Papawai Stream Options Assessment

Prepared for Wellington Water

Prepared by Beca Limited

20 January 2021

Contents

Revision History

Revision Nº	Prepared By	Description	Date
1	Justine Jones and Stephen Fuller	Draft for client approval	20/08/2020
2	Justine Jones and Stephen Fuller	Draft issue for WCC approval	25/08/2020
3	Justine Jones, Stephen Fuller, Dirk Jansen van Vuuren and Mhairi Rademaker	Updated to include further detail on Options 6, 7 and 8 as requested by WCC	18/12/2020
4	Justine Jones, Stephen Fuller, Dirk Jansen van Vuuren and Mhairi Rademaker	Updated to address WWL comments	20/01/2021

Document Acceptance

Action	Name	Signed	Date
Prepared by	Justine Jones and Stephen Fuller		20/01/2021
Reviewed by	Richard Hickman		20/01/2021
Approved by	Richard Hickman		20/01/2021
on behalf of	Beca Limited and Boffa Miskell		

1 Introduction

Beca has been commissioned to undertake a study to address Wellington City Council (WCC) license condition LC 62. This requires that prior to construction an investigation into opportunities to improve flood management of the Papawai Stream around the Lower Sports Field associated with the Prince of Wales Park, is undertaken to determine if any mitigating solution exists that can feasibly be implemented in conjunction with the Omāroro Reservoir project.

This condition requires the study to consider:

i. Flood management: Any feasible options that may exist to improve the management of flood events in the Papawai Stream that could avoid or reduce the flow of stormwater over the stream's bund edge onto the field and general seepage through the bund into the field

ii. Papawai Stream ecological enhancement: Any feasible options that may exist to enhance the ecological function of the stream in conjunction with any flood management enhancements

iii. Stream enhancement incorporation in lower playing field reinstatement: Any design solutions arising from (i) and/or (ii) that could be practically incorporated into works associated with reinstating the lower playing field following the completion of reservoir backfilling.

1.1 Papawai Stream Existing Condition

Papawai Stream was realigned to its current course to allow sufficient flat ground to develop the lower sports field. Since this major work, a number of additional flood mitigation measures have also been completed. These include:

- circa. 2006 – Papawai Terrace scruffy dome was installed.
- circa. 2011 – Culvert replacement under sports field access road upgraded (Consent Ref 30727)
- circa. 2011 – Sediment and vegetation removal from the bed of the Papawai Stream (Consent No. WGN110123 [30728]).
- 2013 – Bund constructed parallel to stream between the stream and lower sports field
- 2017 – Salisbury Terrace Flood Protection upgrade (Consent WGN170333 [34789] and [34830])
- 2018-2019 – Armouring of Papawai Stream adjacent to sports pavilion (Consent No. WGN34467 and WGN34473)

Figure 1 is a site plan which identifies the key features of the site. Figure 2 is a photo showing the bund, and the saturated area of playing field which requires rectification.

Figure 1 - Papawai Stream Site Location Plan (sourced from Google Maps 2020)

Figure 2 – Papawai Stream Bund showing boggy ground as a result of either over-topping or seepage through the bund wall.

Figure 3 shows the design height of the bund to be in the region of 1.3 m.

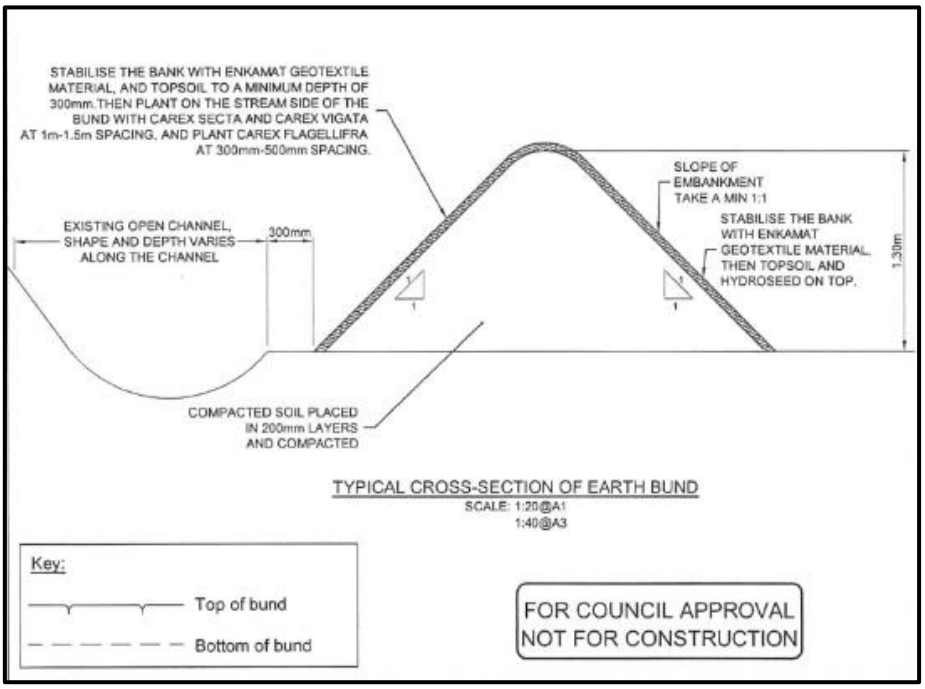


Figure 3 – Extract from Wellington City Council Consent Plan Outlining Typical Bund Cross Section

Site inspection on the 30 July 2020 showed the vertical distance between stream bed and bund crest initially reduces from 0.52 m at the point where the stream meets the sports field and bund to 0.4 m, 25 m downstream. It then steadily increases from 0.4 m to 1.36 m over the length of the stream with the bund meeting the design requirement of 1.3 m at the culvert by the pavilion as shown in Figure 4. This suggests that significant sedimentation has occurred since the bund was constructed so that it no longer meets the design requirements.

Figure 4 – Measurements from stream bed to crest of bund (stream flows from bottom (south) to top (north)) as at 30 July 2020.

1.2 Current Flood Mapping

Wellington Water (WWL) has provided flood mapping of the site (Figure 5) which shows the modelled flood risk to the lower playing field for the 10% annual exceedance probability (AEP, equivalent to the 10 year average recurrence interval) flood event. This is the smallest duration storm event that WWL hold information on for this watercourse.

This modelling is based on the following assumptions:

1. 690 mm diameter culvert under the access track adjacent to the sports pavilion in the north eastern corner of the site;
2. Bund constructed parallel to the Papawai Stream around the western edge of the sports field was constructed as per WCC design (Figure 3).
3. Stream bed 1.3 m minimum below crest of bund over length of bunded waterway.

Figure 5 - Wellington Water 10% AEP Flood Map

Anecdotal evidence of flooding at the site does not correspond to the flood mapping shown in Figure 5. It is likely this change in flooding is due to high levels of sedimentation within the Papawai Stream channel noted during site visits and illustrated in Figure 4 and Figure 6a-c below.

This has resulted in significantly reduced capacity behind the flood bund and likely overtopping of the bund in events less than a 10% AEP flood event and flooding across the sports field towards the pavilion.

Figure 6a – Papawai Stream Bund at the low point where the stream bed lies 400mm below the crest of the bund.

Figure 6b – Culverted crossing. Culvert interior dimension 690mm. Bund visible top centre.

Figure 6c – Sports pavilion with Papawai stream descending along its eastern wall.

2 Methodology

The assessment outlined in this report has been undertaken following the methodology outlined below:

- Confirm with WCC the current level of protection (10% AEP) and the options assessed are acceptable.
- Undertake a site visit and walkover of the immediate catchment and upstream of the site.
- Review available reporting from previous assessments and stream modification works. This included information on the existing Papawai Stream realignment, sports field bunding and Papawai Terrace drainage upgrade.
- Develop a matrix to assess options outlined above against the requirements of the consent condition and feasibility of the options in relation to the Omāroro Reservoir project.

After review of the options assessment provided by WCC further work was undertaken as outlined below:

- Update the report to include further detail on likely maintenance requirements for options 6, 7 and 8 (top three options).
- Undertake high level capital expenditure (CAPEX) and operational expenditure (OPEX) costings for the top three options identified.
- Undertake high level planning review for the top three options identified.

This options assessment has not considered any upstream options for management of the Papawai Stream flow as these are considered to be infeasible for implementation in conjunction with the reservoir project.

3 Options Assessment

Beca and Boffa Miskell have collaborated to develop a list of options for assessment to address condition LC 62. These options do not reconsider the works previously undertaken as outlined in bullet points 3 and 4 of Section 1.1.

The options considered further in this study are outlined below:

1. Do nothing
2. Raise the bund
3. Return stream to 2013 design and upgrade culvert under sports field access track
4. Stop seepage through bund
5. Stop seepage through bund, return stream to 2013 design and increase culvert size under access track
6. Increase width of Papawai Stream channel at southern entry to sports field, stop seepage through southern portion of bund, return stream to 2013 design and increase culvert size under access track
7. Install sediment trap designed for 10% AEP at southern entry to the sports field diverting flows back into stream coupled with stopping seepage through southern portion of bund, returning stream to 2013 design and increase culvert size under access track
8. Install sediment trap designed for 10% AEP at southern entry to the sports field piping flows under the sports field and discharging back into the stream downstream of the access track culvert coupled with stopping seepage through southern portion of bund and returning stream to 2013 design
9. Increase stream basal gradient through the site
10. Replace the lower sports field with a constructed wetland habitat

Each of the options presented has been assessed against the condition criteria. The results of the assessment are outlined in Table 1 below.

Table 1 – Options Assessment

#	Option	Option Outline	Implications of Option	Anticipated Interventions Required	Does Option Meet Resource Consent Condition Requirements (as outlined in Section 1)? Requirement i	Requirement ii	Requirement iii
1	Do nothing	No change to existing stream maintenance schedules or improvements undertaken to manage existing issues relating to flooding of the sports field or downstream residential properties.	Stream sedimentation levels remain and continue to increase at existing rates. Seepage through bund continues. Stream will overtop bund at some point in the near future.	Design remains as currently, no future intervention proposed.	**NO IMPROVEMENT** Likely to increase playing field flooding as sedimentation increases to meet the top of the bund over time (possibly within next 2-5 years based on visual assessment of historical aerial imagery). When bund is overtopped stream could potentially reclaim previous route across sports field. Seepage is not managed.	**NO IMPROVEMENT** Ecological enhancement not provided; however, current situation will be maintained for next few years until bund is overtopped.	**NOT APPLICABLE**
2	Raise the bund	Increase the height of the bund to restore some of the original 1.3 m separation distance between the current stream water level and top of bund.	Figure 3 outlines a uniform side slope design, however, due to space constraints the bund cross section would have to be amended to increase the slope on the sports field side only. This limits the increase in bund height to 0.5 m before it starts impacting on the sports field playable areas (based on a limit of increasing the footprint of the bund by 1m towards the playing surface). The bund may require to be redesigned to manage slope stability with the increased size of the bund. If the bund is redesigned then the seepage issue could be addressed at the same time. If the bund stability was not impacted by the increased height seepage would continue to be an issue with this option. The bund is currently used as an informal walkway through the lower sports field; therefore handrails may be required to manage possible safety risks to park users. Stream sedimentation levels remain as current and continue to increase at existing rates.	Planning consents may be required for works. Civil works will be necessary to enable this option to proceed. It is anticipated that the following work would be required: Review current geotechnical design of bund to confirm stability when bund height is increased. Assuming existing design is sufficient bund height increased with compacted earth and sports field side slope increased. Possible installation of handrail and formalization of current informal path along top of bund. This would be a one-off construction. This option delays stream overtopping for up to 5 years based on current sedimentation levels.	**NO IMPROVEMENT – delayed implications** Defer flooding for up to approximately 5 years (based on visual assessment of historical aerial imagery and a maximum increase in bund height of 0.5 m). When bund is overtopped stream could potentially reclaim previous route across sports field. Seepage is not managed.	**NO IMPROVEMENT – delayed implications** No change to ecological environment in short term until bund is overtopped. Could potentially increase velocity in stream which may impact fish abundance.	**YES**

#	Option	Option Outline	Implications of Option	Anticipated Interventions Required	Does Option Meet Resource Consent Condition Requirements (as outlined in Section 1)? Requirement i	Requirement ii	Requirement iii
3	Return stream to 2013 design, ongoing maintenance of the streambed and upgrade culvert under sports field access track	Dredging of stream bed to restore the 1.3 m separation between base of stream and top of bund (as outline in Figure 3). Increase culvert size under access track.	Channel sedimentation continues at current rate. This will require regular dredging to maintain stream capacity. Based on review of aerial imagery dredging frequency is likely to be within the order of every 5 years (based on the assumption the bund was constructed in 2013 and the sports field started being impacted by water seepage through the bund in 2018). Additional dredging may be required more frequently after significant rainfall events. Culvert upgrade reduces flood risk currently identified in flood modelling.	The following steps would be required for each dredging operation: Planning consent for works in bed of stream. Ecological works including: • fish salvage • reinstatement of channel habitat after dredging including placement of gravels, boulders, woody debris and replanting vegetation • replace fish Civil works including: • track machinery across sports field • install coffer dams • divert channel through temporary system • excavate and truck away dredged material • reinstate field surface • repair any damage to the bund • replace culvert under access track with larger capacity culvert. • reinstate access track	**PARTIAL IMPROVEMENT** Stream capacity would be increased from current condition temporarily.	**NO IMPROVEMENT** Ecological habitat would be repeatedly degraded approximately every 5 years.	**YES**
4	Stop seepage through bund	Replace existing bund along entire length with redesigned bund which stops seepage of stream onto sports field. This option improves ground conditions within the sports field but does not manage sediment deposition which leads to flooding of downstream environment.	Figure 3 indicates that the bund geotextile layer has not been anchored into the ground to create a barrier stopping groundwater and stream seepage at the base of the bund. Redesign would manage this improving ground conditions within the sports field. Stream sedimentation levels remain as current and continue to increase at existing rates. As per option 1 the bund will be overtopped in the future.	Planning consents may be required for works. Civil works will be necessary to enable this option to proceed. It is anticipated that the following work would be required: Redesign geotechnical membrane layer to stop seepage of water from stream. Install coffer dams and divert channel through a temporary system. Remove existing bund and construct new bund. This would be a one-off construction. It is assumed this work could be undertaken without extensive ecological works being required.	**PARTIAL IMPROVEMENT** Ground conditions improved on sports field only.	**NO IMPROVEMENT** Ecological habitat would be repeatedly degraded approximately every 5 years	**YES**
5	Stop seepage through bund, return stream to 2013 design, ongoing maintenance of the streambed and increase culvert size under access track	Replace existing bund along entire length with redesigned bund which stops seepage of stream onto sports field. Dredging of stream bed to restore the 1.3 m separation between base of stream and top of bund (as outline in Figure 3).	Channel sedimentation continues at current rate. Regular dredging is required to maintain stream capacity as outlined in Option 3. As outlined in Option 4 bund redesign would be anchored into the ground to create a barrier stopping groundwater and stream seepage at the base of the bund.	As outlined in Options 3 and 4 and summarized below: • Planning consents may be required for works. • Ecological works required approximately every 5 years. • Civil works required every 5 years which will require reinstatement of playing surface.	**YES**	**NO IMPROVEMENT** Ecological habitat would be repeatedly degraded approximately every 5 years.	**YES**

#	Option	Option Outline	Implications of Option	Anticipated Interventions Required	Does Option Meet Resource Consent Condition Requirements (as outlined in Section 1)? Requirement i	Requirement ii	Requirement iii
6	Increase width of Papawai Stream channel at southern entry to sports field, stop seepage through southern portion of bund, return stream to 2013 design and increase culvert size under access track	Develop a small-scale wetland/sedimentation basin within the approximately 270 m^2 of the lower sports field not currently being utilised for recreational sports (this may be able to be increased to 560 m^2 with removal of some trees). Upgrade the bund in the vicinity of the wetland/basin to limit seepage onto sports field. Dredge the stream bed to restore the 1.3 m separation distance.	Channel sedimentation continues at reduced rate as most sediment will be dropped out in specifically designed basin/wetland. Initial guesstimate on frequency of stream dredging is every 5-10 years. As outlined in Option 4 bund redesign would be anchored into the ground to create a barrier stopping groundwater and stream seepage at the base of the bund. Rest of the bund would remain as currently designed. Increasing the width (and therefore capacity) of the stream channel where it emerges beside the playing field, would provide a small area of wetland in line with natural size stream without impacting on playing field.	As outlined in Options 3 and 4 and summarized below: • Planning consents may be required for works. • Ecological works required approximately every 5-10 years within stream. • Wetland monitoring and maintenance required annually (plant survival, weeds, insect pests, inlet – outlet function), reviewed every five years with regard to deposition and potential excavation, and with potential event monitoring after floods. • Wetland maintenance can be reduced if flows limited to small to moderate rainfall events, and large events (e.g. 5 yr plus) bypass to stream/culvert. • Civil works required every 5 years which will require reinstatement of playing surface.	**YES** Works are targeted to area where seepage is most prevalent. Additional storage is provided for sedimentation which improves capacity of stream downstream.	**YES** Extended habitat at entrance to sports field with less frequent dredging and more natural frequency of degradation than provided with Option 3.	**YES**
7	Install sediment trap designed for 10% AEP at southern entry to the sports field diverting flows back into stream coupled with stopping seepage through southern portion of bund, returning stream to 2013 design and increase culvert size under access track	Divert all flows greater than stream base flow through a sediment trap located in the same location as the wetland proposed in Option 6. This would capture the majority of the sediment reducing the degree of sedimentation within the stream channel itself. Upgrade bund to limit seepage onto sports field in the vicinity of the sediment trap only. Dredge the stream bed to restore the 1.3 m separation distance.	Dredging of channel is almost eliminated. As outlined in Option 4 bund redesign would be anchored into the ground to create a barrier stopping groundwater and stream seepage at the base of the bund. Base flows continue through stream to maintain fish passage Sediment trap would have to be located above ground to allow flows to be redirected back into the stream from the sediment trap.	As outlined in Options 3 and 4 and summarized below: • Planning consents may be required for works. • Ecological works limited to stream bed and likely to be required infrequently. • Civil works of bund limited to southern portion of bund only. Civil works for sediment trap as outlined below: • design structure for 10 year event • inspection of trap after flood events/as per design specs • hardened track access around edge of playing field suitable for maintenance vehicle access which may be within the field runoff zone required by WCC	**YES** Works are targeted to area where seepage is most prevalent. Additional storage is provided for sedimentation which improves capacity of stream downstream.	**YES** Eliminates need for ongoing dredging.	**YES**
8	Install sediment trap designed for 10% AEP at southern entry to the sports field piping flows under the sports field and discharging back into the stream downstream of the access track culvert coupled with stopping seepage through southern portion of bund and returning stream to 2013 design	Divert all flows greater than stream base flow through a sediment trap located in the same location as the wetland proposed in Option 6. This would capture the majority of the sediment reducing the degree of sedimentation within the stream channel itself. Upgrade bund to limit seepage onto sports field in the vicinity of the sediment trap only. Dredge the stream bed to restore the 1.3 m separation distance.	Dredging of channel is almost eliminated. As outlined in Option 4 bund redesign would be anchored into the ground to create a barrier stopping groundwater and stream seepage at the base of the bund. Base flows continue through stream to maintain fish passage, remaining flows directed under sports field to downstream side of access track eliminating flooding currently shown in modelling. Sediment trap could be buried allowing this ground to be utilized for ad hoc recreation.	As outlined in Option 7 with the addition of the following civil works: • design pipe for 10% AEP event • laying pipe under sports field (while manholes would be needed every 90 m to comply with WCC standards a high-level review confirmed that the system could be designed without manholes being required within the playing surface) • construction around pavilion footings • new headworks into stream at Pavilion	**YES** Works are targeted to area where seepage is most prevalent. Additional storage is provided for sedimentation which improves capacity of stream downstream.	**YES** Eliminates need for ongoing dredging.	**YES**

#	Option	Option Outline	Implications of Option	Anticipated Interventions Required	Does Option Meet Resource Consent Condition Requirements (as outlined in Section 1)?		
					Requirement i	Requirement ii	Requirement iii
9	Increase stream basal gradient through the site.	Regrade the stream from the southern entry of the sports field to the downstream side of the access track culvert by the sports pavilion.	Dredging of channel may be eliminated if grade is sufficient to increase flow velocity therefore reducing sediment deposition, however, sedimentation is likely to move downstream to shallower pipe system within residential area. May be able to remove the bund if channel is deeper than the field, particularly along the northern end of the stream.	The following steps would be required for each dredging operation: Planning consent for works in bed of stream. Ecological works including: • fish salvage • reinstatement of channel habitat after dredging including placement of gravels, boulders, woody debris and replanting vegetation • replace fish Civil works including: • install coffer dams • divert channel through temporary system • regrade channel bed, this may require retaining in places depending on depth, and truck away dredged material • install handrail if required based on depth of stream from top of bund • remove or repair any damage to the bund • replace culvert under access track with larger capacity culvert • pavilion foundations may need to be reviewed and potentially redesigned	**YES**	**NO IMPROVEMENT** Potentially detrimental to fish population depending on grade change and flow velocity.	**YES**
10	Replace the lower sports field with a constructed wetland habitat	Lower sports field is removed and replaced by a wetland taking up the majority of the space. Papawai Stream redirected through the wetland re-joining the existing channel at the pavilion. Removal of the culvert under the access track.	The lower sports field would no longer be viable. A constructed wetland would not be replacing lost habitat as a wetland would not have naturally occurred in this location. Discharge to the wetland of Papawai Stream and deposition would require regular excavation of sacrificial portions of the wetland. In addition, it is likely that Papawai Stream has insufficient flow to support a wetland the size of the playing field. Large wetlands in residential areas are susceptible to issues such as odour (via decomposition) and insect pests (such as mosquitos and midges) which often lead to complaints, and sometimes cannot be rectified. If all current structures are maintained these will manage flooding removing the need for flood storage.	The following steps would be required: • Planning consent for works in bed of stream. • Long term maintenance of wetland planting.	**YES** Flood storage provided; however, this scale of flood storage is not required at this point in the catchment.	**YES** Habitat could be created, and fish populations expanded, however, for this to be sustainable throughout the year a much smaller area would be required which has a better balance with the stream flow.	**NOT APPLICABLE**

4 Multi-Criteria Analysis

Each of the options outlined in Table 1 were then assessed as part of a multi-criteria analysis. This assessed the following criteria:

- Capital Cost (not including consenting or design) – Nil[1], Low[2], Moderate[3], High[4], Very High[5]
- Operational Cost – Nil, Low, Moderate, High
- Maintenance – Nil, Low, Moderate, High
- Flood Management Potential – Poor[6], Status Quo[7], Improved[8]
- Ecological value – Poor, Status Quo, Improved
- General Public Health and Safety – Poor, Status Quo, Improved
- Operator/Contractor Public Health and Safety – Poor, Status Quo, Improved

Table 2 outlines the results of each option against the multi-criteria analysis.

[1] No cost implication or maintenance required

[2] Cost less than $250,000 or infrequent maintenance which does not require specific technical skills

[3] Cost between $250,000 and $750,000 or regular maintenance

[4] Cost between $750,000 and $1,000,000 or frequent maintenance which may require specialist knowledge or equipment

[5] Cost exceeds $1,000,000

[6] Increases risk

[7] Risk remains as currently

[8] Risk is reduced

Table 2 – Multi-Criteria Analysis

Option #	Capital Cost	Operational Cost	Maintenance	Flood Management Potential	Ecological Enhancement	Public Health and Safety	Contractor Health and Safety
1	Nil	Nil	Nil	Poor	Status Quo	Status Quo	Status Quo
2	Low or Moderate[9]	Nil	Nil	Poor	Status Quo	Poor	Status Quo
3	Low	Moderate	Low	Improved	Poor	Status Quo	Status Quo
4	Low	Nil	Low	Poor	Status Quo	Improved	Improved
5	Low	Moderate	Low	Improved	Poor	Improved	Improved
6	Low	Moderate	Moderate	Improved	Improved	Improved	Improved
7	High	High	Moderate	Improved	Improved	Poor	Poor
8	Very High	High	Moderate	Improved	Improved	Poor	Poor
9	Very High	Moderate	High	Improved	Poor	Poor	Poor
10	High	Moderate	High	Improved	Improved	Poor	Poor

[9] Subject to bund design review (low is bund design not undertaken, medium if redesign is required)

4.1 Ranking System

The options were then ranked to determine preferred options for further investigation of feasibility and applicability to being undertaken as part of the reservoir construction project. The options were ranked based on the requirements of the resource consent condition; primarily the option has to improve flood management of the downstream catchment, then the option should maintain and where possible enhance the existing ecological environment found in the Papawai Stream around the sports field. The options were then assessed to ensure that public and contractor health and safety was not being put at risk (as outlined in Table 3).

Table 3 – Ranking Matrix

Ranking	Flood Management Improved	Ecological Enhancement Improved	Health and Safety Improved
1	Improved	Improved	Improved
2	Improved	Improved	Status Quo/Poor
3	Improved	Status Quo/Poor	Improved
4	Improved	Status Quo/Poor	Status Quo/Poor

The results of the assessment are presented in Table 4 below.

Table 4 – Ranked Options

Rank	Option #	Capital Cost	Operational Cost	Maintenance	Flood Management Potential	Ecological Enhancement	Public Health and Safety	Contractor Health and Safety
1	6	Low	Moderate	Moderate	Improved	Improved	Improved	Improved
2	7	High	High	Moderate	Improved	Improved	Poor	Poor
2	8	Very High	High	Moderate	Improved	Improved	Poor	Poor
2	10	High	Moderate	High	Improved	Improved	Poor	Poor
3	5	Low	Moderate	Low	Improved	Poor	Improved	Improved
4	3	Low	Moderate	Low	Improved	Poor	Status Quo	Status Quo
4	9	Very High	Moderate	High	Improved	Poor	Poor	Poor
NA[10]	1	Nil	Nil	Nil	Poor	Status Quo	Status Quo	Status Quo
NA	2	Low or Medium	Nil	Nil	Poor	Status Quo	Poor	Status Quo
NA	4	Low	Nil	Low	Poor	Status Quo	Improved	Improved

[10] Not accessed because do not meet resource consent criteria.

5 Further Assessment of Top Three Options

Table 4 identified the top three options as:

1. Option 6 - Increase width of Papawai Stream channel at southern entry to sports field, stop seepage through southern portion of bund, return stream to 2013 design and increase culvert size under access track

2. Option 7 - Install sediment trap designed for 10% AEP at southern entry to the sports field diverting flows back into stream coupled with stopping seepage through southern portion of bund, returning stream to 2013 design and increase culvert size under access track

3. Option 8 - Install sediment trap designed for 10% AEP at southern entry to the sports field piping flows under the sports field and discharging back into the stream downstream of the access track culvert coupled with stopping seepage through southern portion of bund and returning stream to 2013 design

On review of this options assessment WCC requested the following additional analysis be undertaken to allow a decision to be made regarding which options to be progressed:

- Update the report to include further detail on likely maintenance requirements for options 6, 7 and 8 (top three options).
- Undertake high level CAPEX and OPEX costings for the top three options identified.
- Undertake high level planning review for the top three options identified.

5.1 Refining Options

Drawing numbers 3262332-CE-T006, T007 and T008 (Appendix A) outline in a little more detail the proposed options to manage stormwater in the Papawai Stream, providing cross sections of the anticipated final system and indicative locations of devices proposed.

The further work undertaken identified a number of additional constraints in the applicability of some of the options. These are outlined below.

5.1.1 Option 7

The design requires the sediment trap to be placed above ground and at a higher elevation that the downstream discharge point to allow the system to work via gravity. Review of levels outside the Town Belt and within the remit of the Omāroro Reservoir project indicated that it would be very difficult to design such a system within the constraints of the site. The sediment trap would need to be located upstream of the site to allow flow from the Papawai Stream into and out of the system and back into the stream without mechanical assistance.

5.1.2 Option 8

The proposed option requires the sediment trap to be buried underground and the discharge pipe from the sediment trap to outlet by the Sports Pavilion. Review of the depth of the irrigation system under the lower sports field and the depth of the Papawai Stream at the Sports Pavilion make getting a suitable grade on the discharge pipe system for the pipe to be self-cleaning very unlikely. It is not recommended that this option is progressed further given these constraints to the design.

5.2 Maintenance Requirements

All maintenance operations would be accessed via a reinforced grassed maintenance road which is shown in Drawings 3262332-CE-T006, T077 and T008. This access road shown on the plans is for illustration purposes only (with no design work having been undertaken to date) but shows that it is likely there is sufficient space available to design a access track wide enough to allow appropriate maintenance vehicles to the stream. It is proposed the access road is formed using a grasscrete or similar system which provides structural support while allowing grass to grow through the system. This will allow maintenance of this road to be undertaken at the same time as the sports field maintenance.

5.2.1 Option 6

Maintenance for Option 6 can be summarised as follows:

- Assessment of performance of the system after all major storms to confirm whether ad hoc maintenance work is needed to ensure system works as designed.
- Monitoring of the sediment basin/wetland vegetation following any rainfall event greater than a 5 year average recurrence interval storm event, and one-off repairs as required.
- General review and necessary maintenance (vegetation repair, armouring, channel repair) of the sediment basin/wetland vegetation every 2 years.
- Removal of sediment from the sediment basin/wetland approximately every 5 years.
- Replanting of basin after sediment removal.
- Dredge stream approximately every 10+ years to maintain capacity for larger storm events.

Based on the information available at this stage it is estimated that construction could be undertaken during a period of 6 weeks with stream diversion, where needed, for half of this time.

5.2.2 Option 7

Maintenance for Option 7 can be summarised as follows:

- Assessment of performance of the system after all major storms to confirm whether ad hoc maintenance work is needed to ensure system works as designed.
- Removal of sediment from the gravel trap annually using a street sweeper vacuum truck or similar.
- Dredge stream approximately every 10 years to maintain capacity for larger storm events.

Based on the information available at this stage it is estimated that construction could be undertaken during a period of 6 weeks with stream diversion, where needed, for half of this time.

5.2.3 Option 8

Maintenance for Option 8 can be summarised as follows:

- Assessment of performance of the system after all major storms to confirm whether ad hoc maintenance work is needed to ensure system works as designed.
- Investigation and potential removal of any debris build up behind the screens for discharge pipe from the gravel trap twice a year (around autumn and winter).
- Removal of sediment from the gravel trap annually using a street sweeper vacuum truck or similar.
- Flushing out of the discharge pipe of sediment build up every 5 years.

Based on the information available at this stage it is estimated that construction could be undertaken during a period of 6 weeks with stream diversion.

5.3 Cost Assessment

5.3.1 Capital Expenditure

Presented below in Table 5 is a high level cost estimate. This estimate is based on very high level conceptual optioneering. No design has been undertaken to underpin these costings. Further design, investigation and safety reviews are required to confirm the project scope and corresponding budget.

All assumptions made when undertaking these costs are outlined in the Appendix B.

Due to the stage of development of the concepts a confidence level of +/-30% should be applied to the costs below.

Table 5 – High Level CAPEX Cost Estimates

Papawai Stream Study Options	Base estimate	Total Estimated Cost	Cost Range (based on +/. 30% confidence)
Option 6	$211,500	$470,000	$329,000 - $611,000
Option 7	$956,000	$1,950,000	$1,365,000 - $2,535,000
Option 8	$1,030,000	$2,094,000	$1,466,000 - $2,722,000

5.3.2 Operational Costs

Presented below in Table 6 is a high level OPEX cost estimate. This estimate is based on very high level conceptual operating cost models aligned with the scope described in Section 5.2.

Due to the uncertainty around the concepts costed a confidence level of +/-30% has been considered.

Table 6 – High Level OPEX Cost Estimates

Papawai Stream Study Options	OPEX cost/Year	OPEX Cost/10 Years
Option 6	$19,000 - $26,000	$189,000 - $251,000
Option 7	$16,000 - $21,000	$155,000 - $207,000
Option 8	$13,000 - $18,000	$130,000 - $173,000

5.4 Planning Considerations

5.4.1 Wellington City Council Requirements

The works for Options 6, 7 and 8 are all within the footprint of the Omāroro Reservoir Designation and Wellington Town Belt Licence/easement.

The Omāroro Reservoir Designation includes remediation of the Sports Field following construction. Improving the flood management of the Papawai Stream is considered to fall within the scope of the Lower Sports Field remediation and therefore within the scope of the designation. It is considered that all three options could be undertaken under the designation with submission of an Outline Plan to WCC in accordance with section 176 of the Resource Management Act 1991 (RMA).

The investigation into flood management opportunities is required by a condition of the Omāroro Town Belt licence. While it does not automatically follow that any works recommended by the investigation are also covered by the licence, the licence covers the same Lower Sports Field Remediation works as the designation and therefore, it is considered that all three options are within the scope of the existing licence.

5.4.2 Greater Wellington Regional Council requirements

There are a number of aspects common to all three options; including:

- Returning the stream to the 2013 design which is assumed to include removal of accumulated bed.
- Sediment in the first instance and then (more importantly) ongoing maintenance of the stream and any new structures.
- Stopping seepage through the southern portion of the bund through reconstruction of that section of bund.
- Increasing the size of the culvert under the access track.

The planning implications of these activities are considered below.

- **Maintenance of the Papawai Stream including sediment removal (e.g. dredging)**
  - Discretionary activity under PNRP Rule R129 (All other uses of river and lake beds): Rule R121 (Maintenance of drains and highly modified rivers or streams) provides for the removal of bed material and associated sediment from highly modified streams. While the Papawai Stream may fall within the definition of highly modified stream, it is arguably managed by WWL as part of the stormwater network making its classification uncertain. Regardless, ongoing maintenance of the Papawai Stream (and any of the structures included in options 6, 7, and 8) will be a key part of the flood management strategy and to provide future certainty, it is recommended that an ongoing maintenance consent is obtained that covers all anticipated maintenance activities for the reach (including for any new structures). This would require consent as a Discretionary Activity under the catch-all rule R129.
  - Discretionary activity under PNRP Rule R131 (Damming or diverting water within or from rivers): Ongoing sediment removal is assumed to require periodic diversion (for example by way of over-pumping or diversion channel) of flows from the stream for a period of 2-3 days every 5-10 years. Temporary diversion is not provided for by a specific rule and therefore would require consent as a Discretionary Activity under catch-all rule R131
  - Key considerations: Type and frequency of anticipated maintenance activities, fish rescue/relocation, sediment management, remediation post-dredging, consistency with the National Policy Statement for Freshwater Management 2020 (NPSFM) which requires (among other things) avoidance of the loss of stream extent and value (unless functional need is demonstrated), the protection of habitats of indigenous freshwater species, and management of streams firstly for the health and well-being of water bodies and freshwater ecosystems, then for the health needs of people, and finally for the social, economic and cultural well-being of people and communities.

- **Reconstruction of the southern portion of the bund**
  - Permitted activity (in part) under PNRP Rule R113 (diversion of flood water by existing structures): Rule R113 provides for diversion of flood waters by existing structures provided that the size of the stopbank or structure shall not increase by more than 5% of the plan or cross-sectional area from 31 July 2015. It is expected that the majority of the bund can comply with this rule.
  - Discretionary activity (in part) under PNRP Rule R135 (general rule for damming and diverting water): Where the requirements of Rule R113 cannot be met or where relocation of the bund is required under Options 6 and 7, Discretionary Activity Rule R135 would apply.
  - Key considerations: Upstream and downstream flood impacts, erosion and scour/deposition effects.

- **New (larger) culvert under the access track**
  - Discretionary activity under PNRP Rule R129 (All other uses of river and lake beds): Rule R115 (Culverts) allows for new culverts as a permitted activity subject to a number of conditions including a maximum culvert length of 20m and maximum width of 1.2m. Assuming that the culvert replacement will be larger than this, consent would be required as a Discretionary Activity under the catch-all rule R129.
  - NESFW Regulation 71 (Culverts - Discretionary Activities): NESFW Regulation 70 (Permitted Activities) sets out the requirements for culverts to be allowed as a permitted activity including: water velocity shall be no greater than adjoining reaches, culvert to be embedded 25%, substrate must be present and

stable below 80% flows. These conditions are intended to provide for fish passage and may be achievable; however, meeting these conditions should not be given priority over a robust hydraulic design where fish passage can be otherwise demonstrated. Where the conditions are not met, consent would be required as a Discretionary Activity under Regulation 71.

- NESFW Regulation 62 (Requirement for all activities: information about structures and passage of fish) and 63 (Requirement for culvert activities: information about culverts): Whether Regulation 70 or 71 applies to the culvert, the information specified in NESFW Regulations 62 and 63 must be provided to GWRC post-construction.
- Key considerations: Fish passage, hydraulic design, erosion and scour.

Option 6 includes a diversion of the stream at the southern end of the field to create a small flood terrace. The planning implications of these activities are considered below:

- **Discretionary activity under PNRP Rule R131 (Damming or diverting water within or from rivers):** The permanent diversion that would be required is not provided for by a specific rule and therefore would require consent as a Discretionary Activity under catch-all rule R131.
- **Key considerations:** Fish passage / exclusion, erosion and scour, consistency with the NPSFM which requires (among other things) avoidance of the loss of stream extent and value (unless functional need can be demonstrated), the protection of habitats of indigenous freshwater species, and management of streams firstly for the health and well-being of water bodies and freshwater ecosystems, then for the health needs of people, and finally for the social, economic and cultural well-being of people and communities. It should also be made clear in any consent application that the flood terrace area is being constructed for stormwater management purposes (and not ecological purposes) to ensure that it is not inadvertently captured by the definition of natural wetland.

Option 7 includes the installation of a sediment trap in or adjacent the stream upstream of the field which discharges back into the existing stream alignment. The planning implications of these activities are considered below:

- **Discretionary activity under PNRP Rule R129 (All other uses of river and lake beds):** Rule R117 (New Structures – Permitted Activity) provides for new structures as a permitted activity subject to conditions including a requirement that the structure "*shall not alter the natural course of the river, including any diversion of water from the natural course during floods*". The proposed sediment trap would include a diversion and is unlikely to comply with Rule R117 as a permitted activity; therefore, consent would be required as a Discretionary Activity under the catch-all rule R129.
- **Discretionary activity under PNRP Rule R131 (Damming or diverting water within or from rivers):** The diversion of flows through the sediment trap is not provided for by a specific rule and therefore would require consent as a Discretionary Activity under catch-all rule R131.
- **Discretionary activity under NESFW Regulation 73 (Weirs - Discretionary Activities):** It is unlikely that all conditions of Regulation 73 (Permitted Activities) will be met and therefore consent would be required as a Discretionary Activity.
- **NESFW Regulation 62 (Requirement for all activities: information about structures and passage of fish) and 64 (Requirement for weir activities: information about weirs):** Whether Regulation 72 or 73 applies to the weir structure, the information specified in NESFW Regulations 62 and 64 must be provided to GWRC post-construction.
- **Key considerations:** Fish passage / exclusion, erosion and scour, consistency with the NPSFM which requires (among other things) avoidance of the loss of stream extent and value, the protection of habitats of indigenous freshwater species, and management of streams firstly for the health and well-being of water bodies and freshwater ecosystems, then for the health needs of people, and finally for the social, economic and cultural well-being of people and communities.

Option 8 includes installation of two weirs in the stream (design to be confirmed) to divert flood flows (>10% AEP) to a sediment trap/sump and piped diversion under the sports field. Base flows would remain in the existing channel. The planning implications of these activities are considered below:

- **Discretionary activity under PNRP Rule R129 (All other uses of river and lake beds):** Rule R117 (New Structures – Permitted Activity) provides for new weirs as a permitted activity subject to conditions; however, this includes a requirement that the structure "*shall not alter the natural course of the river, including any diversion of water from the natural course during floods*". Therefore, consent would be required as a Discretionary Activity under the catch-all rule R129.
- **Discretionary activity under PNRP Rule R131 (Damming or diverting water within or from rivers):** The diversion of flood flows through a pipe is not provided for by a specific rule and therefore would require consent as a Discretionary Activity under catch-all rule R131.
- **Discretionary activity under NESFW Regulation 73 (Weirs - Discretionary Activities):** It is unlikely that all conditions of Regulation 73 (Permitted Activities) will be met and therefore consent would be required as a Discretionary Activity.
- **NESFW Regulation 62 (Requirement for all activities: information about structures and passage of fish) and 64 (Requirement for weir activities: information about weirs):** Whether Regulation 72 or 73 applies to the weir structure, the information specified in NESFW Regulations 62 and 64 must be provided to GWRC post-construction.
- **Key considerations:** Fish passage / exclusion (assuming fish passage excluded over the diversion weir), maintenance of base flows including regular maintenance of stream channel to maintain capacity (and ensure that diversion only occurs above 10% AEP), erosion and scour at pipe outlet, consistency with the NPSFM which requires (among other things) avoidance of the loss of stream extent and value, the protection of habitats of indigenous freshwater species, and management of streams firstly for the health and well-being of water bodies and freshwater ecosystems, then for the health needs of people, and finally for the social, economic and cultural well-being of people and communities.

5.4.3 Summary of Planning Considerations

While the consent status for all options is likely to be the same (ie a Discretionary Activity), there is likely to be variation in the consistency of the options with the regional plan, regional policy statement, and the NPSFM. The NPSFM and associated National Environmental Standards for Freshwater are both recent documents and variations in interpretation across the country are causing challenges for works involving waterbodies, particularly where diversions are concerned.

Option 8 involves a permanent diversion of flood flows through a pipe. While this may have "stormwater management" advantages it requires additional hard infrastructure. As one of the last remaining sections of "daylighted" stream within the central city, maintain the natural processes of the Papawai Stream to the extent practicable is seen as important. Similarly, the weir structure in Option 7 does not appear consistent with the desired maintenance of the stream in a natural state to the extent practicable.

Option 6 appears to be best balance the desire to maintain a natural stream environment with stormwater and flood management requirements.

Further, where there may be any loss of stream extent or value, the NPSFM requires demonstration of functional need for the works. As the Papawai Stream is managed, at least in part, for stormwater management purposes, there is a functional need to undertake stormwater management within the stream. However, even where a functional need exists, the expectation of the mitigation hierarchy is that effects are first avoided before being remedied, mitigated, or offset. Where a viable option exists that avoids construction of weir structures, it will be difficult to argue consistency with the mitigation hierarchy unless there are other matters that outweigh the effects of the structures (for instance long-term maintenance requirements).

From a maintenance perspective, Option 8 provides a significant advantage in that the pipe can be used as a full temporary diversion during periodic clearing of the stream. This would avoid requiring temporary works such as overpumping. However, on the basis that each maintenance round would be in the order of 2-3 days, the need to temporarily overpump is not seen as a significant flaw in Options 6 or 7.

Overall, Option 6 is considered most consistent with the regulatory requirements and national policy.

Whichever option is selected, developing a robust plan for management of ongoing stream maintenance, in particular ecological remediation post-dredging, will be critical to demonstrate consistency with the NPSFM stream management hierarchy (management of streams firstly for the health and well-being of water bodies and freshwater ecosystems, then for the health needs of people, and finally for the social, economic and cultural well-being of people and communities).

6 Preferred Option – Option 6

Using the assessment matrix outlined in Table 3 the ten options were reviewed and ranked as detailed below in Table 4. This identified the top three options for management of the 10 year stormwater flows through the site to be Options 6, 7 and 8. Further analysis was undertaken on the practicality, cost and planning implications of these options. All this worked identified that Option 6 was the preferred option; practically it is the easiest option to design and install, the CAPEX cost of the option is the lowest (of the top three options identified), while the OPEX cost is slightly higher over a 10 year period the system is still cheaper than other options reviewed and the planning implications are the most straight forward given this option is the most 'natural' of those reviewed.

A

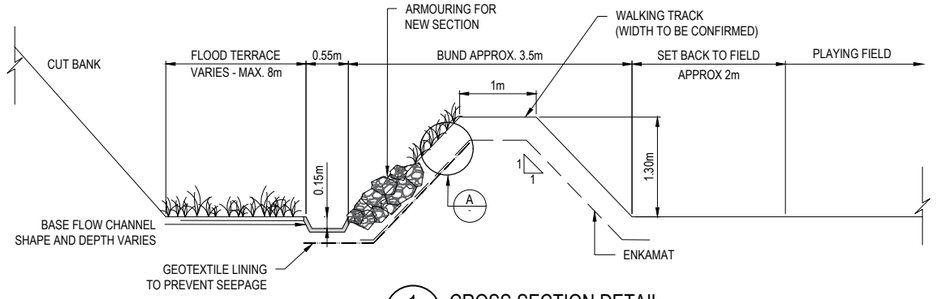
Appendix A – Drawings

NOTES:

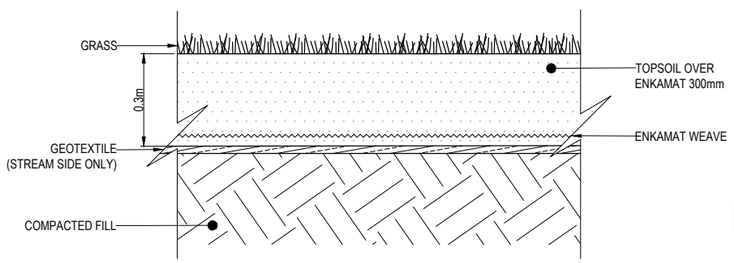
1. VEHICLE TRACKING HAS NOT BEEN UNDERTAKEN.
2. NO DESIGN HAS BEEN UNDERTAKEN OF THE OPTION PROPOSED

PROVISIONAL QUANTITIES:

NEW BUND	= 62m
ROCK ARMOUR	= 24m
FLOOD TERRACE	= 1m DEEP
ACCESS ROAD	= 100m LONG x 4m WIDE
STREAM	= 195m



1 - CROSS SECTION DETAIL
SCALE 1:40 (A1)



A - GRASSED BANK AREA
SCALE 1:10 (A1)

ORIGINAL DRAWING IN COLOUR

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	TW	JJ	JJ	17-12-20

Drawing Originator: Beca

Original Scale (A1) 1:125
Reduced Scale (A3) 1:250

Design	J.JONES	17-12-20	Approved For Construction*
Drawn	T. WICKENS	17-12-20	
Verifier	J. JONES	17-12-20	
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Wellington Water

Project: OMĀRORO RESERVOIR

OPTION 6
LAYOUT PLAN

Discipline: CIVIL
Drawing No.: 3262332-CE-T0006
Rev.: A

Document No. P:\3262326232\CAD\3262332-CE-T0006.DWG

DO NOT SCALE

IF IN DOUBT ASK.

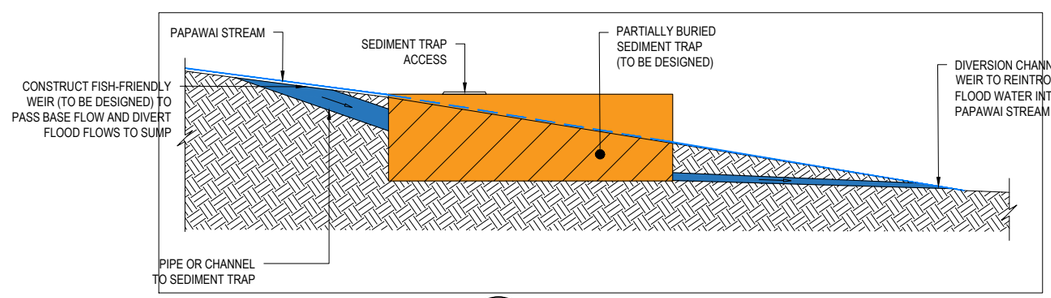
Drawing Plotted: 18 Dec 2020 9:35 am

NOTES:

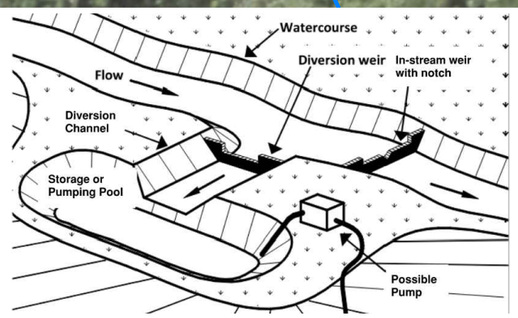
1. VEHICLE TRACKING HAS NOT BEEN UNDERTAKEN.
2. NO DESIGN HAS BEEN UNDERTAKEN OF THE OPTION PROPOSED

PROVISIONAL QUANTITIES:

NEW BUND	= 62m
ROCK ARMOUR	= 24m
ACCESS ROAD	= 100m LONG x 4m WIDE
STREAM	= 195m
SEDIMENT TRAP	= 500m³
WEIR (x2)	= 500m³ EACH



1 / - CROSS SECTION DETAIL
SCALE 1:40 (A1)



A / - SCHEMATIC EXAMPLE OF DIVERSION WEIR CONCEPT
NOT TO SCALE

ORIGINAL DRAWING IN COLOUR

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	TW	JJ	JJ	18-12-20

Drawing Originator: Beca

Original Scale (A1)	1:125		
Reduced Scale (A3)	1:250		
Design	J. JONES	18-12-20	Approved For Construction*
Drawn	T. WICKENS	18-12-20	
Verifier	J. JONES	18-12-20	
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Wellington Water

Project: OMĀRORO RESERVOIR

OPTION 7
LAYOUT PLAN

Discipline: CIVIL

Drawing No.: 3262332-CE-T007

Rev.: A

DO NOT SCALE

IF IN DOUBT ASK.

www.beca.com

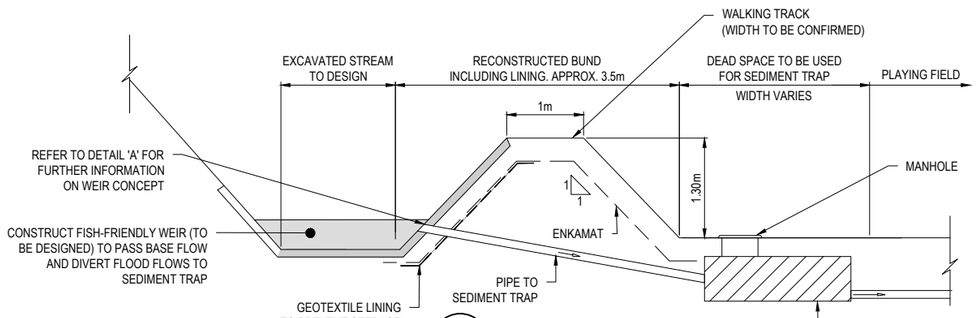
Document No. P:\3262332\CAD\3262332-CE-T0007 RECOVERED.DWG

NOTES:

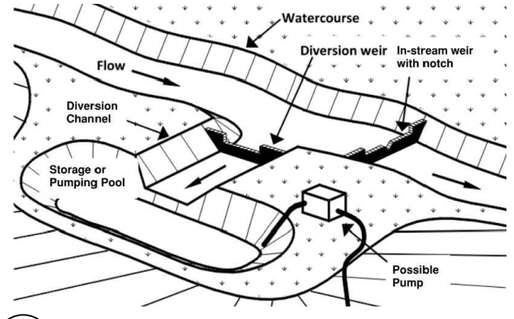
1. VEHICLE TRACKING HAS NOT BEEN UNDERTAKEN.
2. NO DESIGN HAS BEEN UNDERTAKEN OF THE OPTION PROPOSED

PROVISIONAL QUANTITIES:

NEW BUND	= 57m
PIPING	= 115m
ACCESS ROAD	= 100m LONG x 4m WIDE
STREAM	= 195m
SEDIMENT TRAP	= 500m³
WEIR	= 500m³



1 - CROSS SECTION DETAIL
SCALE 1:40 (A1)



A - SCHEMATIC EXAMPLE OF DIVERSION WEIR CONCEPT
NOT TO SCALE

ORIGINAL DRAWING IN COLOUR

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	TW	JJ	JJ	18-12-20

Drawing Originator: Beca

Original Scale (A1)	1:125		
Reduced Scale (A3)	1:250		
Design	J. JONES	18-12-20	Approved For Construction*
Drawn	T. WICKENS	18-12-20	
Verifier	J. JONES	18-12-20	
Dwg Check			Date

* Refer to Revision 1 for Original Signature

Client: Wellington Water

Project: OMĀRORO RESERVOIR

OPTION 8
LAYOUT PLAN

Discipline: CIVIL

Drawing No.: 3262332-CE-T008

Rev.: A

B

Appendix B – Cost Estimates

HIGH LEVEL COST ESTIMATE
Papawai stream Study

Code	Description	Quantity	Unit	Rate	Total
	HIGH LEVEL COST ESTIMATE - OPTION 6				
	Project No: 3262332				
	Estimate prepared by: Dirk Jv Vuuren				
	Estimate Verified by: Barry Wallace 15/12/2020				
	Date of Estimate: 8/12/2020				
	Exclusions and Clarifications				
	Excludes GST				
	It is assumed that a robust tendering process will be followed and that a minimum of 3 sub-contractor tenders (where possible) are received for the project as part of the agreed procurement process.				
	It is assumed that all of the work will be carried out in a single phase.				
	No allowance to test or removal of hazardous material				
	No allowance for escalation beyond the date of this estimate				
	No allowance for admin, legal or financing costs				
	Provisional allowance for Building and Resource consent fees and charges has been included				
	No allowance to remove, extend or relocated general services				
	No allowance for risk analysis and associated costs				
	No allowance for removal of haul road				
	No allowance for abnormal ground conditions (contamination, rock breaking, obstructions encountered).				
	No allowance for OPEX costs, i.e. sediment removal, general services maintenance, etc				
	Assume imported fill for buildup of new bund				
	Assume 30 days of traffic management				
	Assume a construction period of 6 weeks				
	Assume a 3 week stream diversion period				
	Achieved cost confidence of +-30%				
	Papawai Stream Study				
1	Option 6	1	LS		470,000

HIGH LEVEL COST ESTIMATE
Papawai stream Study

Code	Description	Quantity	Unit	Rate	Factor	Total
Option 6						
	HIGH LEVEL COST ESTIMATE - OPTION 6					
	Basis of Estimate					
	Beca civil concept sketches 3262332-CE-T0001 RevA 3262332-CE-T0006 RevA received from Justine Jones, 15/12/2020					
	Following Quantities received from Justine Jones: Bund 62m Rock armour 24m Flood terrace 1m deep Access road 100m long x 4m wide Stream 195m					
	Ecology Pricing information from Stephen Fuller 9/12/2020					
	Site clearance & Earthworks					
1.1	General site clearance low vegetation and grassing	1	LS			4,000
1.2	Cut to waste and remove off site (Including clean tipping fees)	1	LS			43,000
	Bund					
1.3	Grassed bund, incl enkamat, armouring, geotextile etc	1	LS			29,000
	Drainage					
1.4	Flood terrace	1	LS			40,500
1.5	Stream diversion enabling works	1	LS			42,000
	Miscellaneous					
1.6	Ecology (Planting included in "Bund" costing)	1	PS			13,000
1.7	Traffic management	1	PS			10,000
1.8	Access Road	1	PS			30,000
	Sub-Total					**211,500**
	Main Contractors Preliminary and General	15	%			31,800
	Margin	10	%			24,400
	Estimating Contingency	30	%			80,400
	Regulatory compliance & Consent Fees	1	PS			50,000
	Professional Fees	18	%			71,700
	Rounding	-3	dec			200
	TOTAL - OPTION 6					**470,000**

HIGH LEVEL COST ESTIMATE
Papawai stream Study

Code	Description	Quantity	Unit	Rate	Total
	HIGH LEVEL COST ESTIMATE - OPTION 7				
	Project No: 3262332				
	Estimate prepared by: Dirk Jv Vuuren				
	Estimate Verified by: Barry Wallace 15/12/2020				
	Date of Estimate: 8/12/2020				
	Exclusions and Clarifications				
	Excludes GST				
	It is assumed that a robust tendering process will be followed and that a minimum of 3 sub-contractor tenders (where possible) are received for the project as part of the agreed procurement process.				
	It is assumed that all of the work will be carried out in a single phase.				
	No allowance to test or removal of hazardous material				
	No allowance for escalation beyond the date of this estimate				
	No allowance for admin, legal or financing costs				
	Provisional allowance for Building and Resource consent fees and charges has been included				
	No allowance to remove, extend or relocated general services				
	No allowance for risk analysis and associated costs				
	No allowance for abnormal ground conditions (contamination, rock breaking, obstructions encountered).				
	No allowance for OPEX costs, i.e. sediment removal, general services maintenance, etc				
	Assume imported fill for buildup of new bund				
	Assume 30 days of traffic management				
	Assume a construction period of 6 weeks				
	Assume a 3 week stream diversion period				
	Achieved cost certainty of +-30%				
	Papawai Stream Study				
1	Option 7	1	LS		1,950,000

HIGH LEVEL COST ESTIMATE
Papawai stream Study

Code	Description	Quantity	Unit	Rate	Factor	Total
Option 7						
	HIGH LEVEL COST ESTIMATE - OPTION 7					
	Basis of Estimate					
	Beca civil concept sketches 3262332-CE-T0001 RevA 3262332-CE-T0007 RevA received from Justine Jones, 15/12/2020					
	Following Quantities received from Justine Jones: Bund 62m Rock armour 24m Access road 100m long x 4m wide Stream 195m Buried sump 500m3 Weir 500m3 (2 of)					
	Ecology Pricing information from Stephen Fuller 9/12/2020					
	Assumed Buried sump to be able accommodate 500m3 of water at a time					
	Site clearance & Earthworks					
1.1	General site clearance low vegetation and grassing	1	LS			4,000
1.2	Cut to waste and remove off site (Including clean tipping fees)	1	LS			43,000
	Bund					
1.3	Grassed bund, incl enkamat, armouring, geotextile etc	1	LS			29,000
	Drainage					
1.4	Sediment Trap	1	LS			615,000
1.5	Stream diversion enabling works	1	LS			212,000
	Miscellaneous					
1.6	Ecology (Planting included in "Bund" costing)	1	PS			13,000
1.7	Traffic management	1	PS			10,000
1.8	Access Road	1	PS			30,000
	Sub-Total					**956,000**
	Main Contractors Preliminary and General	15	%			143,400
	Margin	10	%			110,000
	Estimating Contingency	30	%			362,900
	Regulatory compliance & Consent Fees	1	PS			80,000
	Professional Fees	18	%			297,500
	Rounding	-3	dec			200
	TOTAL - OPTION 7					**1,950,000**

ROUGH ORDER COST ESTIMATE
Papawai stream Study

Code	Description	Quantity	Unit	Rate	Total
	HIGH LEVEL COST ESTIMATE - OPTION 8				
	Project No: 3262332				
	Estimate prepared by: Dirk Jv Vuuren				
	Estimate Verified by: Barry Wallace 15/12/2020				
	Date of Estimate: 8/12/2020				
	Exclusions and Clarifications				
	Excludes GST				
	It is assumed that a robust tendering process will be followed and that a minimum of 3 sub-contractor tenders (where possible) are received for the project as part of the agreed procurement process.				
	It is assumed that all of the work will be carried out in a single phase.				
	No allowance to test or removal of hazardous material				
	No allowance for escalation beyond the date of this estimate				
	No allowance for admin, legal or financing costs				
	Provisional allowance for Building and Resource consent fees and charges has been included				
	No allowance to remove, extend or relocated general services				
	No allowance for risk analysis and associated costs				
	No allowance for abnormal ground conditions (contamination, rock breaking, obstructions encountered).				
	No allowance for OPEX costs, i.e. sediment removal, general services maintenance, etc				
	Assumed Buried sump to be able accommodate 500m3 of water at a time				
	Assume imported fill for buildup of new bund				
	Assume 30 days of traffic management				
	Assume a construction period of 6 weeks				
	Assume a 3 week stream diversion period				
	Achieved cost certainty of +-30%				
	Papawai Stream Study				
1	Option 8	1	LS		2,094,000

HIGH LEVEL COST ESTIMATE
Papawai stream Study

Option 8

Code	Description	Quantity	Unit	Rate	Factor	Total
	HIGH LEVEL COST ESTIMATE - OPTION 8					
	Basis of Estimate					
	Beca civil concept sketches 3262332-CE-T0001 RevA 3262332-CE-T0008 RevA received from Justine Jones, 15/12/2020					
	Following Quantities received from Justine Jones: Bund 57m Access road 100m long x 4m wide Stream 195m Buried sump 500m3 Weir 500m3 Piping 115m					
	Ecology Pricing information from Stephen Fuller 9/12/2020					
	Assumed Buried sump to be able accommodate 500m3 of water at a time					
	Site clearance & Earthworks					
1.1	General site clearance low vegetation and grassing	1	LS			4,000
1.2	Cut to waste and remove off site (Including clean tipping fees)	1	LS			41,000
	Bund					
1.3	Grassed bund, incl enkamat, armouring, geotextile etc	1	LS			25,000
	Drainage					
1.4	Sediment Trap	1	LS			565,000
1.5	Piping	1	LS			190,000
1.6	Stream diversion enabling works	1	LS			152,000
	Miscellaneous					
1.7	Ecology (Planting included in "Bund" costing)	1	PS			13,000
1.8	Traffic management	1	PS			10,000
1.9	Access Road	1	PS			30,000
	Sub-Total					**1,030,000**
	Main Contractors Preliminary and General	15	%			154,500
	Margin	10	%			118,500
	Estimating Contingency	30	%			390,900
	Regulatory compliance & Consent Fees	1	PS			80,000
	Professional Fees	18	%			319,400
	Rounding	-3	dec			700
	TOTAL - OPTION 8					**2,094,000**

www.beca.com