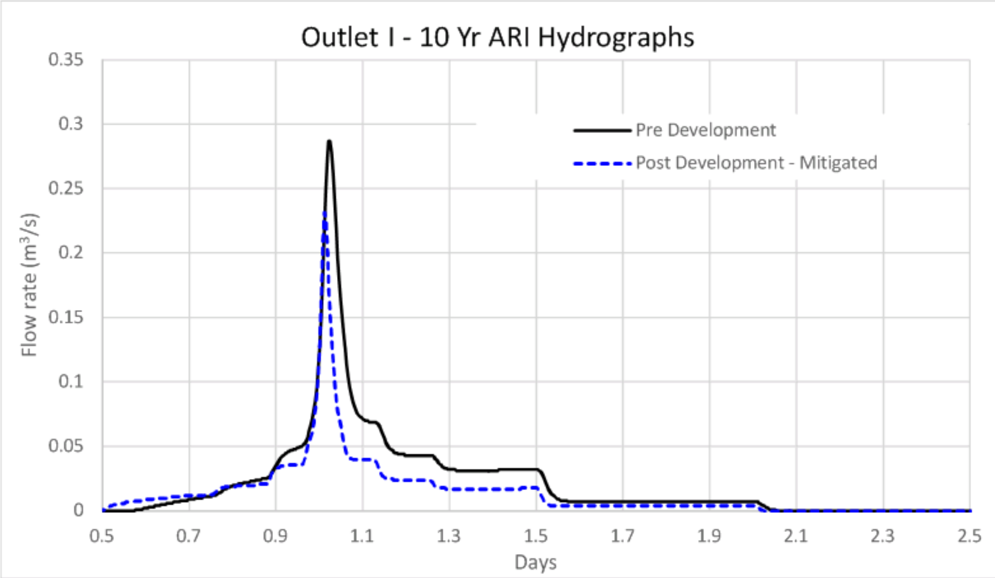

Outlet E - 2 Yr ARI Hydrographs
Pre Development
Post Development - Mitigated
Flow rate (m³/s)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days

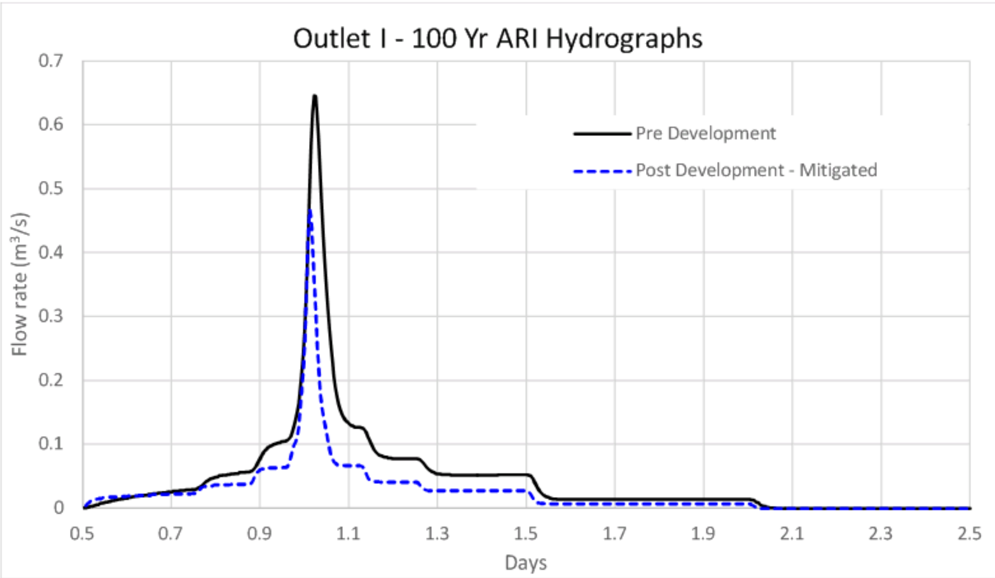

Outlet E - 10 Yr ARI Hydrographs
Flow rate (m³/s)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated

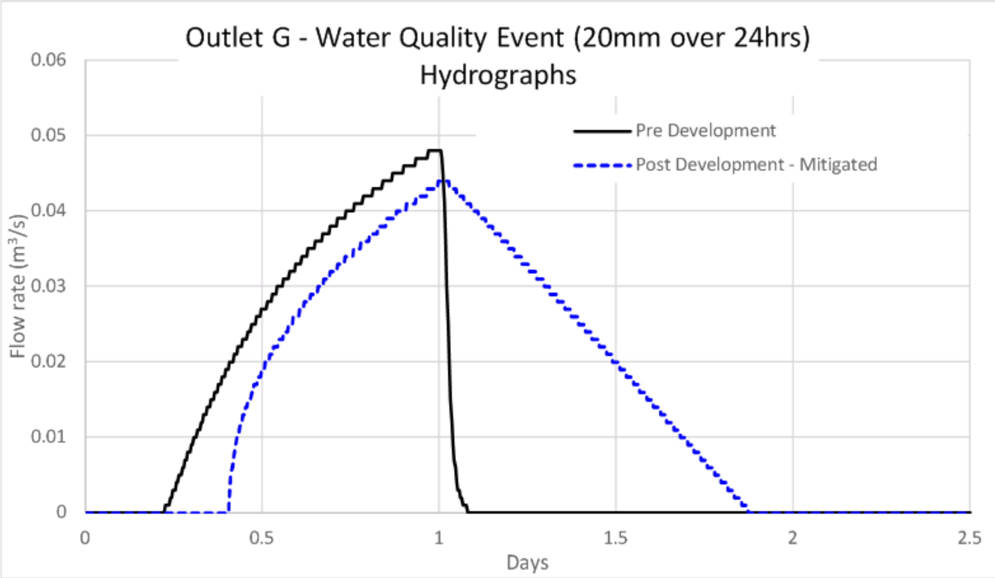

Outlet E - 100 Yr ARI Hydrographs
Flow rate (m³/s)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated

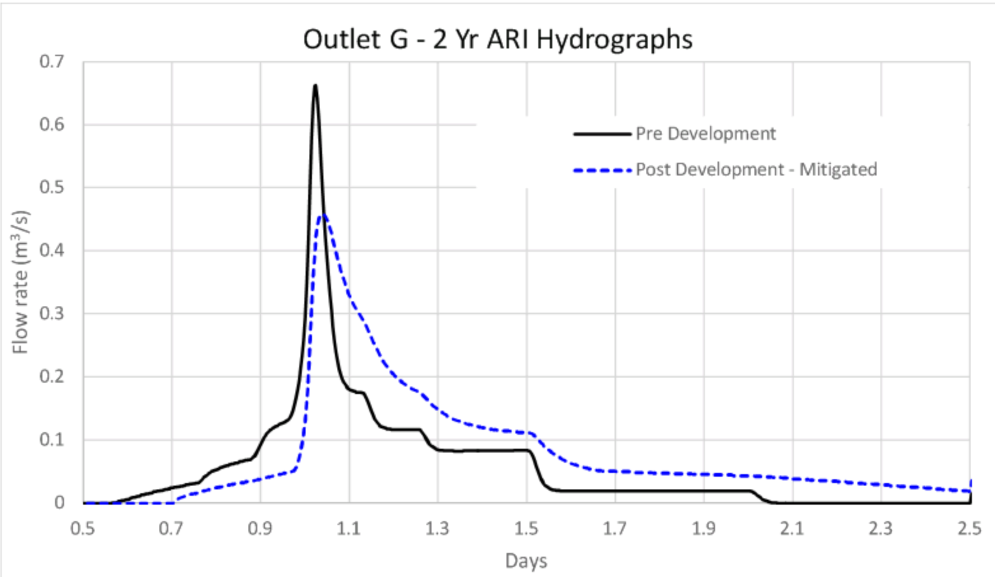

Outlet I - Water Quality Event (20mm over 24hrs) Hydrographs
Flow rate (m³/s)
0.01
0.008
0.006
0.004
0.002
0
0
0.5
1
1.5
2
2.5
Days
Pre Development
Post Development - Mitigated

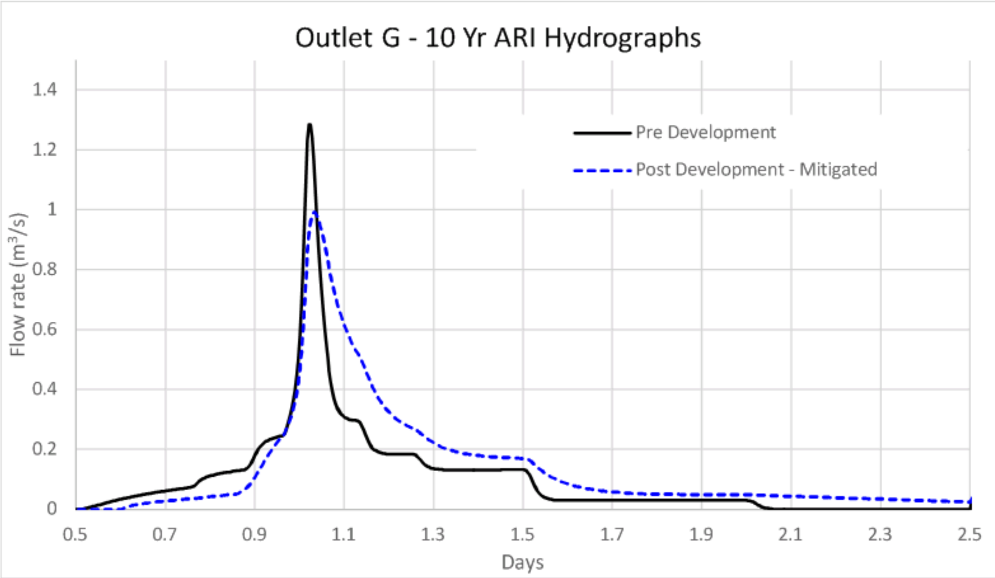

Outlet I - 2 Yr ARI Hydrographs
Flow rate (m³/s)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated


Outlet I - 10 Yr ARI Hydrographs
Flow rate (m³/s)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated

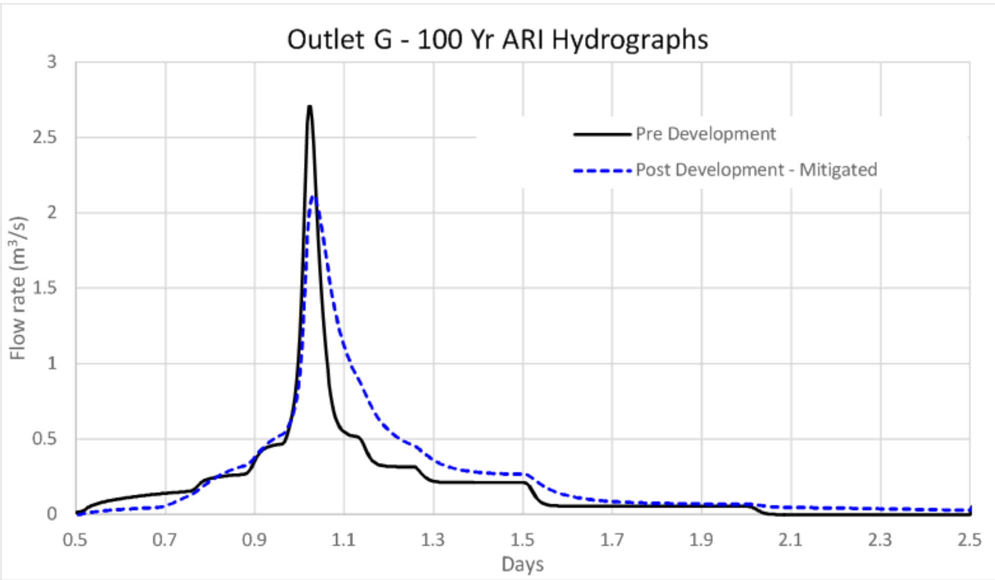

Outlet I - 100 Yr ARI Hydrographs
Flow rate (m³/s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated


Outlet G - Water Quality Event (20mm over 24hrs) Hydrographs
Flow rate (m³/s)
0.06
0.05
0.04
0.03
0.02
0.01
0
0
0.5
1
1.5
2
2.5
Days
Pre Development
Post Development - Mitigated


Outlet G - 2 Yr ARI Hydrographs
Flow rate (m³/s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated



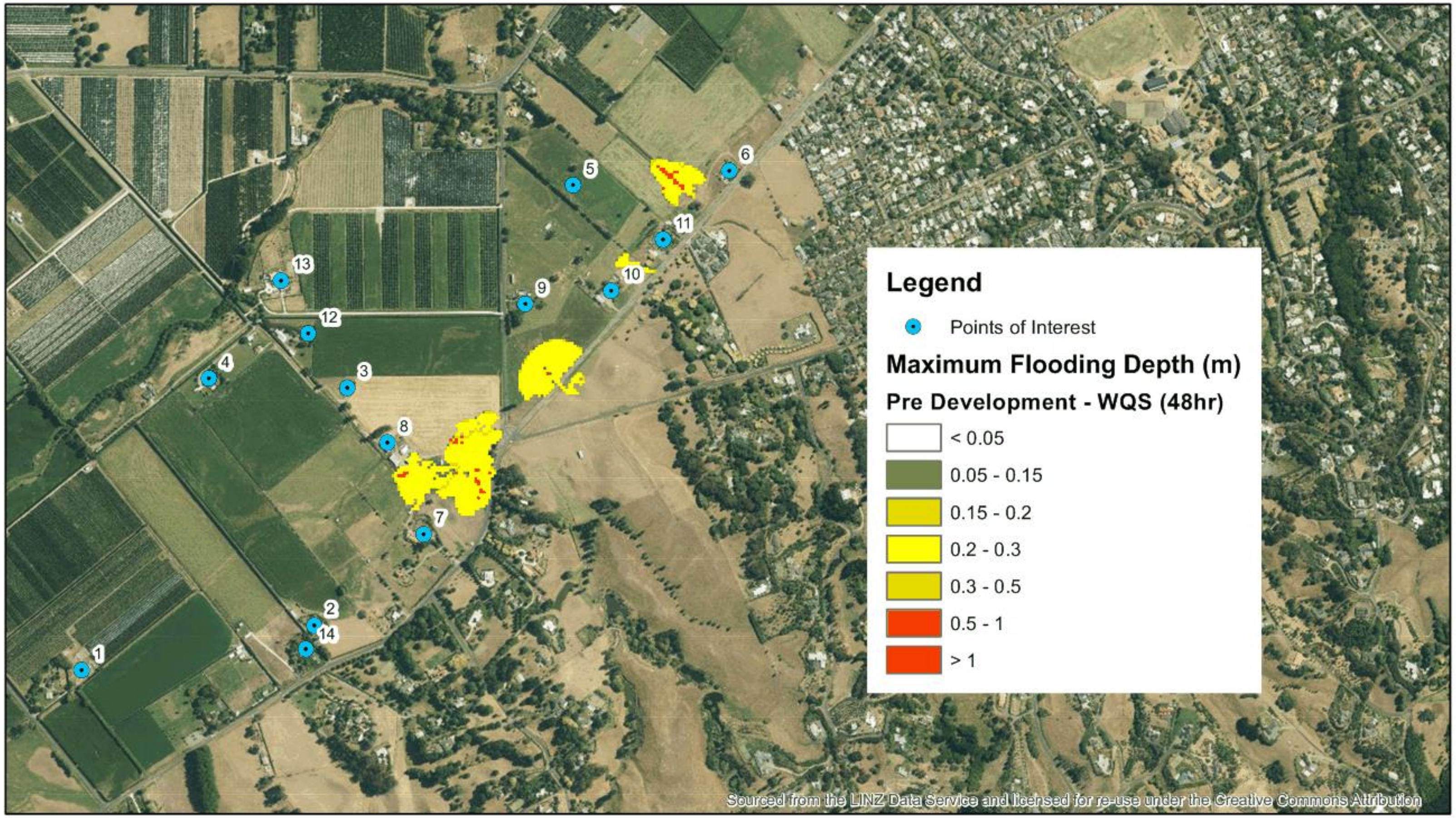
Outlet G - 10 Yr ARI Hydrographs
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Flow rate (m3/s)
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated



Outlet G - 100 Yr ARI Hydrographs
3
2.5
2
1.5
1
0.5
0
Flow rate (m3/s)
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Days
Pre Development
Post Development - Mitigated

Appendix D: Hydrodynamic model plots

- Water Quality Event – Pre development flood depths, Post development flood depths, Flood depth difference (Pre – Post)
- 2 Year ARI Event – Pre development flood depths, Post development flood depths, Flood depth difference (Pre – Post)
- 10 Year ARI Event – Pre development flood depths, Post development flood depths, Flood depth difference (Pre – Post)
- 100 Year ARI Event – Pre development flood depths, Post development flood depths, Flood depth difference (Pre – Post)
- Post development flood extents


Legend
Points of Interest
Maximum Flooding Depth (m)
Pre Development - WQS (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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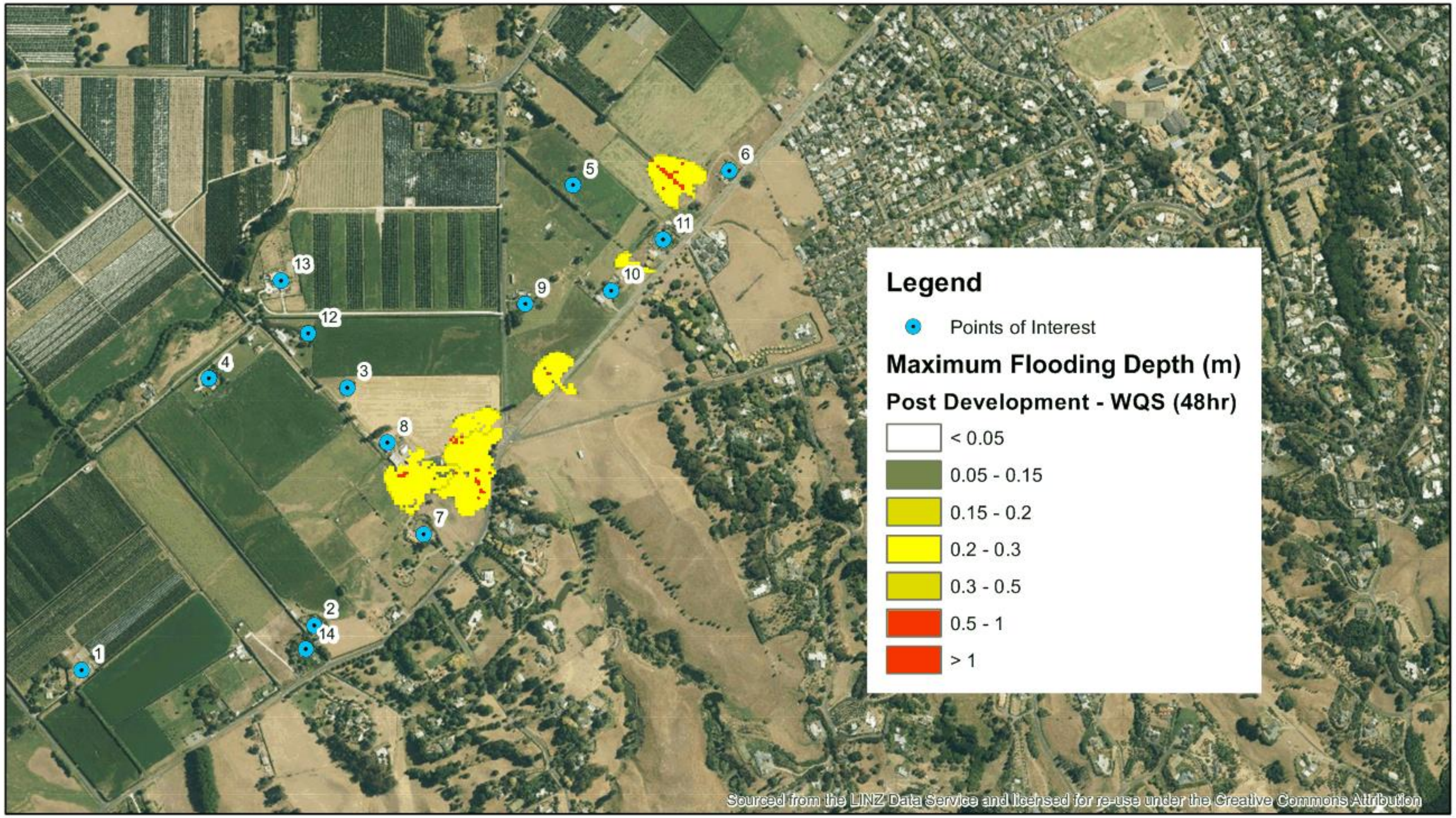
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Legend
Points of Interest
Maximum Flooding Depth (m)
Post Development - WQS (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
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Legend
Points of Interest
Water Level Difference (m)
Pre. Dev. minus Post Dev. - WQS (48hr)
< -0.15
-0.15 - -0.1
-0.1 - -0.05
0.05 - 0.1
0.1 - 0.15
> 0.15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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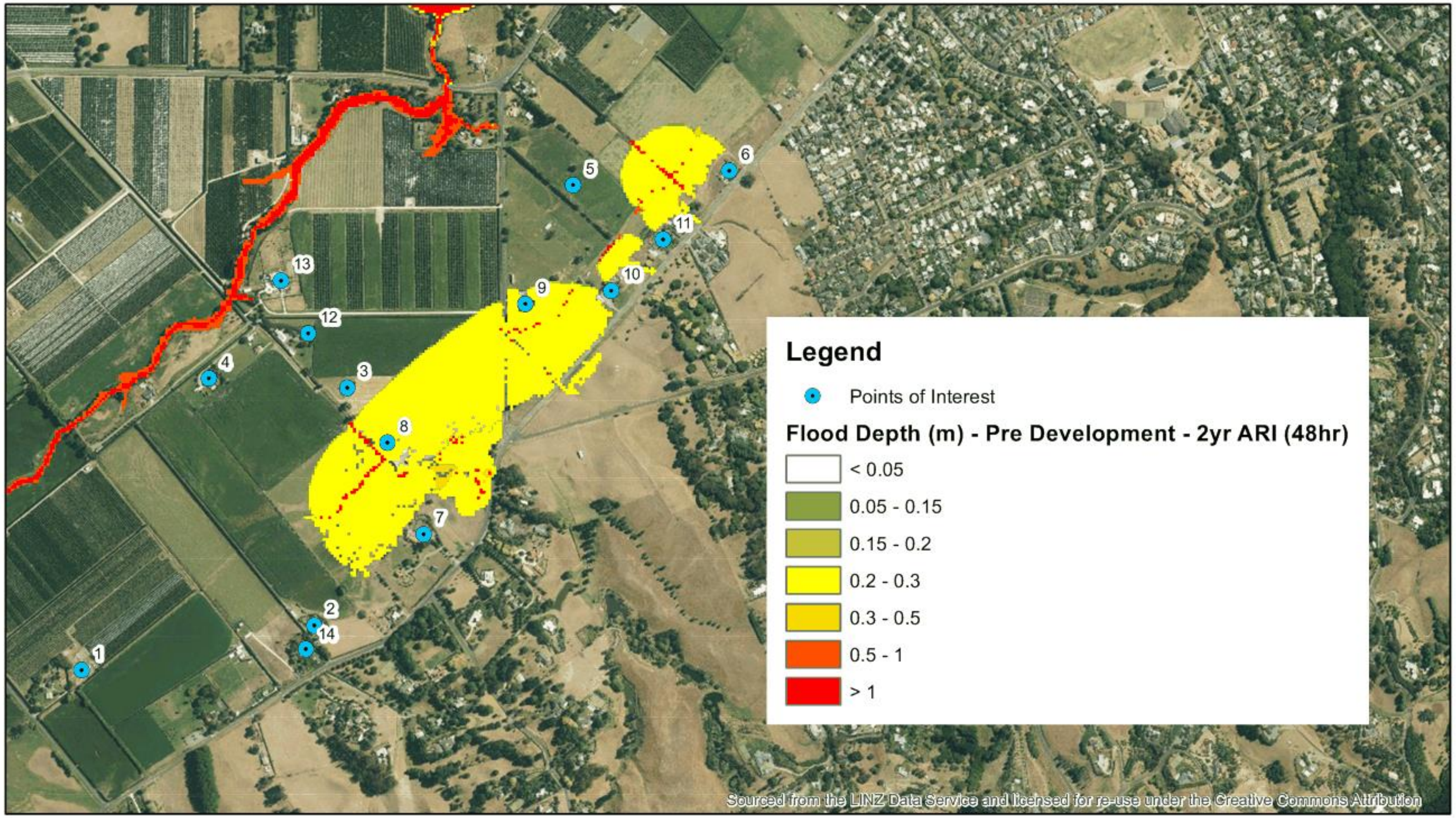
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Legend
Points of Interest
Flood Depth (m) - Pre Development - 2yr ARI (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
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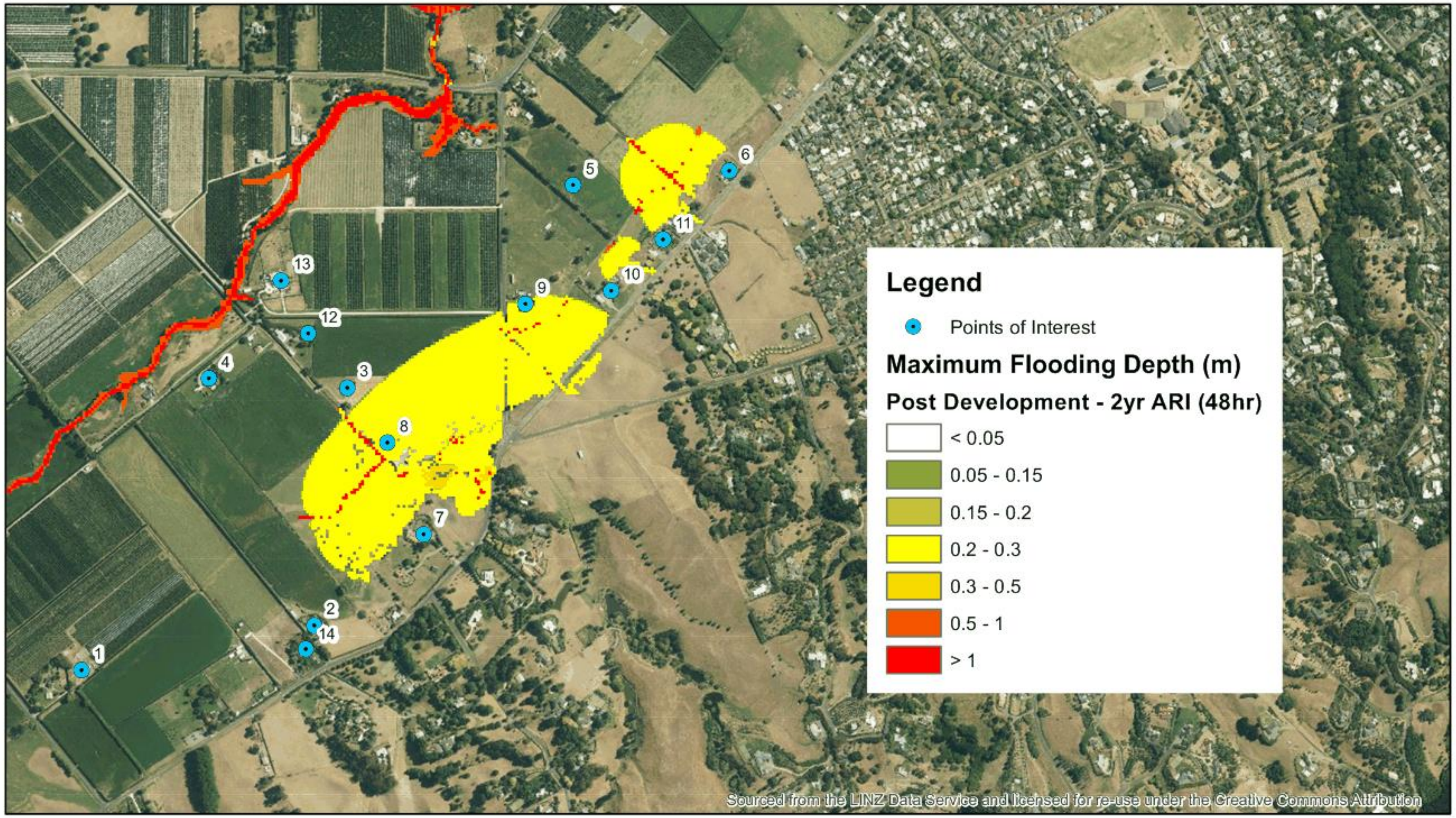
Legend
Points of Interest
Maximum Flooding Depth (m)
Post Development - 2yr ARI (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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1
2
3
4
5
6
7
8
9
10
11
12
13
14
Legend
Points of Interest
Water Level Difference (m)
Pre. Dev. minus Post Dev. - 2yr ARI (48hr)
< -0.15
-0.15 - -0.1
-0.1 - -0.05
0.05 - 0.1
0.1 - 0.15
> 0.15
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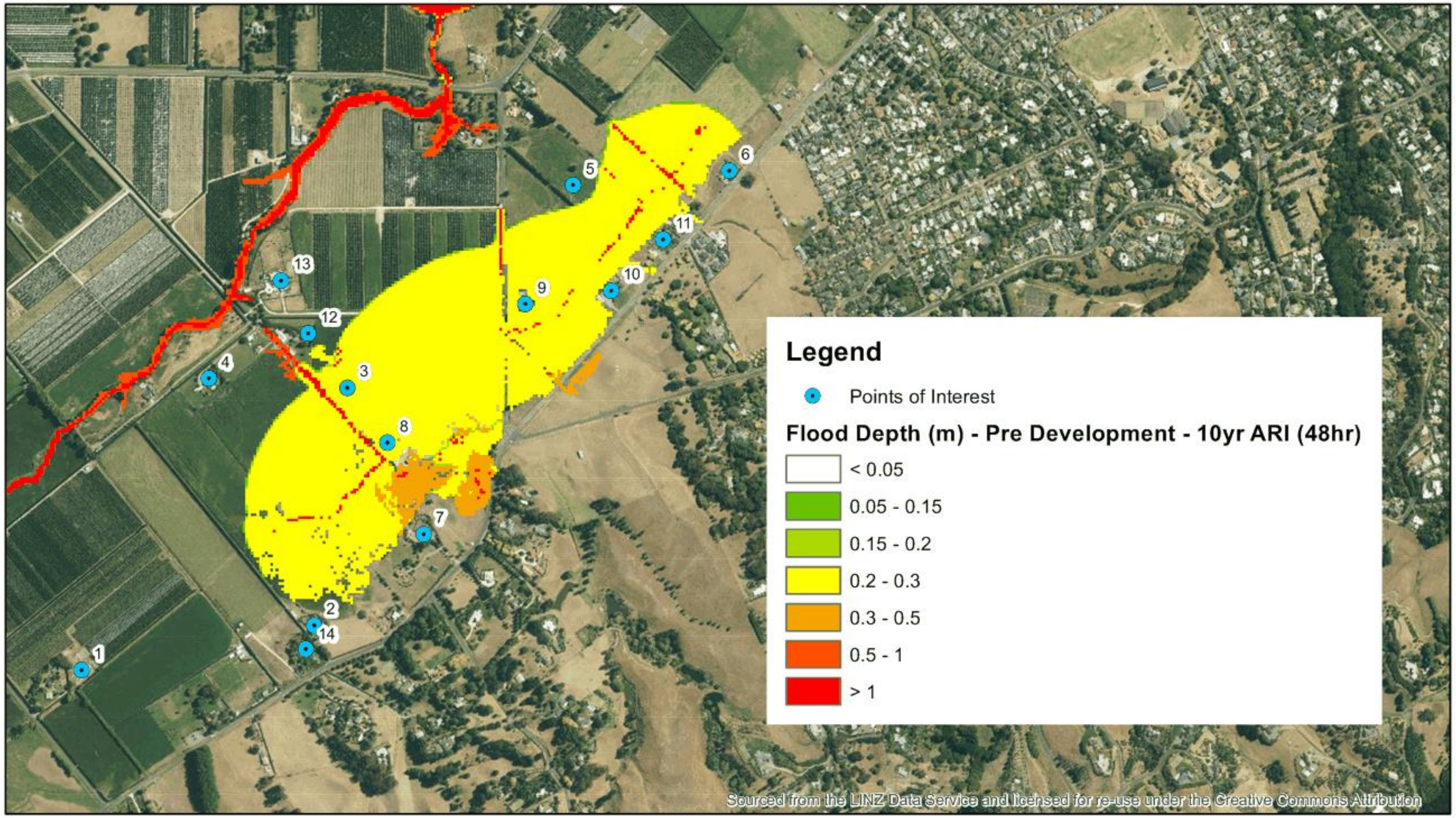

1
2
3
4
5
6
7
8
9
10
11
12
13
14
Legend
Points of Interest
Flood Depth (m) - Pre Development - 10yr ARI (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
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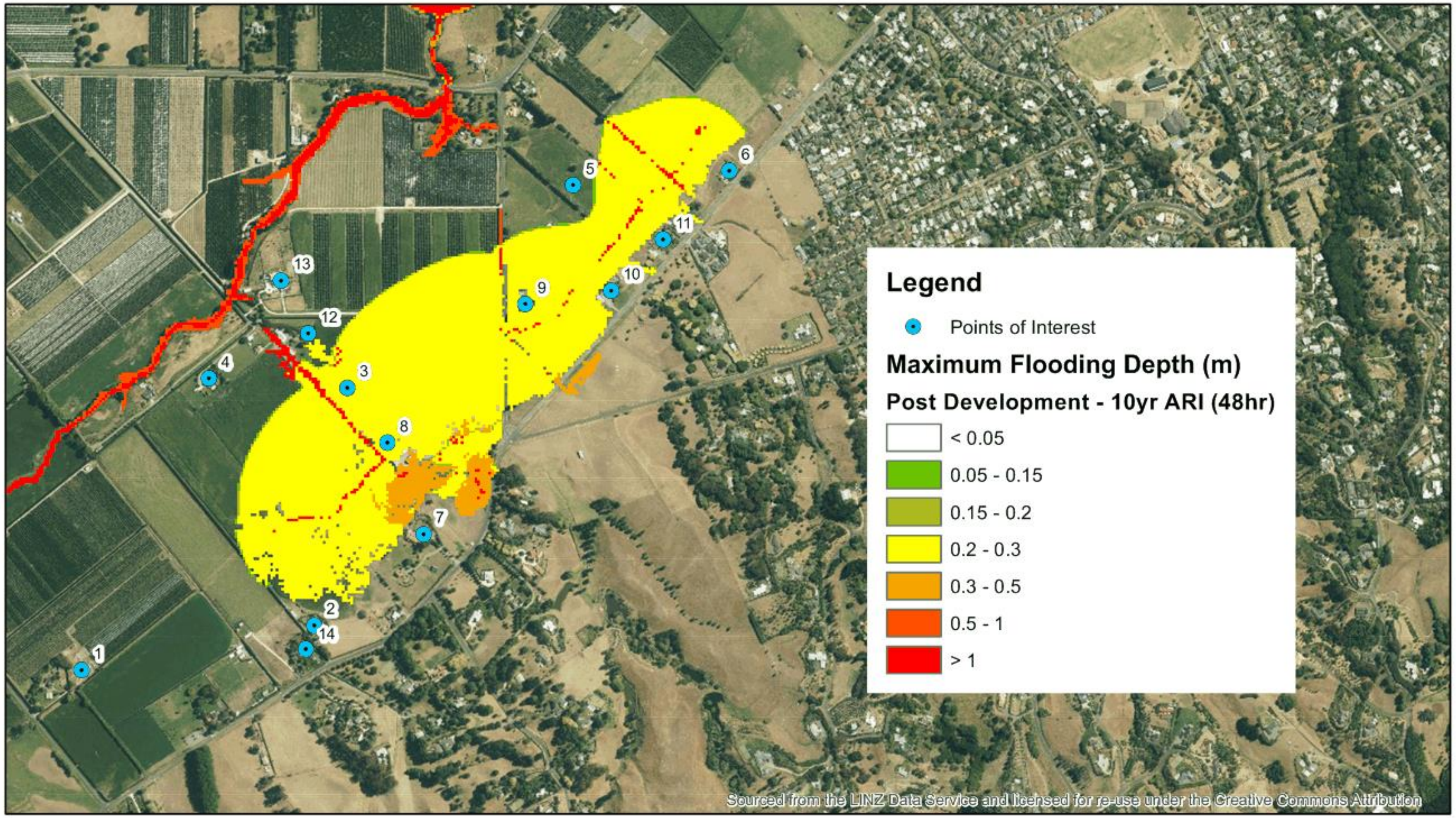
Legend
Points of Interest
Maximum Flooding Depth (m)
Post Development - 10yr ARI (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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Legend
Points of Interest
Water Level Difference (m)
Pre. Dev. minus Post Dev. - 10yr ARI (48hr)
< -0.15
-0.15 - -0.1
-0.1 - -0.05
0.05 - 0.1
0.1 - 0.15
> 0.15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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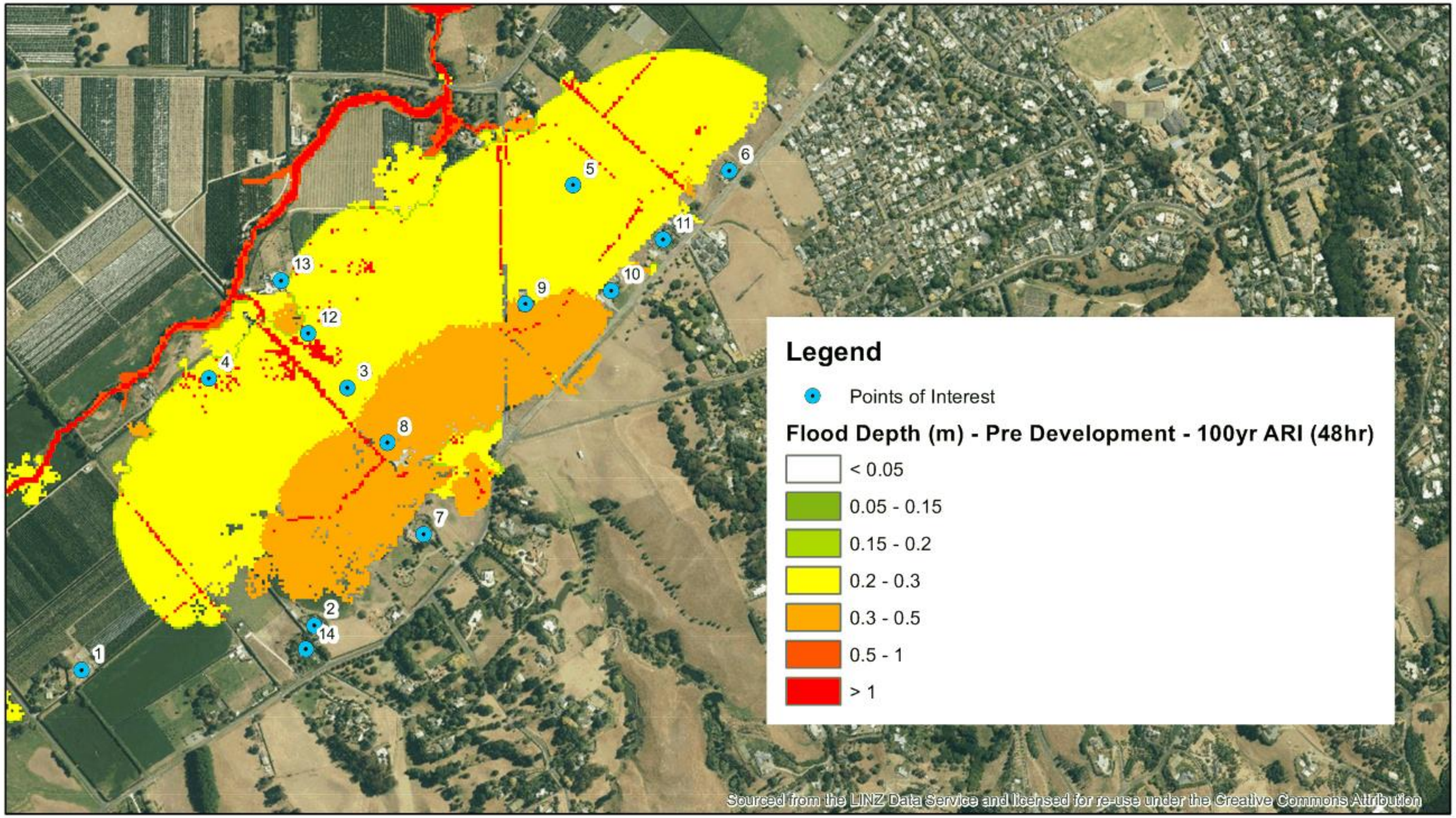

Legend
Points of Interest
Flood Depth (m) - Pre Development - 100yr ARI (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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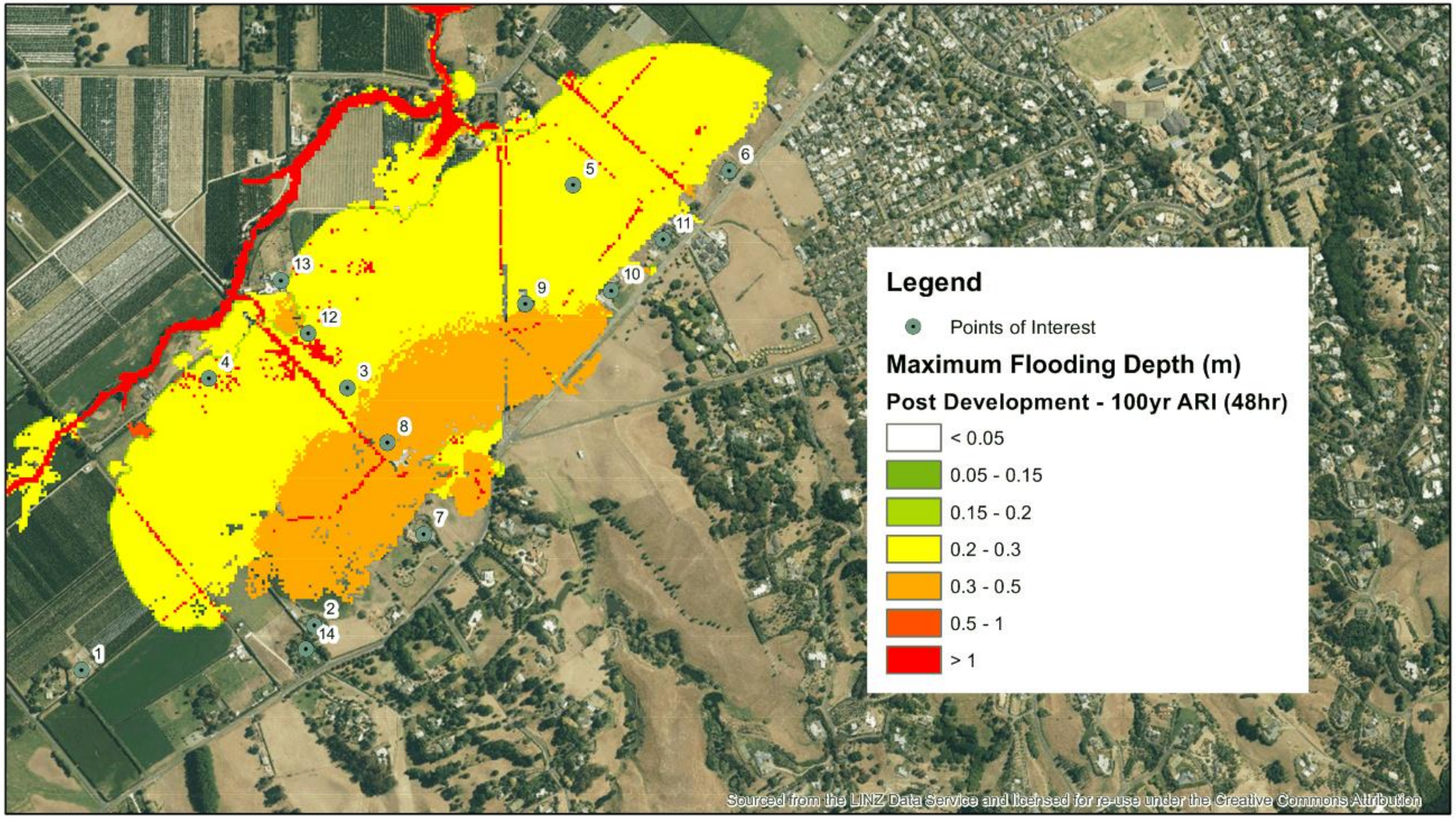
Legend
Points of Interest
Maximum Flooding Depth (m)
Post Development - 100yr ARI (48hr)
< 0.05
0.05 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1
> 1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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Legend
Points of Interest
Water Level Difference (m)
Pre. Dev. minus Post Dev. - 100yr ARI (48hr)
< -0.15
-0.15 - -0.1
-0.1 - -0.05
0.05 - 0.1
0.1 - 0.15
> 0.15
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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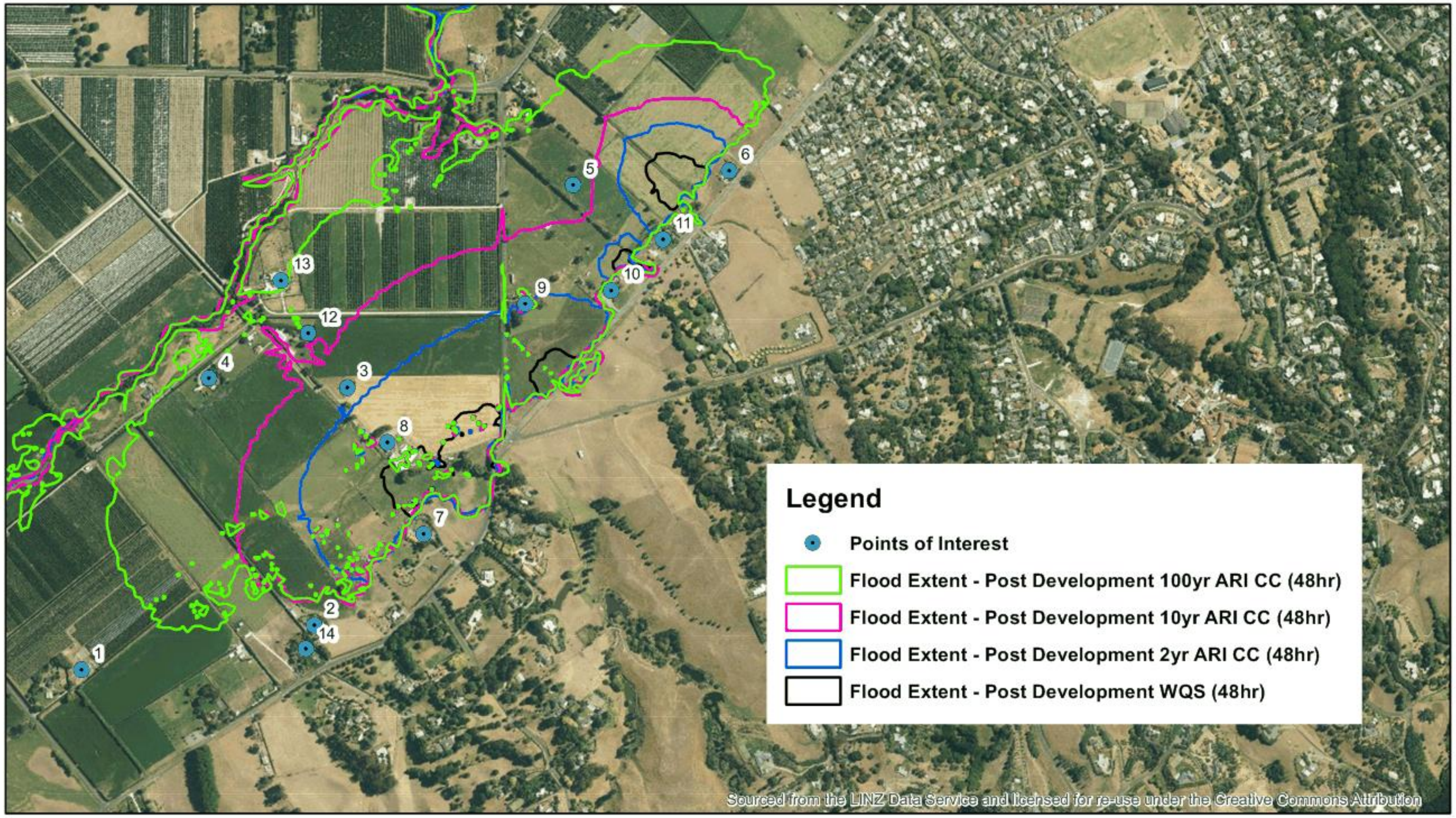
Legend
Points of Interest
Flood Extent - Post Development 100yr ARI CC (48hr)
Flood Extent - Post Development 10yr ARI CC (48hr)
Flood Extent - Post Development 2yr ARI CC (48hr)
Flood Extent - Post Development WQS (48hr)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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17 November 2017

Hastings District Council
Attn: Rowan Wallis – Environmental Policy Manager
Private Bag 9002
HASTINGS 4156

RE: Iona/Middle Road Urban Development Stormwater Peer Review

Dear Rowan,

Christensten Consulting Limited (CCL) has been commissioned by the Hastings District Council (HDC) to undertake a peer review of stormwater matters relating to the Iona/Middle Road urban development. The Applicants technical assessment of stormwater flood effects is presented in a report prepared by Tonkin & Taylor – *Middle and Iona Road Proposed Development, Havelock North – Stormwater Flood Effects Assessment (DRAFT October 2017).* A detailed review of this report has been undertaken along with a site visit with HDC on 15 November 2017. The review has been split into key topic areas with questions or statements for Tonkin & Taylor (T&T) to consider and respond to.

Hydrological Parameters – Curve Numbers & Initial Abstraction

The SCS Curve number method has been used for the assessment which is in reasonably common use across New Zealand, particularly in the North Island. Very careful consideration needs to be given to the selection of Curve Number as well as any modification to key parameters, especially the initial abstraction (I_a) which accounts for all losses (mainly infiltration & interception) before run-off begins.

T&T have used the Landcare Research Soil Maps (LINZ) as the basis for determining the hydrological soil group to apply within the SCS method. Inspection of the soil map shows the lower areas of the catchment, where the development is primarily occurring is classed as "Poorly Drained" with a small amount of "Imperfectly Drained" and the upper catchment being predominantly "Well Drained". In paragraph 2 on pg 19 of the T&T report it states that SCS hydrological soil group B has been applied for "Moderately Well Drained" areas as defined on the LINZ maps. From inspection of the maps there are no "Moderately Well Drained" areas within the catchments under consideration.

1. ***T&T to check the use and applicability of "Moderately Well Drained" classification to Class B SCS hydrologic soil group.***

It is further noted that there is no "Very Poorly Drained" soil as defined by the LINZ classification within any of the catchments included in this study so the use of "Poorly Drained" for SCS hydrologic soil group D may not be correctly representing the soil conditions. Further to this the soil type as described in Landcare Research 2008 Report - *Soils of the Havelock North Borough and their infiltration rates and permeability's* as Poporangi - ashy sandy loam on sandy loam with infiltration rates of 18 – 72 mm/hr and saturated hydraulic conductivity of < 1mm/hr. The SCS descriptors for Class D all include in some part "clay" whereas Class C is sandy clay loam. This would suggest that this soil is more likely to fit into the SCS hydrologic soil group C or even perhaps between B & C if the initial abstraction is also modified.

2. ***T&T to check the applicability of "Poorly Drained" classification of poporangi soils to Class D SCS hydrologic soil group.***

It is noted that no modification has been applied to the initial abstraction (Ia) from the default of 0.2 x S, where S = potential maximum retention after run-off begins. It is highlighted that in Auckland and Kapiti the adopted initial abstractions are Ia = 0 mm for developed areas and Ia = 5 mm for undeveloped areas. More recent work in Wellington, based on detailed hydrological model calibration, has resulted in the adoption of Ia = 0.1 x S for undeveloped areas, Ia = 5 mm for developed pervious areas and Ia = 0 mm for developed impervious areas.

3. *T&T to consider modification or sensitivity testing of initial abstraction in conjunction with review of SCS hydrologic soil groups as highlighted above.*

With regard to the above comments on the applicability of the curve numbers used by T&T attention is brought to Table 7 on pg 22 of the T&T report where a Rational Method comparison is provided for a small undeveloped catchment. The effective Rational Method run-off coefficients increase from 0.53 to 0.79 for the 2-year to 100-year storm events respectively. This is far outside the expected range for an undeveloped rural catchment and is more akin to a highly developed industrial/commercial area. It is noted that Acceptable Solutions and Verification Methods for the New Zealand Building Code E1 Surface Water provides a run-off coefficient of 0.8 for "near flat & slightly absorbent roof surfaces" and that pasture and grass cover is in the range 0.3 to 0.4 for "medium soakage to heavy clay soil types". It is highlighted that overestimating the pre-development run-off characteristics will result in an underestimation of mitigation storage.

4. *T&T to consider validating or sensitivity testing on pre-development hydrological model outputs following reconsideration of curve numbers and initial abstraction to something closer to the expected Rational Method range.*

Hydrological Parameters – Catchment Areas

It is noted that the sum of the post-development catchment areas provided in Appendix B is 1.7 Ha less than the pre-development catchment areas.

5. *T&T to check catchment boundaries.*

Assessment of Development Effects – Increased Run-Off

The over estimation of pre-development flows as well as the underestimation of post-development flows will result in the underestimation of the required storage volumes to mitigate flooding and water quality effects. The use of composite Curve Numbers from the "residential districts by average lot size" categories from table 2-2a in TR-55 is a source of possible error given the uncertainty around the hydrological soil group type and initial abstractions. Alternative methods, such as using a measured impervious area with the initial abstraction modified to reflect generally accepted practice across the North Island (Ia = 0) would provide a greater level of confidence in the determination of post-development run-off. In addition to this it is suggested that there needs to be specific recognition of the post development pervious areas that have been subject to large scale earthworks, compaction and largely consist of urban grass, parks and road berms. These types of pervious areas are likely to generate higher run-off than the pre-development pervious areas which are predominantly pasture.

6. *T&T to reconsider or undertake sensitivity testing on post-development Curve Numbers for pervious and impervious land cover.*

Assessment of Development Effects – Target Peak Flows

There appears to be an error in the calculated post development target peak flow for outlet D with only a 0.25 m^3/s reduction stated in Table 11. of the T&T report. This is less than the increase from only part of the developed area within this catchment. Catchment C-Pre has a peak flows of 1.23 m^3/s for the 100-yr event which has a slightly enlarged catchment area and a post development C1-Post peak flow of 1.61 m^3/s being a difference of 0.38 m^3/s. In addition to this there is development related increases in the C2-Post and A2-Post catchments.

It is noted that only a relatively small portion of the total catchment is being developed however, there is an additional 3 Ha of catchment area due to the site earthworks and two sub-catchments of relatively high density development (C1 & C2) in addition to the lower density A2 development area. Reference is made to pg 29 of the T&T report which states that a 20% reduction has been made to the peak flow at outlet D based on the run-off from the pre-developed area being developed. It is not clear how this has been applied and how the additional catchment area and development within that has been incorporated.

An alternative approach would be to use the pre-development run-off characteristics with the post-development sub-catchment boundaries to determine theoretical pre-development sub-catchment flows and to then set the 100-year attenuation target at the outlet based on the sum of the difference between the 80% pre and post sub-catchment flows for the developed areas.

It is acknowledged that the currently proposed mitigation provides a reduction in peak flows greater than than the target through attenuation of the largely undeveloped upper catchment (discussed in later section) but it is considered important that the method for determining the target post development flows is transparent and accurate.

7. ***T&T to check calculation of post development target flows for outlet D.***

Assessment of Development Effects – Floodplain Filling

The hydrological model has not assessed the effects of the floodplain and gully filling that is identified in sub-catchments C1, C2, E, F2, I & G. This loss of storage is unlikely to be offset by the proposed swales and rain-gardens within these catchments and there will most likely be an increase in downstream flooding. It also appears that the currently proposed filling is based more on an overall development earthworks arrangement rather than to specifically raise building platforms above flood levels. This is particularly for the properties along Middle Road which may need to be raised to avoid being flooded.

8. ***T&T to consider whether further earthworks are needed to raise building platforms out of flood hazard areas in lower catchment area and to then assess effects of floodplain filling including the gully/floodplain filling already proposed in catchments C1, C2, E, F2, I & G.***

Design of Mitigation Works – Outlet D

The proposed mitigation pond for outlet D is upstream of the main post-development stormwater inputs from catchments C1 & C2. The online pond is in an area that appears to be already subject to ponding which hasn't been accounted for in the pre-development model. It is also highlighted that there is the possibility of higher intensity short duration events affecting the lower developed areas (C1 & C2) with unmitigated run-off and there unlikely to be any significant benefit from the upstream mitigation storage.

9. **T&T to undertake sensitivity testing to better quantify the stormwater quantity effects from the development of catchments C1 and C2 especially for shorter duration high intensity events. Specific consideration should also be given to providing direct mitigation by the inclusion of storage downstream of the C1 & C2 outlets.**

Design of Mitigation Works – Outlet E

The mitigation pond/wetland for outlet E appears to be in an area already subject to flooding and with potentially high groundwater levels that would limit the degree of useful enlargement by excavation that could be achieved. It appears that there is some excavation required by way of the reference to the 1 m retaining wall around the knoll on pg 33 of the T&T report.

10. **T&T to provide further information about relative depth of the pond related to current ground levels, how it is likely to be affected by current flooding and groundwater conditions.**

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Summary

Overall I consider there are some significant issues that need to be resolved including more accurately representing the pre and post development stormwater flows and specifically accounting for the large scale gully/floodplain filling that is proposed. The combined effect of overestimated pre-development flows, underestimated post-development flows will be a less than adequate provision of storage to offset stormwater quantity effects.

I also consider that there needs to be more work put into the provision of direct mitigation to the quantity related effects of stormwater discharges from catchments C1 & C2 upstream of outlet D as there is the risk that the upstream mitigation currently proposed won't provide sufficient benefit.

There are a number of other more minor issues that also need to be resolved.

I trust the above adequately covers the required matters but please feel free to contact me if you require any further information.

Yours faithfully,

Kyle Christensen

Director – Christensen Consulting Limited

REPORT

Tonkin+Taylor

Addendum Report to Stormwater Flood Effects Assessment

Middle and Iona Road Proposed Development, Havelock North

Prepared for
Lowe Corporation Ltd

Prepared by
Tonkin & Taylor Ltd

Date
March 2018

Job Number
1003185.v1

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Document Control

Title: Addendum Report to Stormwater Flood Effects Assessment					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
Oct 17	1	Middle and Iona Road Proposed Development, Havelock North – Stormwater Flood Effects Assessment	CWS		
01/03/18	1	Addendum to main report	CWS		

Distribution:

Lowe Corporation Ltd 1 copy

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Executive summary

This addendum has been prepared in response to peer review comments undertaken by Christensten Consulting Limited (CCL) on 17 November 2017. It should be read in conjunction with the main report "*Middle and Iona Road Proposed Development, Havelock North – Stormwater Flood Effects Assessment*" undertaken by T+T in October 2017.

The agreed changes to the October 2017 assessment involved reassessing the hydrology using more conservative parameters which have the effect of increasing the difference between pre-development and unmitigated post-development discharges. The differences were then mitigated using flood attenuation devices.

By applying the changes in hydrological parameters, the following changes are recommended to the original mitigation measures proposed in the October 2017 report:

- Outlet D catchment – no change to the recommended mitigation approach or to the previous design. Our recommended approach relies on over-attenuation of upstream flows and therefore no attenuation required for development. Opposing views to this approach are acknowledged and we have identified that additional mitigation opportunities are available relating to on-site detention. Sufficient space has been identified within the proposed development area within which alternative mitigation may take place.
- Outlet E catchment – pond area has increased by approximately 10% and 100 year ARI flood depth increased from 1 m to 1.1 m;
- Outlet G catchment – pond area has increased by approximately 25% and 100 year ARI flood depth increased from 1.6 m to 2 m; and
- Outlet I catchment – a small increase in peak flow occurs for 2 year ARI, but no increase for 10 year ARI and 100 year ARI design flows. The 2 year ARI increase can be mitigated by reducing the contributing catchment at preliminary design stage. Alternatively, the use of rainwater tanks and/or on-site detention would reduce the 2 year ARI impact.

The updated mitigation options proposed achieve the target peak flows for the proposed development.

1 Introduction

This addendum has been prepared in response to the peer review undertaken by Christensten Consulting Limited (CCL) on 17 November 2017. It should be read in conjunction with the main report "*Middle and Iona Road Proposed Development, Havelock North – Stormwater Flood Effects Assessment*" undertaken by T+T in October 2017.

The following changes to the October 2017 assessment were agreed with Kyle Christensen (CCL) and Craig Goodier (HBRC) on 5 December 2017 for this stage of the planning process:

- Re-run the hydrological model with the Curve Numbers (CN's) shifted up a soil class (to higher permeability) for undisturbed areas (both in the pre and post developed case) and the CN's unchanged for any disturbed areas (in the post developed case)
- Specific consideration given to providing direct mitigation by the inclusion of storage downstream of the C1 and C2 outlets.

As additional detailed information becomes available during the subsequent consenting and design phases of this project, additional information may be required in support of resource consent applications.

Catchment boundaries and methodology are as per the October 2017 report.

2 Hydrological assessment of proposed site (without mitigation)

2.1 Hydrological model inputs

Appendix A shows the updated runoff curve numbers (CN's) in comparison to CN's used previously. The CN's have been adjusted as follows:

- Pre-development:
  - Reduction in Hydrological Soil Group (HSG) for all pervious areas, which reduces runoff potential. This has the effect of increasing the difference between pre-development and post-development runoff.
- For post-development:
  - Same as "pre-development" for catchment outside of the proposed development
  - Raise the CN for pervious areas within the proposed development to reflect the effect of soil disturbance during the earthworks process. In practice this has meant keeping the same CN for pervious areas within the development as in the Oct 17 report.

2.2 Model results (unmitigated post development)

The pre development and unmitigated post development peak discharges have been updated as shown in Table 1 below.

Table 1 - Post development (unmitigated) peak flows at the outlet location

			Peak discharge (m^3/s)			
Outlet locations	**Scenario**	**Total catchment area (ha)**	**Water Quality Storm (20mm over 24hrs)**	**2 Year ARI (CC)**	**10 Year ARI (CC)**	**100 Year ARI (CC)**
Outlet D	Pre developed	146	0.10	1.27	3.25	8.58

	Unmitigated post development	149	0.15	1.61	3.61	8.88
Outlet E	Pre developed	36	0.05	0.67	1.62	4.05
	Unmitigated post development	32	0.07	0.81	1.74	3.97
Outlet I	Pre developed	4	0.01	0.11	0.25	0.60
	Unmitigated post development	2	0.01	0.13	0.23	0.46
Outlet G	Pre developed	16	0.04	0.58	1.19	2.60
	Unmitigated post development	19	0.07	1.26	2.29	4.61

2.3 Discussion of unmitigated hydrological effects

The discussion regarding outlet catchments D, E and G is still applicable from the main report.

Although the post developed catchment area upstream of Outlet I has been reduced by 50% from the pre developed area, there is still a small increase (~20 L/s) in the post developed 2 year ARI peak flow, compared to the pre developed case. This is due to the increased runoff resulting from development.

3 Development of hydrological mitigation options

3.1 Water quantity requirements

The water quantity target flow rates have been updated as shown in Table 2 below.

Table 2 - Water quantity requirements based on recommendations in the HBRC's WGSM

		Post Development (unmitigated) peak discharge (m^3/s)			
Outlet locations	**Scenario**	**Water Quality Storm (20mm over 24hrs)**	**2 Year ARI (CC)**	**10 Year ARI (CC)**	**100 Year ARI (CC)**
Outlet D	Unmitigated post development	0.145	1.61	3.61	8.88
	Target peak flow	NA	1.27	3.25	8.20
Outlet E	Unmitigated post development	0.07	0.81	1.74	3.95
	Target peak flow	NA	0.67	1.62	3.24
Outlet I	Unmitigated post development	0.01	0.13	0.23	0.46
	Target peak flow	NA	0.11	0.25	0.48

Outlet G	Unmitigated post development	0.073	1.26	2.29	4.61
	Target peak flow	NA	0.58	1.19	2.08

Refer to the discussion on setting target peak flows in the main report. The calculation of the Outlet D target peak flow has been updated.

The HBRC's Waterway Guidelines recommend that the post development peak discharge for the 100 year ARI storm be limited to 80% of the pre development peak discharge. To calculate the Outlet D target peak flow for the 100 year ARI storm, the pre-development run-off characteristics have been used with the post development sub-catchment boundaries A2, A3, C1 and C2 to determine the theoretical pre development sub-catchment flows. The required 20% reduction of the pre-development 100 year ARI peaks for these future developed sub-catchments has been subtracted from the total pre development 100 year ARI peak at Outlet D to give the target peak flow.

3.2 Water quantity mitigation options

3.2.1 Mitigation for Outlet D catchment

The October 2017 recommendation to provide flood detention immediately upstream of the proposed 'Spine' road remains the preferred mitigation option. This approach "over-attenuates" upstream flows and does not specifically require attenuation of development runoff. This approach mitigates stormwater further up the catchment where there is gradient to attenuate flood volume.

The proposed pond meets the mitigation requirement. However there was feedback requesting the potential of this site to attenuate peak flows further. Currently the embankment height has been limited by a constraint to keep the upstream flood extents within the Lowe Corporation land. The embankment can be raised higher to increase flood storage and attenuate peak flows further but is likely to cause flooding of the adjacent property to the west in a 100 year ARI rainfall event. The increased flood extent would not impact buildings or accessways. This option can be investigated further if a need to do so is demonstrated.

We acknowledge our recommended approach is inconsistent with HBRC feedback that the runoff from catchments C1, C2 and A3 needs to be specifically attenuated. Should Lowe Corporation wish to adopt an on-site approach to stormwater mitigation there are two main options available which have been considered:

1. On-site detention
2. Additional stormwater detention pond upstream of Outlet D

An additional stormwater detention pond upstream of Outlet D could be constructed as an offline pond (i.e. away from the existing watercourse). Indicatively, the pond would require an area of approximately 1 ha with a 100 year ARI flood depth of 1.2m and a permanent depth of 200mm to store 50% of the water quality volume. We believe there is sufficient space to construct the pond, however stream realignment is likely to be required, together with filling in the floodplain which may require considerable earthworks, particularly along the west facing slopes of the proposed development. There may be an effect of filling in the floodplain on the adjacent property to the west.

Therefore on-site detention would be our recommended approach for Lowe Corporation. This could incorporate a combination of rainwater tanks and/or detention tanks. These could be provided on a building by building basis, or by providing detention devices for clusters of buildings or by street. Ownership, maintenance and operational costs of on-site devices would need consideration before agreeing the preferred approach.

We recommend that all mitigation options remain available for subsequent stages of the planning process.

Refer Figure 1 shows the discussed mitigation options for Outlet D.

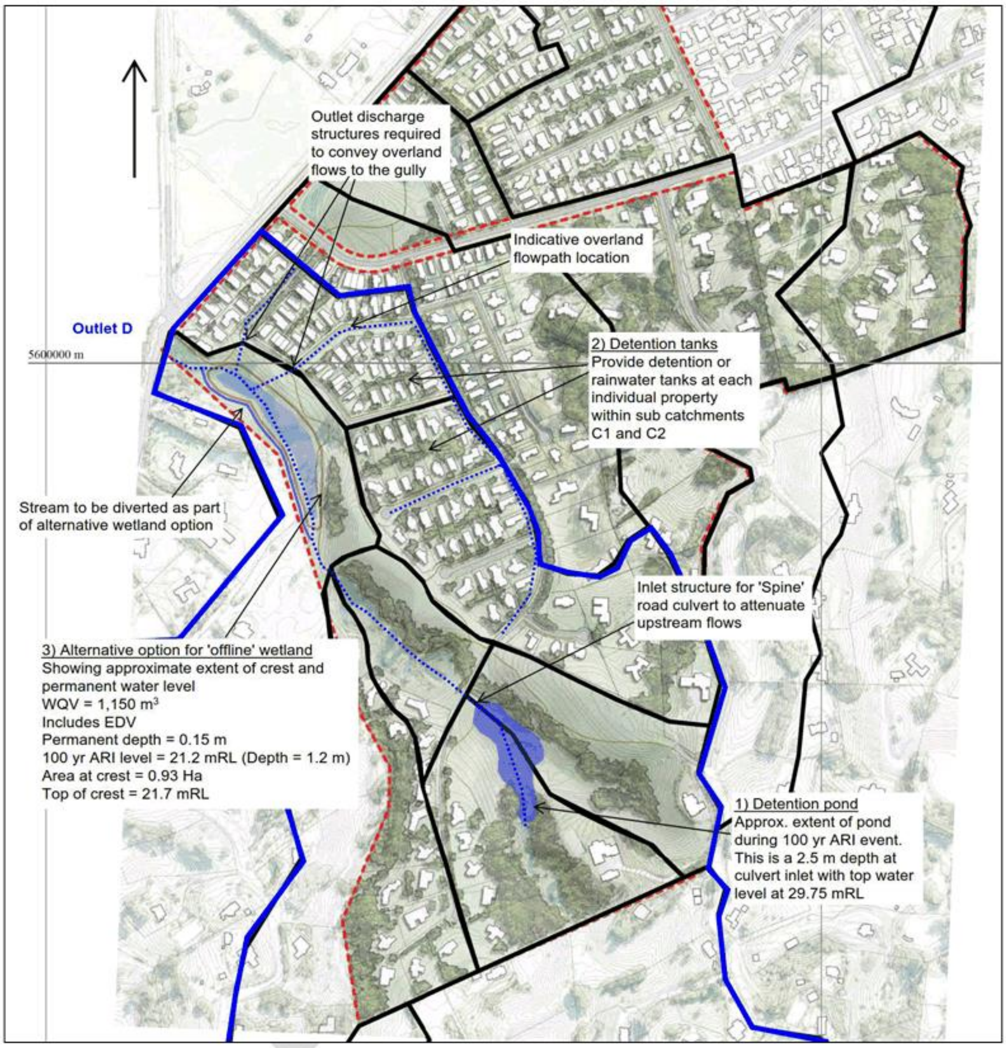

Figure 1 - Proposed mitigation options for Outlet D catchment

3.2.2 Mitigation for Outlet E catchment

The wetland proposed has been revised with the updated characteristics provided below:

- Water quality volume is 530 m^3 and extended detention volume is 630 m^3
- A permanent depth of 200 mm to store 50% of the water quality volume
- Pond area of approximately 0.76 ha to the crest
- 100 year depth within the wetland of 1.1 m
- Side slopes of 1V:5H with a 3 m wide safety bench.

The invert of the wetland would be similar to that of the receiving channel at 18.8 mRL. The 100 year ARI water level within the wetland will be approximately 19.9 mRL with a required crest level of 20.4 mRL. To achieve this a 1.1 m high bund will be required around the north western edge of the wetland. To maximise the available space for the wetland it is likely that some low retaining (i.e. 1 m height) will be required around the knoll side of the wetland. An outlet pipe sized to convey the attenuated 10 year flow will be required to connect into the existing culvert crossing Middle Road.

The hydraulic modelling completed indicates a flood level at outlet E of up to 19.3 mRL for the 100 year ARI event. In determining the 100 year ARI level within the pond, a tailwater level and initial pond level of 19.3 mRL was modelling to ensure the proposed pond could achieve the required attenuation under the influence of the 100 year ARI flood plain.

Refer Figure 2 showing the proposed updated mitigation options for the Outlet E catchment.

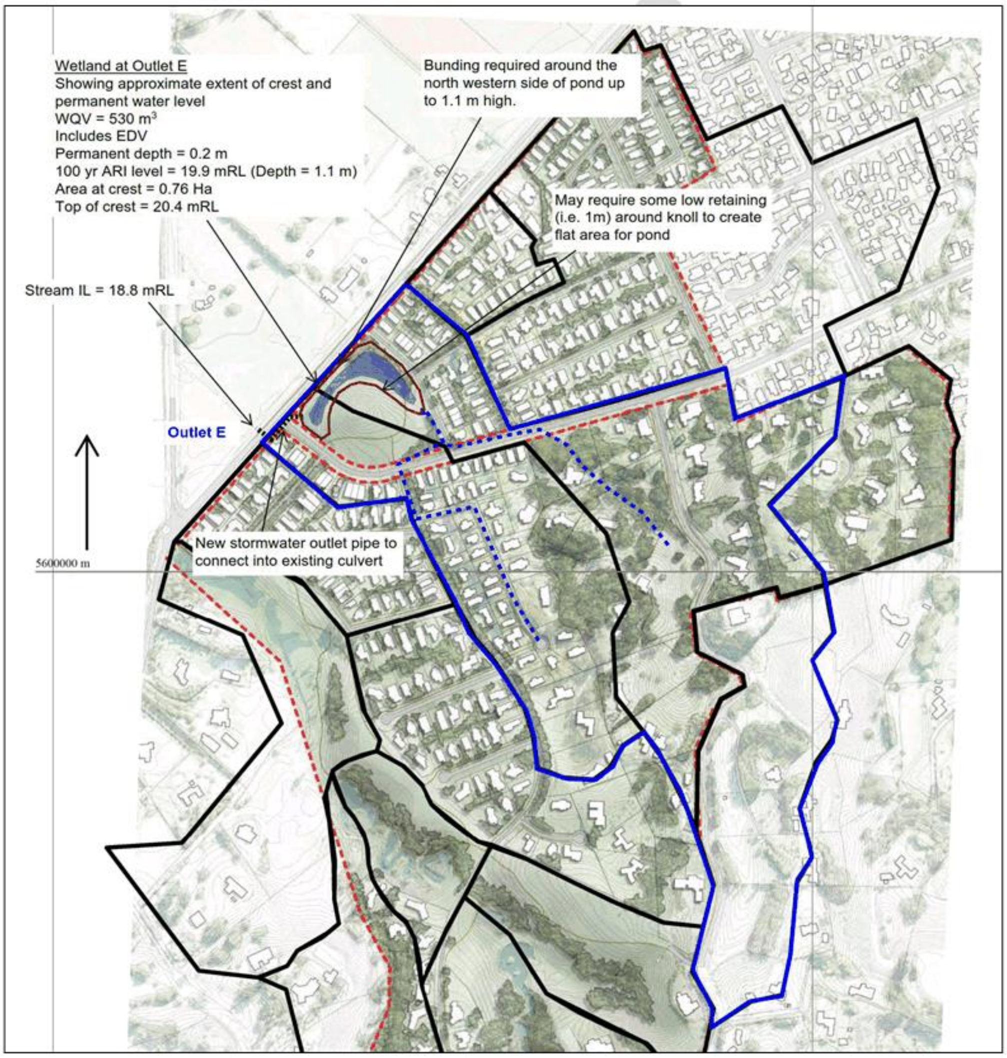

Figure 2 - Proposed mitigation option for Outlet E Catchment

3.2.3 Mitigation for Outlet G catchment

The wetland proposed has been revised with the characteristics provided below:

- Water quality volume is 2,300 m^3 and Extended detention volume is 2,800 m^3
- A permanent depth of 200 mm to store 50% of the water quality volume.
- Pond area of approximately 1.7 Ha to the crest
- 100 year depth within the wetland of 1.1 m
- Side slopes of 1V:5H with a 3 m wide safety bench.

The wetland is proposed to be constructed above the 19.5 mRL ground level. The invert of the wetland would be similar to that of the receiving channel at 18 mRL. The 100 year ARI water level within the wetland will be approximately 20 mRL with a required crest level of 20.5 mRL. To achieve this a 1 m high bund will be required around the north western edge of the wetland.

The hydraulic modelling completed indicates a flood level at Outlet G of up to 19.3 mRL for the 100 year ARI event. In determining the 100 year ARI level within the pond, a tailwater level and initial pond level of 19.3 mRL was assumed to ensure the proposed pond could achieve the required attenuation during a 100 year ARI storm event.

Refer Figure 3 showing the proposed updated mitigation options for the Outlet G catchment.

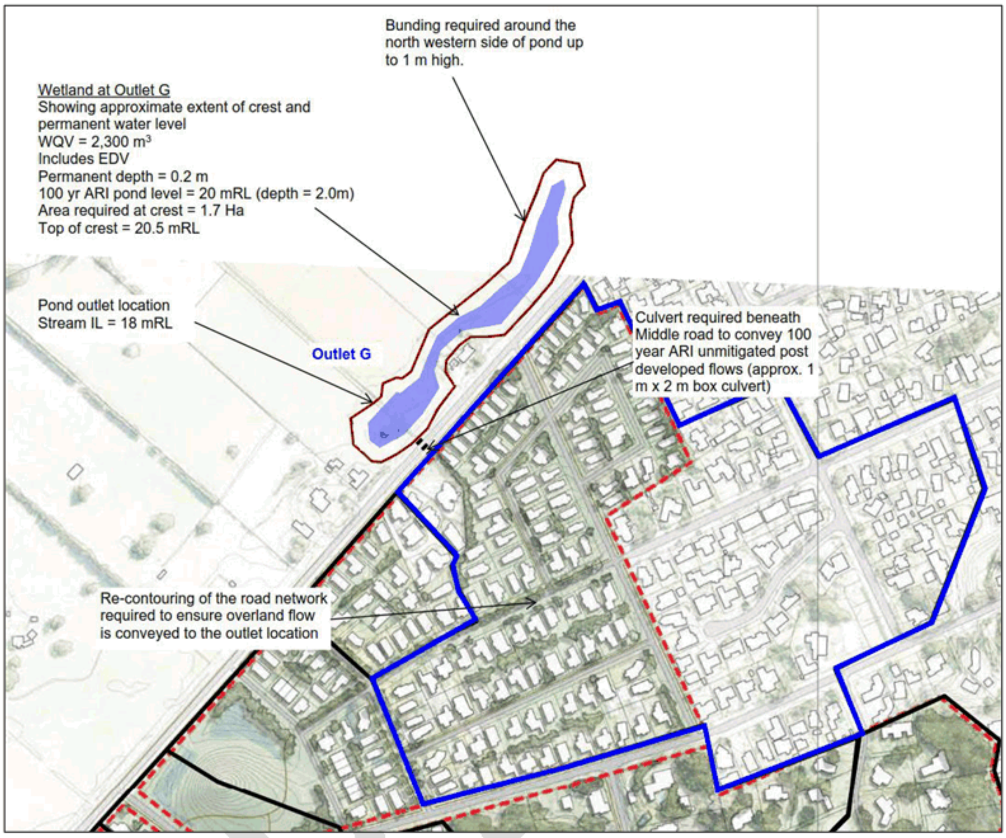

Figure 3 - Proposed mitigation options for Outlet G catchment

3.2.4 Mitigation for Outlet I catchment

The catchment area draining to Outlet I decreases from 3.92 ha to 1.82 ha as a result of the proposed development and masterplan contours. Due to the reduction in catchment area, there is no increase in peak flows for the 10 year ARI and 100 year ARI events. However there is currently a small increase in peak discharge (~20 L/s) during a 2 year ARI design storm.

At this stage of the planning process, we are confident that the 20 L/s increase can be mitigated during subsequent design stages. This can be achieved by decreasing the catchment area further along the western catchment boundary (and increasing runoff to Outlet G and wetland). Alternatively, rainwater tanks and/or detention tanks could be incorporated to mitigate the 2 year ARI event.

3.3 Water quality mitigation

The stormwater quality controls proposed in the main report remain.

4 Hydrological assessment of proposed site (with mitigation)

The results of the updated hydrological model for the post development situation with mitigation has been compared to the pre development peak flows in Table 3 below.

Table 3 - Results of the stormwater assessment of the proposed site (with mitigation)

		Post Development (mitigated) peak discharge (m³/s)			
Outlet locations	**Scenario**	**Water Quality Storm (20 mm over 24hrs)**	**2 Year ARI (CC)**	**10 Year ARI (CC)**	**100 Year ARI (CC)**
Outlet D	Pre developed	0.1	1.27	3.25	8.58
	Target peak flow	NA	1.27	3.25	8.20
	Post developed (with detention pond)	0.11	1.27	3.19	8.16
Outlet E	Pre developed	0.05	0.67	1.62	4.05
	Target peak flow	NA	0.67	1.62	3.24
	Post developed (with mitigation)	0.04	0.66	1.39	3.21
Outlet I	Pre developed	0.01	0.11	0.25	0.60
	Target peak flow	NA	0.11	0.25	0.48
	Post developed (with mitigation)	0.01	0.13	0.23	0.46
Outlet G	Pre developed	0.04	0.58	1.19	2.60
	Target peak flow	NA	0.58	1.19	2.08
	Post developed (with mitigation)	0.03	0.42	0.89	2.03

The proposed mitigation achieves the target peak flows for the development.

5 Conclusion

The aim of this addendum was to update the previous flood effects assessment to incorporate peer review comments that a more conservative approach should be applied.

Mitigation can be achieved within the proposed development and Lowe Development Ltd land as a result of the update. The change in curve numbers has resulted in a relatively small increase in the footprint of Outlet ponds E and G with no change to the current proposed mitigation upstream of Outlet D.

The proposed mitigation options for water quantity and quality include:

- Outlet D catchment - Attenuation of flows upstream of the 'Spine' road culvert through an inlet structure and availability of an upstream ponding volume;
- Outlet D catchment – Secondary option to provide detention or rainwater tanks for individual properties within sub catchments C1 and C2;
- Outlet D catchment - Alternative option for a wetland with 0.93 ha footprint immediately upstream of Outlet D, to treat runoff from sub-catchments C1 and C2 and attenuate flow from the Outlet D catchment. Further assessment required to confirm the feasibility of this option;
- Outlet E catchment – a wetland with 0.76 ha footprint upstream of Outlet E, within the proposed development, to treat and attenuate flows from the Outlet E catchment
- Outlet G catchment - a wetland with 1.7 ha footprint to the north west of the development, on the western side of Middle Road, to treat and attenuate flows from the Outlet G catchment
- Outlet I catchment - rainwater tanks for individual properties within Outlet I catchment
- Water quality – treatment swales within the carriageway verges, particularly in the proposed southern developed areas
- Water quality - facilitate the conveyance of runoff into existing ponds to enable additional water quality treatment

The updated mitigation options proposed achieves the target peak flows for the development.

The mitigation options proposed are conceptual to assist with the Plan Change application for the proposed development. The detailed design of the mitigation options in accordance with consent conditions will be completed during subsequent design stages.

6 Applicability

This report has been prepared for the exclusive use of our client Lowe Corporation Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:

....

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CWS
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Appendix A: Summary table of catchments and peak flows (48hr duration)

Catchment	Area (ha)	% Impervious	Oct '17 Curve Number	Updated Curve Number	Tc (mins)	Ia (mm)	2 yr Peak (m³/s)	10 yr Peak (m³/s)	100 yr (m³/s)
Pre development									
A1A - Pre	34.44	0	71	65	67	27	0.45	1.30	3.64
A1B - Pre	34.36	0	76	66	77	26	0.45	1.27	3.48
A1C - Pre	14.8	0	78	69	71	23	0.24	0.63	1.65
A2 - Pre	5.66	0	79	73	66	19	0.12	0.29	0.70
A3 - Pre	4.64	0	77	68	59	24	0.08	0.21	0.56
A4 - Pre	2.81	0	80	74	57	18	0.07	0.16	0.38
B1 - Pre	18.92	0	77	68	66	24	0.30	0.81	2.15
B2 - Pre	10.92	0	79	73	82	19	0.21	0.50	1.22
C - Pre	8.57	0	77	68	56	24	0.15	0.39	1.05
D - Pre	11.05	0	80	74	86	18	0.22	0.51	1.23
E - Pre	12.96	0	79	71	74	20	0.24	0.59	1.48
F1 - Pre	7.50	0	76	66	74	26	0.10	0.28	0.78
F2 - Pre	15.68	0	79	73	68	19	0.33	0.79	1.94
G - Pre	15.57	35	86	82	30	11	0.58	1.19	2.60
I – Pre	3.92	3	80	75	44	17	0.11	0.25	0.60
Post development									
A1A - Post	34.44	0	71	65	67	27	0.45	1.30	3.64
A1B - Post	34.36	0	76	66	77	26	0.45	1.27	3.48
A1C - Post	14.8	0	78	69	71	23	0.24	0.63	1.65
A2 - Post	5.66	8	81	81	66	12	0.17	0.36	0.79
A3 - Post	4.64	0	77	68	59	24	0.08	0.21	0.56
A4 - Post	2.81	5	81	81	57	12	0.09	0.19	0.42
B1 - Post	18.93	0	77	68	66	24	0.30	0.81	2.15
B2 - Post	10.92	9	81	81	82	12	0.30	0.62	1.37
C1 – Post	8.97	35	84	84	40	9	0.38	0.75	1.61
C2 – Post	4.37	60	91	91	37	5	0.23	0.42	0.86
D - Post	9.41	0	80	74	86	18	0.18	0.43	1.05
E – Post	9.85	10	81	82	47	11	0.36	0.74	1.63
F1 - Post	7.51	0	76	66	74	26	0.10	0.28	0.78
F2 – Post	14.15	8	81	81	66	12	0.42	0.88	1.96
G - Post	19.16	60	91	91	21	5	1.26	2.29	4.61
I – Post	1.82	60	91	91	22	5	0.13	0.23	0.46

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19 March 2018

Hastings District Council
Attn: Rowan Wallis – Environmental Policy Manager
Private Bag 9002
HASTINGS 4156

RE: Iona/Middle Road Urban Development Stormwater Peer Review – Addendum Report

Dear Rowan,

Tonkin & Taylor (T&T) have produced an Addendum Report - *Stormwater Flood Effects Assessment Middle and Iona Road Proposed Development, Havelock North March 2018.* This report is an addendum to the main report (DRAFT October 2017) and has been produced in response to the peer review comments (17 November 2017) and subsequent teleconferences (6 & 8 December 2017). The Addendum Report has been reviewed in terms of the ten issues raised in the November 2017 peer review and following a teleconference with Hastings District Council (HDC) and Hawkes Bay Regional Council (HBRC) officers on 14 March 2018. The ten issues and an assessment of how adequately they have been addressed in the Addendum Report is provided below.

1. ***T&T to check the use and applicability of "Moderately Well Drained" classification to Class B SCS hydrologic soil group.***

Having identified that there are no "Moderately Well Drained" or "Very Poorly Drained" (in terms of LINZ definitions) soils within the area under consideration it was my understanding that the LINZ soil groups were going to move up an SCS hydrologic soil group so that the following was applied –

Table 1 – Soil Groups related to Curve Numbers

LINZ Soil Group	SCS Soil Group	Recommended Curve Number
Well Drained	Group A	49
Moderately Well Drained	No soil of this type within area of interest	
Imperfectly Drained	Group B	61
Poorly Drained	Group C	74
Very Poorly Drained	No soil of this type within area of interest	

It appears that the appropriate changes have been made to the catchments where the "Imperfectly Drained" and "Poorly Drained" LINZ soil groups are evident. However, the "Well Drained" areas in catchments B1, A1A and A1B appear to have been updated to SCS Soil Groups somewhere between Group B & Group C. For example, catchment B1 which is almost entirely "Well Drained" has had its Curve Number modified from 77 to 68 which would place it somewhere between "Imperfectly Drained" and "Poorly Drained". ***This issue has not been resolved for the catchments containing "Well Drained" soils (B1, A1A & A1B).***

2. ***T&T to check the applicability of "Poorly Drained" classification of poporangi soils to Class D SCS hydrologic soil group.***

The curve numbers have been adjusted so that "Poorly Drained" is now classified as Class C SCS hydrologic soil group with a curve number of 74 rather than the previously used Class D soil group and Curve Number of 80. ***This issue has been adequately resolved.***

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3. *T&T to consider modification or sensitivity testing of initial abstraction in conjunction with review of SCS hydrologic soil groups as highlighted above.*

It is accepted that if appropriate SCS soil groups and curve numbers are used then in the absence of calibration data the initial abstractions should not be modified. ***Once the appropriate curve numbers have been applied to catchments A1A, A1B and B1 this issue is considered to be resolved.***

4. *T&T to consider validating or sensitivity testing on pre-development hydrological model outputs following reconsideration of curve numbers and initial abstraction to something closer to the expected Rational Method range.*

No updated comparisons with the Rational Method have been provided in the Addendum Report. It is acknowledged that there are fundamental differences between the SCS Curve Number Method and the Rational Method but it is still considered useful to provide a comparison. ***This issue has not been resolved.***

5. *T&T to check catchment boundaries.*

The total pre and post development catchment areas are now the same. ***This issue has been resolved.***

6. *T&T to reconsider or undertake sensitivity testing on post-development Curve Numbers for pervious and impervious land cover.*

The post development pervious areas have used the higher run-off generating Curve Numbers used in the main report. ***This issue has been resolved.***

7. *T&T to check calculation of post development target flows for outlet D.*

The outputs from the hydrological model presented in Table 1 of the Addendum Report show a difference between pre-development and unmitigated post development flows at outlet D of 0.3 m^3/s. This would appear to be quite small given the scale of the development occurring within the catchment and that the overall catchment area is increasing by 3 ha due to the earthworks associated largely with the development of sub-catchment C2.

A summary of the sub-catchment peak flows and changes in area is presented in Table 2 below. It is highlighted from this analysis that there are significant routing and peak flow coincidence effects within this catchment with the arithmetic sum of peak flows being only 50% of the routed peak flow. It is also notable that the arithmetic sum of differences in pre and post development peak flow is only 20% of the difference in routed peak flow differences. Further to this the additional peak flow just from sub-catchment C2 (0.86 m^3/s), which is largely not within the existing (pre-development) catchment boundaries, is almost three times the routed peak flow difference (0.3 m^3/s) presented in the Addendum Report.

Further to the Outlet D calculations there appears to be some unusual results at the other outlets.
At Outlet E there is a relatively small amount of development occurring but the catchment area is reducing by 4 ha. The modelled catchment response presented in Table 1 of the Addendum Report shows increased peak flows for the water quality storm, as well as the 2-year and 10-year storms but then a decreased flow for the 100-year storm. This inconsistent response would seem somewhat unusual.

A similar situation is presented for Outlet I where there is no change to the water quality storm, increased flow for the 2-year storm and then decreased flows for the 10-year and 100-year storms.

The results from Outlet G consistently show increases across all storms which reflect the increased catchment area (+ 3.58 ha) as well as the development occurring to show an increased peak flow due to development of 2.1 m^3/s for the 100-year storm. It is interesting to compare this to sub-catchments C1 & C2 which have a combined catchment area of 13.34 ha being 70% of the outlet G catchments and the seemingly very small 0.3 m^3/s increased peak flow due to development from all of the Outlet D sub-catchments.

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On this basis it is difficult to have confidence in the figures presented in Table 1 of the Addendum Report which form the basis of mitigation storage requirements. It also highlights the potential issues with providing largely in-direct offset storage for Outlet D which is upstream of where almost all of the development is taking place. ***This issue has not been resolved.***

Table 2 – Analysis of Outlet D Peak Flows

Catchment	Pre-Development 100- year Peak Flow (area in ha)	Post Development 100-year Peak Flow (area in ha)	Difference in Pre-Post Development 100-year Peal Flow (change in area in ha)
A2	0.7 m^3/s (5.66)	0.79 m^3/s (5.66)	+ 0.09 m^3/s (0)
A4	0.38 m^3/s (2.81)	0.42 m^3/s (2.81)	+ 0.04 m^3/s (0)
B2	1.22 m^3/s (10.92)	1.37 m^3/s (10.92)	+ 0.15 m^3/s (0)
C (C1)	1.05 m^3/s (8.57)	1.61 m^3/s (8.97)	+ 0.56 m^3/s (+ 0.4)
C2	Mostly not within Outlet D catchment	0.86 m^3/s (4.37)	+ 0.86 m^3/s (+ 4.37)
D	1.23 m^3/s (11.05)	1.05 m^3/s (9.41)	- 0.18 m^3/s (-1.64)
A1A, A1B, A1C, A3, B1	11.48 m^3/s (107.16)	11.48 m^3/s (107.17)	0 m^3/s (0.01)
Outlet D total	**16.06 m^3/s (146.17)**	**17.58 m^3/s (149.31)**	**1.52 m^3/s (+3.14)**
Outlet D total from T&T Addendum Table 1	8.58 m^3/s (146)	8.88 m^3/s (149)	0.3 m^3/s (+3)
% Sub-Tributary sum of peak flows vs routed flows	53%	51%	20%

8. ***T&T to consider whether further earthworks are needed to raise building platforms out of flood hazard areas in lower catchment area and to then assess effects of floodplain filling including the gully/floodplain filling already proposed in catchments C1, C2, E, F2, I & G.***

No assessment or comment on the potential effects of gully/floodplain filling has been provided. ***This issue has not been resolved.***

9. **T&T to undertake sensitivity testing to better quantify the stormwater quantity effects from the development of catchments C1 and C2 especially for shorter duration high intensity events. Specific consideration should also be given to providing direct mitigation by the inclusion of storage downstream of the C1 & C2 outlets.**

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This has not been completed and the primary mitigation option for Outlet D is still proposed to be indirect offset storage. There remains uncertainty (highlighted at Item 7) in the catchment response at outlet D and the accuracy of the assessment of the development effects. ***This issue has not been resolved.***

10. T&T to provide further information about relative depth of the pond related to current ground levels, how it is likely to be affected by current flooding and groundwater conditions.

It is noted from the Addendum Report that the Outlet E catchment pond has increased in area by 10% and in depth by 0.1 m but it is not clear what additional storage volume this provides as the volume reported in 3.3.2 of 630 m^3 is the same as that presented in the main report for the previously proposed (smaller pond). Similarly, for the Outlet G catchment pond which has increased in area by 25% and in depth by 0.4 m but with a reported storage volume of 2,800 m^3 being the same as the previously proposed (smaller pond).

It is also not clear based on the information presented in 3.2.3 of the Addendum Report how the Outlet G pond would be filled to a 100-year level of 20.0 mRL given the surrounding topography.

Similarly, at Outlet E the required pond level is 19.9 mRL to achieve the required storage. It is not clear how this level will be achieved in the pond and further explanation is required.

This issue has not been adequately resolved.

Summary

Overall I consider there have been some useful steps taken to improve the accuracy of the stormwater assessment but there remain a number of issues that need further consideration -

- Greater certainty around effects of development in terms of increased peak flow especially at Outlet D;
- Direct mitigation of development effects from catchments C1, C2 and A3 upstream of Outlet D;
- Effects of floodplain/gully filling associated with site earthworks to be considered and added to required pond volumes;
- Sizing and feasibility of Outlet G & E pond operation to be confirmed;

I trust the above adequately covers the required matters but please feel free to contact me if you require any further information.

Yours faithfully,

Kyle Christensen

Director – Christensen Consulting Limited

Tonkin+Taylor

Job No: 1003185
4 April 2018

Hastings District Council
Private Bag 9002
Hastings 4156

Attention: Rowan Wallis

Dear Rowan

Middle and Iona Rd Proposed Development, Havelock North - Stormwater Assessment Summary

This document has been prepared to summarise the findings and recommendations of Tonkin + Taylor's (T+T) stormwater assessments completed for the proposed Middle and Iona Rd development in Havelock North.

1 Initial assessment

T+T prepared a draft report[1] that assessed the potential flood-related effects that may be caused by the proposed Middle and Iona Rd development, and identified mitigation controls that would adequately address these adverse effects. Conclusions from this initial assessment included the following:

- The proposed development has the potential, without mitigation, to increase peak runoff from site due to the increase in impervious area and proposed re-contouring.
- The unmitigated increase was particularly significant at the outlet locations in the southern corner of the Triangle site (Outlets D and E) due to downstream ponding issues and at the northern section of the Triangle site (Outlet G) due to large increases in peak flows.
- The proposed mitigation option for Outlets E and G is a wetland with peak flow attenuation to pre-development levels.
- The proposed mitigation option for the Outlet D catchment is an on-line storage pond located immediately upstream of the 'Spine' road which attenuates peak flows at Outlet D to pre-development levels.
- No formal mitigation was specified for upstream of Outlet I.
- The mitigation options proposed achieved the target peak flows[2] for the development.

[1] Tonkin + Taylor, "DRAFT Middle and Iona Road Proposed Development, Havelock North – Stormwater Flood Effects Assessment", Prepared for Lowe Corporation Ltd, dated October 2017.
[2] As per the Hawkes Bay Regional Councils Waterway Guidelines Stormwater Management (May 2009).

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2 Peer review

A peer review of the T+T draft report was undertaken by Christensen Consulting Ltd (CCL) on 17 November 2017. The main conclusions stated in this peer review can be summarised as below:

- The curve numbers used in the assessment should be reviewed as the actual soil is likely more permeable than represented.
- Higher intensity short duration events affecting the lower developed areas (i.e. C1 and C2) have not been adequately addressed and direct mitigation to these areas need to be explored. The upstream mitigation currently proposed won't provide sufficient benefit during these events.
- The effects of large scale gully/floodplain filling that is proposed has not been assessed.

3 Addendum

Following consideration of these review comments, an addendum report[3] was prepared by T+T. This also followed discussions with Kyle Christensen (CCL), Matthew Kneebone (HDC) and Craig Goodier (HBRC) on 5 December 2017 to address the peer review comments. Conclusions of the addendum can be summarised below:

- The hydrological model was re-run with the Curve Numbers (CN's) shifted up a soil class (to higher permeability) for undisturbed areas (both in the pre and post developed case) and the CN's unchanged for any disturbed areas (in the post developed case).
- The footprint of the wetland for Outlet E and G was increased by 10% and 25% respectively but can still be contained within the development or Lowe family owned land.
- There was no change to the previous recommended mitigation approach upstream of Outlet D.
- An alternative option for a wetland upstream of Outlet D was considered as a means of providing direct runoff mitigation to the lower developed areas at catchments C1 and C2. Sizing for this option was presented, but was T+T's least preferred option because it likely requires diversion of the existing stream and filling in the existing floodplain, both of which are likely to have greater effects than the preferred option (and would probably require separate resource consent).

4 Current position

A peer review of the T+T Addendum report was undertaken by Christensen Consulting Ltd (CCL) on 19 March 2018 and was discussed in a teleconference with CCL, HDC and T+T on 28 March 2018. These discussions and the current position is summarised below:

- The assessment and proposed mitigation options at Outlet E, G and I are generally agreed as per the T+T Addendum report.
- No agreement has been reached in regard to the assessment and proposed mitigation option at Outlet D.
- HDC prefer that developed areas C1 and C2 are directly mitigated. It is understood that HDC are of the opinion that higher intensity short duration rainfall events affecting only the lower developed areas (i.e. spatially varied rainfall) will result in adverse effects downstream of the development.

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[3] Tonkin + Taylor, "Addendum Report to Stormwater Flood Effects Assessment", Prepared for Lowe Corporation Ltd, dated March 2018.

- T+T are of the opinion that it is unnecessary to consider different design rainfall (recurrence interval or duration) across the catchment for the effects assessment given the small size of the catchment (~1.5km^2).
- T+T are of the opinion that whilst it may be possible to directly mitigate developed areas C1 and C2 by providing an additional pond upstream of Outlet D, there are significant disadvantages in comparison to the proposed mitigation. The disadvantages in comparison to the proposed mitigation are primarily due to the potential effects caused by filling in the floodplain and diverting the stream. Secondarily, the quantum of earthworks required to construct an offline-pond at Outlet D would be greater than other options, the cost is likely to be higher and there may be a reduction in properties yielded by the Plan Change.

5 Applicability

This report has been prepared for the exclusive use of Hastings District Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Mark Pennington	Jon Rix
Senior Water Resources Engineer	Project Manager

CWS
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11 May 2018

Hastings District Council
Attn: Rowan Wallis – Environmental Policy Manager
Private Bag 9002
HASTINGS 4156

RE: Iona/Middle Road Urban Development Stormwater Peer Review – Downstream Effects

Dear Rowan,

Following ongoing discussion with T&T regarding direct mitigation of the development effects at Outlet D an approximate assessment has been undertaken on the capacity of the downstream channel (Richards Road Drain). In the lower reach of this drain, just before it joins Louisa Stream, there are two culvert crossings. The size and approximate levels of these culverts have been measured by HDC (see attached information). Approximate sub-catchment hydrology has been extracted from the T&T reports and used for the analysis (see attached approximate hydrographs). Using this information an approximate assessment of the culverts capacities for three scenarios has been undertaken.

The first scenario is to determine the approximate bankfull capacity at the upstream end of both of the culverts. This is to provide an indication of what size flood will result in the driveways and surrounding land being flooded.

The second scenario is for the existing (pre-development) situation where there is a large (100 year return period) event across the lower catchment generating a peak flow from catchment C of approximately 1 m^3/s plus an additional 1 m^3/s coming from the upper catchment for a total flow of 2 m^3/s.

The third scenario is for the post-development situation for the same rainfall event but taking account of the development within catchment C1 plus the additional catchment (C2) proposed to be diverted to Outlet D. Under this scenario it is assumed that there is limited routing provided by the proposed upstream detention so there is still 1 m^3/s coming from the upper catchment plus the post development flow from catchments C1 & C2 which is approximately 2.5 m^3/s, for a total flow of 3.5 m^3/s.

Based on the above scenarios approximate analysis had been undertaken using the orifice equation for the drowned inlet scenario and Manning's equation for the partially full culvert scenarios. This is a simplified analysis which does not account for any backwater effects from Louisa Stream. A summary of results is presented in Table 1.

Table 1 – Culvert Capacity at 73 Richard Road

Scenario	1350 mm Culvert	1200 mm & 750 mm Culverts
Bankfull Capacity	5.7 m^3/s Freeboard to top of bank = 0	5.3 m^3/s Freeboard to top of bank = 0
Existing 100 yr lower catchment + approx. 10yr upper catchment	1 m^3/s + 1 m^3/s = 2 m^3/s Freeboard to top of bank = 1.9 m	1 m^3/s + 1 m^3/s = 2 m^3/s Freeboard to top of bank = 1.3 m

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Existing 100 yr lower catchment + approx. 10yr upper catchment	2.5 m^3/s + 1 m^3/s = 3.5 m^3/s Freeboard to top of bank = 1.3 m	2.5 m^3/s + 1 m^3/s = 3.5 m^3/s Freeboard to top of bank = 0.8 m
Effect of Development	**+ 0.6 m increase in water level**	**+ 0.5 m increase in water level**

Key points to note from the results are –

- The current capacity of the channel is approximately 5 m^3/s being around a 10 – 30-year flood event (incl climate change);
- It is likely that when the indirect upstream storage is having its greatest effect (> 10-year event) the surrounding downstream land will already be flooded;
- In a rainfall event which effects the lower (developed) part of the catchment more significantly than the upper catchment it is possible that there could be an increase in flow of approximately 1.5 m^3/s which would result in an increase in water level of between 0.5 – 0.6 m;
- Although this is a notable increase it is not clear what the effects would be as the water levels would still be around 1 m below the top of bank;
- It is understood that there is a tile drainage network discharging into the Richard Road Drain that may be affected by this type of event;
- It is also possible that these increased flows could contribute to bank erosion;
- Further investigation would be required to quantify these effects.

Summary

1. The reliance on indirect mitigation of peak flows from the large, largely undeveloped upstream catchment comes with the risk of increased flows for events that more significantly affect the lower catchment.

2. This could result in an increase in flows of up to 1.5 m^3/s with a corresponding increase in water levels of 0.5 to 0.6 m. Although this is still well below the top of the banks there could be effects on the tile drainage system that discharges into the drain and could possibly contribute to erosion issues within the channel.

3. It is also noted that benefits of storage provided by the upstream storage increases as the size of the event increases. For the larger events it is likely that the land surrounding Richards Road Drain will already be flooded. It is also noted for these larger events that there will be an extended hydrograph recession which may also affect the tile drainage system and exacerbate bank erosion issues.

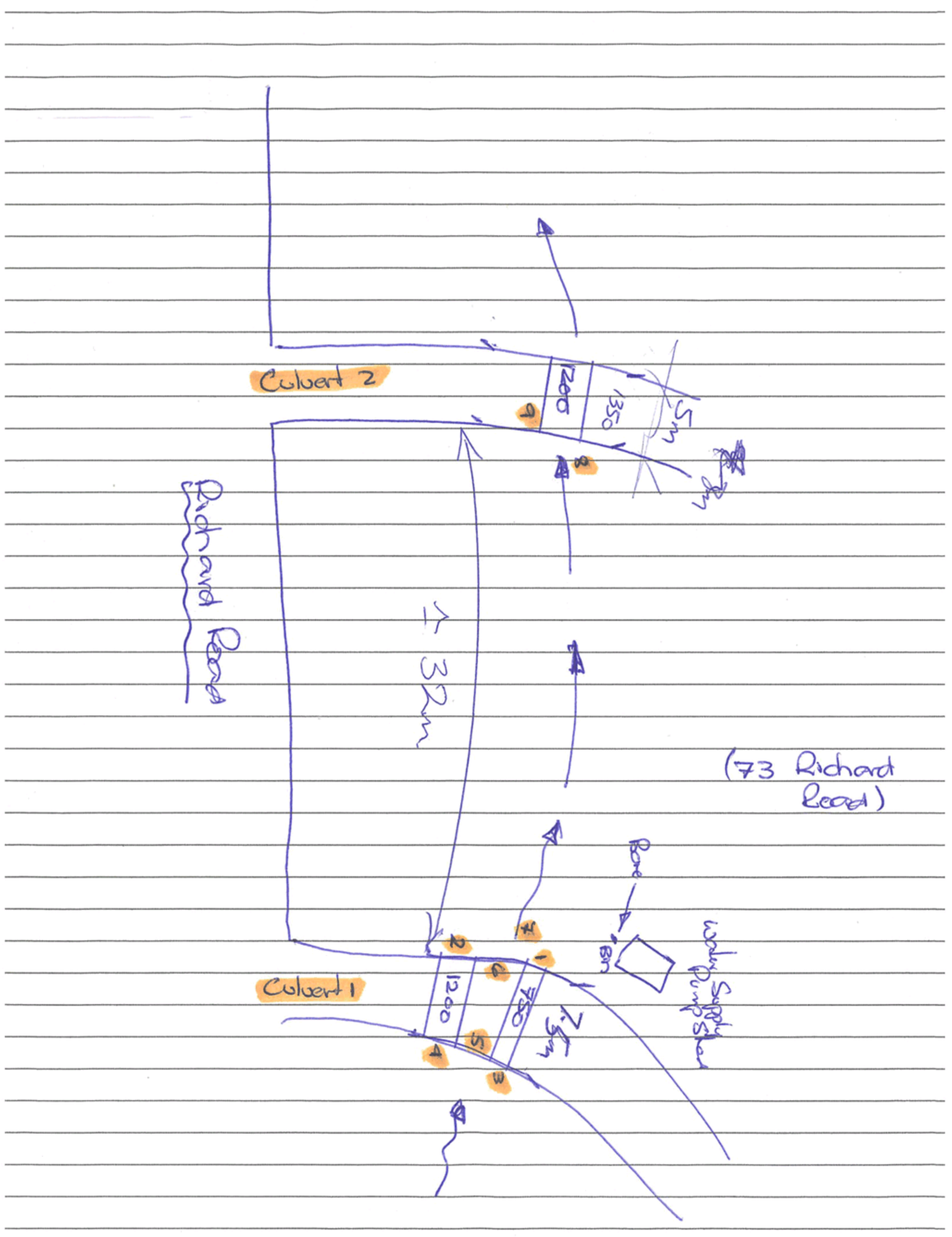
4. Further investigation would be required to quantify the above effects. Alternatively, direct storage mitigation could be provided for catchments C1 & C2.

I trust the above adequately covers the required matters but please feel free to contact me if you require any further information.

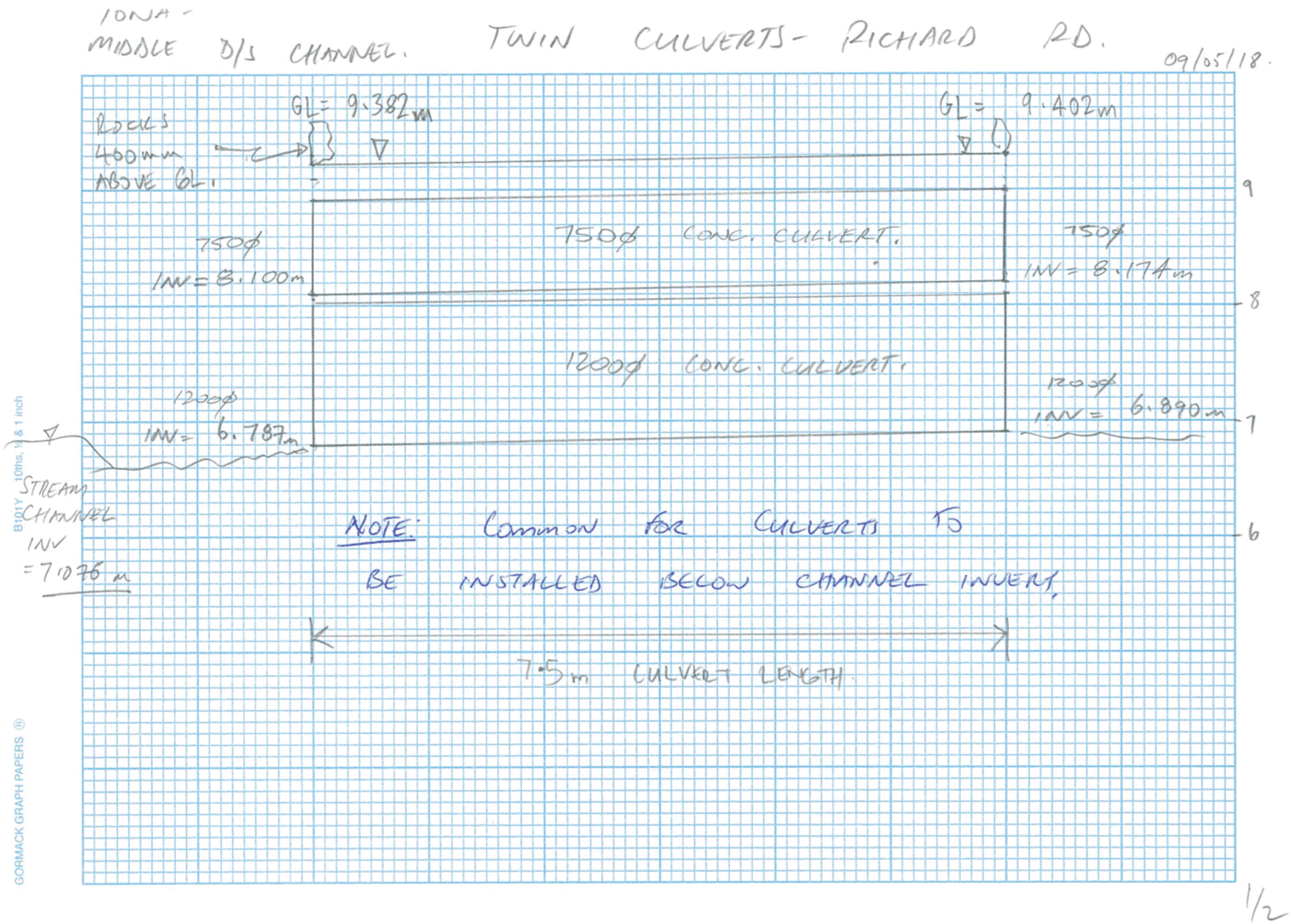
Yours faithfully,

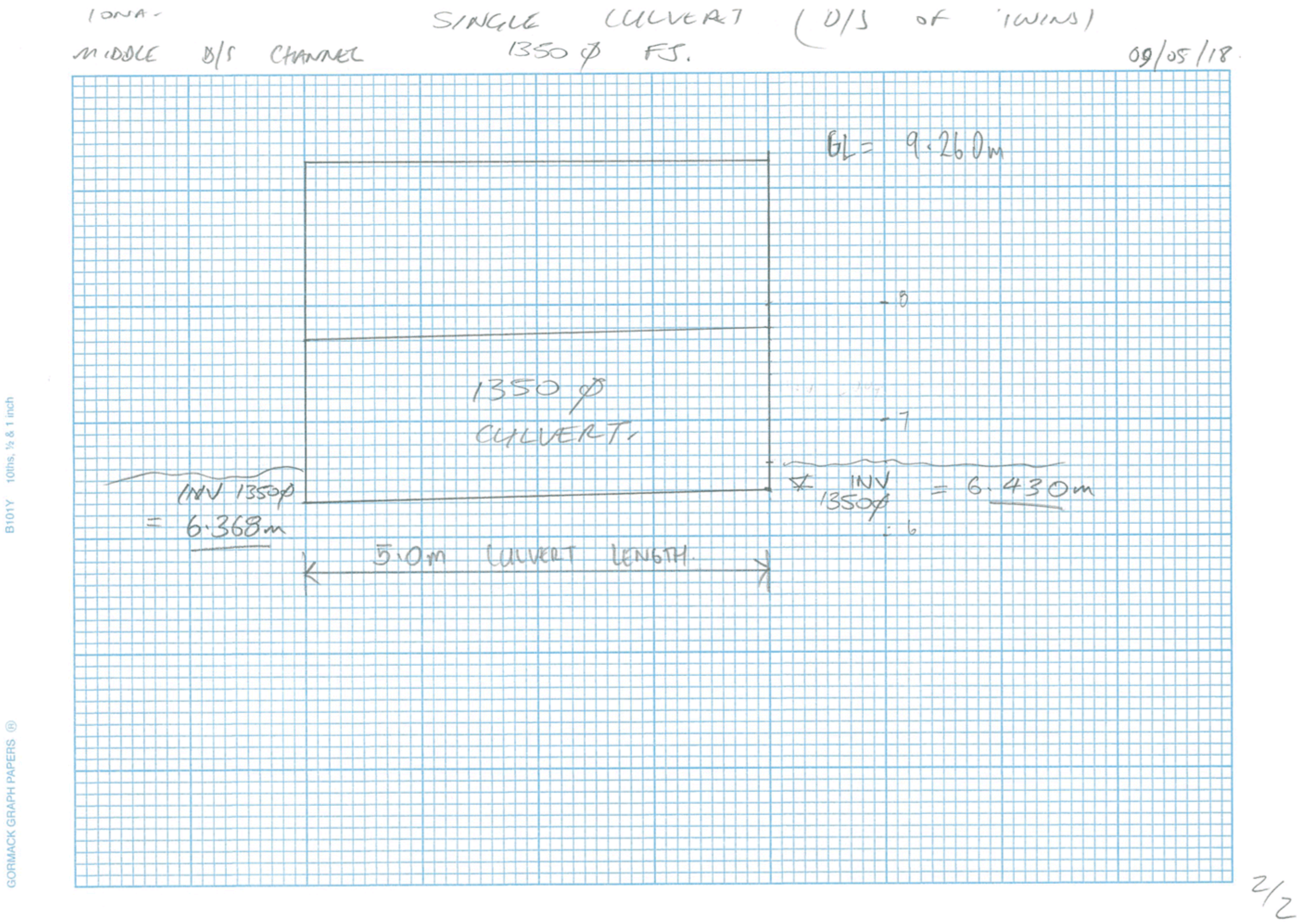
Kyle Christensen
Director – Christensen Consulting Limited


RICHARD ROAD
Culvert x2
HBLASS Rural Imagery Acquisition: 5-6 January 2015, 11 January 2015, 18-19 February 2015, 28 February 2015, 1-2
HASTINGS
DISTRICT COUNCIL
N
73 Richard Road
Map Produced Using Intramaps
8/05/2018
1:600 on A4


Culvert 2
Culvert 1
Richard Road
(73 Richard Road)
32m
1200
1350
5m
7.5m
Bore

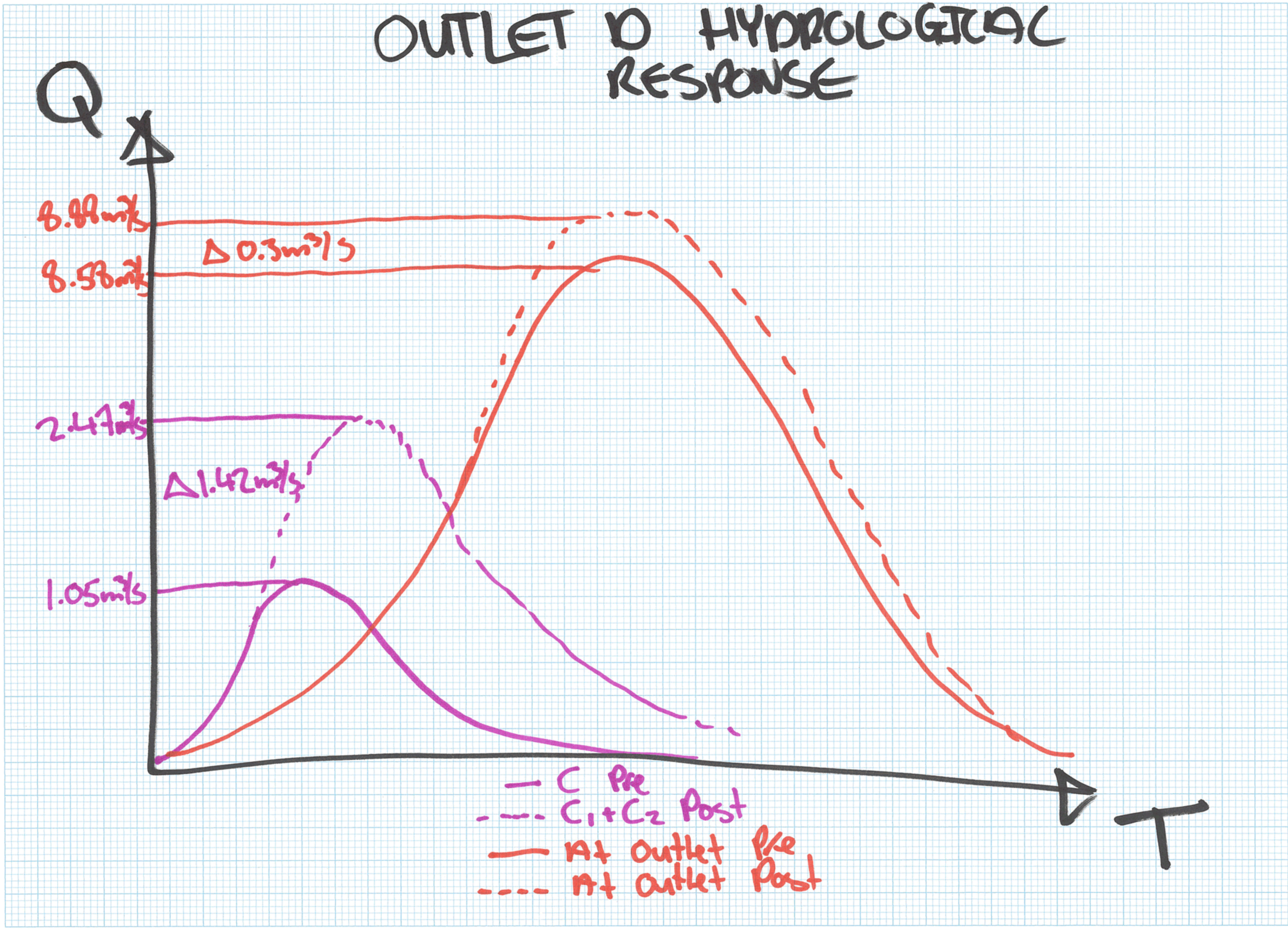

400
u/s 400


IONA -
MIDDLE D/S CHANNEL.
TWIN CULVERTS - RICHARD RD.
09/05/18.
ROCKS 400mm ABOVE GL.
GL = 9.382m
GL = 9.402m
750ø CONC. CULVERT.
750ø IN = 8.100m
750ø IN = 8.174m
1200ø CONC. CULVERT.
1200ø INV = 6.787m
1200ø INV = 6.890m
STREAM CHANNEL INV = 7.076 m
NOTE: Common for Culverts to be installed below channel invert.
7.5m CULVERT LENGTH.
9
8
7
6
1/2
GORMACK GRAPH PAPERS



Item 2

Attachment BS


OUTLET 10 HYDROLOGICAL RESPONSE
Q
8.88m³/s
8.58m³/s
Δ 0.3m³/s
2.47m³/s
Δ1.42m³/s
1.05m³/s
C Pre
C1+C2 Post
At Outlet Pre
At Outlet Post
T