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Peka Peka Interchange Options – Stormwater Analysis

The recently developed Mackays to Peka Peka expressway has a south bound off ramp and a north bound on ramp at Peka Peka. The potential for improving connectivity here by developing a south bound on ramp and a north bound off ramp is being considered by Commute Transportation who are undertaking a single stage business case for improved connectivity at Peka Peka.

The business case is the first phase of three phase process and may be followed by Pre Implementation/Planning (Phase 2) and Implementation/Construction (Phase 3).

The business case development includes Issues Identification, Options Assessment and Recommended Option Identification. The business has progressed to the Options Assessment and four options have been identified for further development. These are described as Option P1, P2a, P5 and P6, the locations of each are shown in Figure 1.

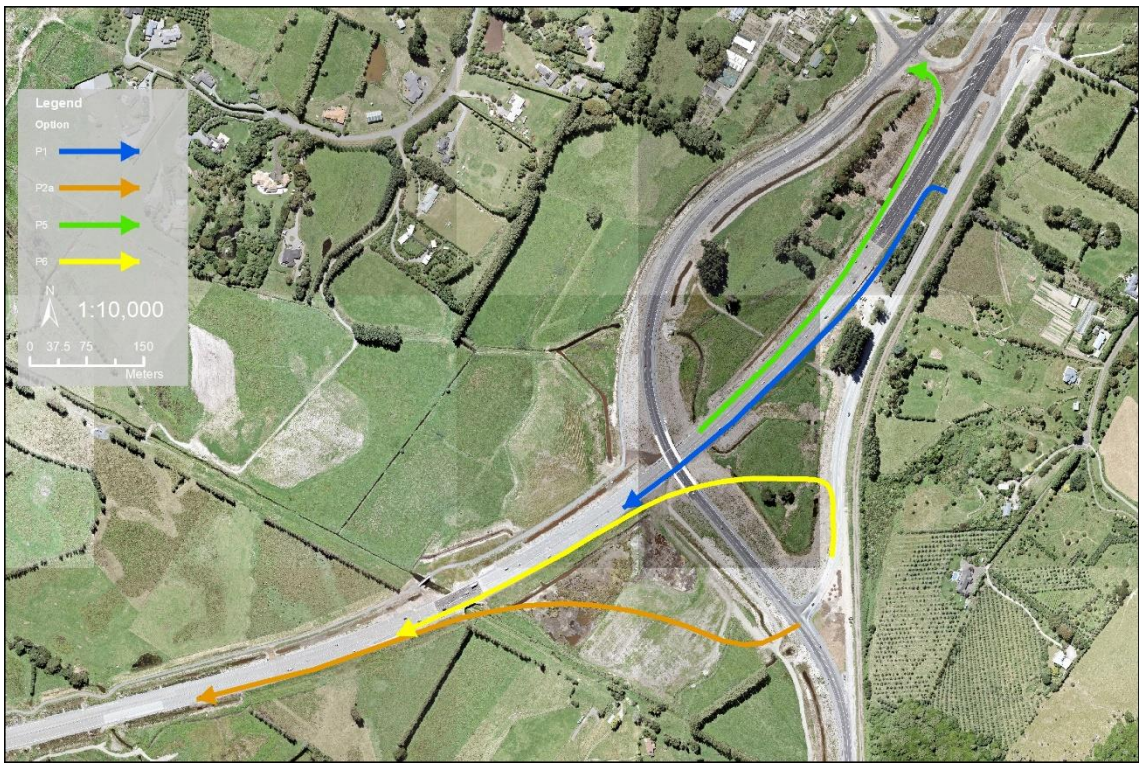

Figure 1 Alignments of Business Case Options for Further Consideration.

The proposed works will be undertaken under the existing consent conditions for the Mackays to Peka Peka Expressway, a variation to this consent, or a separate as yet to be obtained consent.

The consent conditions relating to stormwater for the Mackays to Peka Peka Expressway are detailed in Table 2 in the stormwater compliance report[1]. Our understanding of some of the key conditions that are likely to affect the business case option costs are as follows:

- **Peak Flow Attenuation**
    - Run off from the expressway shall be no more than 100% of the pre-development peak flow rate for the 50%, 10% and 1% AEP critical duration storm events. (Ref SW.1 (a)).
- **Flood Level Effects**
    - Flood level impacts due to the expressway are required to be less than 50mm increase outside the designation in a 1% AEP event. (Ref SW.2(c).ii).
    - Flood risk shall also be assessed against the 1 % AEP mid-range climate change scenario and the high-range climate change scenario as a sensitivity test. (Ref SW.2(b).).
    - Flood levels may increase within the designation. (Ref SW.2(c).i).
    - Where these requirements cannot be met the consent conditions include provisions for obtaining consent from affected land owners. (Ref SW.2(c).iii).
- **Water Quality Treatment**
    - Expressway stormwater runoff to the Paetawa North/Peka Peka Stream shall receive primary treatment using swales followed by secondary treatment using wetlands before discharge. (Ref SW.1(d)). A minimum residence time in the swales of 9 minutes is required.
- **Effects of Culvert Blockage**
    - Culvert blockage risk shall be appropriately managed. (Ref SW.3(f)).

The development of additional ramps will all result in an increase in the impermeable surface area and as a result runoff peak flow and volume. This increase in runoff will need to be mitigated to ensure compliance with the above consent conditions. The run off from the ramps will need to be directed to swales with a minimum retention time of 9 minutes and then to treatment ponds.

The options identified in the business case all cross the existing attenuation ponds and swales constructed to meet the above consent conditions for the Expressway. Any storage volume lost from the ponds could result in an increase in peak discharge from the ponds, this will need to be assessed and mitigated as required.

Any swale crossings or realignments will need to be designed to ensure that the minimum retention times are not compromised.

The four options identified for further consideration are detailed further below, the stormwater impacts of each are identified and possible works to meet the consent conditions are discussed. Swale and attenuation pond names used below are taken from [1].

[1] M2PP-56-D-CRG-0100 Permanent Stormwater Design Compliance Report – Paetawa North/Peka Peka – New Zealand Transport Agency 2015.

Option P1

Option P1 consists of a south bound on ramp running from a new intersection at Hadfield Link Road and connecting to the Express Way at or near the Peka Peka Link Road underpass, see Figure 2.

At the Hadfield Link Road end, the ramp will cross swale SB SWALE CH17307 – 17140, the inlet of culvert 38.5 and the outlet of a stormwater pipe that takes flow from the open channel on the eastern side of Hadfield Link Road.

The length of swale SB SWALE CH17307 – 17140 will be reduced by approximately 75m from the current length of 173m, with the shortened swale ending to the northern side of the ramp. This will reduce the residence time from 42 minutes to approximately 24 minutes.

Culvert 38.5 will need to be extended by approximately 10m at it's upstream end. A new manhole would be positioned at the upstream end of Culvert 38.5. The existing stormwater pipe under Hadfield Road would need to be extended to connect into this manhole. A new stormwater inlet and pipe would be required to convey flows from the truncated swale under the ramp to the new manhole.

The loss of storage volume in swale SB SWALE CH17307 – 17140 and the reduced transit time along the swale will most likely increase the peak discharge from Culvert 38.5. This may need to be offset by increasing the storage volume in Attenuation Area 13B. This should be possible as Attenuation Area 13B is elevated above the ground water table.

The Ramp encroaches into Attenuation Area 13A, reducing the available attenuation volume here. Runoff from the ramp will need to be treated in a swale drain prior to discharge.

A new swale could be located in the northern corner at Attenuation Area 13A with its outlet discharging to the new manhole at the upstream end of Culvert 38.5. Alternatively, the new swale could be positioned further south in Attenuation Area 13A and discharging directly to this attenuation area. Both swale configurations will result in a reduction in the available attenuation volume in Attenuation Area 13A.

It should be possible to offset the resulting loss of attenuation volume by reducing the invert level of Attenuation Area 13A, much of which is currently elevated above the water table. Section 4.6 of 1 details the ground water monitoring undertaken at in Attenuation Area 13A. The monitoring shows that the ground water varies between 7.5m and 8.3m. While much of the attenuation area is above this level, depending on the extent of excavation required, it may be necessary to convert the attenuation area from dry to wet storage. If insufficient additional attenuation volume can be created in Area 13A, due to ground water level constraints, it should be possible to create additional volume in Area 13B.

Culvert 38 will need to be extended by approximately 10m at its upstream end, and the connecting drains will need to be realigned.

Figure 2 Option P1

Option P2A

Option P2 A consists of a new southbound ramp originating at the intersection of Hadfield Link Road and Peka Peka Link Road. From here the ramp crosses the upstream end of swale NB SWALE Peka Peka Link Road NB Swale CH432-644, bisects Offset Storage Area 13, crosses the Paetawa Drain and joins the expressway to the south of Paetawa Drain. Option P2a is shown in Figure 3.

The length of swale PEKA PEKA LINK ROAD NB SWALE CH432 – 644 will be decreased by approximately 37m to 175m. This will reduce the retention time in this swale form 87 minutes to 72 minutes.

The construction of the ramp through Offset Storage Area 13 will reduce the available storage volume, and will increase the runoff volumes from the site. It should be possible to extend the Offset Storage Area 13 to the south east within the extent of the designation to balance the increased runoff and loss of storage.

Off set storage area 13 is designed to take peak flows from the Paetawa Drain via a long weir that runs along the northern bank of the drain. The proposed ramp will cut across the western end of this weir and as such the weir will need to be redesigned.

The ramp bisects Offset Storage Area 13, effectively creating two separate storages. Culverts will need to be installed to allow flows to pass from one to the other.

The ramp is positioned close to the inlet of Culvert 51, this inlet may need to be redesigned.

The ramp crosses Paetawa Drain close to the existing bridge. A new bridge or culvert will be required here. This will need to be carefully designed to ensure that it does not create additional head losses here.

Runoff from the ramp will need to be treated in swale drains prior to discharge. The upstream end of Swale PEKA PEKA LINK ROAD NB SWALE CH432 – 644 could be extended westward along the northern side of the ramp. This extension to the swale would be outside the existing designation, however this land would presumable have to be purchased for the construction of the ramp anyway. Runoff from the portion to the ramp to the east of Paetawa Drain would need to be directed to the swale via a pipe network.

Runoff from the ramp to the west of Paetawa Drain may need to be treated separately. This could be directed to the swale that runs parallel to the expressway near the point where the onramp ends. This swale may need to be extend westward at its upstream end to provide additional retention time and storage capacity.

Figure 3 Option P2a.

Option P5

Option P5 consists of a north bound off ramp that exits the express way immediately north of the Peka Peak Link Road underpass. The offramp follows the alignment of swales NB Swale CH16788 – 17117 and NB Swale CH17162-17261 before a sweeping left turn into the Roundabout at Peka Peka Road. Option P5 is shown in Figure 4.

Culverts 38.5, 38.4 and 44 will all need to be extended by 5-10m as the ramp crosses the outlets of these culverts.

The two swale drains, NB Swale CH16788 – 17117 and NB Swale CH17162-17261, will need to be moved 10-20m north west as the ramp is positioned along the alignment of these drains. The various stormwater pipes that discharge to these drains will need to be extended.

Run off from the ramp can be directed to the realigned swale drains.

The ramp will encroach on Attenuation Area 13B, resulting in a loss of storage volume, this will be compounded by the increased runoff and the realignment of the swale drains. This loss of storage can be compensated for by lowering the invert of the Attenuation Area 13B. It may be necessary to convert this attenuation area from a dry to a wet pond as the invert in much of the pond is close to the ground water level.

It may also be possible to create additional volume in Attenuation Area 13B by further restricting the outflow through Culvert 38.3.

Figure 4 Option P5.

Option P6

This option consists of a new round about at the intersection of Peka Peak Link Road and Hadfield Link Road. The new southbound on ramp will exit Hadfield Road immediately north of the roundabout. The ramp will cross Attenuation Area 13A and the downstream end of swale Peka Peak Link Road SB Swale CH640-177 before passing under Peka Peak Link Road and joining the expressway to the north of Paetawa Drain. Option P6 is shown in Figure 5.

As the ramp cuts across the downstream end of swale PEKA PEKA LINK ROAD SB SWALE CH640 – 177 the length of the swale will be reduced by approximately 30m. Consequently, the retention time in

this swale will reduce from 83 minutes to 72 minutes. The stormwater line that takes the discharge from this swale would also need to be extended.

The ramp bisects Attention Area 13A effectively splitting the storage in two. Culverts through the ramp embankment will be required to maintain connectivity.

The embankment across Attention Area 13A will result in a significant loss of storage volume. The increase in impervious surface will also result in an increase in runoff volumes. This could be mitigated by lowering the invert level of the storage area as per Option 1.

Runoff from the western end of the swale (between Peka Peak Link Raod and Hadfield Link Road) could be directed to the upstream end of swale PEKA PEKA LINK ROAD SB SWALE CH640 – 177.

A new swale could be constructed parallel to the express way between Peka Peka Link Road and the Paetawa Drain to treat run off from this part of the ramp. Offset Storage Area 13 would need to be moved south to accommodate the new swale. The overflow weir from Paetawa Drain to the storage area, and the inlet to Culvert 51 may also require redesign. Alternatively, runoff could be discharged to the existing swale NB SWALE CH16392-16606 on the northern side of the expressway. This would require laying pipes across the expressway.

A new swale may be required west of Paetawa Drain to accept runoff from the final section of ramp.

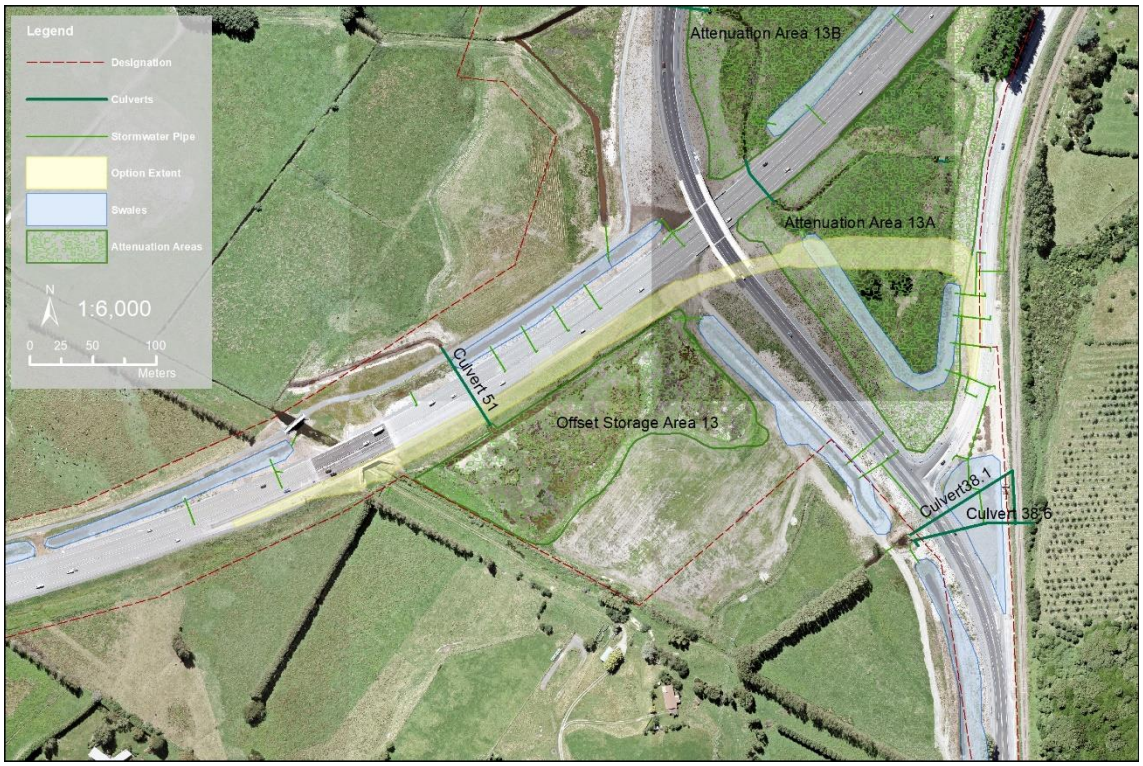

Figure 5 Option P6

Discussion

It appears that stormwater controls for all of the options identified can be accommodated within the existing consent conditions. The stormwater controls could also be accommodated within the

existing designation, with the exception of Option P2a. The proposed ramp for Option P2a is located outside the designation and it would be necessary to purchase the land here anyway.

All of the Options require reducing the lengths of existing water quality swales, which will result in a reduction in retention time and treatment efficiency. However, none of the options will result in the retention time being reduced below the minimum of 9 minutes.

The consent condition conditions require that all road runoff is discharged to swale drains then wetlands. While it appears, all flows are discharged to swales, it does not appear that the swale discharge to wetlands in the existing situation. It is unclear if this is a requirement that would need to be met. This may be an impractical requirement that we would push back on.

All of the options will result in an increase in runoff from the paved surfaces that will need to be accommodated for in the attenuation system. This run off will also need to be directed to water quality treatment swales.

Initial Conclusion

The Attenuation Areas 13A and 13B work in tandem. As it is likely that option P5 will proceed, Option P1 and P6 will work to compound the loss of storage in these attenuation areas. While we believe it is still possible to mitigate within this tandem storage area this will need to be proven.

It would appear at a high level that there is greater resilience in Option P2a. This option provides much greater stormwater flexibility, particularly given additional land adjacent to the designation still sits in the ownership of the Agency.

Assumptions and recommendations

The above analysis has been undertaken at an options identification level of detail only. The design of each option has not been tested using a hydraulic model and further detailed design and modelling would be required to demonstrate compliance with the consent conditions.

It also needs to be noted that we have not considered ecological consent conditions which may also impact on the area required to mitigate each ramp.

It is recommended that further ground water monitoring be undertaken as the construction of the express way is likely to have had an impact on ground water levels in the area since the original monitoring was completed. This will impact the minimum ground levels in the Attenuation Areas and may require these areas to be converted to wet storages/ponds.

Kind Regards

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