Before a Board of Inquiry
MacKays to Peka Peka Expressway Proposal

under: the Resource Management Act 1991

in the matter of: Notice of requirement for designation and resource consent applications by the NZ Transport Agency for the MacKays to Peka Peka Expressway Proposal

applicant: **NZ Transport Agency**
Requiring Authority

Statement of rebuttal evidence of **Graham Levy** (Hydrology) for the NZ Transport Agency

Dated: 25 October 2012

REFERENCE: John Hassan (john.hassan@chapmantripp.com)
Suzanne Janissen (suzanne.janissen@chapmantripp.com)

Chapman Tripp
T: +64 4 499 5999
F: +64 4 472 7111

10 Customhouse Quay
PO Box 993, Wellington 6140
New Zealand

www.chapmantripp.com
Auckland, Wellington,
Christchurch

TABLE OF CONTENTS

STATEMENT OF REBUTTAL EVIDENCE OF GRAHAM LEVY FOR THE NZ TRANSPORT AGENCY

1 My full name is **Graham John Levy**.

2 I have the qualifications and experience set out at paragraphs 2 to 9 of my statement of evidence in chief, dated 30 August 2012 (*EIC*).

3 I repeat the confirmation given in my EIC that I have read, and agree to comply with, the Code of Conduct for Expert Witnesses (Consolidated Practice Note 2011).

4 In this statement of rebuttal evidence, I respond to the evidence of:

4.1 **Sharyn Westlake** and **Richard Percy** on behalf of Greater Wellington Regional Council (*GWRC*) (submitter number 684);

4.2 **Robert van Bentum** and **Emily Thomson** on behalf of Kāpiti Coast District Council (*KCDC*) (submitter number 682);

4.3 **Pranil Wadan** and **Vinod Chand** on behalf of St Heliers Capital Limited (submitter number 644);

4.4 **Sue Smith** on behalf of Waikanae on One (*WOO*) (submitter 514);

4.5 **Dr Mary McIntyre** on behalf of Action to Protect and Sustain our Communities (*APSOC*) (submitter number 677);

4.6 **Melanie Dixon** on behalf of Raumati South Residents Association *(RSRA*) (submitter number 707); and

4.7 **Professor Martin Manning** (submitter number 687).

5 The fact that this rebuttal statement does not respond to every matter raised in the evidence of submitter witnesses within my area of expertise should not be taken as acceptance of the matters raised. Rather, I rely on my earlier technical report,[1] my EIC and this rebuttal statement to set out my opinion on what I consider to be the key hydrological, hydraulic and stormwater management matters for this hearing.

6 Consistent with my EIC, I have referred to the MacKays to Peka Peka Expressway Project as "the Project" in this rebuttal evidence.

EXECUTIVE SUMMARY

7 I have read those statements of evidence provided by submitters that I have been able to identify as relating to my area of expertise.

[1] Technical Report 22 (Assessment of Hydrology and Stormwater Effects).

The submitters' evidence has not caused me to depart from the opinions expressed in my EIC.

8 I remain of the opinion that the stormwater and water crossing design proposed for the Project has been adequately prepared to address the potential effects of these activities such that residual effects will be localised and minor.

EVIDENCE OF SUBMITTERS

Sharyn Westlake for GWRC

9 Over the period of the Project development, I have had extensive discussions with Ms Westlake and others in the GWRC Flood Protection team, and we have sought to reach agreement on as many matters as possible. This process involved several informal and formal meetings, a joint site visit, exchange of letters, an agreement regarding use by the Project of the GWRC flood model for the Waikanae River, and arranging a peer review of the Waikanae River waterway design by a reviewer agreed with GWRC.[2]

10 I sought to clarify outstanding issues with GWRC, assisted by their post-submission publication of a Discussion Document, as described in paragraphs 141 to 142 of my EIC. The Flood Protection elements of that Discussion Document and my responses are set out in the summary table in Annexure B to my EIC. I met again with GWRC Flood Protection on 29 August 2012 to present these responses to them (along with a further response to subsequent correspondence) and to discuss the issues and how to address them. A number of matters were resolved, and it was left for Ms Westlake to address any remaining matters in her evidence.

11 My assessment of Ms Westlake's evidence is that there appears to be a substantial level of agreement between the NZTA and GWRC on technical principles, but there remain issues for GWRC about some matters of detail, and some elements where they would like to see more information or have a review and certification role.

12 In particular, Ms Westlake is seeking greater certainty of outcome, and an explicit GWRC review and certification role in future stages, through the inclusion of a number of additional conditions of consent. There also remain some specific technical matters. I respond to these below.

Review and certification issues

13 In the sections of Ms Westlake's evidence addressing the Waikanae River Bridge (paragraphs 26 to 29), and Hydraulic modelling (paragraphs 35 to 38), Ms Westlake seeks conditions requiring the provision of further information and a review and certification role for GWRC. In response, I will first discuss some issues with GWRC review and certification, and then address the specific details of

[2] Appendix 22.H of Technical Report 22.

each matter raised by Ms Westlake (including the requests for further information).

14 In terms of possible additional conditions relating to GWRC review and certification, the scope of that review would need to be clearly delineated, with explicit performance criteria that the review is conducted against. From what is stated in her evidence,[3] the specific outcomes Ms Westlake seeks to achieve are ones that in most cases I would agree with, and are consistent with the Project objectives and performance targets. I address the details below.

15 In my opinion, the complicating factor in any GWRC review and certification role is that the Flood Protection department of GWRC has a dual role, both as an advisor to the regulatory arm of GWRC, and also as the manager of flood assets. As a result, it has a direct financial interest in the outcome of some of the aspects which Ms Westlake proposes for review and certification. This raises the potential for a conflict of interest, unless there are clear limits placed on any review.

16 An alternative approach, which has been adopted on at least two recent NZTA projects that I am aware of,[4] is for NZTA to obtain an independent peer review of the stormwater and flood risk management design. Such review would be against both NZTA's required performance criteria and any final conditions of consent, leading to the issue of PS1 (designer) and PS2 (design reviewer) producer statements. Such an approach is common practice in the engineering industry, and would avoid any potential for conflict of interest.

17 To support such an approach, and meet the points of detail identified by Ms Westlake and discussed below, a list of appropriate performance criteria could be added to the conditions of consent. Such a list would primarily consist of items drawn from Annexure B of my EIC, as referenced by Ms Westlake in her evidence. In **Annexure A** attached to this evidence I have proposed the content for such a condition, as SW.3.[5]

18 I propose the following condition SW.2(e) be added to address the matter of independent peer review:

> (e) The stormwater management design and flood risk modelling shall be independently peer reviewed for compliance with the conditions of consent.[6]

---

[3] Paragraphs 25, 28, 35 and 38.

[4] Tauranga Eastern Link and Christchurch Southern Motorway (Stage 1)

[5] For ease of reference, I have shown in **Annexure A** the wording of proposed conditions SW.1 and SW.2, updated from that attached to my EIC. I have also added proposed condition SW.3.

[6] This is now shown in **Annexure A** to this evidence.

19 In paragraph 28 of her evidence, Ms Westlake comments on the importance of bridge configuration for flood protection, including number and shape of bridge piers, span between piers, and bridge height for the proposed Waikanae River Bridge. Ms Westlake wants a condition that these not be changed without GWRC review and certification. I have addressed each of these Waikanae River bridge configuration matters in the proposed consent condition SW.3(a), (b), (c) and (e) in **Annexure A** attached to this evidence. I therefore do not consider Ms Westlake's proposed additional Condition SW.2(f) is necessary.

20 In paragraph 29 of her evidence, Ms Westlake seeks to have a condition specifying provision for future services in the bridge. In Annexure B to my EIC I identified a list of future services that have been provided for in the bridge design. I have included the list of proposed service ducts from my EIC in proposed condition SW.3(d) in **Annexure A** to this evidence. With that provision in place, I do not consider that Ms Westlake's proposed additional condition DC.53(i) is necessary. I note also that conditions need certainty and an open ended requirement to provide for undefined future services (as suggested by Ms Westlake) does not achieve that.

21 In paragraph 35 of her evidence, Ms Westlake addresses my culvert blockage risk assessment. In paragraph 42.5 of my EIC I mentioned that I have carried out a blockage risk assessment, and more detail was provided in item 19 of Annexure B of my EIC.

22 I now have summarised that culvert blockage risk assessment, and included it as **Annexure B** to this evidence.

23 As outlined earlier in my evidence, I have proposed additional condition SW.2(e) relating to an independent peer review, and have included a provision for culvert blockage risk assessment in proposed condition SW.3(f) in **Annexure A** to this evidence. This proposed condition identifies the principal criteria used for the blockage risk assessment that I undertook, which I propose would be the criteria for such an assessment at final design. These criteria are that:

23.1 There shall be a safe secondary flow path that does not endanger habitable buildings; or

23.2 There shall be provision at the culvert inlet for debris management such that culvert inlet blockage is avoided.

24 With these provisions in place I consider that this matter will be adequately addressed, and that Ms Westlake's proposed condition SW.2(g) is not necessary.

25 In paragraph 36 of her evidence, Ms Westlake states that she has not been able to review the hydraulic impacts, because there were no flood depth difference plots included in Technical Report 22.

Flood depth difference plots were used in our internal assessment. They were not included in Technical Report 22 because the raw data can be misleading without considerable annotation and interpretation to enable them to be properly understood. In their raw state such plots show adverse effects wherever project works are built to provide mitigation, which is not representative of anticipated effects. The design target was that there should be no flood level increase outside the designation. Thus, the plots from modelling of the final design will show significant areas of coloured flood differences, including within the designation and outside (where there will be some flood level reductions), but none will be related to adverse effects outside the designation, except minor localised effects as identified in proposed condition SW.2(c).

26 It is not necessary to fully re-model every localised area where there were residual flood risk effects evident from the modelling. Instead, in each case I have identified the need for additional storage or alternative mitigation, and included such storage or mitigation in the AEE. Thus, while the modelling does not provide the complete picture of mitigation, for every site where the modelling identified a need for further mitigation appropriate mitigation has been provided in the design submitted in the AEE.

27 As a consequence of the absence of plots for flood level differences, Ms Westlake seeks an additional condition SW.2(e) for GWRC to review and certify the hydraulic performance. I consider that the alternative independent peer review condition SW.2(e) that I propose is more appropriate, in combination with other elements of SW.1 and SW.2 that specify hydraulic neutrality and flood performance criteria.[7]

28 In paragraph 37 of her evidence, Ms Westlake expresses concern that the maps we provided to her on 28 September 2012 to illustrate the flood risk performance in the Te Moana Road and Waimeha Stream area show increased flood risk in Puriri Road. These maps were provided to GWRC to allow them to review the effects in the Te Moana floodway area. The covering email specifically alerted Ms Westlake to the fact that they had been prepared prior to resolving the issues at Puriri Road, and were therefore not up to date in that particular area. That part of the Puriri Road area is not directly connected hydraulically to the Te Moana area, but happens to be in the same flood model. Subsequent to the preparation of that map, further work has been undertaken to confirm that the footprint provided for stormwater management in the vicinity of Puriri Road (around Wetland 9) was sufficient to avoid any increase in flood risk to the Puriri Road area, and the required mitigation measures arising from that work are as described in the AEE[8]. I am therefore satisfied that the performance

[7] SW.1(b), SW.2(a), (b), (c) and (d).

[8] Technical Report 22, pages 89-90

requirements proposed in conditions SW.1 and SW.2 can be met in this area by the works described in the AEE, and that the proposed conditions relating to modelling and peer review provide a robust mechanism for confirming that the final design also achieves hydraulic neutrality. I therefore consider that Ms Westlake's concern about the depiction of flood risk in the plan sent to her earlier has been addressed, and that her proposed condition SW.2(e) is not required.

29 In paragraph 38 of her evidence, Ms Westlake seeks to have the hydraulic modelling peer reviewed. I consider that for the final design this is appropriate. I have therefore proposed an alternative condition SW.2(e) earlier in my evidence to provide for that independent peer review. With such a provision in place I do not consider that Ms Westlake's proposed amendment to condition SW.2(d) is necessary.

Maintenance issues

30 Matters related to Waikanae River bridge maintenance raised in paragraphs 30 and 33 of Ms Westlake's evidence are, in my opinion, details that are more appropriately resolved directly between NZTA and GWRC, rather than needing to be the subject of consent conditions. I addressed this issue of maintenance responsibilities in Item 7 of Annexure B of my EIC, and referenced there the minutes of a meeting between the Project team and GWRC on 3 November 2011, which included a plan delineating the proposed extent of NZTA long term maintenance responsibilities. A copy of that plan is now attached to my evidence as **Annexure C.**

31 In response to Ms Westlake's suggested additional conditions, most of these relate to landscape planting, and are addressed in the rebuttal evidence of **Mr Evans**. Ms Westlake also proposes an additional clause in proposed condition DC.54(d)(vii) relating to responsibility for post-flood debris clearance, vandalism and graffiti and berm drainage through a management plan. As I mention above, I do not consider that this is a matter for resource consent but rather for direct agreement between the NZTA and GWRC as occurs with other parts of the State highway network.

32 In summary:

32.1 I acknowledge that while there are many matters of technical detail that could be included in consent conditions, in my opinion many of these are not essential. I have nevertheless proposed some specific performance criteria for inclusion in proposed condition SW.3, to provide guidance for proposed independent peer review of the detailed design; and

32.2 I disagree with any provisions for GWRC review and certification of final design, and instead recommend an independent peer review process.

Robert van Bentum for KCDC

33 Mr van Bentum raises a number of points that I will address. Some of these relate to approval and review processes (particularly paragraphs 3.3 and 5.12 of his evidence), matters which I have already addressed in my response to Ms Westlake's evidence.

34 In paragraph 5.2 of his evidence, Mr van Bentum expresses concern that one of the flood mitigation options proposed is "removal of downstream constraints." As a result, he seeks the deletion of proposed condition SW.2(a)(iii). I disagree. By way of clarification, there are no specific proposals to use this option, and no consents have been sought for such downstream works. However, as KCDC is a member of the Project Alliance, and as it has related flood issues to address in some watercourses affected by the Project, the potential exists that joint works may be identified in the future that address the flood management needs both of KCDC and of the Project.

35 Any such works would themselves be subject to resource consent, so that any combined effects would be properly addressed at that time. The downstream works would not relieve the Project of the need to mitigate effects, but could provide an appropriate mitigation alternative. In my opinion, it is therefore appropriate that such a possibility be reflected in this consent, so that the Project is able to participate in such joint works without breaching its own consent conditions.

36 While I am confident that the Project can successfully mitigate loss of flood plain storage due to the fill embankment, without the need to seek further consents or rely on downstream capacity improvements, in my opinion it makes sense to include the possibility of a more efficient alternative in conjunction with Council's other stormwater works. I therefore support retention of proposed condition SW.2(a)(iii).

37 In paragraphs 5.3-5.4 of his evidence, Mr van Bentum states that the proposed conditions do not set out performance criteria in respect of watercourse scour and erosion. He seeks a new condition requiring attenuation of flows in swales and wetlands and riprap protected culverts and outlets at bridges. As a result, Ms Thomson's evidence seeks additional wording to be included in SW.2 (a new subparagraph (b)).[9] I do not consider such a condition to be necessary for the reasons set out below. In addition, I consider the proposed wording would be too vague for a designer to implement or to be able to confirm performance against.

38 The design of the Project specifically seeks to minimise discharge to individual waterways by discharging at every waterway

[9] Refer Thomson evidence, paragraph 10.26.

encountered[10], thereby spreading the load. The use of flat-grade swales and wetlands means that in small storm events (where increased frequency and magnitude of discharge has the potential to increase downstream erosion) discharges are significantly attenuated and downstream erosion issues are addressed. In my opinion, there is no further hydrological mitigation needed (e.g. greater attenuation through the use of extended detention).

39 In regard to protection of the waterways from erosion in the vicinity of stormwater outlets and other structures, the proposed design includes erosion protection for all bridges, culvert inlets and outlets, and stormwater discharge outlets.[11] I note that it is not explicitly identified as a design requirement in the proposed consent conditions, except that proposed condition G.1 requires design in accordance with the plans, and proposed conditions WS.4(b) and WS.10(b) require remedy if there is any erosion.

40 In paragraphs 5.5-5.6, Mr van Bentum seeks clarification as to which new open channels, drains and streams are to be "naturalised". In response, I note that all works associated with diversions and in-stream temporary structures, including localised diversions to align with culvert inlets and outlets, will involve restoring the stream bed to resemble natural streams, as sought by Mr van Bentum. I consider this outcome is already required by proposed consent conditions WS.1, WS.3, WS.8 and WS.10. Therefore I do not consider that the conditions proposed by Mr van Bentum, and detailed at paragraph 10.28 of Ms Thomson's evidence, are necessary.

41 I consider that given the all-inclusive nature of the proposed conditions of consent, and the specific description of design details provided in paragraph 65 of my EIC for the more substantial diversions, there is no need for further listing of watercourses in the conditions of consent as sought by Mr van Bentum. Nor do I consider that the additional condition sought by Ms Thomson (at paragraph 10.28) is necessary.[12]

42 At paragraphs 5.7 to 5.8 of his evidence, Mr van Bentum recommends a condition that all offset storage, ecological offset and wetland treatment (excluding offset storage 6A) be included within the final operational designation. I am not in a position to comment on the ecological offset. However, as noted in my EIC,[13] I agree

---

[10] There are a very few exceptions for site-specific reasons, such as at Landfill Drain.

[11] Refer Drawings CV-SW-203, 212, 232, 303, 304, 391, 392 and 393, Volume 5 of the AEE.

[12] Ms Thomson sought a new condition, to follow condition SW.2, reading: "All new, relocated and renovated open channel drains shall be constructed to resemble notional streams with notional stream bed, riparian planting and refuges."

[13] My EIC, paragraph 133.

with this recommendation in relation to offset storage and wetland treatment areas.

43 Mr van Bentum recommends (at paragraph 5.10 of his evidence), that condition SW.2 be strengthened by the inclusion of three further criteria, which are that:

43.1 Council's stormwater requirements and associated accepted best practice, in particular Council's Stormwater Management Strategy and policy of on-side hydraulic neutrality, is adhered to;

43.2 The flows of stormwater and groundwater from the hills to the coast (east-west) are not impeded; and

43.3 The natural flows in wetlands are not impeded.

44 The specific condition changes proposed are set out in Ms Thomson's evidence (paragraph 10.26), as a proposed addition to what was SW.2(d), but which she has renumbered to SW.2(e).

45 In response I note that these criteria are high-level objectives that have already been identified in the Guiding Objectives for the Alliance Board in the Alliance agreement with KCDC. More relevantly, they are, in my opinion, too broad to be measureable as consent conditions, particularly the second and the third criteria. The first criterion is generally too broad to be suitable as a consent condition. However, I note that the latter part, relating to hydraulic neutrality, is already contained in explicit detail in proposed conditions SW.1(b) and SW.2(a) and (d). Therefore I do not agree that it would be appropriate or necessary to include these criteria in consent conditions, and consider that Ms Thomson's suggested addition to what she has renumbered as condition SW.2(e) is unnecessary.

46 Additional information is sought in paragraph 5.13 relating to areas not included in the modelling. I specifically addressed the areas in question (in the vicinity of Poplar Ave and north of Peka Peka Road) in paragraphs 95 and 126 of my EIC, and note that hydraulic neutrality can be achieved, as demonstrated by manual analysis I undertook. In terms of confirmation of this at final design, proposed condition SW.2 adequately covers this matter by requiring effects of filling to be assessed through the use of hydrological and hydraulic modelling, and also requiring independent peer review of the design.

47 Mr van Bentum considers that insufficient detail has been provided in the application around the specific provisions for stormwater treatment. As a result, he seeks additional information around proposed treatment in general and in specific locations (paragraphs 5.14-5.15). In response, I note that the performance of treatment measures is inherently covered by proposed conditions

SW.1 and SW.2, which define the requirements for treatment before discharge for all Expressway runoff.

48 By way of detailed response, I note the following responses to very specific questions in Mr van Bentum's evidence around proposed treatment and ultimate point of discharge of treated stormwater:

48.1 The stormwater layout plans[14] show the type of device, the direction of flow (for swales) and the points where there is discharge.

48.2 *Sub-paragraph (a):* The median drainage from chainages 2900 to 4100 will be discharged at regular intervals into the principal drainage system that runs parallel to it. In the case of the section south of Drain 7, that will be discharged to the adjacent swale for treatment before discharge. Drainage north of Drain 7 will be discharged to the adjacent pipe, which flows to wetland 0A for treatment before discharge. There is a short section of Expressway (about 150m) across the top of Culvert 7 for which treatment will be provided in one or other of the adjacent devices, a detail that will be resolved in final design. All of this section discharges to Drain 7.

48.3 Similar comments apply for the two other sections of median drain noted in sub-paragraph (a). Chainage 4800 to 5400 is partly discharged to Drain 7, and partly to the Wharemauku Stream, both via swales. Chainage 8900 to 9200 is discharged to the Waste Water Treatment Plant Drain.

48.4 *Sub-paragraph (b):* It is unclear to me which swale "south of the Drain 7 crossing of the Expressway" is referred to, as there are two such crossings. However, in both cases they discharge to Drain 7 at the point where their alignment reaches the drain.

48.5 *Sub-paragraph (c):* The Project is not seeking consent for the possible alternative joint shared wetland noted on CV-SW-114. This wetland, if it were implemented, would take advantage of possible efficiencies associated with a future development on land south of Mazengarb Road. Use of the joint wetland would be dependent on the developer or NZTA gaining consent for such a device, and on that device including capacity for the Expressway runoff. In that event, I expect that consent holder would be required to maintain the device under its consent. The location of that discharge is not defined at this stage, but would need to be confirmed as part of gaining consent for the device, and is likely to be similar to that for Wetland 5. If consent is not obtained for the alternative, then the Expressway would simply build Wetland

[14] Drawings CV-SW-100 to CV-SW-132, Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE.

5 (which is the treatment measure the Board of Inquiry is being asked to approve).

48.6 *Sub- paragraph (d):* This Type 2 swale discharges to the 450mm diameter pipe that collects all the swale runoff that flows to Wetland 6.

48.7 *Sub-paragraph (e):* The small catchments 23.3 and 23.4 currently flow into the existing wetland at this location, and there is little scope to separate them from this attenuation area. In fact, controlling flows from these catchments within Wetland 9 is an important component of achieving hydraulic neutrality in this area. The intention is to discharge these culverts to the attenuation part of Wetland 9, with the Expressway runoff discharging separately to the treatment area, as described in section 4.5.2(vii.) of the hydrology report[15]. I acknowledge this separation is not explicitly shown on Drawing CV-SW-119.[16] The size of the culverts depicted in Drawing CV-SW-119 could be misleading in regard to expected flows from the catchments, as they are sized to allow backflow from Wetland 9 across the wetlands in major flood events, and to function hydraulically as part of the flood attenuation area for Wetland 9. The natural flows from these catchments are relatively small.

48.8 *Sub-paragraph (f):* The swales shown in Drawing CV-SW-128[17] are Type 1 swales, apart from a short length of Type 2 south of the culvert 34 outlet, with the remainder of that Type 2 swale discharging south to culvert 33. Following treatment in each of these swales, stormwater from the eastern and western swales will discharge to the upstream and downstream ends of culvert 34 respectively.

49 In paragraphs 5.16 to 5.19 of his evidence, Mr van Bentum addresses wetlands, and expresses the view that the Project design should be sufficiently developed at the application stage to enable confirmation of the extent, size and nature of stormwater treatment to be provided. I can confirm that the design is sufficiently developed for that purpose, and does achieve the required stormwater management performance with the wetland and storage areas described in Technical Report 22 and the stormwater drawings. Ongoing optimisation of the design may, however, achieve the required performance in a more cost-effective manner. As a result, conditions SW.1 and SW.2 have been proposed in order to provide for future optimisation of details. These conditions define the performance basis of the current design, and remain unchanged for any future optimisation of detail.

---

[15] Technical Report 22.

[16] Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE.

[17] Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE.

50 I disagree with Mr van Bentum's suggestion (at paragraph 5.18) that the specific provision for treatment wetlands set out in Technical Report 22 be considered a minimum irrespective of whether optimisation shows it is needed or not. For example, wetlands 10A and 10B may be able to be combined at detailed design with no change to water quality outcomes, and this should not be prevented by the consent conditions.

51 In paragraphs 5.19 and 5.20, Mr van Bentum states that the wetland swales should be designed to retain minimum quantities of water to support wetland plants, and if wetlands are required then there should be swales followed by wetlands. In response, I consider that Mr van Bentum misunderstands the purpose of the wetland swales, which are not explicitly to replace wetlands, but rather to reflect that in low-lying peaty areas grassed swales are not sustainable because the grass may not survive, and would not be able to be mowed due to wet soil conditions that will occur for much of the time. The wetland swales are used to accommodate the soil conditions, and will be planted with species that can sustain both inundation and occasional dry conditions. I therefore disagree with his conclusion and remain of the opinion that the use of wetland swales in low-lying peat areas, with appropriate planting, is the most suitable treatment solution.

52 In paragraphs 3.4-3.5 Mr van Bentum suggests that proposed treatment is insufficient on grounds that "the design approach does not adequately take into account the way in which the Expressway stormwater would be positively directed to major watercourses along the alignment." He expands on this in paragraphs 5.21 to 5.24, seeking a two stage approach involving the use of swales and the treatment wetlands. I disagree. Discharges to all streams will receive BPO treatment, and water quality effects of the discharges have been assessed as minor.[18] The suggestion that any grassed swale treatment should be followed by wetland treatment is not justified. Moreover, it would involve additional land footprint and cost when the effects have already been assessed as minor.

53 Mr van Bentum notes that the "NZTA has proposed a two treatment train for stormwater treatment in a number of locations, without confirming the basis for the exclusion of other sites" (paragraph 5.22). I understand Mr van Bentum is referring to treatment devices discharging to the Ngarara and Kakariki streams. The selection of these two watercourses for additional treatment was made in consultation with the Project ecologists, and was limited to the Ngarara and Kakariki streams on their advice that these two were particularly important because of their relatively direct discharge to Te Harakeke wetland. I do not agree the additional treatment should be applied to any of the other streams listed in Mr van Bentum's evidence (paragraph 5.23). As a result, I

[18] Paragraph 85 to 89 of my EIC.

do not agree with the related amendments to proposed condition SW.1(a) suggested in Ms Thomson's evidence (paragraph 10.24).

54 In summary, I do not consider that there is anything in Mr van Bentum's evidence that justifies a change to the proposed design, or to the proposed conditions of consent.

Pranil Wadan for St Heliers Capital Limited

55 Mr Wadan outlines an alternative design for Wetland 4 which has been proposed by St Heliers, in particular relocating it from a site adjacent to Kapiti interchange as shown in Drawing CV-SW-110,[19] to a point adjacent to the Wharemauku Stream.[20]

56 I note that the location proposed in Mr Wadan's evidence is different to that shown in the St Heliers submission, with the proposed site having been moved from what is currently a sand hill, onto what is currently low-lying flood plain.

57 As I outline later in this evidence, flood risk management constraints in this area make design of any works in the flood plain difficult, and time-consuming modelling and design optimisation is required to confirm hydraulic neutrality. There has been insufficient time since the evidence was submitted for such an assessment to be made, either by Mr Wadan or by me.

58 In terms of Expressway stormwater management, the alternative design will be less efficient hydraulically, and more costly. While further detailed work would be required (such detail not yet being available to the NZTA or KCDC), my initial assessment is that it is possible that this alternative location could be made to work hydraulically, from the point of view of managing Expressway runoff, but at some additional cost.

59 However, the more significant outstanding issue is related to effects on flood risk management in the wider Wharemauku catchment, due to the relocation of the wetland into a significant flood storage area, and the consequent loss of that existing flood storage. In this regard, hydraulic neutrality[21] has not yet been demonstrated for St Heliers' alternative site.

60 Mr Wadan's assertion (at paragraph 31) that the two wetland locations are both flood prone, and therefore "similar', is incorrect.

61 Caution needs to be used when interpreting the SKM and Connell Wagner maps published for KCDC (as referenced by Mr Wadan)[22]

---

19 Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE.

20 Drawing 60523-SK-121005-4 attached to Mr Wadan's evidence.

21 Hydraulic neutrality has been defined to be consistent with KCDC's application of the term. It is defined in 4.2.3(iii) (on page 53) of Technical Report 22.

22 Paragraph 31 of Mr Wadan's evidence.

because as a matter of policy, the flooding extent plotted for KCDC includes what KCDC term a "dynamic freeboard" that varies from 300mm to 500mm depending on the specific site locations. This margin is added on top of the modelled flood level, with the extent of that higher "flood prone" areas are also mapped. Therefore the mapped flood extent is wider that the extent that the modelling identifies as the best estimate of the land that would be subject to actual inundation with water, and covers any land that would be flooded if the flood water level reached the freeboard level.

62 It is relevant to note that:

62.1 The general ground level at proposed Wetland 4 is of the order of 6mRL and slightly above, while the flood level is about 6.32mRL.

62.2 The general ground level at the alternative site proposed by St Heliers is about 4mRL, with a flood level of about 5.17mRL.

62.3 Therefore any pond footprint at the St Heliers site will displace more than 1m of flood water depth, whereas at proposed Wetland 4 it will displace about 0.3m of flood water. This means that the alternative pond footprint would displace more than 3 times as much floodwater as Wetland 4.

63 It is the displaced volume that is significant in terms of effects on the wider Wharemauku catchment, so the alternative site is clearly not "similar" to the Wetland 4 site in this regard.

64 In paragraph 31, Mr Wadan states that the St Heliers design "provides 33,100m^3 of additional flood storage", however, the location of this storage is unclear. If it is to be achieved on the area marked as "ONSITE SWMA" in Mr Wadan's Drawing 4, then it would require excavation of the full footprint by a depth of 1.2m. This could potentially cut through the overlying peat layer, and expose the underlying artesian sand aquifer, which could affect groundwater levels in the area (as **Ms Williams** discusses in her rebuttal evidence). This would need careful geological assessment before such an option could be confirmed.

65 In paragraph 32, Mr Wadan indicates that KCDC has advised that approximately 5.5ha of St Heliers Land would need to be used for wider catchment flood hazard management. Again it is unclear where that area is. Mr Wadan refers to the "ONSITE SWMP" area as "a possible location", but that is only 2.8ha in area. If the Wharemauku Stream and the St Heliers land to the south of the stream[23] is also included, then the total does add up to about 5.5ha. However this whole area, plus other St Heliers land not included in the 5.5ha footprint I have described above, is already identified as

[23] Area A, and the south western corner of Area D on Drawing 60523-SK-121005-1 attached to Mr Wadan's evidence.

flood prone,[24] i.e. it is not available as flood offset storage because it already serves that function under existing conditions.

66 From my experience of working to address hydraulic neutrality of the Project in the Wharemauku catchment, I am of the opinion that there are many complicating matters that would make this difficult to achieve for the St Heliers alternative design, including the extent of existing flooding, constraints on excavation in the flood plain because of subsoil conditions and the effects on local groundwater.

67 During the design phase, I did look at alternative locations for the stormwater system in this area, including options for a channel south alongside the proposed expressway. From an engineering point of view, the NZTA proposed Wetland 4 location is clearly optimum - it is hydraulically most efficient, it is most cost-effective, and it is located on land that is substantially flood-free.

68 In my opinion, there is a high risk that hydraulic neutrality would be difficult to achieve in the alternative location proposed by St Heliers. Hydraulic neutrality has not yet been demonstrated, and in my view, the NZTA (and likely KCDC) would be unwilling to adopt such a design location without robust catchment-wide flood risk modelling, and careful consideration of groundwater effects. I certainly would not.

Vinod Chand for St Heliers Capital Limited

69 Mr Chand's evidence peer reviews Mr Wadan's proposal. Unfortunately, Mr Chand does not address the question of wider catchment flood risk, which is, in my opinion, the key stormwater management challenge that would govern the acceptability of the design proposed by Mr Wadan and St Heliers.

70 In paragraph 15, Mr Chand identifies that it would be better to locate the wetland (and presumably also any excavated flood storage area) within the lower-lying cohesive soils, rather than the sand dunes, to reduce the risks associated with leakage.

71 Reference to the geotechnical drawings included in the application, and in particular Drawing GT-GE-104,[25] suggests that in this area, the peat is relatively thin, and is underlain by sand, (except in the immediate vicinity of the Wharemauku Stream). As mentioned earlier in my rebuttal evidence, any excavation in this area is likely to break through the peat into sand which may result in the widespread groundwater effects discussed in **Ms Williams'** rebuttal evidence in her response to Mr Wadan's evidence. Therefore Mr Chand's conclusion in regard to avoidance of leakage may be optimistic.

---

[24] Technical Report 22, Appendix 22.E, page 22.

[25] Volume 5 of the AEE.

72 I therefore remain of the opinion that there would be significant challenges in designing the alternative pond location in accordance with Mr Wadan's concept, and in achieving hydraulic neutrality without potentially significant collateral effects.

Sue Smith for WOO

73 At paragraph 56 of her evidence, Ms Smith comments that using the Te Moana Road underpass as an emergency floodway is contrary to good planning principles. Ms Smith appears to misunderstand the existing situation, which is that the floodway identified by GWRC and KCDC crosses Te Moana Road about 200m west of the Project,[26] and would only flow in the event of a failure of the Waikanae River stopbank, or in a flood event well in excess of a 0.5% AEP event.

74 This will not change as a result of the Project. The flow path under the Expressway runs parallel to and south of Te Moana Road (as shown on Drawing CV-SW-120[27]), and would not impinge on the road, except as it currently does. Therefore, the Project will not increase the risk of flooding or of closure of Te Moana Road.

David Roil for WOO

75 At paragraph 47 of his evidence, Mr Roil comments on flooding in 2008 in Puriri Avenue, and that it should be taken into account in the design. There is no question that this area is flood prone, and this has been taken into account in the design. Irrespective of the Expressway, there are matters that may need to be addressed in the KCDC drainage system downstream to address the flood risk referred to by Mr Roil. This system includes a pump station to discharge water through the stopbank to the Waikanae River during major flood events, because the land in this area is so low relative to the River flood levels.

76 Referring back to my comments earlier in response to Mr van Bentum's evidence, this location is a prime example where the Project achieving precise hydraulic neutrality within the designation may not be the most cost-effective overall solution. During the preparation of the AEE, options for joint works with KCDC to improve downstream capacity and reduce existing flood risk in this area were considered in some detail, and it is still a possibility that such joint works might eventuate.

77 However, for the purposes of certainty in the AEE, a self-contained hydraulically neutral solution for the Project has been proposed. Flood modelling has been used to optimise the containment of Expressway runoff along with the provision of offset storage, such that the Project does not adversely affect flood risk in this area. One element of this is the attenuation of peak stormwater runoff

[26] Drawing CV-SW-027 (Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE), and also in Appendix 5 of Ms Westlake's evidence.

[27] Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE.

rate from the Expressway footprint to only 9%[28] of the pre-Expressway peak against a target of up to 80% proposed in SW.1. Put another way, the peak Expressway stormwater discharge proposed at this site will be a very small fraction of that currently discharged.

78 At paragraph 55 of his evidence, Mr Roil refers to a series of extreme events, and questions what would happen were these to re-occur. There are two aspects to this:

78.1 What would happen during construction period; and

78.2 What would happen in regard to the permanent works.

79 The probability of such an extreme event occurring during the construction period is statistically much lower than during the much longer life of the Project. Industry standard practices for management of that risk during construction will be adequate in this instance.

80 In regard to the permanent works, these have been designed to accommodate larger storm events than those Mr Roil expresses concern about.

81 Therefore, in my opinion the flood risk matters that Mr Roil raises have been adequately addressed in the AEE.

Dr Mary McIntyre for APSOC

82 Dr McIntyre identifies concerns with potential for increased mosquito habitat due to the creation of artificial standing water pools. I have addressed this matter in general terms in my EIC, at paragraphs 145 to 147.

83 Dr McIntyre specifically refers to three proposed "pools", at chainages 10800, 11200–11300, and "11300.5". By way of clarification:

83.1 The first is offset storage area 9A, which will normally be dry, and will only hold water for a matter of hours during storm events.

83.2 The same applies to a proposed offset flood storage area at about chainage 11350m.

83.3 The pond and wetland between chainages 11200 and 11300 is Wetland 9. This has substantially the same footprint as an existing pond at that location, sometimes referred to as Tocker's Pond. The principal difference is that the Project proposes to wetland plant the south western portion of this

[28] Technical Report 22, 4.5.2(vii), paragraph 6.

currently open water body, for enhanced treatment of stormwater runoff.

Melanie Dixon for RSRA

84 Ms Dixon states at paragraph 46 that there is insufficient information to assess the effects of flood storage area 0B on the hydrology of the Raumati Manukau wetland. I disagree. I addressed this in my EIC at paragraph 97.[29] In summary, the Raumati Manuka Wetland is currently prone to flooding in large flood events (refer Drawing CV-SW-023).[30] This flood risk for the Wetland will not change as a result of the Project, and flood storage area 0B will flood in the same way as the Wetland, as a result of flood water passing into it from the Wetland.

Professor Manning

85 Professor Manning specifically addresses the question of risk associated with climate change. This is expressed in terms of potential sea level rise, consequent potential groundwater level rise, and increased intensity of storm rainfall. While **Ms Williams** provides the principal response to the matter of groundwater level rise in her rebuttal statement, I provide comment below on the interaction with the surface water drainage system. I also address sea level rise and increased rainfall intensity in the context of flood risk management and resilience of the drainage system.

86 I do not propose to comment on the climate change science behind Professor Manning's evidence, which is outside my area of expertise. My response is focussed on discussing the implications for the Project in the event that the more extreme scenarios described by Professor Manning were to eventuate. I have covered the matter of climate change briefly in paragraph 91 of my EIC, and nothing in Professor Manning's evidence changes my conclusions as expressed in my EIC.

87 It is also important to recognise the context of the Expressway relative to the coast and to sea level. The nearest that the Expressway reaches to the coast is 1.1km, both south of the Wharemauku Stream and at the Waimeha Stream. At the Waikanae River, the distance is closer to 2km. The lowest level on the Expressway is 6mRL. Between the Expressway and the coast, in both these areas, there are significant existing urban areas which are much more vulnerable to effects of sea level rise and coastal migration than the Expressway.

88 In the above context, the image suggested by Professor Manning at paragraph 28 of his evidence, that the Expressway could become a "sea wall on which the road is constructed" appears rather fanciful. Similarly, the comparison Professor Manning makes (in paragraphs 38 and 39) to the situation at Haumoana, a small

[29] Also described in Technical Report 22, Section 4.3.2(iii).

[30] Appendix 22.A of Technical Report 22, and included in Volume 5 of the AEE.

coastal settlement in Hawke Bay, hard on the edge of an actively eroding beach, is tenuous in the context of the Project.

89 A fundamental element of the design approach has been to adopt the climate change standards promulgated by KCDC, GWRC and the Ministry for the Environment. These include both sea level rise and increased rainfall intensity, and include consideration of a range of variability. Some of this has been explicitly documented in the AEE[31], and some has been engineering judgement that I have applied during the design process, that has not been explicitly documented for the AEE.

Sea level rise

90 For sea level rise I have adopted the KCDC guide of 0.8m for design. Professor Manning quotes upper bounds in the range of 2m,[32] between 1.2 and 1.9m,[33] along with several other values and time horizons. He does not appear to recommend an upper bound in the context of a time horizon or probability of occurrence, which is not helpful. However, he does append extracts from documents prepared by others, and I have drawn on these.

91 From Figure 8.2 in his Appendix 1, it would appear that a value of 2m might be considered an extreme upper limit. From the summary on page 57 of that Appendix it would appear that there is a very low probability of sea level rise in the Wellington Region reaching 1.3m by 2115, although on page 61 a minimum design value of 1.5m is also suggested for that horizon.

92 Flood modelling for the rivers, which govern the flood levels in the vicinity of the Expressway at waterway crossings, is relatively insensitive to sea level rise in the range being considered. The backwater effects upstream on rivers from impoundments further downstream (including the sea) typically decay relatively quickly, although the rate does depend on river slope and form. On steeper rivers, and where there is extensive flood plain, the upstream effect tends to disappear more quickly. I note however, the flood models have not been tested with the more extreme events that Professor Manning suggests. However, it should be noted that all the models have used a sea level boundary condition that includes climate change, with a 20 year return period high sea event, and river flood peak coinciding with high tide. [34] Thus the sea level used for the extreme event models was of the order of 2.9 mRL[35].

93 For waterways such as Wharemauku and Waimeha, modelled flood levels (including provision for 0.8m sea level rise) are 4.75mRL and

---

31 Technical Report 22, sections 3.1.7, 4.2.3(ii), 5.1.4.

32 Paragraph 27.

33 Paragraph 37.

34 For example Technical Report 22, Appendix 22.E, page 7.

35 For example Technical Report 22, Appendix 22.F, Table 3.

3.15mRL respectively[36]. For the Waikanae River, the flood level is 4.9mRL.[37] In both the Wharemauku and Waimeha streams there is significant ponding available downstream of the Expressway which will mean that the magnitude of increased design flood level resulting from sea level rise is significantly reduced at the Expressway. On the Waikanae River the Expressway is further upstream, further reducing the potential effect.

94 In the low probability event that sea level rise were to be 1.5m within the life of the Project, then that would be 0.7m higher than assumed for the flood models. In each case the effects would be much less at the Expressway. The bridges over principal watercourses are designed (in accordance with NZTA design standards) with 1.2m freeboard to allow for uncertainty of flow estimates, wave action and debris. Therefore the potential effect of 1.5m sea level rise would be to reduce the available freeboard slightly towards the end of the design life of the bridges.

95 The Project provides gravity surface water drainage from all parts of the Expressway to the principal waterways described above. The Expressway is designed with 0.5m freeboard from flood level to the carriageway. Therefore any changes in flood level adjacent to the Expressway would similarly be small, and would serve to slightly reduce that freeboard in an extreme flood event towards the end of the Project's economic life.

96 As noted the potential for sea level rise to affect groundwater level is addressed by **Ms Williams**. However, I note that the Expressway's comprehensive surface drainage system means that there will always be gravity surface drainage to control the water level at the Expressway. It is possible, if groundwater levels were to rise, that some swales would tend to be wetter, and might begin to flow continuously. The design incorporates wetland swales in all low-lying areas, which will be well able to cope with increased wetness.

97 Therefore, from a flood risk and drainage point of view, I remain confident that the Expressway design is sufficiently robust to be able to perform as designed even in the event of sea level rise of the magnitude Professor Manning identifies.

Increased rainfall intensity

98 The design has been based on an estimated increase in rainfall intensity of 16%, but with a 50% increase also considered, in accordance with KCDC guidance. It appears from Professor Manning's evidence at paragraph 27 that he accepts this is an appropriate upper bound consideration. He does not appear to question this aspect of the design any further.

---

[36] Drawings CV-SW 024 and -028 respectively, as included in Volume 5 of the AEE.

[37] Drawing CV-SW-027, as included in Volume 5 of the AEE.

99 Therefore, in summary, I remain of the opinion that the design of the Expressway is sufficiently robust to cope with the range of climate change scenarios that are appropriate to the life of the Project and to the Kāpiti environment.

Graham Levy
25 October 2012

ANNEXURE A: PROPOSED CONSENT CONDITIONS

For ease of reference, the proposed stormwater conditions (as shown in my EIC, Annexure A) are repeated below in standard font. Further conditions proposed in this rebuttal evidence are included in red text and underlined.

Proposed new stormwater conditions	
SW.1	Operational stormwater discharge from the Expressway shall meet the following performance criteria: a) Expressway stormwater shall be treated before discharge to the receiving environment in accordance with the NZTA publication *Stormwater Treatment Standard for State Highway infrastructure*, 2010, or equivalent industry standard methods. b) The peak rate of stormwater discharge from the Expressway at any point shall not exceed 80% (urban areas) or 100% (rural areas) of the pre-Expressway peak discharge from the same footprint, in each of the 50%, 10% and 1% AEP critical duration storm events.
SW.2	The effects of the Expressway embankment, water crossing and stormwater discharge on flood risk shall be addressed in the following manner: a) Any loss of flood plain storage due to the fill embankment shall be offset by: i. provision of equivalent alternative flood storage volume; or ii. attenuating runoff; or iii. removing downstream constraints; or iv. a combination of the above. b) Flood risk shall be assessed against the 1% AEP storm, with climate change to 2090 (mid-range) estimated. c) Culvert and bridge waterway crossings shall be designed so that any increase in flood risk in the 1% AEP storm is either contained within the designation, or is localised within the flood plan, minor, and no more than 50mm above existing flood levels. d) The combined effects of filling, waterway crossings and Expressway stormwater discharge shall be assessed through the use of hydrological and hydraulic modelling. e) The stormwater management design and flood risk modelling shall be independently peer reviewed by a suitably qualified and experienced hydrologist (at the cost of the consent holder) to ensure that the hydraulic modelling is appropriate and that the stormwater design and flood risk management meets the performance criteria set out in SW.1, SW.2 and SW.3. The results of the peer review shall be provided to the Manager.

SW.3	The design of waterway crossings shall also meet the following performance criteria: a) The design of the Waikanae River Bridge shall provide at least 5m clearance to the beam soffit across all parts of berm where required for operation of maintenance machinery. At least 4.5m minimum clearance shall be provided for the El Rancho access road. b) The top surface of berm riprap under the Waikanae River Bridge shall be no higher than existing berm level, and shall retain existing berm drainage patterns. c) Freeboard for Waikanae River Bridge above modelled level for the 1% AEP flood plus climate change to 2090 shall be at least 2.2m. d) The following allowance shall be made for future services to pass under the Waikanae River Bridge in between the Super Tee beams with oversize sleeves in the abutments and crosshead beams. i. 6-Ø100mm duct for telecommunications below northbound outer shoulder. ii. 5-Ø100mm ducts, 4 for telecommunications and 1 for gas below southbound outer shoulder. iii. 2-Ø300mm water pipes. e) The Waikanae River Bridge configuration shall consist of 5 spans, with twin-column piers, and with all piers being clear of the permanent waterway. The main river channel shall have a clear span at berm level of no less than 35m. f) For the final design for all culverts, a culvert blockage risk assessment shall be undertaken to confirm that the following criteria are met: i. There shall be a safe secondary flow path that does not endanger habitable buildings; or ii. There shall be provision at the culvert inlet for debris management such that culvert inlet blockage is avoided.

ANNEXURE B: CULVERT BLOCKAGE RISK ASSESSMENT

Culvert blockage risk assessment (sheet 1 of 3)

Culvert	Houses Potentially Affected?	Overflow RL	Comments	Base assessment	Assessment	Design action required
6	No	9.6	Would pond east of railway until it spilled over	No change to existing risk.	OK	
7.1	No	10	Would pond east of railway until it spilled over	No change to existing risk	OK	
7.4	No	7	Swale would back up and then spill over cycleway and into paddocks	Primary risk is within Expressway footprint, potential for overflow north	minor	RL under bridge =7.07m, low point on northern off ramp = 7.1m. May need to look at raising the cyclewayslightly to ensure that secondary flow does not overfow into paddocks north west of
7.5	No	6.1	Would pond east of on ramp until it spilled over into swale/Poplar Ave	Primary risk is within Expressway footprint	OK	
7.5a	No	6.9	Would pond between existing SH1 and Expressway until it spilled over SH1 and then roundabouts	Primary risk is within Expressway footprint	OK	
8	Yes	7.6	Would pond in paddocks and swales and then overflow onto Poplar Ave between roundabouts. Would spill over Poplar Ave west of roundabout at 7.6m, which is lower than current overflow at 7.78m.	Long section of existing road shows low point of 7.78m at culvert, new pofile has low point of 7.6m at west end of island on roundabout approach, there flood risk reduced.	OK	
9.3	No	7.1	Woul pond between Expressway and northern off ramp and onto Poplar Ave between roundabouts before spilling over off ramp		minor	As for 7.4-7.5
10	Yes	8.3	Would pond in paddocks and then spill over Expressway at low point over culvert. Houses would begin to flood at RL 8m. A glass house would flood at 7m. To reach this level would require approx. 1m deep ponding over a large large percentage of catchment, so unlikely to flood this high even in very extreme flood plus full culvert blockage.	Very large upstream storage area, but still a potential low probability risk of house flooding before spill over M2PP.	Some risk	Provide debris rack. Consider slight lowering of Expressway level at culvert during detailed design.
11	No		Would flood OSA2	Flow balance across to Wharemauku	OK	
11.3	No		Would flood OSA2	Flow balance across to Wharemauku	OK	
11.2	Yes	4.5	There is no existing culvert, but under existing conditions this area would back up from Kiwi Pond and flood houses before spilling into Wharemauku.	Drainage is an improvement on existing.	OK	
13	No	8.4	Internal Expressway pipe. Would pond in swale and southbound lanes of Expressway before spilling over median and into Wetland 5	OK as this is only internal drainage.	OK	
14	Yes	7	Would pond and then spill onto local roads at much the same level as if existing Mazengarb Drain / Fytfield Place culvert blocked. Fytfield Place culvert will contain any large objects from upstream.	There is currently no other outlet from this area if the culvert blocks - flow back upstream does not relieve risk, although there is significant storage available in lakes upstream. Large, developed catchment.	Some risk	Provide debris rack
15	No	8	Would pond in paddocks and southbound Expressway lanes then spill over median into Wetland 6	Would pond on low-lying WWTP land and into old ponds. Not a problem.	OK	

Culvert blockage risk assessment (sheet 2 of 3)

Culvert	Houses Potentially Affected?	Overflow RL	Comments	Base assessment	Assessment	Design action required
16	No	8	Would pond a small amount in paddocks and then spill into swale and culvert 15 catchment	Would pond on low-lying WWTP land and into old ponds. Not a problem.	OK	
17	No	8.5	Would flood OSA 6A then enter swales. Would spill over Expressway before spilling to Otaihanga Road. However, could spill into transfer station area.	Probably OK.	Some risk	Provide large grill on culvert overflow entry
18.1	No	9	Would flood paddocks then spill over access road		OK	
21	No	6.55	Would flood paddocks and northbound Expressway lanes then spill over median and into Wetland 8	Balancing culverts for Waikanae flood water. Significant storage present on low-lying farm land, accounting for a large proportion of catchment. Would spill at RL6.55m, but massive runoff needed to reach this level (1.5m deep over half the catchment).	OK	
22.1	Yes	6.1	Would flood properties and then spill over into Waikanae River	Balancing culvert for Waikanae flood water. Flood level would not reach house. Flood storage occupies about 70% of catchment, up to 3m deep below house level.	OK	
22.2	No	5	Would flood Wetland 8 then spill onto road and into Muaupoko		OK	
23.3	No	5.5	Would flood paddocks and then spill into 23.4 catchment	Balancing culverts. No buildings at risk.	OK	
23.4	No	5.5	Would flood paddocks and then spill into 23.3 catchment		OK	
24	No	3.4	Would flood floodway and then spill over off ramp	Part of floodway. Only ponds within Expressway footprint and existing floodway area.	OK	
24.1	No	3.4	Would flood paddocks and wetland 10 and then spill over off ramp and Te Moana Rd		OK	
24.2	No	4.4	Would flood floodway and then spill over on ramp		OK	
24.3	No	3.5	Would flood paddock and then spill over Te Moana Rd	Low level, minor implications in already flood-prone area.	OK	
24.4	Yes		Minor local drainage for area protected from Waikanae overflow floodway by low stopbank.	Only local runoff, minor.	Minor	Provide grill on culvert inlet
25.3	No	5.05	Would floods paddocks and then spill over into terrain that drains to Waimeha	Balancing culvert	OK	
26	Yes	8.5	Would flood paddocks and then enter swale. Would then spill to small inlet pipe to wetland 10B. Capacity of pipe too small to carry sufficient flow. Area will continue to pond and potentially flood houses at RL=8m. Will flow over Expressway at 8.5m. Overflow to south east is at 9m.	Would need to flood to a high level over a very wide area to affect houses.	Some risk	Reassess at design stage. Allow for debris rack.

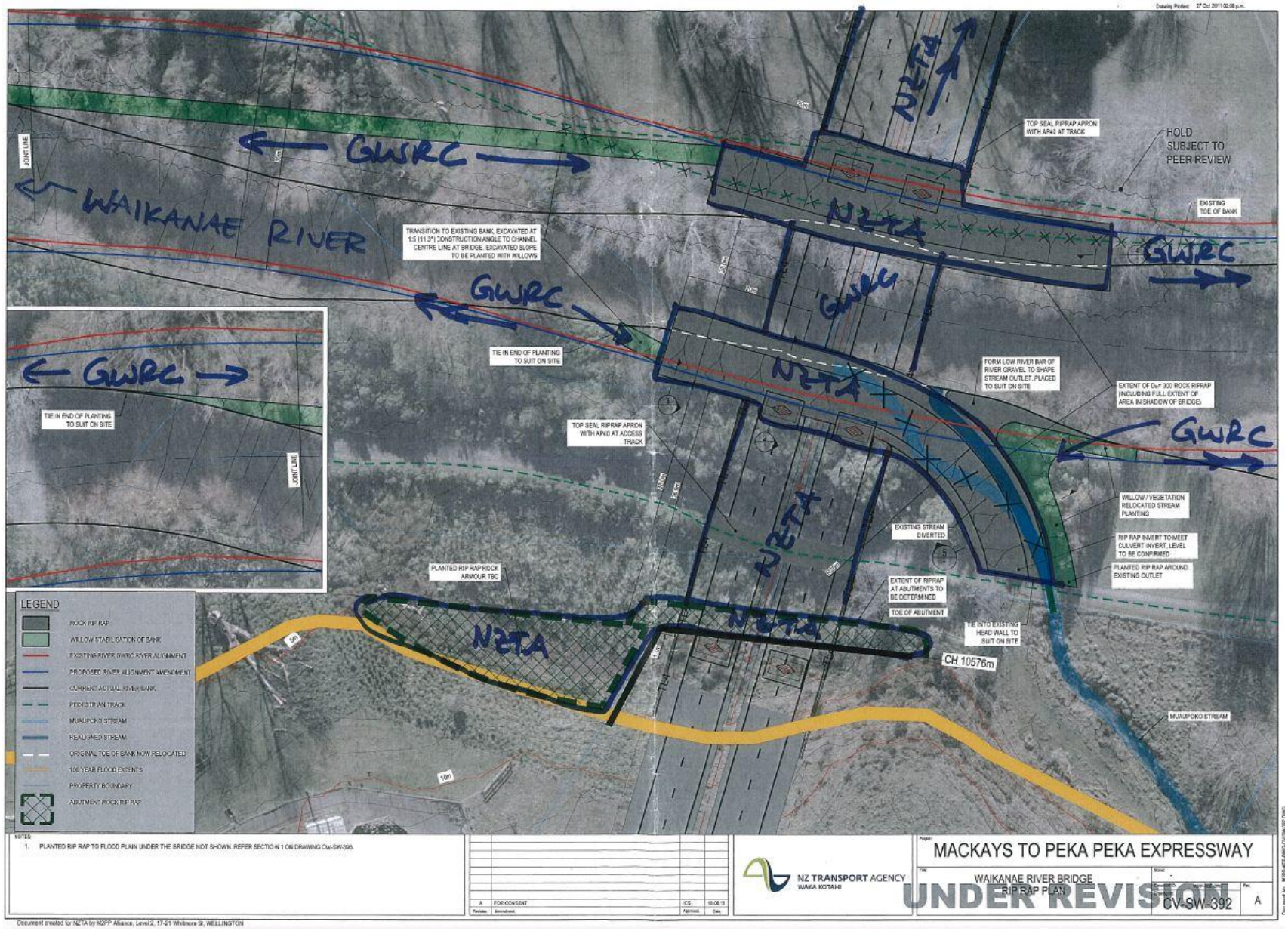
Culvert blockage risk assessment (sheet 3 of 3)

Culvert	Houses Potentially Affected?	Overflow RL	Comments	Base assessment	Assessment	Design action required
27	No	7.4	Would have minor ponding then spill into swale	Balancing culvert	OK	
30	No	8.4	Would pond in paddocks and then spill over Smithfield Rd near intersection, into Kakariki Stream	Would pond on low-lying farmland. Massive storage up to 2m deep over about 70% of catchment.	OK	
30.1	No	7.3	Would pond in paddocks then spill onto Smithfield Rd	Minor ponding and spill over local road.	OK	
30.2	No	6.86	Would pond in paddocks then spill onto Smithfield road and into OSA11		OK	
30.3	No	7.1	Would pond in paddocks then spill into 30.2 catchment		OK	
30.4	No	7.5	Would pond in paddocks, swale and north bound lanes then spill over median and into OSA 11	Pond up to 1.5m deep, significant storage over 50% of catchment.	OK	
31	No	8.5	Would pond and then spill to the north west. Very small catchment		OK	
33	No	9.1	Would pond in adjacent farmland until 9.1m when it would flow over the Expressway.		OK	
34	No	8.9	Would pond in adjacent farmland. All contained until RL 8m. Would flow over Expressway at 8.3m. Houses all above 10m.		OK	
35	No	8.9			OK	
35.1	No	8.9			OK	
38	No	10-11	Would fill OSA 13 A then spill onto either roundabout, Expressway or SH1	Contained in M2PP land until it overflows downstream	OK	
38.1	No		Would pond east of SH1 then spill over SH1	Little changed from existing	OK	
38.2	No		Would pond east of SH1 then spill over SH2	Little changed from existing	OK	
38.3	No	11	Would flood area between local road and Expressway then spill either over on ramp or over local road	Little changed from existing	OK	
38.4	No	13.4	Would pond east of SH1 then spill into 39 catchment and then onto SH1	Little changed from existing	OK	
39	No	13.4	Would pond east of SH1 then spill into 38.4 catchment and then onto SH1	Little changed from existing	OK	
40	No	13.3	Would pond east of SH1 then spill onto SH1	Improved from existing	OK	
40.1	No		Would spill south into stream		OK	
40.2	No		Would spill south into stream		OK	
40.3	No	11	Would pond between on ramp and local road then spill either over on ramp into potential OSA or over local road	Possible slight change of discharge point, depending on final local road profile, but reaches same drain eventually.	OK	

ANNEXURE C: PLAN IDENTIFYING MAINTENANCE RESPONSIBILITIES REGARDING WAIKANAE RIVER BRIDGE

Plan attached to minutes of a meeting between Project staff and GWRC Flood Protection staff held on 3 November 2011.

Note that the channel design details have changed slightly between this drawing and that finally submitted with the AEE. However, the principles in regard to the split of responsibilities between GWRC and NZTA would remain the same, and the details should be resolved through a mutual agreement between the two parties.


GWRC
WAIKANAE RIVER
GWRC
N2TA
TRANSITION TO EXISTING BANK, EXCAVATED AT 1:5 (11.3°) CONSTRUCTION ANGLE TO CHANNEL CENTRE LINE AT BRIDGE. EXCAVATED SLOPE TO BE PLANTED WITH WILLOWS
TIE IN END OF PLANTING TO SUIT ON SITE
TOP SEAL RIPRAP APRON WITH AP40 AT TRACK
HOLD SUBJECT TO PEER REVIEW
EXISTING TOE OF BANK
FORM LOW RIVER BAR OF RIVER GRAVEL TO SHAPE STREAM OUTLET. PLACED TO SUIT ON SITE
EXTENT OF D50 300 ROCK RIPRAP (INCLUDING FULL EXTENT OF AREA IN SHADOW OF BRIDGE)
WILLOW / VEGETATION RELOCATED STREAM PLANTING
EXISTING STREAM DIVERTED
RIP RAP INVERT TO MEET CULVERT INVERT. LEVEL TO BE CONFIRMED
PLANTED RIP RAP AROUND EXISTING OUTLET
PLANTED RIP RAP ROCK ARMOUR TBC
EXTENT OF RIPRAP AT ABUTMENTS TO BE DETERMINED
TOE OF ABUTMENT
TIE INTO EXISTING HEAD WALL TO SUIT ON SITE
CH 10576m
MUAUPOKO STREAM
JOINT LINE
LEGEND
ROCK RIP RAP
WILLOW STABILISATION OF BANK
EXISTING RIVER GWRC RIVER ALIGNMENT
PROPOSED RIVER ALIGNMENT AMENDMENT
CURRENT ACTUAL RIVER BANK
PEDESTRIAN TRACK
MUAUPOKO STREAM
REALIGNED STREAM
ORIGINAL TOE OF BANK NOW RELOCATED
100 YEAR FLOOD EXTENTS
PROPERTY BOUNDARY
ABUTMENT ROCK RIP RAP
NOTES
1. PLANTED RIP RAP TO FLOOD PLAIN UNDER THE BRIDGE NOT SHOWN. REFER SECTION 1 ON DRAWING CW-SW-393.
A FOR CONSENT ICS 10.08.11
NZ TRANSPORT AGENCY WAKA KOTAHI
MACKAYS TO PEKA PEKA EXPRESSWAY
WAIKANAE RIVER BRIDGE RIP RAP PLAN
UNDER REVISION
CW-SW-392 A
Document created for NZTA by M2PP Alliance, Level 2, 17-21 Whitmore St, WELLINGTON