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26 February 2020

Attention: James Beban
Director / Planner
Urban Edge Planning Limited
PO Box 39071 Wellington Mail Centre
Lower Hutt 5045

By email: james@uep.co.nz

Project Name: Pinehaven Stream Improvements
Project Number: IZ089000

Subject: Response to section 92 requests for further information - submissions

Dear James

Thank you for your letter dated 3 February 2020 setting out the matters have been raised by the submitters in relation to which further information is required under section 92 of the Resource Management Act 1991 by the Upper Hutt City Council to fully assess the notice of requirement for designation for the proposed Pinehaven Stream Improvements.

Responses to the matters raised in the Section 92 letter are addressed in the tables attached at Appendix A.

This letter does not respond to your first section 92 request dated 6 December 2019. That further response will be provided in a separate document.

We trust that the responses above sufficiently satisfy the section 92 request for further information. Please don't hesitate to contact me if you have any other queries or need further clarification.

Yours sincerely

Helen Anderson
Technical Director – Planning
GHD
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26 February 2020

Subject: Response to section 92 requests for further information - submissions

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Appendices

Appendix A Response table

Appendix B Comparative assessment of 8 December 2019 event

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Appendix A. Response table

Table 1: Responses to questions

#	Requested Information	Response
1.	*Please confirm the ARI (annual recurrence interval) of the storm and associated flood event. If the ARI for the rainfall event is different to that of the flood event, please provide some commentary as to why this may be the case (i.e. distribution or rainfall, duration of event etc.....)*	*Return Rainfall* Analysis of the recorded rainfall at the Pinehaven Reservoir gauge site shows the rainfall that preceded the flood event of 8 December had an Average Return Interval (ARI) of 30 years for the two-hour duration, i.e. it was a 1 in 30-year ARI rainfall event for the two hour duration (being the critical duration (i.e. the duration that will result in the highest runoff rates). *Flood Period* There are no flow gauge records within the catchment to allow assessment of the ARI of the flooding. We have observations from the flood event (photographs), and these provide information on the maximum flood extents, which are the next best thing to flow gauge data. We have considered these and determined that the rainfall ARI is not inconsistent with the observations of flood extents.
2.	*Please provide a comparison assessment of the flood/rainfall event of 8 December 2019 with the model outputs for the comparable flood event, and comparisons with the modelled 10-year and 100-year events. Is the relevant model output comparable to the December 2019 event? Please provide comments on differences between observed flood extents and those contained in the FMP and planning maps, noting whether any discrepancies are due to factors such as the size of event, or the inclusion of freeboard, blockage or allowances for climate change.*	A comparative assessment has been undertaken and the resulting report is attached at Appendix B.
3.	*Please explain the infiltration capacity used in the model, why this has been used and why it is*	*Infiltration Capacity*

	appropriate for this location. Has the catchment been treated as 'bare' (i.e. no trees, infiltration from bush/forest areas)? What is the CN value that has been applied for the pre-development hydrology? Is the CN value 96, as back-calculated by RJ Hall's review?	The infiltration capacity used in the model was developed by MWH in 2008 using HYDSTRA software. The hydrological method applied by MWH used the Initial Loss - Continuous Loss model to represent the infiltration capacity of the catchment. This method is commonly used in NZ and is a good method for representing the rainfall-runoff process. The model parameter values have been determined through calibration to debris line survey data for the 31 July 2008 storm event, which is estimated by MWH to have an ARI of between 1 in 1-year and 1 in 2-years. The model has been validated against independent flow estimation methods including McKerchar and Pearson (1989), Pearson (1990), Pearson (1991) and the Rational Method for events with ARIs of 1 in 2-years, 1 in 5-years, 1 in 10-years, 1 in 20-years, 1 in 50-years and 1 in 100-years. It is appropriate to use this hydrological method and the parameter values that were applied because the model has been calibrated and validated to the local conditions. The catchment has not been treated as 'bare'. By calibrating and validating the model MWH have developed a model that is demonstrably a good model for representing the rainfall-runoff process in the catchment. *CN Values* The hydrological method used did not use CN values. It is the Soil Conservation Service (SCS) method that uses CN values and is a US-based method that was developed in the 1980s. There are significant differences between the Initial Loss – Continuous Loss method and the SCS method, and using the parameter values from one to estimate or back-calculate parameter values for the other is a small part of the overall process of comparing the two models. It is the opinion of our lead modeller (Peter Kinley) that, if it was desirable to change from the Initial Loss – Continuous Loss method to another hydrological method, such as the SCS method, then the main part of the process would be to calibrate and validate the new method to available field data such as flood extents and level gauging. The outcome of this process would be a model with calibrated parameter values (i.e. calibrate CN values if the SCS method was used). Only once this was done it would be appropriate to make comparisons to alternative model parameter values. As CN values were not applied to the pre-development hydrology, without further work as identified above, it is not possible to say what the CN values would have been. The SCS method was selected as a regional method for use on Wellington Water flood studies in 2016, based on work by Cardno Ltd. However, the Initial Loss - Continuous Loss model remains an appropriate method for representing the rainfall-runoff process. Our lead modeller's assessment of the back-calculation by RJ Hall has raised some concerns with the way that calculation has been undertaken. It appears that the imperviousness for the full upper catchment may have

		been applied to a single sub-catchment and then the results applied across the full upper catchment, i.e. the imperviousness is counted multiple times. In summary: · The hydrological method used in the model does not actually use CN values, so could not have used a CN value of 96. · The process used by Robert Hall to estimate CN values is not consistent with good practice. · The application of a regional method is not preferred when calibration data are available. · The back-calculation of CN numbers appears to contain some inconsistencies, probably in the assumptions.
4.	*Please confirm whether improvement works at the 122 Pinehaven Road culvert are required and within the scope of this work.*	No improvement works are proposed at 122 Pinehaven Road either as part of the project, or in order to mitigate the effects of the Project.
5.	*Please advise whether the increased elevation of the Silverstream Reformed Church site (associated with the discharge of cleanfill material to land) has been included in the model and Flood Hazard Assessment?*	The fill proposed to be deposited on the Silverstream Reformed Church and associated Christian School site, as noted on Sheet 1 of the General Arrangement plans, is no longer proposed to be included in the Project works. Amended designation plan and GA plans reflect this change were attached to the previous section 92 response. A separate resource consent for these works will be sought at a later date to provide for these works if this activity is progressed. The increased elevation of the cleanfill site was not included in the model, and therefore removal of this aspect of the works will not have any impact on the effectiveness of the Project.
6.	*Please provide an assessment of effects of stormwater runoff and associated flooding due to the discharge of cleanfill material to land at the Silverstream Reformed Church.*	
7.	*Please confirm the volume of cleanfill material to be discharged to land at the Silverstream Reformed Church, including a plan showing the proposed area and height of the discharged material.*	
8.	*Please confirm how it is proposed to secure the Secondary Overland Flow Path along the driveway of 11 Birch Grove?*	The process for securing the Secondary Overland Flow Path along the driveway of 11 Birch Grove is still to be determined in consultation with the landowner to accommodate the long-term aspirations of the landowner for the property.

Appendix B. Comparative assessment of 8 December 2019 event

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Memorandum

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Subject	**Response to Jan 23 2020 Section 92 Request - Mapping 8 December 2019 flood event**	**Project Name**	Pinehaven Stream Improvements Project
		Project No.	IZ089000
Author	Damian Debski		
Date	February 26, 2020		

This memorandum provides a response to a question on the 8 December 2019 flooding event from the January 23, 2020 Section 92 Request on the consent application for the Pinehaven Stream Improvements project:

> *Please provide a comparison assessment of the flood/rainfall event of 8 December 2019 with the model outputs for the comparable flood event, and comparisons with the modelled 10-year and 100-year events. Is the relevant model output comparable to the December 2019 event?*

Comparison assessment of the flood/rainfall event of 8 December 2019 with the model outputs for the comparable flood event, and comparisons with the modelled 10-year and 100-year events.

The technical memorandum *Frequency Analysis Rainfall Event on 8 December 2019* (Wellington Water, 13 December 2019) estimated that, based on data from a rain gauge in the Pinehaven Stream catchment (Pinehaven Stream at Pinehaven Reservoir), the average recurrence interval (ARI) of the rainfall in this event at the gauge location was 10-20 year for a 20-minute duration and 30-40 year for a 60-minute duration.

There are no model outputs for a directly comparable flood event. The photographed and first-hand observations of flooding from the December 2019 event have been compared to the modelled 10-year and 100-year events as presented in the Pinehaven Stream Floodplain Management Plan, Revision 6 dated September 2016 ("the FMP"). These model events encompass the likely range of the December 2019 event based on the rainfall analysis. It should be noted that the modelled flood maps in the FMP include an increase in rainfall over present day to allow for the effect of climate change. Because of this climate change allowance, the maps will tend to show a greater extent of flooding than would occur in 2019 for the same event.

Data considered

Attachment 1 to this letter provides a listing of the photographs and videos examined (identified by the filename, as supplied by Wellington Water) and indicates those which show evidence of flooding originating from the Pinehaven Stream. The assessment is limited to the reach of the Pinehaven Stream

between Whitemans Road and the Pinehaven Reserve (i.e. the extent of the Pinehaven Stream Improvements Project).

It is important to note that most of the photographs and videos are reported to be taken between 7.30AM and 9.30AM, sometime after the peak of the flood which was reported by an observer to have been around 6.30AM. The following types of visual information, where recorded, have been used to estimate the approximate areas of flooding in the event:

- Standing or flowing water;
- Debris ("trash") such as small branches and leaves and sediment which tend to be deposited during a flood near the extremities of flooding as the water level starts to recede;
- Ponded water in low points on the ground or retained behind walls and fences;
- "Watermarks" – line marks on buildings or vehicles where floating or suspended matter in the flood water has adhered, typically around the maximum height of the flood water.

Comparison with modelled events

Further to the description below, Attachment 2 contains a visual comparison with the flood maps from the Pinehaven Stream Floodplain Management Plan, Revision 6 (September 2016).

- Birch Grove to Pinehaven Road:

  The flooding photographed at 11 and 12 Birch Grove is predicted in both the 10-year and 100-year model flood extent. The photographs do not show how far along Birch Grove the flooding extended. Debris photographed at Pinehaven Road on the true left bank of the Stream is approximately at the 10-year model flood extent.

  In this section of the Stream the observations indicate flooding was at least as extensive as the model 10-year flood extent.

- Between 26 and 36 Blue Mountains Road:

  The flooding and debris recorded at No. 36 Blue Mountains Road appears to be consistent with the model 100-year flood extent. At Nos. 26, 32 and 34 Blue Mountains Road the records appear to be consistent with the model 10-year flood extent. At No. 28 the extent of flooding to the rear of the property cannot be established from the photographs – evidence of flooding to the front of the property is within the model 10-year and 100-year flood extent.

  In this section of the Stream the observations suggest the flooding lies between the model 10-year and 100-year flood extent.

- Between Sunbrae Drive and Willow Park:

  Debris recorded on the south side of Sunbrae Drive appears to be consistent with the model 10-year results for deeper flooding. However, the extent of flooding along the road is not clear from the photographs. Recorded flooding at Nos. 10, 12 and 14 Blue Mountains Road appears similar to both the model 10-year and model 100-year flood extents. Flooding is contained at this location by the rise in ground level along Blue Mountains Road. In Willow Park, the debris recorded appears to be consistent with the model 10-year extent.

In this section of the Stream the observations suggest the flooding lies between the model 10-year and 100-year flood extent.

Conclusions

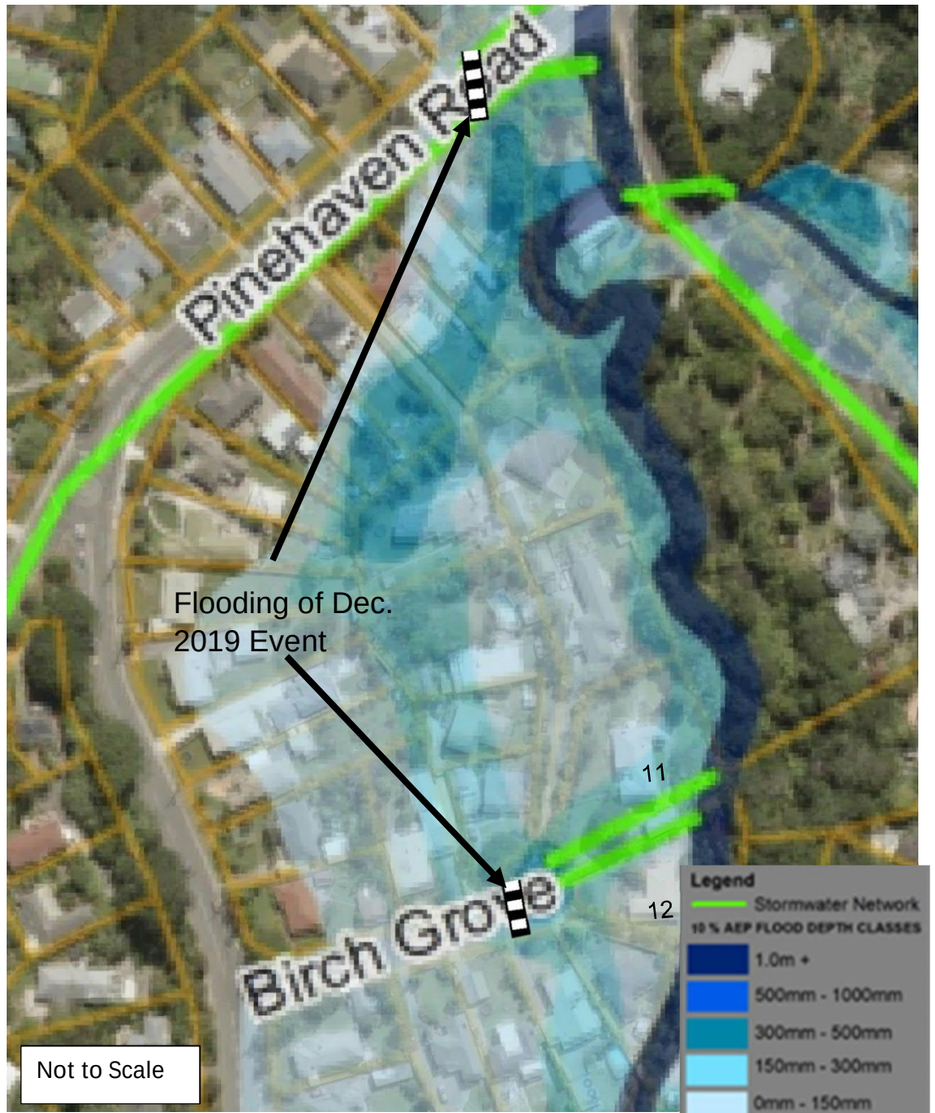
The observed data is limited as it does not capture the full extent of flooding and did not capture the peak of the flood event. The flooding observations on 8 December do however record the lack of channel capacity and flooding potential in Birch Grove, Blue Mountains Road and Sunbrae Drive. A comparison of the model outputs for the 10-year and 100-year rainfall events and the observational data shows that the December 2019 flooding is somewhere between these two models outputs. This is consistent with the Wellington Water memorandum which summarised that the rainfall ARI for the flooding that occurred at the Pinehaven Stream on December 8, 2019 was 10-20 year event (20-minute duration) and 30-40 year event (60-minute duration).

ATTACHMENT 1

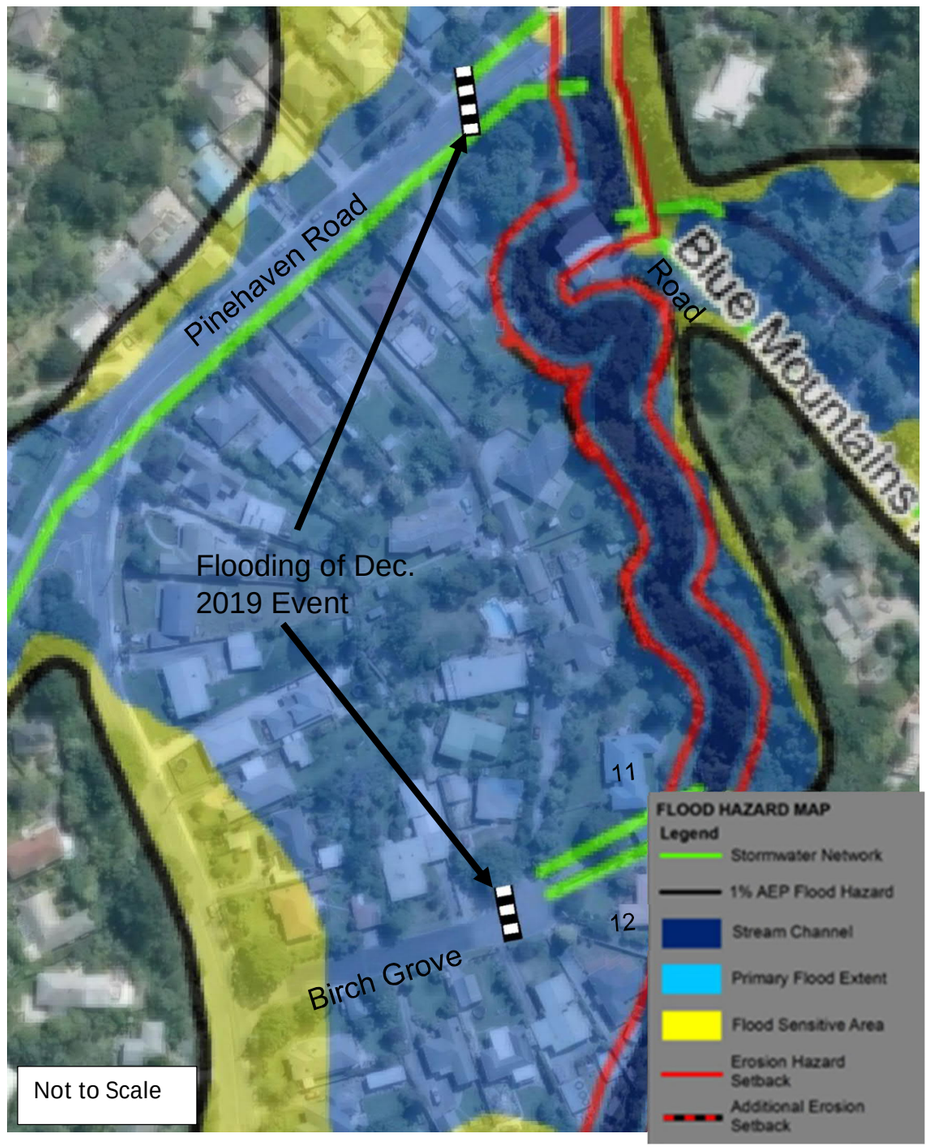
Sr. No.	Photograph	Location	Remarks
1	20191209 2 Pinehaven Rd debris line from Pinehaven Rd flooding.JPG	2 Pinehaven Rd	Useful Information
2	20191209 10 Blue Mtn Rd.JPG	10A - 14 Blue Mountains Rd	Useful Information
3	20191209 10A Blue Mtn Rd.JPG		Useful Information
4	20191209 12 Blue Mtn Rd 2.JPG		Useful Information
5	20191209 12 Blue Mtn Rd 3.JPG		Similar to Above
6	20191209 12 Blue Mtn Rd.JPG		Similar to Above
7	20191209 12 Whitemans Rd vid.MOV		Similar to Above
8	20191209 14 Blue Mtns Rd driveway.JPG		Useful Information
9	20191209 28 Blue Mtn Rd 2.JPG	Blue Mountains Rd	Useful Information
10	20191209 28 Blue Mtn Rd.JPG		Useful Information
11	20191209 32 Blue Mtn Rd 2.JPG		Useful Information
12	20191209 32 Blue Mtn Rd vid.MOV		Similar to Above
13	20191209 32 Blue Mtn Rd.JPG		Similar to Above
14	20191208_32 BM Rd - pic from Gen.jpg		Similar to Above
15	20191209 36 Blue Mtn Rd 2.JPG		Useful Information
16	20191209 36 Blue Mtn Rd 3.JPG		Similar to Above
17	20191209 36 Blue Mtn Rd 4.MOV		Similar to Above
18	20191209 36 Blue Mtn Rd.JPG		Similar to Above
19	20191209 36 Blue Mtn Rd backyard vid.MOV		Useful Information
20	20191209 36 Blue Mtn Rd front yard.JPG		Useful Information
21	20191209 36 Blue Mtn Rd house.JPG		Useful Information
22	20191209 38A Blue Mtn Rd driveway 2.JPG		Not Relevant
23	20191209 38A Blue Mtn Rd driveway.JPG		Not Relevant
24	20191209 Blue Mtn Rd southbound lane flooding at 32 Blue Mtn Rd 2.JPG		Not Relevant
25	20191209 Blue Mtn Rd southbound lane flooding at 32 Blue Mtn Rd.JPG		Not Relevant
26	20191209 34 Blue Mtn Road resident photo.jpg		Useful Information
27	received_429712004645242 32 BM Rd Resident Photo (1).jpeg		Useful Information
28	received_429712004645242 32 BM Rd Resident Photo (2).jpeg		Useful Information
29	received_429712004645242 32 BM Rd Resident Photo (3).jpeg		Useful Information
30	received_429712004645242 32 BM Rd Resident Photo (4).jpeg		Useful Information
31	received_429712004645242 32 BM Rd Resident Photo (5).jpeg		Useful Information
32	20191209 culverts into Pinehaven Reserve at Winchester 2.JPG	34 Winchester Avenue	Not Relevant
33	20191209 culverts into Pinehaven Reserve at Winchester.JPG		Not Relevant
34	20191209 Pinehaven Rd Winchester flow across intersection vid.MOV		Not Relevant
35	20191209 Pinehaven Rd Winchester flow across intersection.MOV		Not Relevant
36	20191209 Pineahven Reserve channel looking towards PHaven Rd.JPG	Pinehaven Reserve	Not Relevant
37	20191209 Pineahven stream upstream of Birch Grove.JPG		Not Relevant
38	20191209 Pinehaven Reserve channel 2.JPG		Not Relevant
39	20191209 Pinehaven Reserve channel 3.JPG		Not Relevant
40	20191209 Pinehaven Reserve channel.JPG		Not Relevant
41	20191209 Pinehaven stream us of Birch looking upstream.JPG		Not Relevant
42	20191209 Pinehaven stream usptream of Birch Grove 2.JPG		Not Relevant
43	20191209 stream in Pinehaven Reserve.JPG		Not Relevant
44	20191209 stream in Pineahven Reserve vid.MOV		Not Relevant
45	20191209 stream downstream of Pineahven Rd culvert vid.MOV	Pinehaven Culvert	Not Relevant
46	20191209 stream downstream of Pineahven Rd culvert.JPG		Not Relevant
47	20191209 stream upstream of Pinehaven Rd culvert vid.MOV		Not Relevant
48	20191209 stream upstream of Pinehaven Rd culvert.JPG		Not Relevant
49	20191209 Sunbrae Dr culvert - 5 Sunbrae.JPG	Sunbrae Dr Culvert	Useful Information
50	20191209 Sunbrae Dr culvert - downstream.JPG		Not Relevant
51	20191209 Sunbrae Dr culvert - upstream 2.JPG		Not Relevant
52	20191209 Sunbrae Dr culvert - upstream 5 Sunbrae.JPG		Useful Information
53	20191209 Sunbrae Dr culvert - upstream.JPG		Not Relevant
54	20191209 Whitemans Rd bypass 2.JPG	Blue Mountains and Whitemans Rd Intersection	Not Relevant
55	20191209 Whitemans Rd Bypass vid.MOV		Not Relevant
56	20191209 Whitemans Rd bypass.JPG		Not Relevant
57	20191209 4 Whitemans Rd Church Ped Bridge 2.JPG		Not Relevant
58	20191209 4 Whitemans Rd Church Ped Bridge and stream.JPG		Not Relevant
59	20191209 Willow Park debris 2.JPG	Willow Park	Useful Information
60	20191209 Willow Park 1.JPG		Similar to Above
61	20191209 Willow Park 2.JPG		Similar to Above
62	20191209 Willow Park 3.JPG		Similar to Above
63	20191209 Willow Park 4.JPG		Similar to Above
64	20191209 Willow Park 5.JPG		Similar to Above
65	20191209 Willow Park 6.JPG		Similar to Above
66	20191209 Willow Park 7.JPG		Similar to Above
67	20191209 Willow Park 8.JPG		Similar to Above
68	20191209 Willow Park debris.JPG		Similar to Above
69	20191209 Willow Park upstream Church bridge 2.JPG		Not Relevant
70	20191209 Willow Park upstream Church bridge.JPG		Not Relevant
71	20191209 Willow Park vid.MOV		Not Relevant
72	20191209 Willow Park.JPG		Not Relevant
73	20191209 stream flow ds of church bridge.MOV		Not Relevant
74	20191208_11 Birch - pic from Gen.JPG	Birch Grove	Useful Information
75	20191209 Birch #12 Resident Photo.JPG		Useful Information

ATTACHMENT 2

Between Birch Grove and Pinehaven Road:



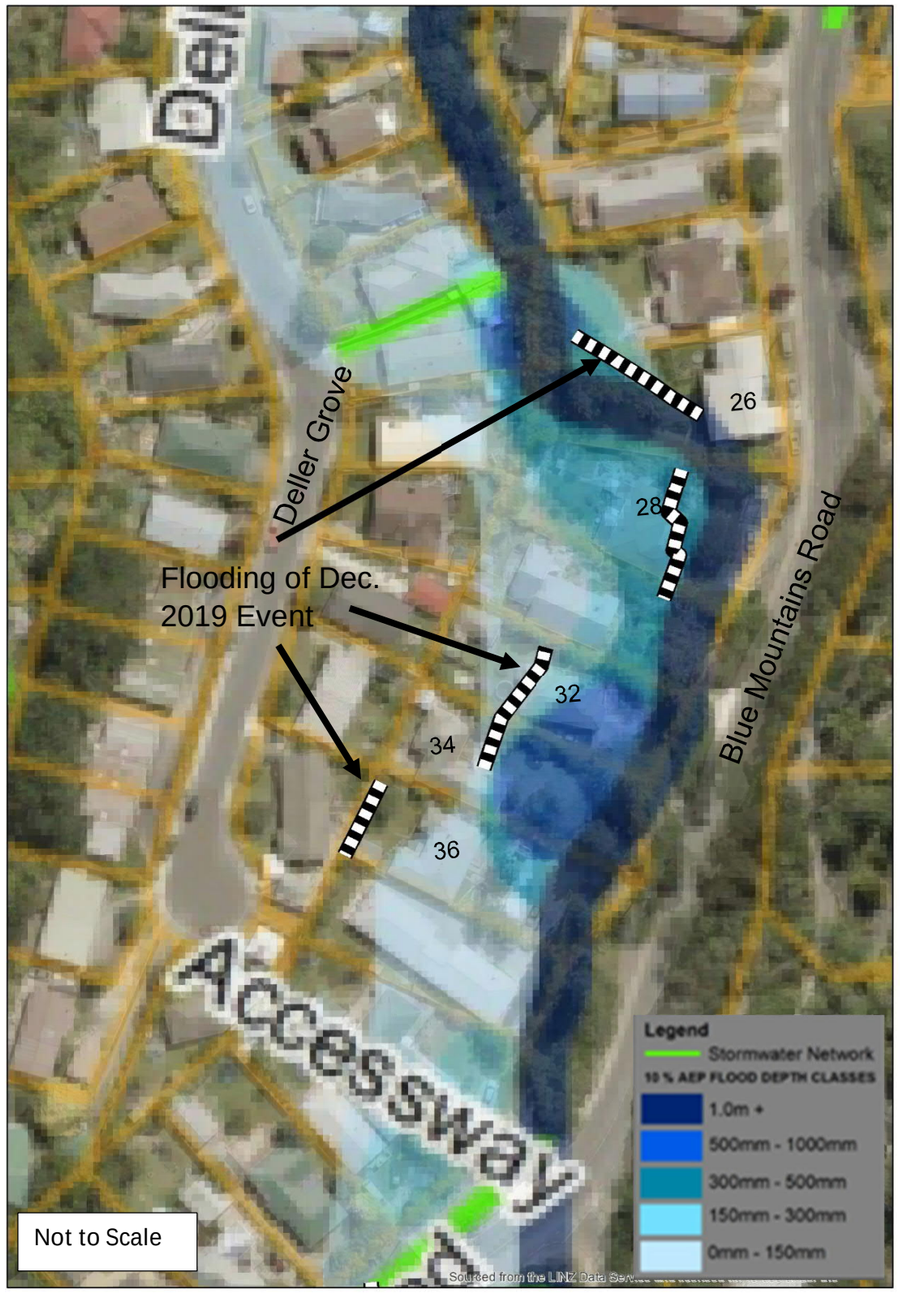
Comparison of December 2019 Event Flooding with 10% AEP Event



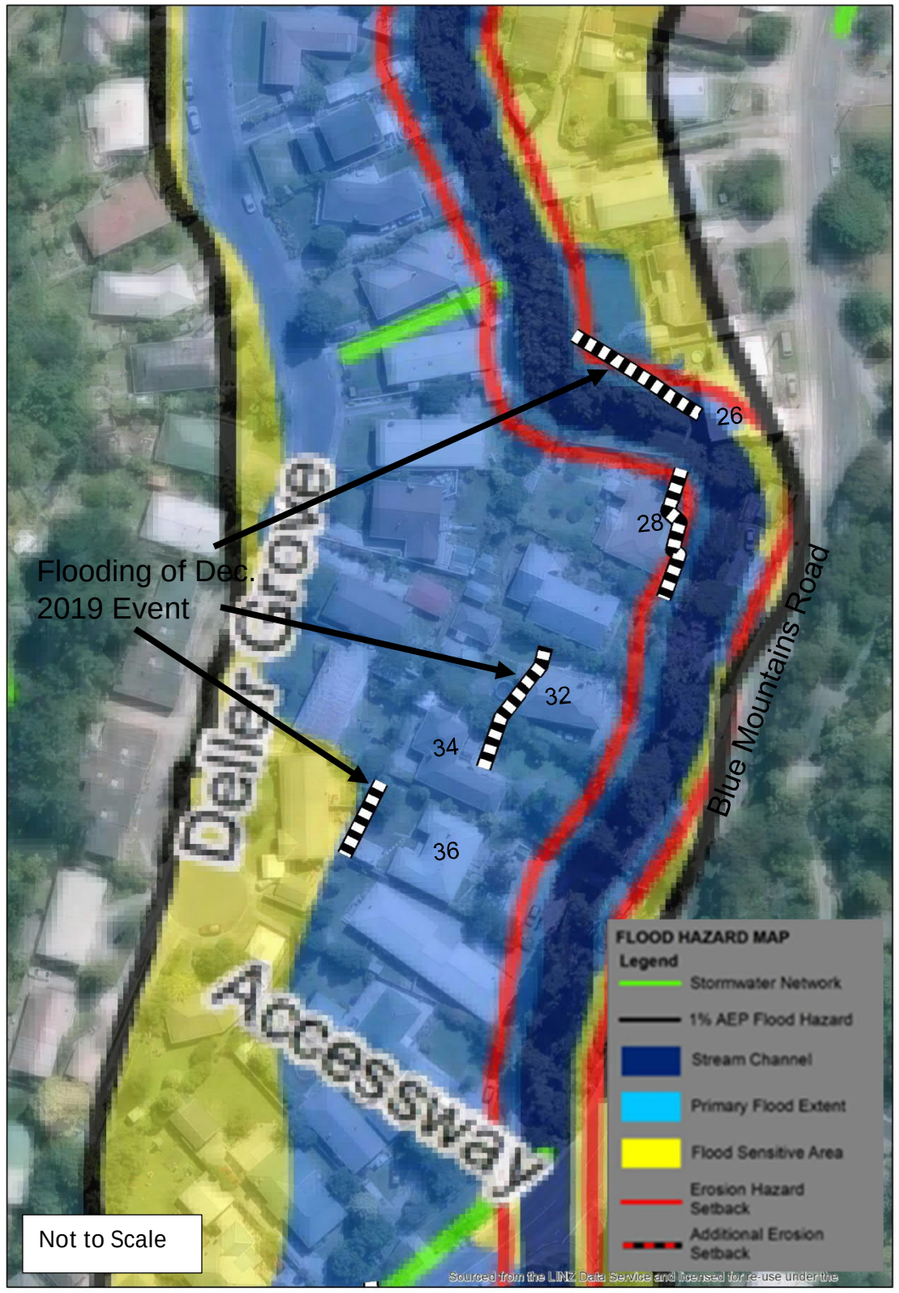
Comparison of December 2019 Event Flooding with 1% AEP Event

Flooding at 11 and 12 Birch Grove during December 2019 event:

Between 26 and 36 Blue Mountains Road:

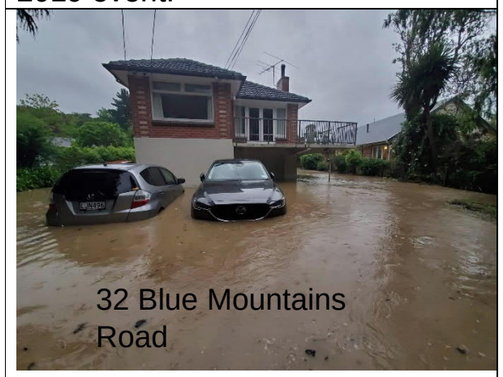


Comparison of December 2019 Event Flooding with 10% AEP Event

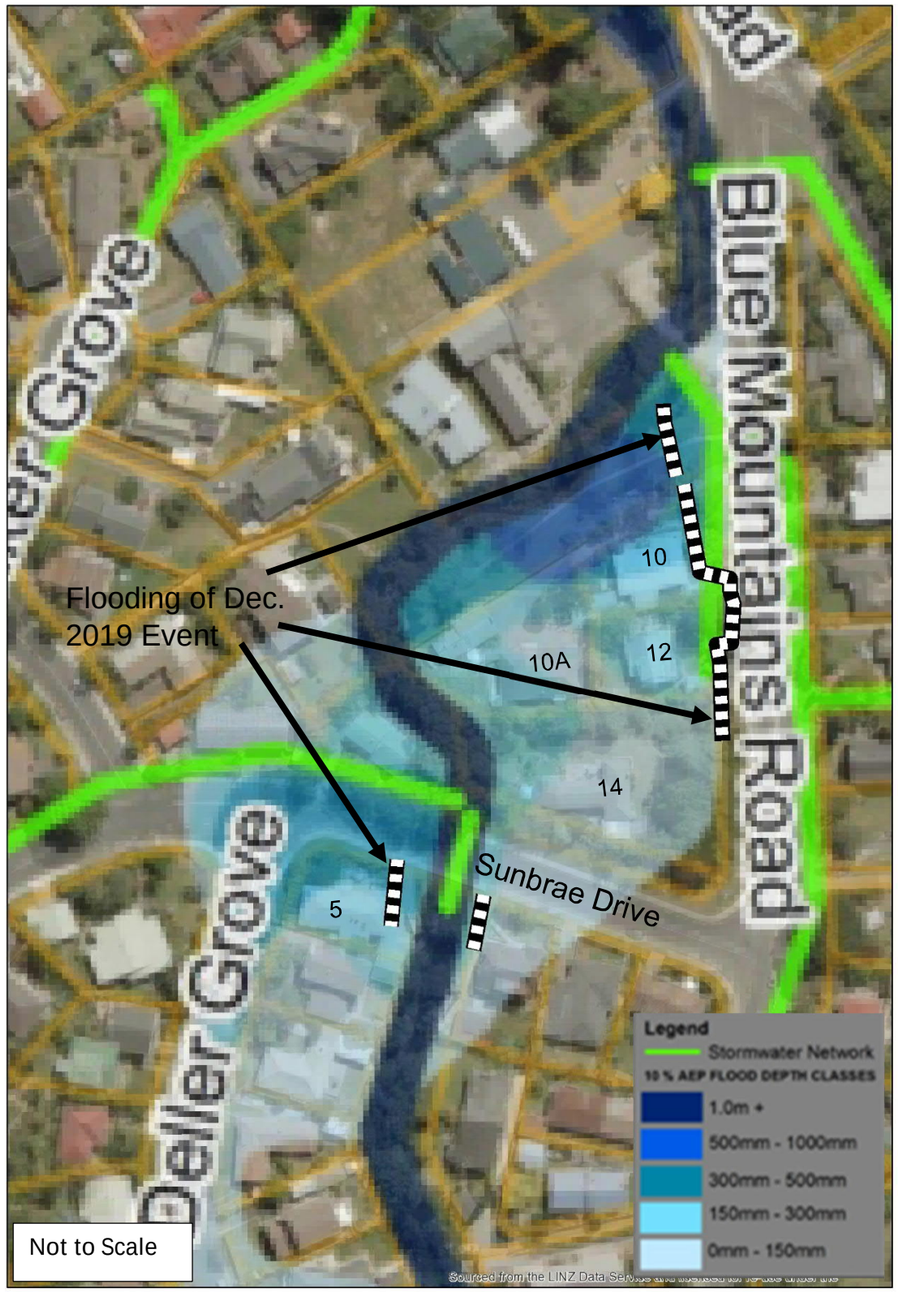


Comparison of December 2019 Event Flooding with 1% AEP Event

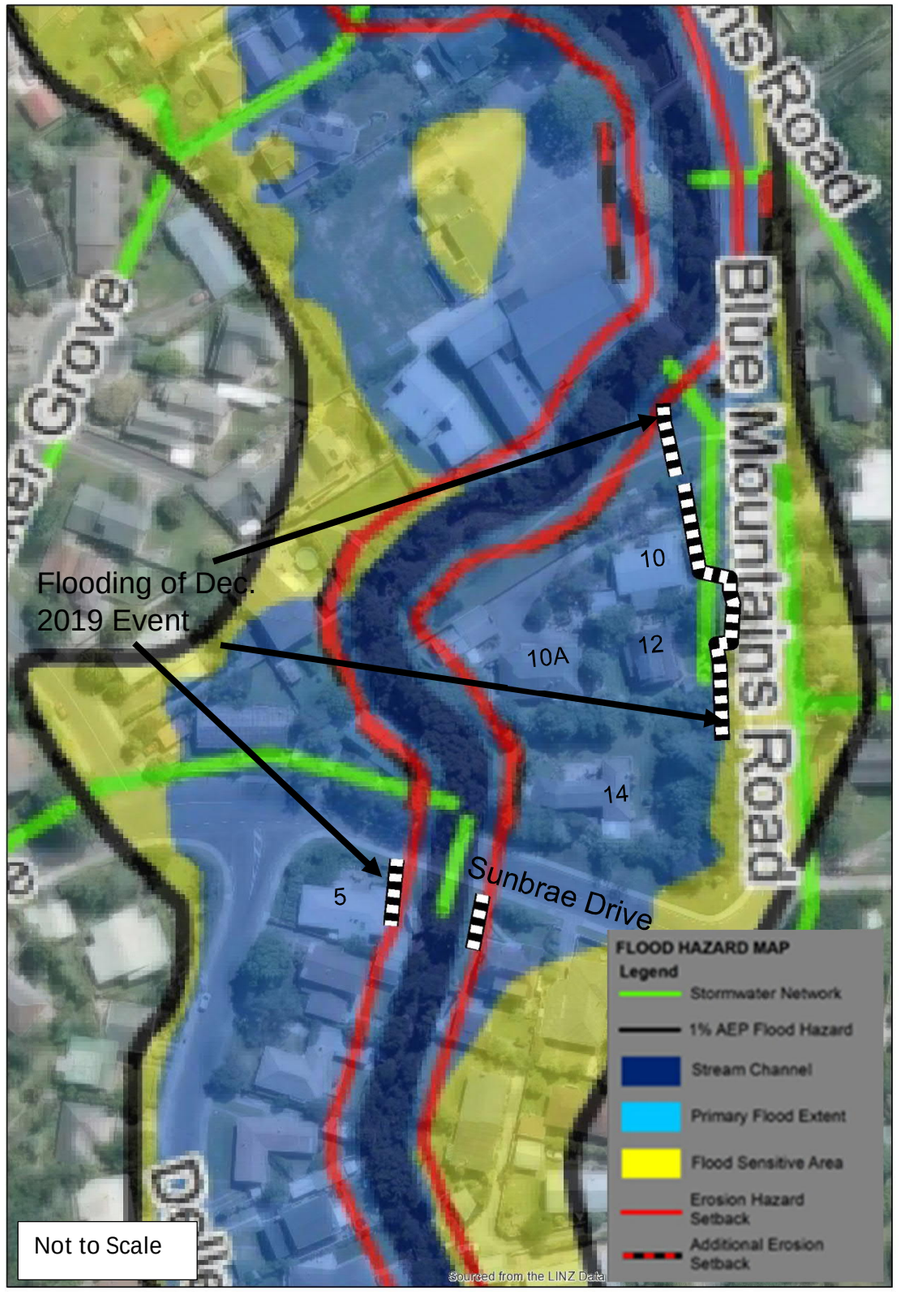
Flooding at 32, 34 and 36 Blue Mountains Road during December 2019 event:



Between Sunbrae Drive and Willow Park:



Comparison of December 2019 Event Flooding with 10% AEP Event



Comparison of December 2019 Event Flooding with 1% AEP Event

Flooding at 12 Blue Mountains Rd, 5 Sunbrae Dr and Willow Park during December 2019 event: