

**BEFORE THE PORIRUA CITY COUNCIL
AND GREATER WELLINGTON REGIONAL COUNCIL**

IN THE MATTER of the Resource Management Act 1991

AND applications for resource consent under Part 6

BETWEEN WELLINGTON REGIONAL COUNCIL
Local Authority

AND PORIRUA CITY COUNCIL
Local Authority

AND JAGGER NZ LIMITED
Applicant

**STATEMENT OF EVIDENCE OF KYLE JOHN CHRISTENSEN ON
BEHALF OF THE APPLICANT**

INTRODUCTION AND BACKGROUND

1. My name is Kyle Christensen and I am the Water & Environment Leader for Cardno in New Zealand. My qualifications are a Bachelor of Natural Resources Engineering (Hons) from the University of Canterbury and a Masters of Natural Resources Engineering specialising in water resources from Lincoln University. I am a member of the Institute of Professional Engineers of New Zealand (MIPENZ) as well as an IPENZ practice area assessor for water resources engineering, a Chartered Professional Engineer (CPEng) and an International Professional Engineer (IntPE(NZ)). I am also a member of the New Zealand Hydrological Society the New Zealand Society of Large Dams and I am the Chairman of the IPENZ/Water NZ Rivers Group. I have over 16 years' experience in water resources engineering including hydrological and hydraulic modelling, design of river control infrastructure and floodplain management.

2. I have been engaged by the Applicant to provide expert advice on flood and erosion hazard management for the proposed Brookside development adjacent to the northern most reach of Duck Creek which is located in the Porirua suburb of Whitby.

3. In preparing my evidence I have –
 - Visited the application site;
 - Supervised and reviewed the hydrological and hydraulic model used quantify flood and erosion hazard;
 - Supervised and reviewed the report provided in the application documents - Flood & Erosion Hazard Assessment - Duck Creek North, Whitby, Porirua (Leanne Sutherland, Cardno NZ, 2015);
 - Participated in a meeting with Greater Wellington Regional Council (GWRC), Wellington Water Limited (WWL) and Porirua City Council (PCC) to discuss and agree the scope of the peer review of the hydraulic model;
 - Participated in a full day interactive peer review of the hydraulic model with Mr Tom Joseph from Mott MacDonald;
 - Received and responded to queries raised in the 1st Minute of the Commissioners' as well as additional comments from WWL and GWRC and the peer reviewer;
 - Participated in a meeting on 2 March 2016 with Greater Wellington Regional Council (GWRC), Wellington Water Limited (WWL) and Porirua City Council (PCC) to discuss the updated information provided on stormwater treatment devices as well as the extent of erosion protection works;
 - Reviewed the officers S42A reports from GWRC and PCC; and
 - Reviewed the submissions the reference flooding (Roberts, Clement & Noble, Seabrook, Saunders).

4. I have read and agree to comply with the Code of conduct for expert witnesses outlined in the Environment Court Practice Note 2014. I understand that, according to the current Code of conduct:

- (a) an expert witness has an overriding duty to assist the Court impartially on relevant matters within the expert's area of expertise;
 - (b) an expert witness is not an advocate for the party who engages the witness.
5. I confirm that the statements made in this evidence are within my area of expertise (unless I state otherwise) and I also confirm that I have not omitted to consider material facts which might alter the opinions stated in this evidence.

Scope of Evidence

6. This evidence is split into three parts. The first part provides a brief overall summary of the salient matters relating to the flood and erosion hazard for the site. The second part responds to the outstanding issue highlighted in Mr Fletcher's S42A report on behalf of GWRC. This issue is regarding the extent of the erosion protection works proposed by Cardno as shown in drawing NZ0115065-PL-C251 provided in the application documents. The third part responds to flooding related matters raised in submissions.

Part 1 – Summary of Flooding and Erosion Matters

7. The flooding and erosion matters relevant for the proposed Brookside development have been assessed using a peer reviewed hydrological and hydraulic model.
8. The modelling has been used to determine the required level of fill to provide flood free platforms for new dwellings and to assess the effects of this floodplain filling on existing dwellings. The 100 year flood event that has been used is based on rainfall data that is 41.6% greater than the current interpolated rainfall information for the catchment. This interpolated rainfall data is 19% higher than the information available from the nearest raingauge (Judgeford). On this basis the rainfall input used for the design flood is over 60% greater than the nearest measured rainfall data. This is vastly higher than the more typically used 16-20% increase in rainfall taking into account the Ministry for the Environment guidance.
9. Further to this a minimum of 300 mm of freeboard has been added to these levels to inform minimum building level platforms for the proposed new lots. In addition to this an extreme climate scenario has been analysed which effectively uses rainfall that is double the current 100 yr measured rainfall depth. All of the proposed and existing lots are above this flood level. This level of precaution is considered prudent given that there are no measured flood records for this catchment.
10. To achieve these flood free building platforms requires filling in some areas of the floodplain. This is somewhat offset by excavation of floodplain areas particularly around the three bridge locations as shown in the earthworks drawing NZ0115065-PL-C120 provided in the application documents. The hydraulic model has been used to examine the pre and post development scenarios in terms of effects on flood levels through this reach as well as upstream and the effects have been demonstrated as being less than minor.
11. The hydraulic model has also been used to identify areas where there is a risk of erosion that need either protection with rock, or vegetation noting that riparian restoration planting is now proposed for the entire reach as highlighted in Mr Millers evidence.

12. The extent of the erosion protection works also takes into account the existing vegetation, the stability of the existing channel from inspection of aerial photographs from 2002, and is based on the same methodology as successfully used on the reach immediately upstream (Duck Creek South). The overall philosophy for the erosion protection works has been based on minimising the use of rock to where it is absolutely necessary to protect structures and embankment fill. The threshold velocities that have been examined (2.2 – 2.7 m/s) are based on average to poor plain grass cover for durations of up to 2 hours as presented in CIRIA 116 Design of Reinforced Grassed Waterways.
13. The areas that have been identified as being at risk have had mitigation proposed in the form of erosion protection based on three typical details as shown on drawing NZ0115065-PL-C253. I have used engineering judgement, with input from Ray O'Callaghan, based on proven, specific experience on Duck Creek South as well as on successful erosion protection works around the country to determine the appropriate type and extent of protection from the areas initially identified with the hydraulic model.
14. In addition to the specific areas identified for engineered protection the entire reach is now going to have riparian restoration planting down both banks which will provide a natural erosion buffer and protection. This planting is in addition to the extent of planting as shown on the landscape concept drawing NZ0115065-PL-C800.

Part 2 - Extent of Erosion Protection Works

15. Mr Fletcher's S42A report specifically highlights (GWRC S42A report pg 39 paragraph 5 & page 66 paragraph 5) that further information is required on the extent of the stream bank erosion protection in order to address the concerns raised by Mr Joseph in his peer review report. In order to address these concerns each reach where Mr Joseph has suggested further erosion protection works is specifically discussed below. Figures covering each reach are provided in Annex 1. It should be noted that the figures provided in Annex 1 have been extracted from Figure 3.6 of Mr Joseph's peer review report.
16. To provide some context around the currently proposed extent of erosion protection works as shown in drawing NZ0115065-PL-C251 and detailed on drawing NZ0115065-PL-C253 it is worth further describing the Cardno design philosophy for these works. The design philosophy has been fundamentally based on using natural vegetative cover as much as possible and only introducing engineered rock solutions where absolutely necessary. This is the same philosophy that has been successfully employed on the reach immediately upstream (Duck Creek South). The erosion protection works in this reach have been in place for close to two years and have performed well during this time which included the notable May 2015 flood event. The drivers behind this philosophy are the desire to maintain and improve the ecological integrity of the stream and to utilise natural solutions that provide terrestrial habitat as well as more visual and recreational amenity.
17. The aspects relating to the ecological effects of the stream works are outside my area of expertise but reference is drawn to the evidence of Mr Miller who has provided input and advice into the scale and effects of the erosion protection works. Further to this in conversations with Mr Miller during the preparation of this evidence it is noted that the extent

of riparian restoration and planting has been extended to cover the entire reach of Duck Creek that flows through the proposed development.

Reach 1 – Upstream of Site (Samuel Marsden) Figure 1 (See Annex 1)

18. Mr Joseph has recommended rock lining almost this entire reach. I do not consider this appropriate or necessary. Firstly, the majority of this reach is outside the property boundary of the proposed development and is not being affected by the proposed works. Secondly there is mature vegetation on both sides of the channel in this reach and inspection of aerial photographs from 2002 suggests it has been stable for at least the past decade. Mr Joseph has also extended the rock proposed by Cardno on the right bank, near the downstream end of the reach, to extend all the way back to the bend. I do not consider this extent of rock is necessary in what is a straight and relatively stable reach of the creek.

Reach 2 – Upstream of Bridge Nr.3 Figure 2 (See Annex 1)

19. Mr Joseph has recommended additional rock protection work on the inside of two of the bends in this reach as well extending the rock protection upstream of Bridge Nr. 3. I don't consider that rock protection is required on the inside of bends and I am satisfied that the rock length for the bridge is appropriate also noting that we have provided rock protection to the earthworks batter in this location rather than to the creek bank itself.

Reach 3 – Between Bridges Nr. 2 and Nr 3 (see Annex 1)

20. Mr Joseph has recommended rock lining most of this reach. Most of this reach has mature vegetation that has been stable for the past decade and the proposed landscape plan (Cardno drawing NZ0115065-PL-C800) provides extensive planting through this reach. It is also worth highlighting that the key areas around the outside of the bends have a mixture of vegetative protective cover and rock protection for the new earthworks batter. Accordingly, I don't consider rock lining of this reach as necessary.

Reach 4 - Between Bridges Nr.1 and Nr.3 (see Annex 1)

21. Mr Joseph has recommended rock lining most of this reach. Similar to the reach immediately upstream there is mature vegetation through much of this reach and the extension of the proposed riparian restoration and planting through this reach will provide some additional protection. It is also noted that this is a relatively straight and stable reach of the creek and that engineered vegetative cover is provided in the current Cardno design to protect the earthworks batter.

Part 3 – Response to Submissions

22. Mr Roberts has suggested that the flood risk has been under estimated and that the SH58 culvert is under capacity. As highlighted in Part 1 of this evidence the flood risk has been quantified using a precautionary approach with all new and existing dwellings above the flood level that would be generated by a rainfall event close to double (+94%) the current rainfall from the nearest rainfall gauge. On this basis the flood risk has not been under estimated. With regard to the SH58 culvert, it is acknowledged that this already overtops in the 10 year event and the frequency of overtopping will increase with the anticipated increases in rainfall and sea level due to climate change. However, the effects attributable to the change in land use from the proposed development have a less than minor effect on the extent and frequency of overtopping, as shown in Tables 4.2 – 4.4 in the Flooding and Erosion Assessment Report (Cardno, 2015) provided with the application documents. On this basis no mitigation with regard to this culvert is considered necessary.
23. Clement and Noble have queried whether the damming nature of the fallen vegetation and the existing sewer crossing adjacent to Observatory Close have been incorporated into the hydraulic model. These items have been addressed through a sensitivity model run where the Manning's roughness has been increased by 25% for the entire channel and floodplain for the 2090-Mid climate scenario. The flood levels from this sensitivity run were lower than the design levels adopted from the 2090-High climate change scenario so it is concluded that sections of fallen vegetation and the sewer crossing have been adequately accounted for in the analysis.
24. Mr Seabrook raises concerns regarding his perception around the lack of widening and strengthening at the lower end of Duck Creek. This reach does in fact have a significant degree of enlargement through excavation of the left floodplain as shown in Cardno drawing NZ0115065-PL-C120 and vegetative protective cover as shown in NZ0115065-PL-C251. Further to this the additional riparian restoration planting proposed through this reach will provide further protection.
25. Mr Saunders raises concerns regarding the capacity of the creek to take increased flows. As presented in Section 4 of the Flooding and Erosion Assessment report (Cardno, 2015) the increase in flows associated with the proposed development is less than minor. It should also be noted that the main creek itself only takes around the 10 year flood with larger floods flowing out across the floodplain (berm) areas.

Conclusions

26. The flooding and erosion hazard has been quantified for the proposed Brookside development using a hydrological and hydraulic model that has been deemed fit for purpose by an independent peer review completed by Mott MacDonald. The model has been used to demonstrate that all existing and proposed residential dwellings are above the 100 year design flood accounting for a high climate change scenario (+41.6% interpolated rainfall + 0.5 m sea level) and 300 mm of freeboard. The model has also quantified the effects of the floodplain filling as having a no more than minor effect. The model has also been used to identify areas of high velocity and engineering judgement has been used to determine the appropriate type and extent of erosion protection works.
27. The extent of currently proposed erosion protection measures shown in Cardno drawing NZ0115065-PL-C251 are considered appropriate to mitigate the erosion risk in this reach of Duck Creek. The proposed erosion protection works have used engineered rock where considered necessary and elsewhere rely on either the existing established vegetation or the proposed riparian restoration planting that has now been extended to cover the entire reach. I do not consider it necessary to extend the rock protection works as suggested by Mr Joseph.
28. In my opinion, the submitters concerns have all been addressed by referring to details contained in the application documents.



DATED THIS 17 DAY OF MARCH 2016

Annex 1 - Extent of Erosion Protection Works Reach by Reach Figures

PROPOSED BANK REMEDIAL WORKS

-  VEGETATIVE PROTECTIVE COVER
(350 LINEAR METRES - SEE TYPICAL DETAIL A SHEET C253)
-  ROCK PROTECTION WITHIN EXISTING STREAM CHANNEL
(100 LINEAR METRES - SEE TYPICAL DETAIL B SHEET C253)
-  ROCK PROTECTION OF NEW EARTHWORKS BATTER
(165 LINEAR METRES - SEE TYPICAL DETAIL C SHEET C253)
-  PROPOSED SW OUTLET STRUCTURES

 Additional Bank and Channel Protection (As recommended by Mr Joseph)

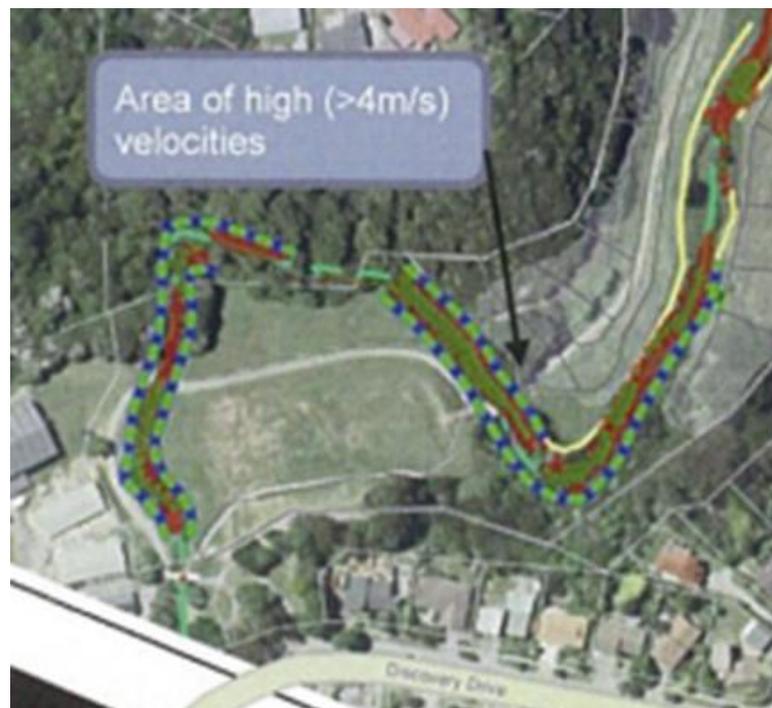


Figure 1 - Reach 1 Upstream of Site (Samuel Marsden)



Figure 2 – Reach 2 Upstream of Bridge Nr. 3



Figure 3 – Reach 3 Between Bridges Nr.2 and Nr.3

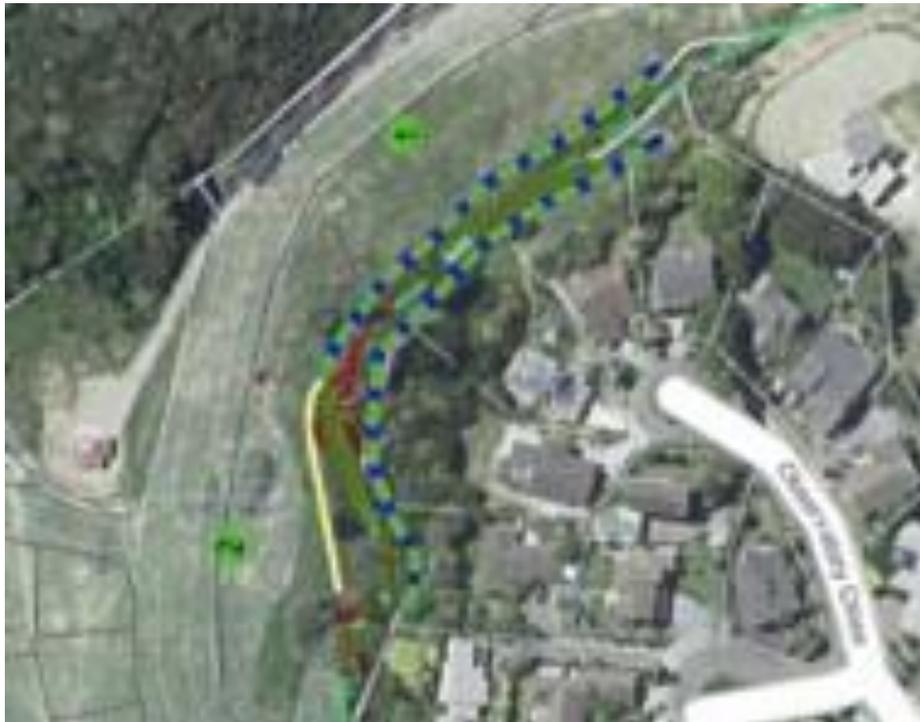


Figure 4 – Reach 4 Between Bridges Nr.1 and Nr.3