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Our Reference: RDG-32-138-03 / 260408092074

8 April 2026

To whom it may concern

Belfast to Pegasus (B2P) Motorway and Woodend Bypass - Flood Assessment Report – Commentary on work carried out by Aurecon

1.0 Purpose

The purpose of this letter is to provide comment regarding the Waimakariri District Council (WDC) view on the approach that has been taken by Aurecon with regards to assessing flood impacts from the proposed B2P Woodend Bypass.

2.0 Executive Summary

The Council received a draft Flood Assessment Report (dated 20 August 2026, Trim 260127013528) from Aurecon, for its consideration. To assist in preparing a considered response, the Council prepared a table of comments, with some separate assessment of the consequence of the issue raised.

The Council then went through a series of internal reviews and workshops with Aurecon to discuss the issues, and possible physical mitigation works and modelling amendments.

After each round the table of comments was revised, and each was either noted as being accepted, or requiring further consideration.

The series of tables included in Sections 3.0, 4.0 and 5.0 below follow that process in a chronological order. Note the tables include commentary written in the first person by the Network Planning Team Leader. However, they were subsequently discussed and agreed by the wider Council team and accurately reflect that wider view. For the purposes of accuracy, they have not been amended for this memo.

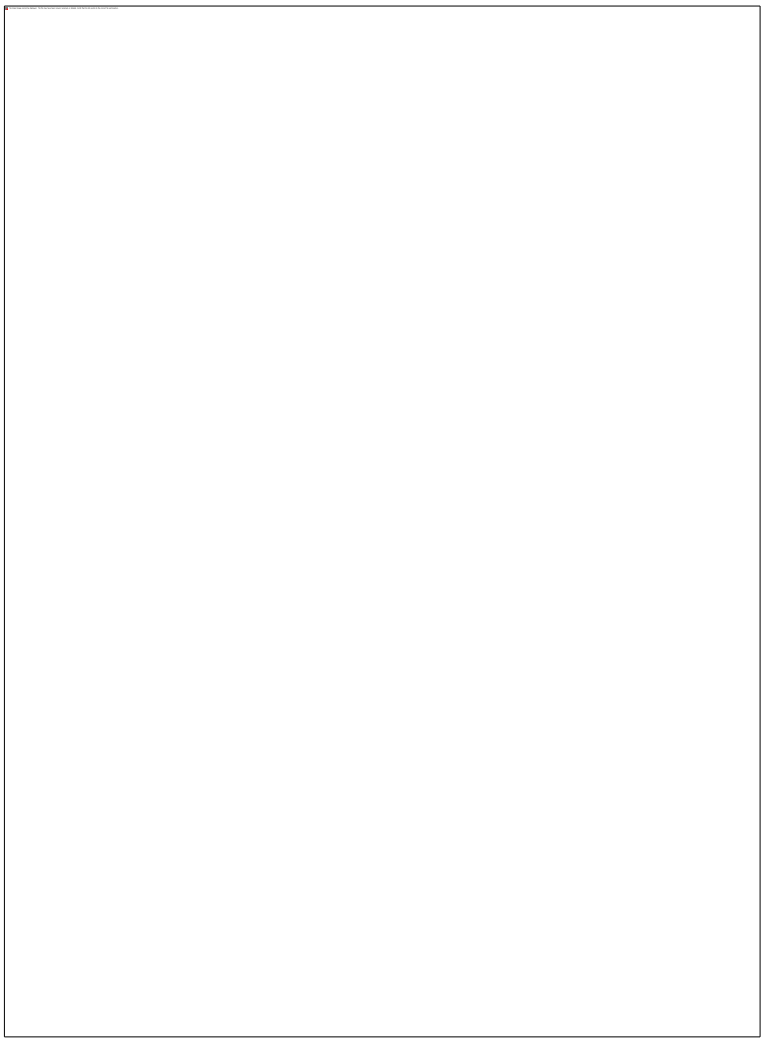
Section 6.0 concludes that the Council is satisfied with the final outcome, in terms of accurately modelling the situation, and appropriately considering the effects.

3.0 Draft Flood Assessment Report

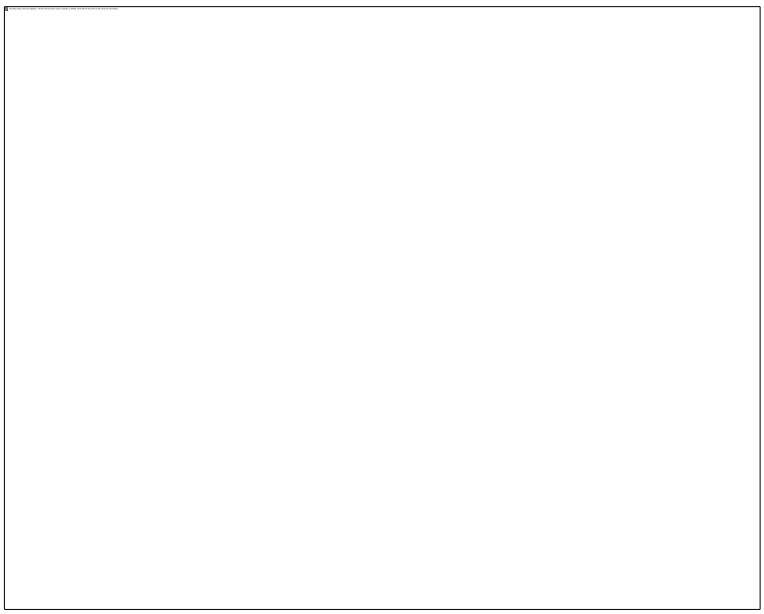
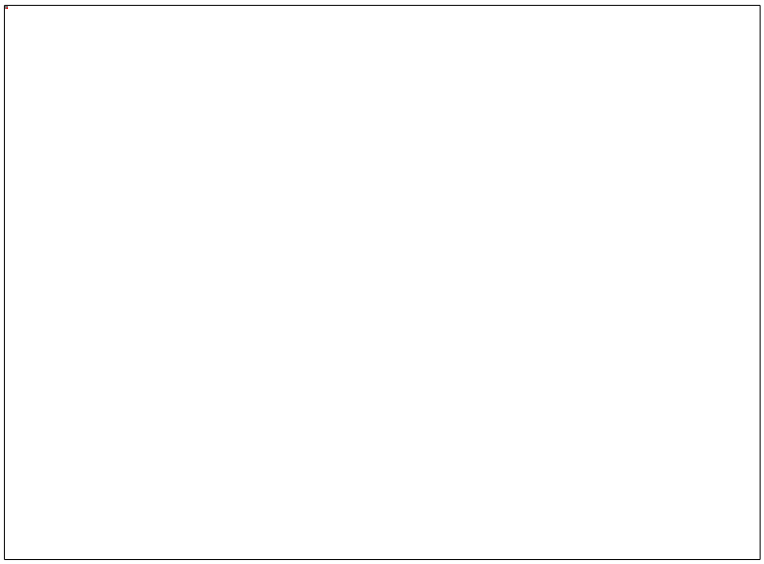
Aurecon provided a draft Flood Assessment Report to the Council on the 20th August 2025 for consideration. Council subsequently identified a number of potential issues as summarised below in Table 1. Note the Table is supplied here verbatim in terms of recording the comments made by the Network Planning team Leader, but they capture the view of the Council.

Table 1 - Draft Report Comments

Item	Comments	Consequence/Actions
Model Validation	The model validation against the WDC district model is generally ok. There are some areas where there is a discrepancy which have been noted by Aurecon in their report. I'm generally comfortable with the explanations provided noting that for the most part these are down to a different LIDAR dataset being used by Aurecon. The additional flow in the Waihora catchment appears to be due to how the culvert was modelled in the WDC model vs the Aurecon model and the explanation for this appears reasonable. The report states that the WDC model did not allow for development of Ravenswood and this is the reason for the discrepancy in flood levels here. This is incorrect as the WDC model adopted a design surface for Ravenswood whereas the 2020 LIDAR used by Aurecon features a partial development of the subdivision which was available with the 2020 LIDAR. However I'm comfortable this should not make a material difference to the model results.	Minor – No actions
Model Build	The Aurecon model was built in Tuflow and the assumptions used for the modelling appear reasonable. I do note that the Aurecon model has been based on 2020 LIDAR and has assumed a current state (2025) of development. Where development has occurred between 2020 and 2025 this may not have been captured in the model. Furthermore, modelling a current state model may not reflect the future state of developments around the Woodend area once the motorway opens in approximately 2030. On balance I think these issues are relatively minor as any new developments are designed to manage flows through their developments and so any discrepancies between the level of development in the model and real world is probably not going to make a significant difference.	Minor – No actions
Model Results	Aurecon have produced three versions of the model • Predevelopment (current state, no motorway) • No Mitigation (future state with motorway but no additional mitigation measures) • Mitigation (future state with motorway and mitigation measures to address issues identified in the 100 and 200 year simulations For this section I'm going to comment on the final 'Mitigation' model as this represents the model simulation that should address and mitigate any effects of the	

	motorway. The flood level difference for the 200 year event is shown below with the areas of concern highlighted 	
	Flood levels and flows have increased along Taranaki Creek which is evident both in increased flood levels along Mapleham Drive and the flow hydrographs provided for the Taranaki Creek east of the new motorway. I'm generally comfortable with the increased flood levels at Mapleham Drive and the nearest house (61 Mapleham Drive) appears to be clear of the increased flood depth. However, it would be good for Aurecon to confirm this as it is a little difficult to tell from the pdf maps. The increase in flooding along the Taranaki may be more concerning. It is not clear whether the increase in flow here will result in issues further downstream on the Taranaki channel down to Waikuku Beach. It would be useful to see the flow hydrograph on the Taranaki near the boundary of the model to confirm whether this increase in flow is being felt further downstream or natural attenuation in the channel is offsetting the effects. If there is still a significant increase at this point	Moderate – needs further assessment Need to confirm the property at 61 Mapleham Drive is not affected by flooding increases. Confirm the increase in flow (if any) nearer the boundary of the model to determine whether

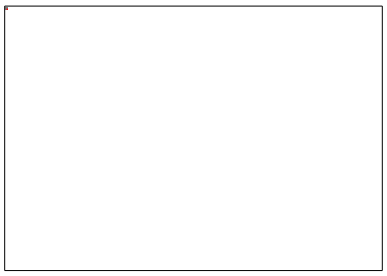
	then further work may be required to assess effects at Waikuku Beach. 	the effect is likely to be significant further downstream towards Waikuku Beach. Further work may be needed to confirm the additional flows will have no significant effects on the Taranaki Creek downstream to Waikuku Beach
	Flood levels at the Garlick Street SMA (Ravenswood) have increased. This has been explained by the need to effectively block the existing overflow weir and construct the road at grade. This raises a number of issues: 1. What impact does this have on the operation of the SMA now that the emergency overflow has been blocked? 2. Does there need to be some additional mitigation required at the SMA to replicate the performance of the overflow weir once the new road is built? 3. For the purposes of assessing offsite flood effects should this weir be left in place assuming that whatever mitigation is put in place it should mimic the effect of the existing weir?	Moderate – needs consideration. Recommendation would be to reinstate the weir in the model for purposes of assessing off-site effects and to size any downstream culverts or stormwater infrastructure with this additional flow in mind.

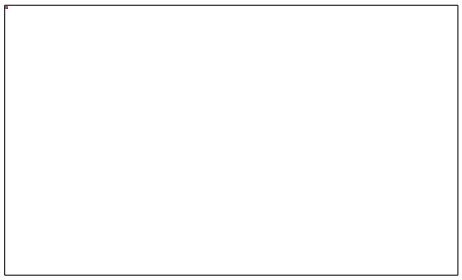
		
	Flood levels and flows have increase on the Waihora Creek downstream of the study area. The report notes the additional flow but discounts the effects as there are no houses affected by the increased flooding within the model study area. However this takes no account of properties further downstream outside of the model study area. 	Moderate – needs consideration. Need to consider the effects of the increased flows in the Waihora Creek downstream of the study area to determine whether the effects are significant or not.

4.0 Revised Modelling

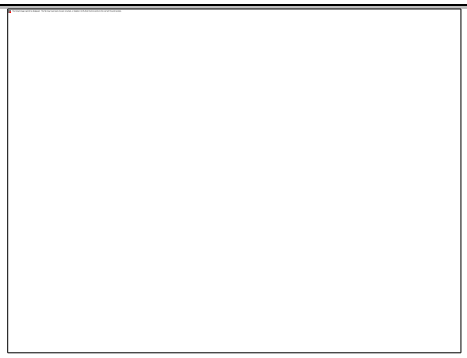
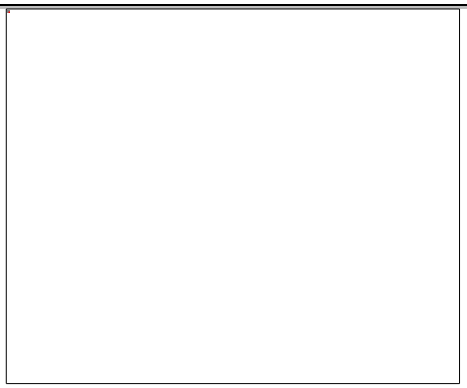
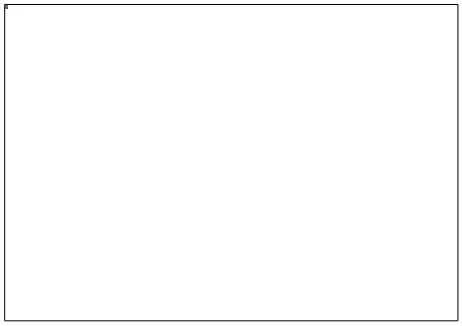
Following the Council's response to the draft Flood Assessment Report Aurecon undertook additional modelling and updated their draft report. Aurecon provided the responses as recorded in Table 2 to the issues raised by the Council (Trim 251028203671).

Table 2 - Revised Modelling and Investigation Comments

Issue	Aurecon Response	Council Response
Taranaki Creek Flooding		
1. Some small increases are shown on Taranaki Creek downstream of the project, however the impacts of the downstream impacts have not been assessed.	Some minor increases in flood levels are observed downstream of the project along Taranaki Creek. However, the overall downstream impacts are considered negligible. Figures 1 and 2 show the afflux mapping results for the 100-year and 200-year ARI events. Under the 100-year ARI event, the extent of afflux is limited to the immediate downstream of the Taranaki culvert, with a maximum rise of less than 60 mm. For the 200-year ARI event, the afflux remains contained within the defined overland flow path, with a maximum increase of less than 80 mm.  Figure 1: 100 year afflux map at downstream of Taranaki Stream  Figure 2: 200 year afflux map at downstream of Taranaki Stream	Accepted
2. Report to be updated to include commentary on effects at 61 Mapleham (floor level vs flood level)	There is an increase up to 70mm closed to 61 Mapleham Drive as shown in Figure 2, however, it is still within the existing flood plain area. The ground level immediately around the dwelling at 61 Mapleham is at 6.00mRL, with maximum water level sitting at 5.54mRL under 200-year ARI event. The available freeboard at the property is at least 460 mm (noting that the floor level will be higher than the surrounding ground level). • 100-year ARI Pre-dev flood level = 5.32m • 100-year ARI Mitigation flood level = 5.33m • 200-year ARI Pre-dev flood level = 5.47m • 200-year ARI Mitigation flood level = 5.54m	Agreed that there are no significant impacts on the existing property.
3. Report to be updated to include a	To further assess the potential downstream effects, hydrographs were extracted at two locations within the overland flow path (Lines 34 and 42, as shown in Figure 3).	The modelling is showing both an

downstream hydrograph, hopefully showing less than minor impact at downstream limits of Taranki Creek, discuss any potential impacts of increases with WDC	As illustrated in Figures 4 and 5, the differences in discharge between the pre-development and mitigation scenarios under the 100-year ARI event are only marginal, which is consistent with the afflux map as shown in Figure 1 (with no impacts shown further downstream). Under the 200-year ARI event, the peak discharge at Line 34 increases by approximately 1 m³/s due to additional flow being diverted from the north (overland flowpath within golf course) toward the Taranaki culverts. However, at Line 42, where the northern overland flow branch merges with the main Taranaki flow path at the downstream, the difference becomes less significant, at around 0.25 m³/s or 3%.  Figure 3 Hydrograph extraction at the downstream of Taranaki Stream.  Figure 4: Hydrographs extraction at Line 34  Figure 5: Hydrographs extraction at Line 42	increase in peak flow and volume downstream on the Taranaki. Noting that this ultimately discharges downstream to Waikuku Beach Needs further consideration
Garlick Street / Ravenswood SMA		
1. The current modelling includes a roadway level with an increased level (RL)	See response under Question 2 below.	N/A

relative to the existing roadway. This results in an increase in the flood levels, confined to the SMA within the pond.		
2. Aurecon has been working with WDC to determine the appropriate of the pond overflow. WDC will be advising Aurecon on the decided outcome	The previous model, submitted as part of the 50% design stage, adopted a proposed weir level of 10.40 m. Since then, the proposed road surface levels have been updated to match the existing weir level of 10.20 m. Figures 6 and 8 present the afflux maps (both 100 year and 200 year ARI) from the previously submitted model, while Figures 7 and 9 (both 100 year and 200 year ARI) show the results from the latest model incorporating the updated road surface levels. The previous submitted model generally shows higher water levels within the basin and wetland, which is mainly due to the higher weir level (10.40 m) previously proposed along Garlick Street. For the 100-year ARI event, both the previous submitted and latest models indicate a slight decrease in flood levels downstream. Under the 200-year ARI event, both models show a minor increase in downstream flood levels, with the previous submitted model showing slightly higher afflux overall. In the latest model, the downstream afflux is lower even though the basin stores less water. This occurs because the Taranaki culvert invert level has been lowered, allowing runoff to discharge downstream earlier. As a result, the latest model shows a slightly higher local afflux immediately downstream of the culvert compared with the earlier model. However, if the previous submitted model had used the same lower culvert invert, it would likely have shown a lower downstream afflux because more water would be retained in the basin. It may be worth considering whether the existing basin volume could be more effectively utilised by raising the proposed Garlick Street weir level to 10.40 m to provide additional upstream storage.	Accepted

	 Figure 6: 100 year afflux map at Ravenswood basin (previous submitted model result)  Figure 7: 100 year afflux map at Ravenswood basin (latest model result)  Figure 8: 200 year afflux map at Ravenswood basin (previous submitted model result)  Figure 9: 200 year afflux map at Ravenswood basin (latest model result)	
3. Updated report to include RL on the pond level vs surrounding roadways and houses to assess freeboard, etc	Figures 6 and 8 present the afflux maps (both 100 year and 200 year ARI) from the previously submitted model, while Figures 7 and 9 (both 100 year and 200 year ARI) show the results from the latest model incorporating the updated road surface levels. Results labelled (pre) refers to outputs from the previously submitted model, while (latest) are taken from the most recent model. In the latest model, the building near the Ravenswood basin shows an improvement, with freeboard increasing to 0.70 m under the 100-year ARI event and 0.610 m under the 200-year ARI event. The Harvey Norman building maintains a minimum freeboard of 2.106 m under the 100-year ARI event and 1.704 m under the 200-year ARI event, both well above the required minimum. In the previous model, the building adjacent to the existing Ravenswood basin showed a reduction in freeboard. However, it still maintained a minimum of 0.50 m under the 100-year ARI event and 0.439 m under the 200-year ARI event.	Accepted

<table>
<tr><td></td><td>To make better use of the available basin storage while maintaining the minimum freeboard to nearby buildings, the weir level could potentially be increased.</td><td></td></tr>
<tr><td>4. WDC has requested some information around the weir levels (consented, existing, modelled) - to be emailed to Don / WDC</td><td>
<table>
<tr><th>Scenario</th><th>Weir Level</th><th>Weir Length</th><th>Modelled Flood depth (100 year ARI)</th><th>Modelled Flood depth (200 year ARI)</th></tr>
<tr><td>Approved design level</td><td>10.45 m</td><td>9.75 m</td><td></td><td></td></tr>
<tr><td>Constructed weir Level</td><td>10.19 m</td><td>8.0 m</td><td>0.076</td><td>0.193</td></tr>
<tr><td>Proposed weir level (latest model)</td><td>10.20 m</td><td>10.0 m</td><td>0.030</td><td>0.102</td></tr>
<tr><td>Proposed weir level (previous model)</td><td>10.40 m</td><td>10.0 m</td><td>0.054</td><td>0.104</td></tr>
</table>
Note that for all modelled scenarios, the piped outlet structure from the SMA is assumed to be blocked.
</td><td>Accepted</td></tr>
<tr><td colspan="3">Waihora Creek</td></tr>
<tr><td>1. The modelling indicates some increases are shown on Waihora Creek downstream of the project, however the impacts of the downstream increases have not been assessed.</td><td>Model results indicate minor increases in flood levels along Waihora Creek downstream of the project area. Figures 12 and 13 illustrate the afflux maps at the downstream of Woodend Beach Road. Under the 100-year ARI event, a maximum flood level increase of approximately 130 mm is observed downstream of Woodend Beach Road, primarily due to the upsizing of the Gladstone and Woodend Beach Road culverts. However, these increases remain well contained within the existing overland flowpath. For the 200-year ARI event, only a slight rise in flood level is observed (up to 61 mm) immediately downstream of Woodend Beach Road, with no noticeable afflux further downstream.</td><td>Accepted</td></tr>
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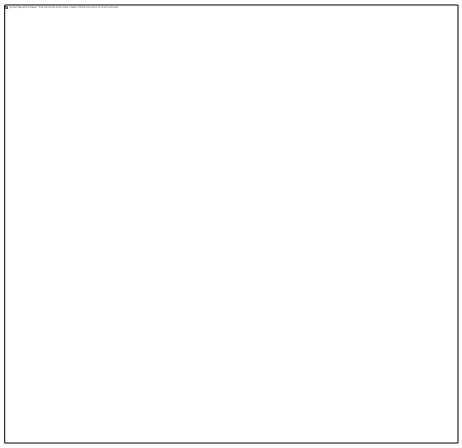
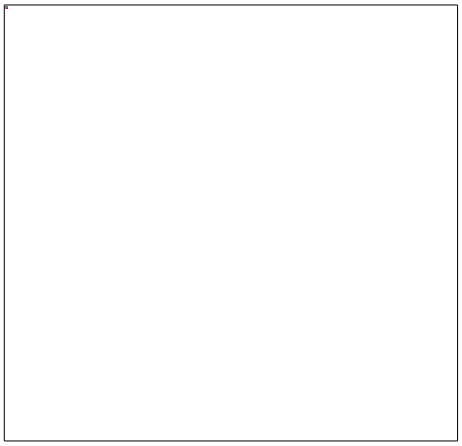
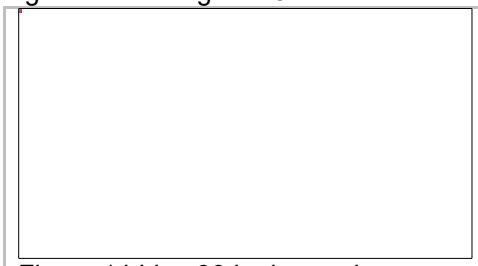
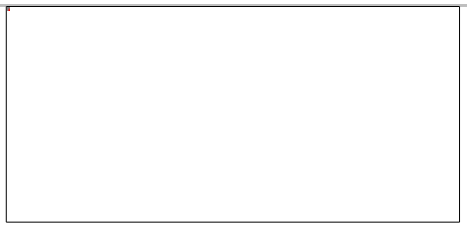
	 Figure 12: 100 year afflux map at downstream of Woodend Beach Road  Figure 13: 200 year afflux map at downstream of Woodend Beach Road	
2. Updated terrain modelling will include actual landform design, which will allow for more in channel flood storage and overflow to adjacent storage areas, reclaiming existing flood storage	Terrain has been updated in the latest model run to better represent the landform design.	Accepted
3. Don suggests holding off on final assessment of Waihora until final modelling of the proposed landform has been completed	No response required.	N/A
4. WDC supports	No response required.	N/A

<table>
<tr><td>maintaining existing natural channel storage to the greatest extent possible</td><td></td><td></td></tr>
<tr><td>5. WDC notes there has been some complaints from the Stalkers Road subdivision area around flooding behind the houses</td><td>See response under Question 6 below</td><td>N/A</td></tr>
<tr><td>6. If there is still an increase in flood depths / volumes within Waihora Creek, Aurecon will generate a hydrograph at D/S boundary and conduct an assessment on the downstream areas, especially the Stalkers Road area.</td><td>To better understand the downstream impacts, a hydrograph was extracted at Line 38 (downstream of Woodend Beach Road). As shown in Figure 15, peak flow under the 100-year ARI event increased by approximately 1 m³/s, while the 200-year ARI event shows negligible change, which aligns with the afflux mapping results in Figure 12 and Figure 13.
 
Figure 14 Line 39 hydrograph extraction
 
Figure 15: Hydrograph at the downstream of Waihora Stream (Line 38)

Further assessment was undertaken to estimate the potential change in flood level downstream of the model extent using a volumetric approach. Based on the hydrograph analysis, the increase in flow volume was estimated at
• 21,200 m³ for the 100-year ARI event
• 31,180 m³ for the 200-year ARI event.
Assuming a conservative “bathtub” storage extent as shown in Figure 16, with an existing ponding area of 1,062,837 m² at RL 1.165 m, the increment in water level was calculated to be approximately 0.029 m under 200 year event, resulting in a post-development water level of RL 1.194 m. Under 100 year event, the increment in</td><td>Using a bathtub analysis Aurecon have estimated that the 200 year flood level will increase in the order of 29mm down at Woodend Beach based on increased flows along the Waihora. Whilst 29mm is not a major increase in flood level and the bathtub analysis used is conservative it does however exceed our usual limit of 20mm where we would normally consider the effects to be less than minor. Of concern is the fact that under the 200 year event it</td></tr>
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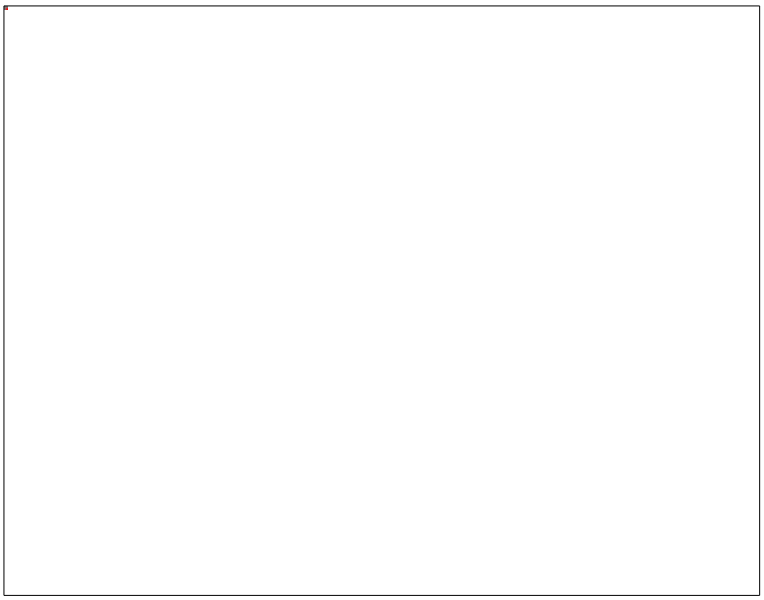
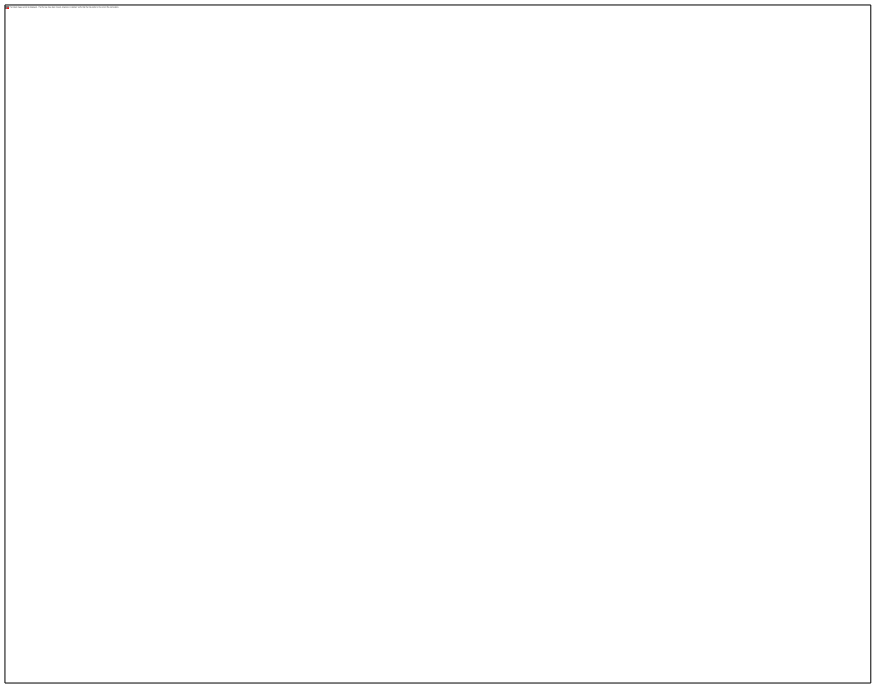
	water level was calculated to be approximately 0.020 m, resulting in post-development water level of 1.185 m  Figure 16: Bathtub extent at RL 1.165m closed to Stalker Road (Line 38) As shown in Figure 17, the resulting flood extent from this volumetric assessment shows negligible differences compared to the pre-development condition. These changes are minor and do not affect any additional properties. The assessment is considered conservative, as it assumes no outflow from the ponding area while, in reality, with flow movement, the actual increase in flood level and extent would likely be lower.  Figure 17: Flood Extents results from the Volumetric Assessment (Brown– Pre-development Scenario; Green – Mitigation Scenario)	appears some dwellings in Woodend Beach may be affected

5.0 Final Outstanding Issues

Following receipt of the comments provided in Table 3 above, Council identified two outstanding issues namely:

1. The modelling is showing both an increase in peak flow and volume downstream on the Taranaki Stream. Noting that this ultimately discharges downstream to Waikuku Beach.

2. Using a bathtub analysis Aurecon have estimated that the 200-year flood level will increase in the order of 29mm down at Woodend Beach based on increased flows along the Waihora. 29mm is not a major increase in flood level and the bathtub analysis used is conservative it does however exceed our usual limit of 20mm where we would normally consider the effects to be less than minor. Of concern is the fact that under the 200-year event it appears some dwellings in Woodend Beach may be affected (see diagram below).



Following further meetings with Aurecon on the 24th October and the 7th November Council was satisfied that the two outstanding issues did not present a significant issue, for the following reasons:

- *The increased peak flow and volume shown in the model results on the Taranaki Stream are due to changes being made to the upstream flow paths across SH1 and the total volume of water passing across the SH1 corridor is effectively the same as existing and therefore doesn't present a significant issue to downstream flood levels in Waikuku Beach.*

- *The flood events shown using the bathtub analysis in Woodend Beach misrepresented the actual effects as the bathtub analysis did not delineate the floodplain directly affected by increased volumes in the Waihora Creek catchment and instead presented the showed the increase in flood depth across all of Woodend Beach.*

6.0 Conclusion

Following further work undertaken by Aurecon and submitted to the Council on 20th October 2025 we are now satisfied that the modelling approach is appropriate to assess any flooding effects from the proposed works.

Yours sincerely

Don Young

Senior Engineering Advisor