Before an Independent Hearings Panel
Appointed by Waimakariri District Council

*under:* the Resource Management Act 1991

*in the matter of:* Submissions and further submissions on the Proposed Waimakariri District Plan

*and:* Hearing Stream 12D: Ōhoka rezoning request

*and:* **Carter Group Property Limited**
*(Submitter 237)*

*and:* **Rolleston Industrial Developments Limited**
*(Submitter 160)*

# Supplementary statement of evidence of Ben Throssell (Flooding)

Dated: 13 June 2024

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# SUPPLEMENTARY STATEMENT OF EVIDENCE OF BEN THROSSELL

## INTRODUCTION

1 My full name is Benjamin Graham Throssell.

2 My area of expertise, experience, and qualifications are set out in my statement of evidence dated 5 March 2024 for this hearing stream.

3 The purpose of this supplementary evidence is to respond to matters raised in the Officer's Report dated 31 May 2024 relevant to my evidence.

## CODE OF CONDUCT

4 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in Part 9 of the Environment Court Practice Note 2023. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

## RESPONSE TO OFFICER'S REPORT

5 In the Officer's report, Mr Willis acknowledges that flooding concerns on the site and its vicinity can be addressed based on Mr Bacon's evidence. However, in paragraph 113, he notes that Mr Bacon's assessment excludes potential impacts on downstream flooding in Kaiapoi, stating:

> "Based on the advice of Mr Bacon, I accept that flooding issues on the site and the immediate surrounds can be managed. I note however that Mr Bacon's evidence does not consider downstream flooding issues in Kaiapoi so I am unsure if this will be an issue."

6 I interpret his second sentence to refer to effects on downstream flooding issues in Kaiapoi rather than flooding issues in general.

7 **Attachment 7** of my evidence in chief shows the effects on flooding for the 200YR (0.5% Annual Exceedance Probability) event. This attachment shows:

7.1 The greatest impact occurs closest to the proposed subdivision, with water levels potentially rising up to 100 mm adjacent to the development.

7.2 The effect diminishes with distance. At 500 meters from the boundary, the increase is no more than 20 mm.

7.3 Further interrogation of the model results indicates that by Jacksons Road (roughly 1.5 km downstream of the modelled area), the impact is minimal, not exceeding 15 mm.

7.4 Given Kaiapoi's location approximately 6 km downstream from the proposed development, any potential influence on flooding will be negligible.

8 Determining the flood hazard, and therefore the effects on flood hazard for Kaiapoi is complex with several mechanisms to consider including:

8.1 Fluvial (river) flooding from the Kaiapoi River and Cam River. Noting that Ōhoka Stream is a tributary of the Kaiapoi River;

8.2 Coastal conditions, including sea level rise, storm surge and tides;

8.3 Local precipitation conditions in Kaiapoi;

8.4 Potential stopbank failure;

8.5 Operation of pump stations; and

8.6 Breakout flows from the Ashley River.

9 I note the proposed development would only influence one of these factors – Ōhoka Stream. Considering the significant distance between Kaiapoi and the development, coupled with the multiple sources of flood risk in Kaiapoi, I do not consider there is a credible risk of an adverse effect on flooding in Kaiapoi due to the proposed development.

**RESPONSE TO COLIN ROXBURGH**

10 In Mr Roxburgh's evidence (paragraphs 27-31), he raises some concerns regarding the off-site effects of the proposed development on the 50-year event. He recognises that whilst the peak flow discharged from site may not increase for the 50-year event, there could still be adverse effects relating to the timing and duration of flood inundation.

11 I note flood damages, which in my opinion, makes up the majority of any effects, are estimated from flood damage curves which consider the peak flood depth only. Therefore, duration and patterns of inundation, whilst of some relevance, should not be afforded the same weight as flood depths when assessing effects.

12 To summarise assessments to date:

12.1 we have shown through an extensive modelling exercise, that effects on the 200-year event will be less than minor, both upstream and downstream; and

12.2 we have shown that the 50-year flow can be attenuated to ensure no increase in the post development flow.

13 To address the issues that Mr Roxburgh raises requires an estimate of the 50-year flow pre and post development.

14 The PDP model, which we have used to assess the effects on flooding, derives hydrological inputs from the Waimakariri District wide model (see my evidence in chief for further details on models).

15 The Waimakariri District wide model does not include a 50-year event, it only has a 100-year, 200-year and 500-year event. Therefore, I have estimated 50-year flow inputs by:

15.1 plotting the peak flow discharged from site over Whites Road (100-year, 200-year and 500-year events) against the six-hour rainfall depth for the respective events (**Attachment 1**);

15.2 In **Attachment 1**, I fit a power equation to the data points to estimate the 50-year flow, I employ a power equation rather than a linear regression as the relationship between flow and rainfall depth is expected to be non-linear;

15.3 I find a power equation of the form $y = 0.000083x^{2.83}$ gives a good fit to the data points;

15.4 For the 50-year event, with climate change, the rainfall six-hour rainfall depth is 84.3 mm[1]. Applying the power equation gives an estimated peak flow (over Whites Road) for the 50-year event of 23.6 $m^3/s$;

15.5 Finally, we scale the 100-year hydrograph so that the peak matches the newly derived 50-year peak flow. The measured 500-year, 200-year and 100-year flows over Whites Road, downstream of the proposed subdivision and the assumed 50-year flow are presented in **Attachment 2**.

16 I recognise that the above approach is an approximation which I consider suitable to obtain an indication of what effects might be. For the resource consent stage, I would expect the 50-year event to be derived more accurately.

17 Applying the assumed 50-year hydrograph and rainfall hyetographs to the pre and post hydraulic model (see my evidence in chief for further information on this model construction), we can assess the effects.

18 Summarising the main differences between the pre and post hydraulic models, the post development hydraulic model incudes impervious areas representing the developed sections as well as attenuation basins for storage of stormwater.

19 Of note is that the attenuation basins are 'blocked out' in the PDP hydraulic model. They are not modelled as active storage basins. This makes the

[1] https://hirds.niwa.co.nz/

assessment conservative because the hydraulic model does not include attenuation of any post development flow.

20 **Attachment 3** shows the flood levels, pre and post development, for various locations downstream of the proposed subdivision. See **Attachment 4** for the locations where water level data was extracted.

21 **Attachment 3** shows:

21.1 Generally, flood levels do not change for the North Branch of the Ōhoka Stream (north of Mill Road). This is expected as all stormwater discharge, and therefore effects are to the south, via Whites Road;

21.2 For the waterways south of Mill Road, the most pronounced effects are on the rising limb of the hydrograph (prior to the peak level). At the time of peak level, there is minimal difference between the pre and post levels;

21.3 The 'lower' series shows that the pre and post water levels are closer compared to the 'upper' series which is closer to the proposed development. As discussed above, effects will be less as distance from the subdivision increases;

21.4 The South flow path has minimal differences which can be explained by the area upstream of this flow path which has low density residential lots;

21.5 The Mid flow path and South Branch of the Ōhoka Stream show similar responses. The post development response deviates from the pre development water levels at around three to four hours into the event. This is due to the impervious area of the subdivision which increases run-off but also shortens the response time (lag time between rainfall and runoff);

21.6 I note that some of the post development flow will be attenuated by the basins and this is not incorporated in the current round of modelling. The effect of attenuation will be to release stormwater over a longer time period which will result in less differences between the pre and post series.

22 In conclusion, I consider there are no significant increases to the flood levels for the 50-year event. Further, differences between pre and post development are largely restricted to the rising limb of the hydrograph, over a duration of around five hours. Therefore, I conclude that based on the evidence provided in my evidence in chief and supplementary evidence,

there is a viable solution for stormwater which can adequately mitigate the off-site flooding effects.

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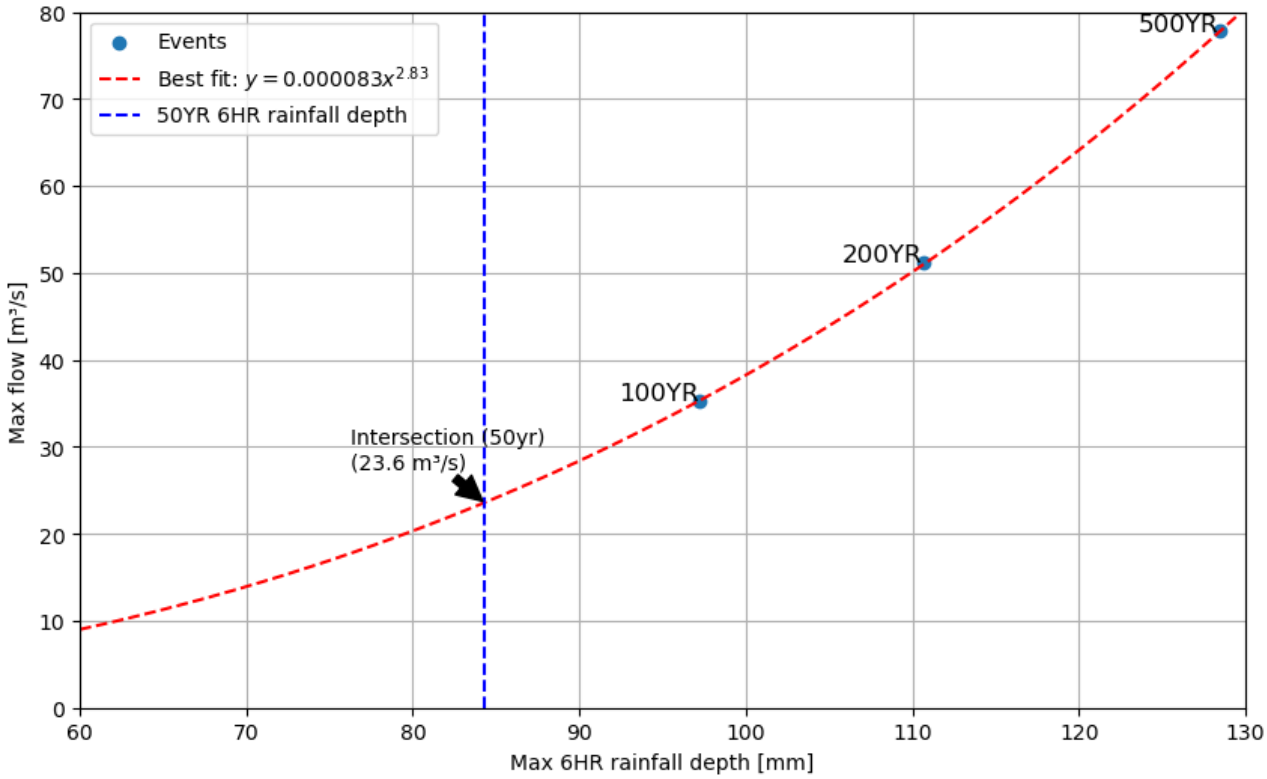
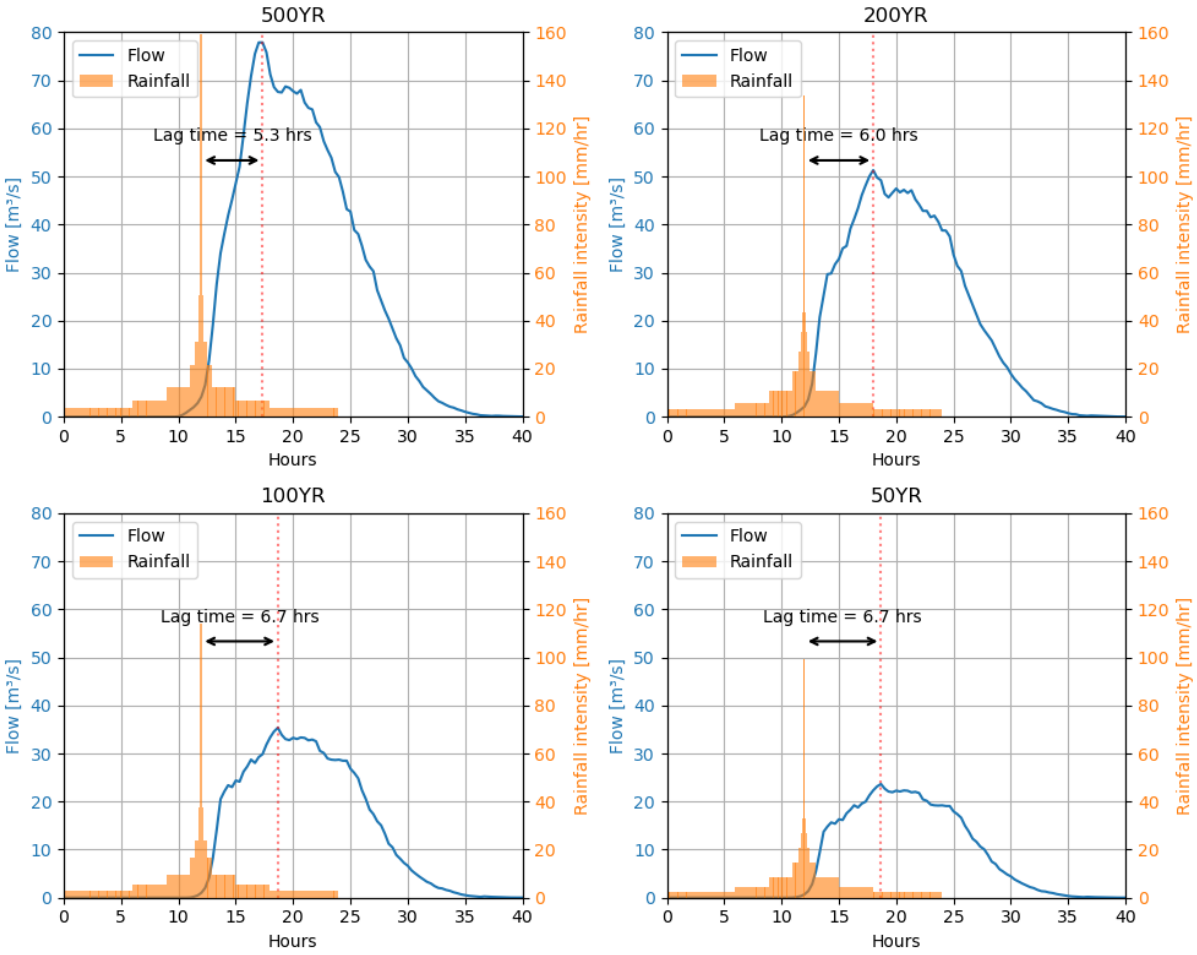
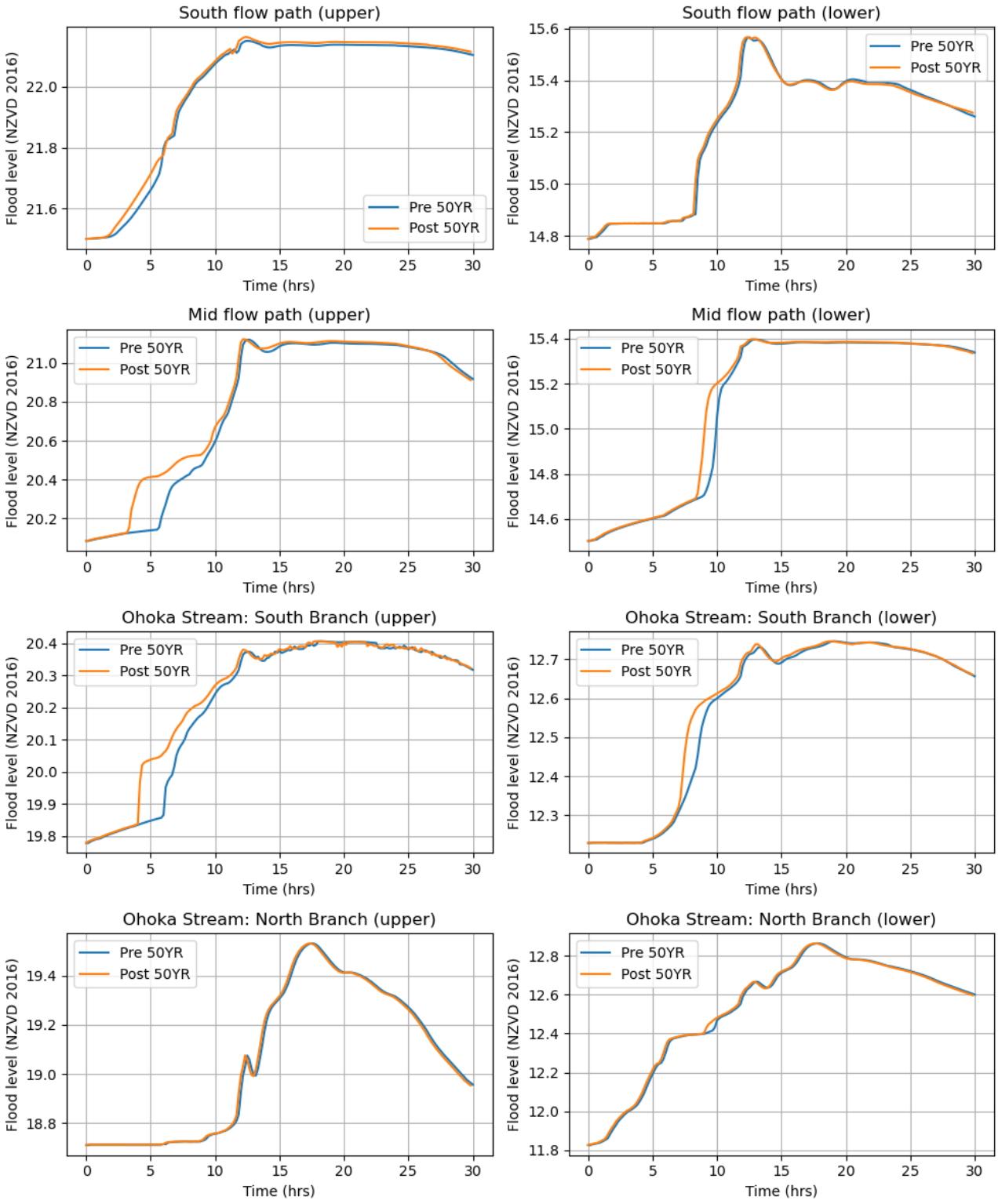
Ben Throssell



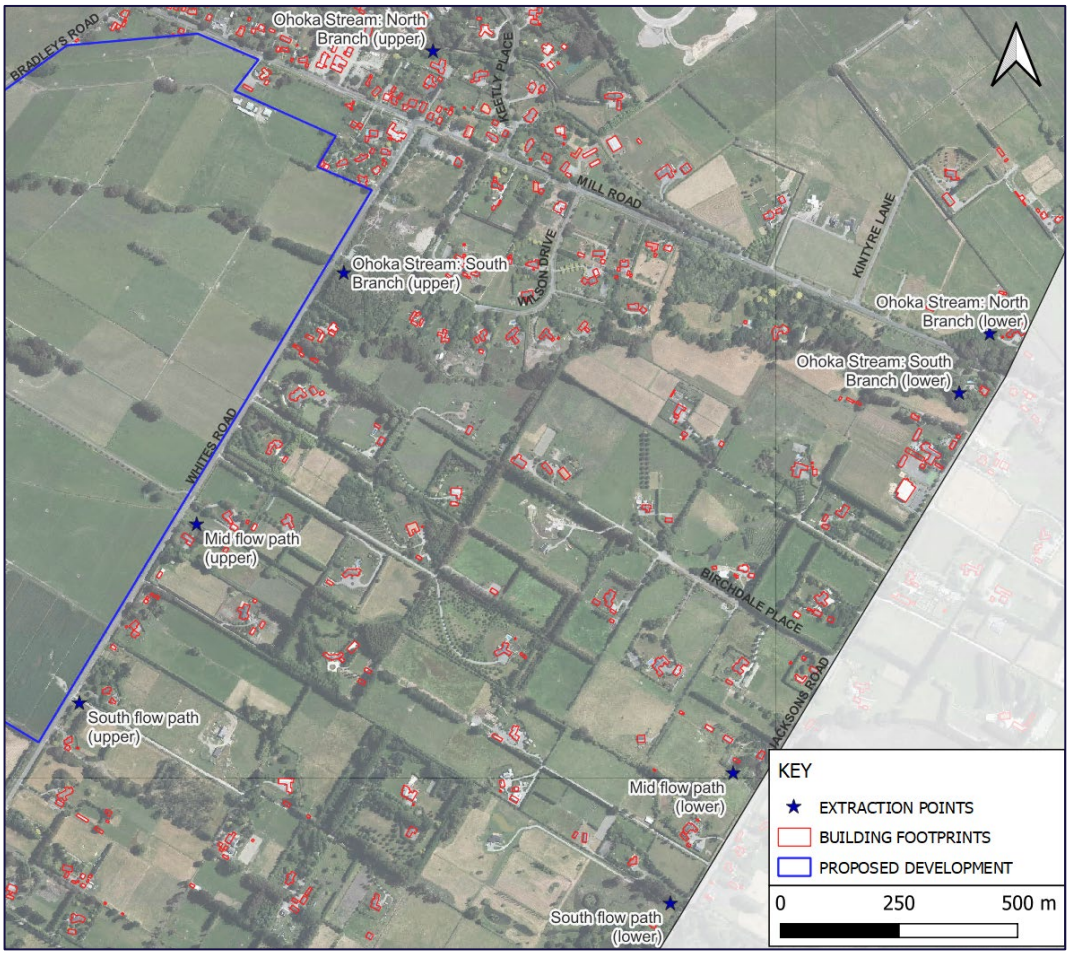

**Attachment 1**: Derivation of 50-year flood flow across Whites Road downstream of the proposed subdivision




**Attachment 2**: Plot of 500-year, 200-year and 100-year flows over Whites Road. These flows were abstracted from the WDC District Wide Model. Also shown is the assumed 50-year flood flow across Whites Road downstream of the proposed subdivision. Nested 24-hour rainfall hyetographs for each of the respective storm events are presented too and the lag time between rainfall peak and flow peak.




**Attachment 3**: Pre and post water levels over time at various locations downstream of the subdivision. See Attachment 4 to view the extraction points.




**Attachment 4**: Location of water level extraction points from the hydraulic model