Appendix Q
AC Pond Replacement – Options Assessment

This options assessment was carried out for the pre-development scenario (i.e. post-development catchment changes such as increased impervious areas and provision of water quality and peak flow attenuation wetlands were not part of this assessment). These assessment results are solely associated with the options to mitigate the removal of the AC ponds. The preferred option from this assessment has been carried through to the post-development scenario and full results of the post-development scenario are reported in **Section 5.3.3**.

Option 1 – Ramps wetland

Option 1 considers locating a replacement wetland at the western side of SH1 between the proposed SH1 to SH18 ramps, as shown in **Figure A14**.

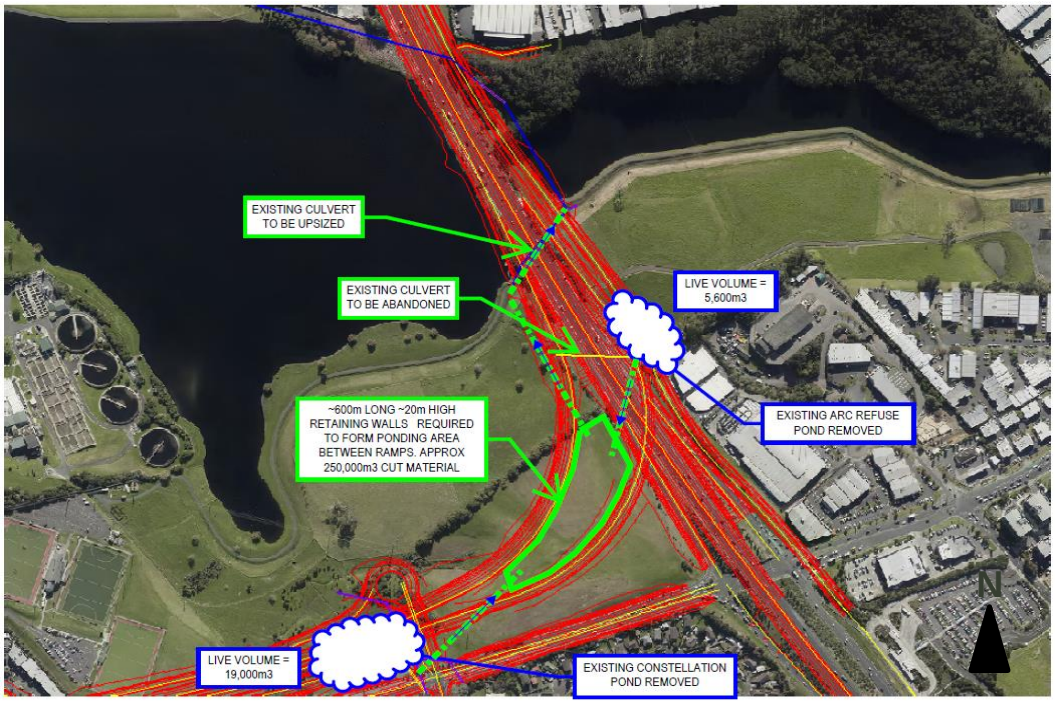
Although there is space available for a pond at this location, the vertical levels mean significant retaining structures are required for this option to work, as illustrated in **Figure A15**. This is required in order to drain the upstream catchment to the relocated wetland by gravity means only.

This option would require cutting the existing surface from 55-61mRL to 41mRL (with 15-20m high retaining walls). Although this solution is theoretically possible, it introduces the following risks:

- Safety risks associated with deep excavation and construction of high retaining wall; and
- Ground water inundation risks as finished surface is significantly lower than natural surface.

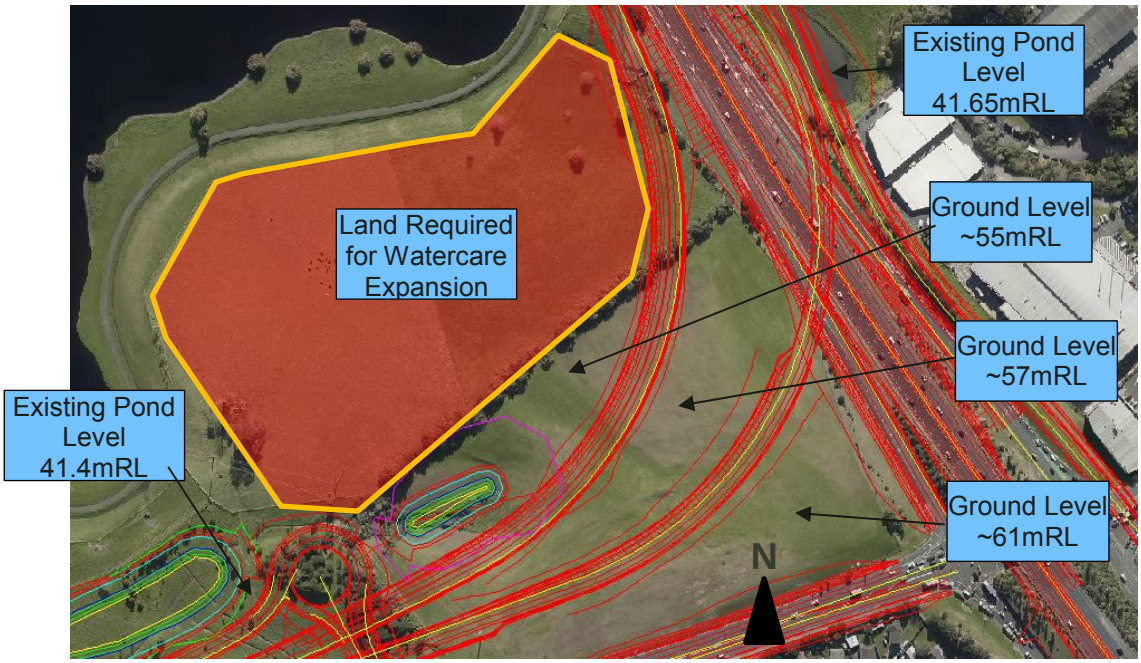
Due to other more practical and safer options with less risk available at similar or lower costs, this option has been discarded.

Figure A14 Option 1 'Ramps wetland' schematic



- ✓ Stakeholder: No additional land acquisition required
- × SiD: Unnecessary construction risk associated with deep excavation and construction of 20m high retaining walls

Figure A15 Ground level and existing ponds comparison



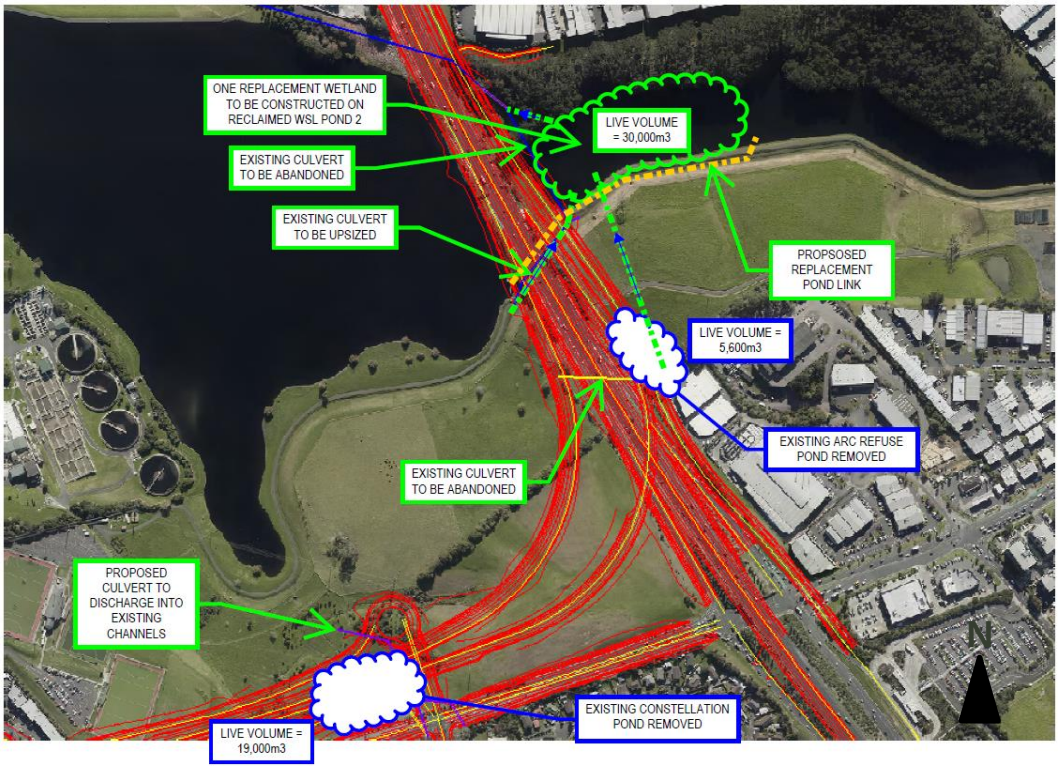
Option 2 – Wetland over reclaimed Pond 2

Option 2 rationalises and consolidates all stormwater management infrastructure into one central location, as shown in **Firgure A16**, located on land reclaimed from Pond 2.

This is the option most preferred by Watercare. As confirmed through consultation with Watercare, Pond 2 is not required for treatment of wastewater, and hence can be converted (fully or partially) into a stormwater management device.

This option is preferred to the on-land options (e.g. Option 4a) as it leaves the land adjacent to the existing commercial development vacant for future development by Watercare.

Figure A16 Option 2 'Wetland over reclaimed Pond 2' schematic



- ✓ Stakeholder: Watercare prefers land south of Pond 2 to be left vacant for future development
- ✓ Cost: No additional land acquisition required for this option
- × Hydro: slight increase in overflows to Watercare Ponds from existing scenario
- × Cost: Significant reclamation required
- × Cost: New pond link required

This option has been discarded due to high cost associated with reclamation. The BPO achieves better hydraulic outcomes with less cost.

Option 2a – Wetland over reclaimed Pond 2, with retained culvert

Option 2a is similar to Option 2, however the culvert under SH1 from east to west is retained. This option was to confirm that the results from Option 2 were not due to timing issues of the hydrograph peaks. Option 2a was discarded for the same reasons as Option 2: the high cost associated with reclamation. The BPO achieves better hydraulic outcomes with less cost.

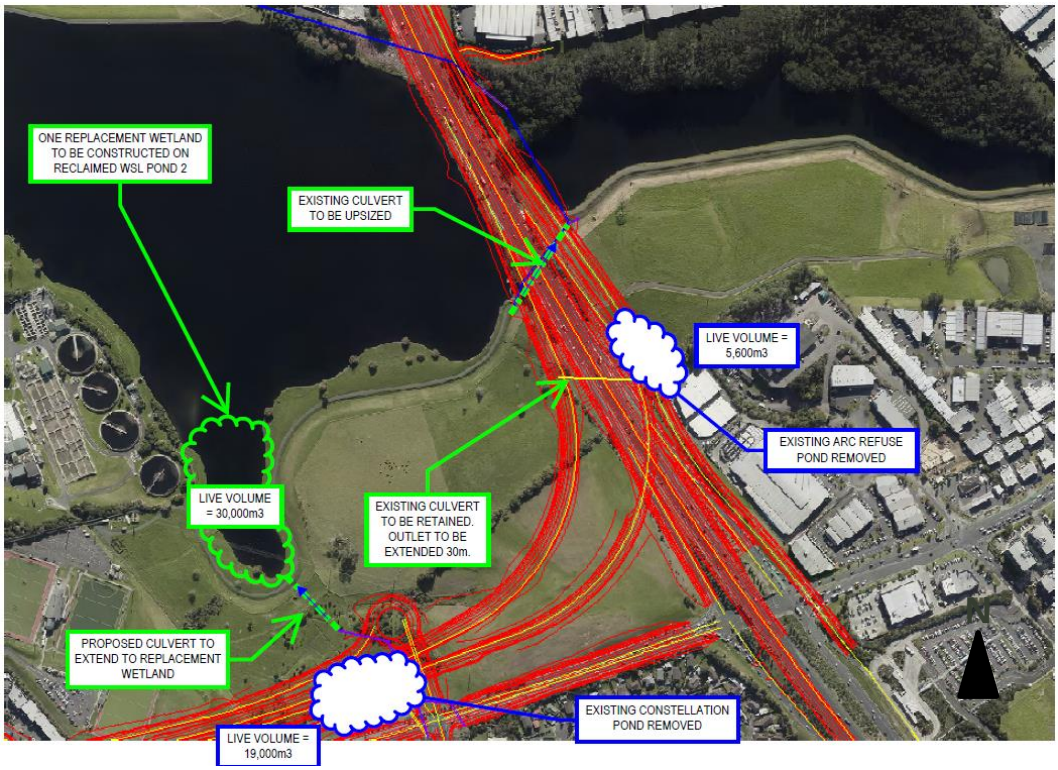
Option 3 – Wetland over reclaimed Pond 1

Option 3 rationalises and consolidates all stormwater management needs into one central location. This option is similar to Option 2, but reclaims Pond 1 instead of Pond 2.

The possibility of reclaiming the "finger" part of the pond has previously been discussed with Watercare through the options assessment phase for North Harbour Hockey Club relocation. Hence, it is considered feasible to reclaim a small part Pond 1 for stormwater management use. Pond 1 is currently being used by Watercare for wastewater treatment, therefore this option slightly reduces the treatment capacity of the plant.

Option 3 has no increase on the total overflow volumes to the Watercare Ponds in the 100 year ARI event, but slightly changes the balance so that less overflows into Pond 1 than Pond 2. Water levels upstream of ARC Pond are slightly increased. In the 10 year ARI event, total overflow volumes into the Watercare ponds are slightly increased (+2%).

Figure A17 Option 3 'Wetland over reclaimed Pond 1' schematic



- ✓ Cost: No additional land acquisition required for this option
- × Hydro: slight increase in overflows to Watercare Ponds from existing scenario in 10 year ARI event
- × Cost: Significant reclamation required
- × Stakeholder: slightly reduces wastewater treatment capacity of Pond 1

This option has been discarded due to high cost associated with reclamation. The BPO achieves better hydrological outcomes with less cost.

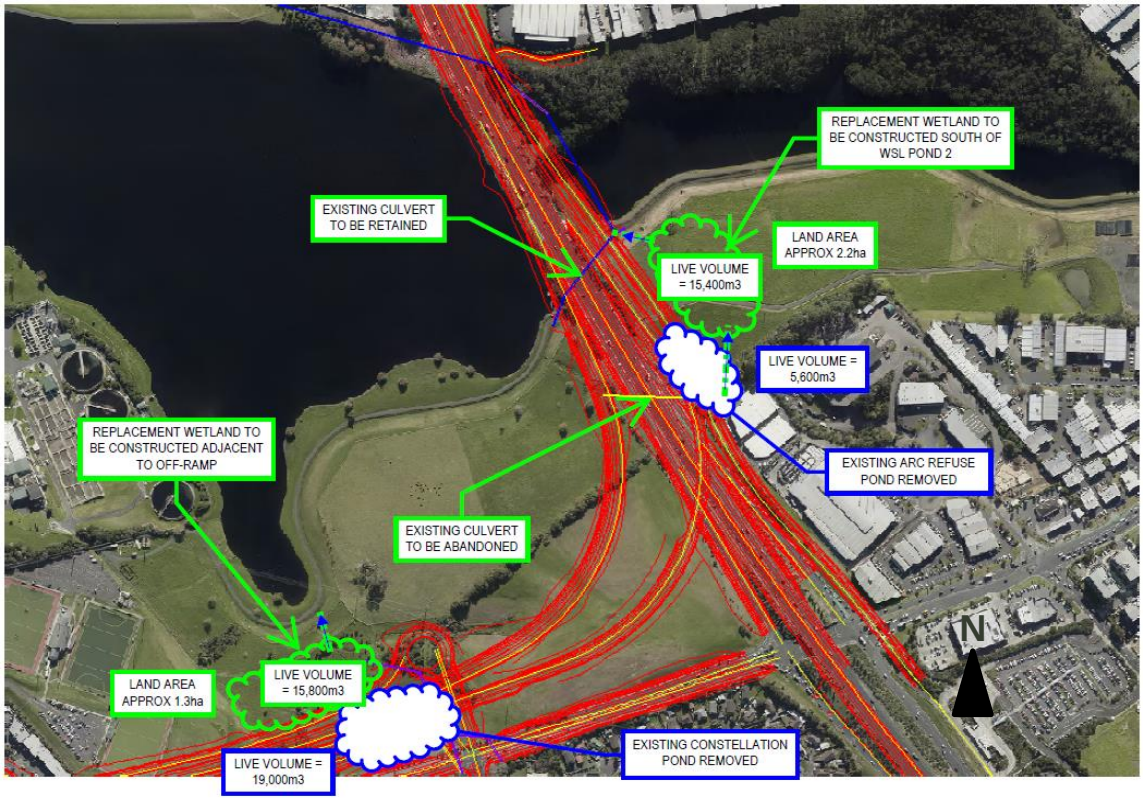
Option 4a – 2x wetlands: on-land

Option 4a is the option that best mimics the location and attenuation volumes of the existing ponds, and involves constructing replacement devices directly adjacent to existing devices as shown in **Figure A18**.

The main drawback of this option is the significant land acquisition cost, as both replacement wetlands are located on land. This is particularly true for the ARC Refuse Pond replacement, as it is located adjacent on land with future potential for commercial development.

This option has been discarded due to the amount of land acquisition required. The BPO achieves better hydraulic outcomes with less land required.

Figure A18 Option 4a '2x wetlands: on-land' schematic



- ✓ Construction Risk: No reclamation required
- × Hydro: increases in overflows to Watercare Ponds from existing scenario in both 100 year and 10 year ARI events
- × Stakeholder: Not preferred by Watercare due to replacement of ARC Refuse Pond being located on land with future commercial development potential
- × Cost: The highest land acquisition costs of all options

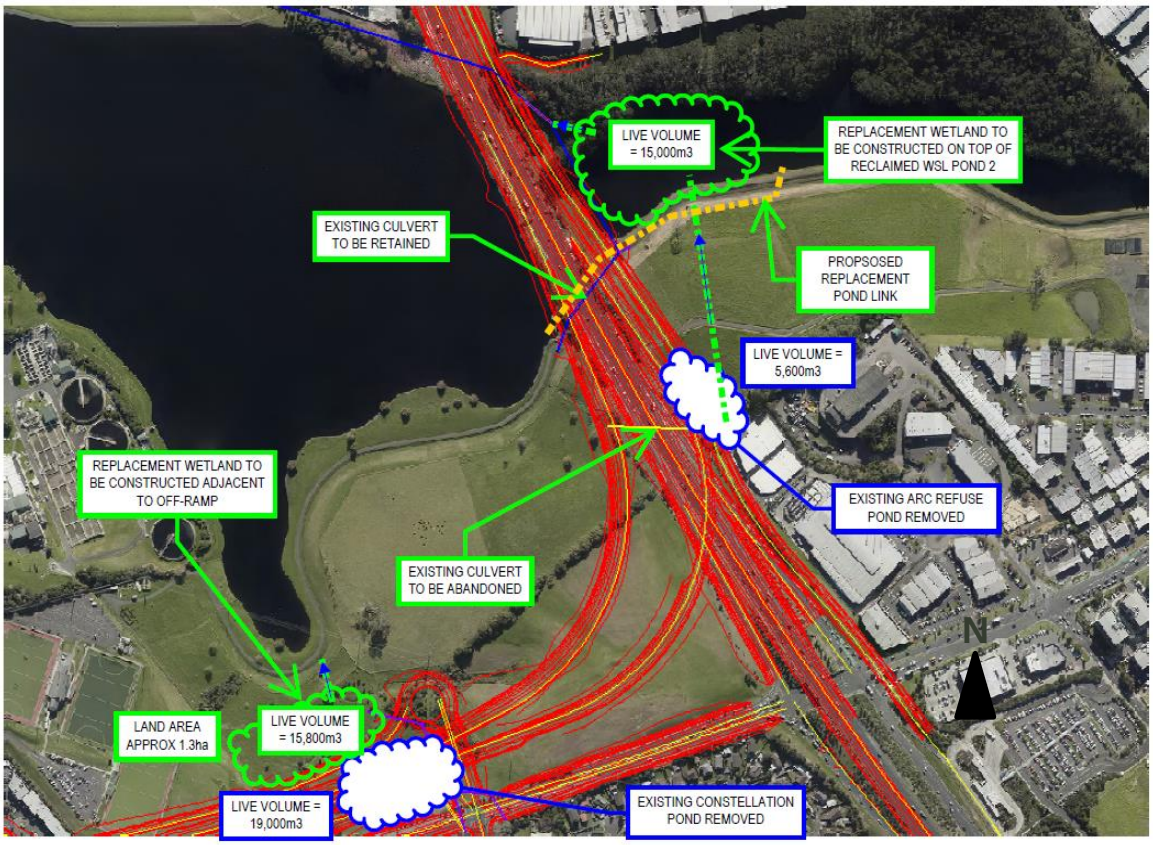
Option 4b – 2x wetlands: one reclaimed over Pond 2

Option 4b is similar to Option 4a, with difference being that the ARC Refuse Pond is built on reclaimed land at Pond 2 to address the main drawback of Option 4A of having a wetland on potential commercial land. A schematic layout is shown in **Figure A19**.

This option is slightly different hydraulically to Option 4A, as the replacement wetland in Option 4B discharges at a location further downstream.

Note when compared with Option 2, the reclaimed wetland volume and reclamation required is less in this option. This option is a hybrid option that balances reclamation costs and land acquisition costs.

Figure A19 Option 4b '2 x wetlands: one reclaimed over Pond 2'



- ✓ Cost: Balance between reclamation costs and land acquisition costs
- × Hydro: slight increase in overflows to Watercare Ponds from existing scenario
- × Cost: New pond link required

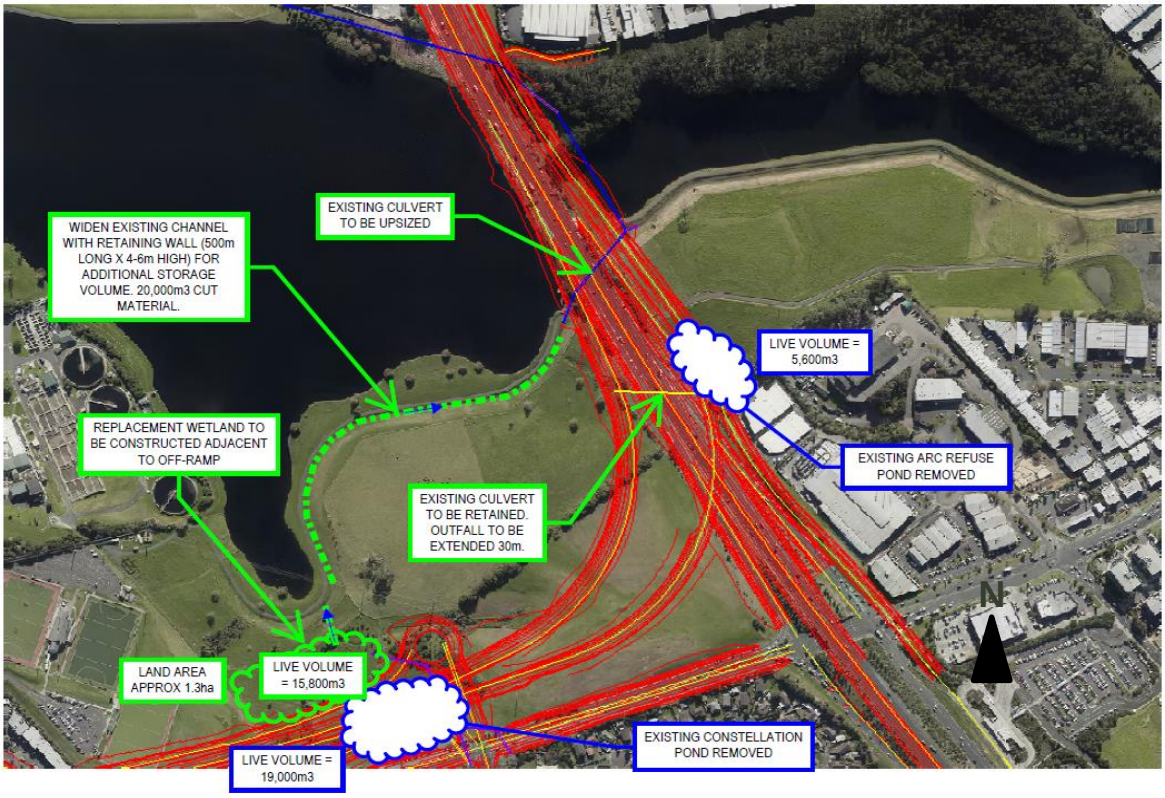
This option has been discarded due to high cost associated with reclamation. The BPO achieves better hydrological outcomes with less cost.

Option 5 – Wetland reclaimed over Pond 1 with channel upgrade

Option 5 provides all stormwater attenuation devices on the west side of SH1, as shown in **Figure A20**. The main advantage of this option is that land on west side of SH1 can be left vacant for any future development.

The excavation of the hill side batter removes 20,000m^3 of cut material, and provides 12,000m^3 of additional stormwater storage for attenuation purposes.

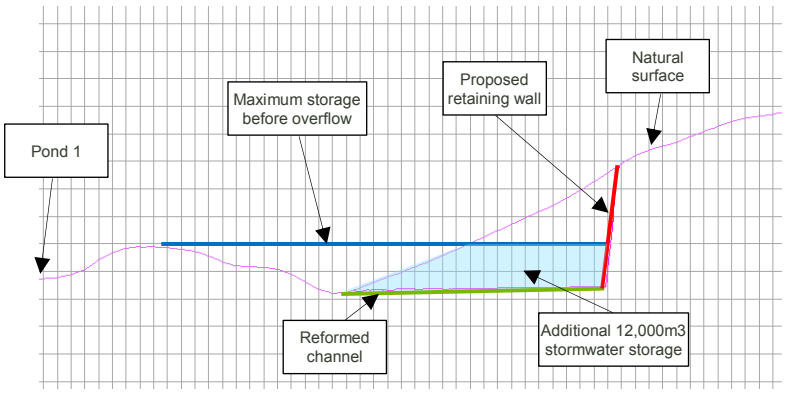
Figure A20 Option 5 'Wetland reclaimed over Pond 1 with channel upgrade' schematic



- ✓ Construction Risk: No reclamation required
- ✓ Cost: No works required in Pond 2 or on land with future commercial development potential
- × Cost: Significant costs associated with constructing a 500m long retaining wall

Figure A21 illustrates a typical section across the proposed channel.

Figure A21 Channel capacity upgrade cross-section



This option has been discarded due to high cost associated with construction of retaining wall. The BPO achieves better hydraulic outcomes with less cost.

Comparison of Hydraulic Performance

Options in **Table 34** were run in the MIKE Urban component of the model only to determine the effects at the following key locations:

- Downstream peak flows and water levels at the modified watercourse north of Pond 1;
- Water levels upstream of Constellation Pond;
- Water level upstream of ARC Refuse Pond;
- Overflow volumes into Pond 1;
- Pond 1 peak water level;
- Overflow volumes into Pond 2; and
- Pond 2 peak water level.

The modelling assumed that Pond 1 and Pond 2 are full to spillway level at the start of the simulation.

The hydraulic modelling results for each option are shown in **Table 36, Table 37** and **Table 38** for the 100, 10 and 2 year ARI storm event respectively. Review of the results indicates the following:

- For the 100 year ARI event:
  - All options increase total overflow volumes into the Watercare Ponds, with the exception of Option 0A which decreases total overflows by 3%;
  - All options reduce overflow volumes into Pond 1 and increase overflow volumes into Pond 2;
  - The difference between water levels in the modified watercourse north of Pond 1 are minor for all options. This is consistent with the 1200mm diameter pipe acting as a restriction to the flows;
  - There is negligible impact on water levels upstream of the Constellation Pond; and
  - Water levels upstream of ARC Pond are increased in options where the ARC Refuse Pond is removed.
- For the 10 year ARI event:
  - All options increase total overflow volumes into the Watercare Ponds, with the exception of Option 0A which decreases total overflows by 13%;
  - All options reduce overflow volumes into Pond 1 and increase overflow volumes into Pond 2;
  - The difference between water levels in the modified watercourse north of Pond 1 are minor for all options
  - There is negligible impact on water levels upstream of the Constellation Pond; and
  - Water levels upstream of ARC Pond are increased in options where the ARC Refuse Pond is removed.
- For the 2 year ARI event:
  - There are negligible overflows into the Watercare Ponds for all options;
  - The difference between water levels in the modified watercourse north of Pond 1 are minor for all options; and
  - There are no water level impacts upstream of Constellation or ARC Refuse Pond.

Table 36 **Option Assessment Summary – Hydrological Performance, 100 year ARI event + climate change 2121, Existing Development catchment**

Peak Discharge, Water Level, Overflow Volumes - Change from pre-development scenario									
Option	**DS Flow (m3/s) 'A'**	**DS level (mRL) 'A'**	**US level Constellation (mRL) 'B'**	**US level Refuse (mRL) 'C'**	**Pond 1 level (mRL) 'D'**	**Pond 2 level (mRL) 'E'**	**Overflow into Pond 1 (m^3) 'D'**	**Overflow into Pond 2 (m^3) 'E'**	**Total Overflows into Watercare Ponds (m^3)**
Pre-Dev	**5.36**	**21.40**	**49.63**	**45.56**	**37.81**	**38.31**	**82,950**	**89,880**	**172,830**
Option 0	5.40 +1%	21.41 +10mm	49.63 +0mm	45.63 +70mm	37.81 +0mm	38.40 +90mm	80,200 -3%	94,430 +5%	174,640 +1%
Option 0A	5.39 +1%	21.41 +10mm	49.63 +0mm	45.63 +70mm	37.80 -10mm	38.37 +60mm	75,580 -9%	92,640 +3%	168,220 -3%
Option 1	Hydraulic effects not quantified. Option discarded due to other considerations.								
Option 2	5.18 -3%	21.40 +0mm	49.63 +0mm	45.54 -20mm	37.88 +70mm	39.34 +1030mm	68,830 -17%	109,910 +22%	178,740 +3%
Option 2a	5.17 -4%	21.40 +0mm	49.63 +0mm	45.63 +70mm	37.88 +70mm	39.18 +870mm	83,100 0%	97,700 +9%	180,800 +5%
Option 3	5.39 +0%	21.41 +10mm	49.63 +0mm	45.69 +130mm	37.81 +0mm	38.36 +50mm	81,200 -2%	92,230 +3%	173,430 +0%
Option 4a	5.57 +4%	21.42 +20mm	49.63 +0mm	45.54 -20mm	37.83 +20mm	38.46 +150mm	67,950 -18%	113,790 +27%	181,750 +5%
Option 4b	5.68 +6%	21.43 +30mm	49.63 +0mm	45.86 +300mm	37.81 +0mm	38.43 +120mm	66,700 -20%	108,850 +21%	175,540 +2%
Option 5	Hydraulic effects not quantified. Option discarded due to other considerations.								

Table 37 **Option Assessment Summary – Hydrological Performance, 10 year ARI event + climate change 2121, Existing Development catchment**

Peak Discharge, Water Level, Overflow Volumes - Change from pre-development scenario									
Option	**DS Flow (m3/s) 'A'**	**DS level (mRL) 'A'**	**US level Constellation (mRL) 'B'**	**US level Refuse (mRL) 'C'**	**Pond 1 level (mRL) 'D'**	**Pond 2 level (mRL) 'E'**	**Overflow into Pond 1 (m^3) 'D'**	**Overflow into Pond 2 (m^3) 'E'**	**Total Overflows into Watercare Ponds (m^3)**
Pre-Dev	**5.12**	**21.36**	**49.24**	**44.97**	**37.36**	**37.34**	**23,940**	**9,200**	**33,140**
Option 0	5.19 +2%	21.36 +0mm	49.24 +0mm	44.97 +0mm	37.37 +10mm	37.35 +10mm	20,160 -16%	15,290 +66%	35,460 +7%
Option 0A	5.18 +2%	21.36 +0mm	49.24 +0mm	44.97 +0mm	37.35 -10mm	37.34 +0mm	15,840 -34%	13,140 +43%	29,980 -13%
Option 1	Hydraulic effects not quantified. Option discarded due to other considerations.								
Option 2	5.10 -0%	21.36 +0mm	49.24 +0mm	44.97 +0mm	37.40 +40mm	37.54 +200mm	15,210 -36%	22,050 +140%	37,260 +12%
Option 2a	5.10 -0%	21.36 +0mm	49.24 +0mm	44.97 +0mm	37.40 +40mm	37.50 +160mm	21,060 -12%	17,190 +87%	38,240 +15%
Option 3	5.15 +1%	21.36 +0mm	49.24 +0mm	45.01 +40mm	37.36 +20mm	37.34 +0mm	21,360 -11%	12,500 +36%	33,860 +2%
Option 4a	5.20 +2%	21.36 +0mm	49.24 +0mm	44.97 +0mm	37.37 +10mm	37.36 +20mm	18,220 -24%	19,820 +116%	38,040 +15%
Option 4b	5.26 +3%	21.37 +10mm	49.24 +0mm	45.08 +110mm	37.37 +10mm	37.36 +20mm	17,540 -27%	18,100 +97%	35,640 +8%

Option 5	Hydraulic effects not quantified. Option discarded due to other considerations.

Table 38 Option Assessment Summary – Hydrological Performance, 2 year ARI event + climate change 2121, Existing Development catchment

Peak Discharge, Water Level, Overflow Volumes - Change from pre-development scenario									
Option	**DS Flow (m3/s) 'A'**	**DS level (mRL) 'A'**	**US level Constellation (mRL) 'B'**	**US level Refuse (mRL) 'C'**	**Pond 1 level (mRL) 'D'**	**Pond 2 level (mRL) 'E'**	**Overflow into Pond 1 (m^3) 'D'**	**Overflow into Pond 2 (m^3) 'E'**	**Total Overflows into Watercare Ponds (m^3)**
Pre-Dev	**4.65**	**21.32**	**48.28**	**43.68**	**37.21**	**37.12**	**0**	**70**	**70**
Option 0	4.83 +4%	21.33 +10mm	48.28 +0mm	43.68 +0mm	37.21 +0mm	37.12 +0mm	0	70 +0%	70 +0%
Option 0A	4.81 +3%	21.33 +10mm	48.28 +0mm	43.68 +0mm	37.21 +0mm	37.12 +0mm	0	70 +0%	70 +0%
Option 1	Hydraulic effects not quantified. Option discarded due to other considerations.								
Option 2	4.04 -13%	21.27 -50mm	48.28 +0mm	43.68 +0mm	37.21 +0mm	37.19 +70mm	0	70 +0%	70 +0%
Option 2a	4.04 -13%	21.27 -50mm	48.28 +0mm	43.68 +0mm	37.21 +0mm	37.19 +70mm	0	70 +0%	70 +0%
Option 3	4.67 -0%	21.32 +0mm	48.28 +0mm	43.69 +10mm	37.21 +0mm	37.12 +0mm	0	70 +0%	70 +0%
Option 4a	4.37 -6%	21.30 -20mm	48.28 +0mm	43.68 +0mm	37.21 +0mm	37.12 +0mm	0	70 +0%	70 +0%
Option 4b	4.43 -5%	21.30 -20mm	48.28 +0mm	43.68 +0mm	37.21 +0mm	37.12 +0mm	0	70 +0%	70 +0%
Option 5	Hydraulic effects not quantified. Option discarded due to other considerations.								