THE VALUE OF VALUE ENGINEERING – ACHIEVING THE REQUIRED OUTCOMES IN PINEHAVEN STREAM IMPROVEMENT WORKS

K. Sliepen (GHD Ltd)

ABSTRACT

The Pinehaven Stream in Upper Hutt, Wellington, has a long history of flooding. The largest recorded flood event was in 1976, and in more recent years multiple properties and garages have experienced flooding.

In 2016, Wellington Water commenced the Pinehaven Stream Improvement Project. This project is being delivered on behalf of the Greater Wellington Regional Council (GWRC) and Upper Hutt City Council (UHCC) which form the project's Steering Group.

The aim of these improvement works is to ensure that during a 1-in-25-year flood event, floodwater stays within the stream banks. Additionally, during a 1-in-100-year event, flood water does not impact habitable floors. Detailed stormwater modelling was completed to assess various options and confirm the preferred approach. Following a challenging consent process, consents from GWRC and UHCC were granted. The scope of works included the removal of three flood prone properties to improve the flow path, 1,236 metres of stream channel widening(which includes 321 metres of new retaining walls),two new culverts and 14 new domestic bridges.

The project budget was established in 2018 and as the project moved through the design and procurement phases it became clear that the project budget was significantly lower than the amount required to complete the full scope of intended works. With the impacts of inflation on material supply and construction costs becoming an ever-increasing issue, value engineering can play a key role in achieving successful project outcomes. For the Pinehaven Stream Improvement project, several value engineering workshops were held to assess various initiatives with subsequent stormwater modelling used to validate potential options. It was through this process that large portions of proposed stream improvement works could be removed from the scope without adverse effects on the required project outcomes. This reduction in scope provided both cost savings and a more environmentally sustainable solution.

The project Steering Group considered the stream reaches that had the largest risk on property flooding and prioritised the construction works using a staged approach. As additional project funds were made available, additional phases could commence. Phase 1 (Culvert Installation) was completed in June 2022, Phase 2 (Willow Park) is due to commence in June 2023 and Phase 3 (Blue Mountains Road) in late 2023.

This paper details the value engineering process GHD led with the support of the Steering Group to assess and prioritise the works. Through this process, the project team were able to achieve significant flood protection benefits while working within the available budgets. The sustainability of the approach also improved significantly without increasing the risk of flooding to other areas.

KEYWORDS

Flood management, value engineering, sustainability

PRESENTER PROFILE

Kama is a Water Lead (Principal Engineer) and CPEng registered with 19 year's experience in civil engineering. Roles include design and management for a wide range of local infrastructure capital and operational projects including water, wastewater, stormwater and pump station design and contract administration.

1 INTRODUCTION

1.1 HISTORICAL FLOODING

Pinehaven is a suburb in Upper Hutt, Wellington. Through the heart of Pinehaven runs the Pinehaven Stream which is prone to flooding. The largest recorded flood event was in 1976 (see Figure 1) and in more recent years multiple properties and garages have experienced flooding. Based on the results of stormwater modelling completed by Jacobs Solutions Inc. (Jacobs), there are currently 75 properties prone to habitable floor flooding in a 1 in 100 year event.

Figure 1: Historical image of 1976 flood

1.2 DESIGN PHASE

In 2016, Wellington Water commenced the Pinehaven Stream Improvement project. This project is being delivered on behalf of Greater Wellington Regional Council (GWRC) and Upper Hutt City Council (UHCC) which form the project's Steering Group.

The objectives of the project have been defined by the Project Steering Group, these include:

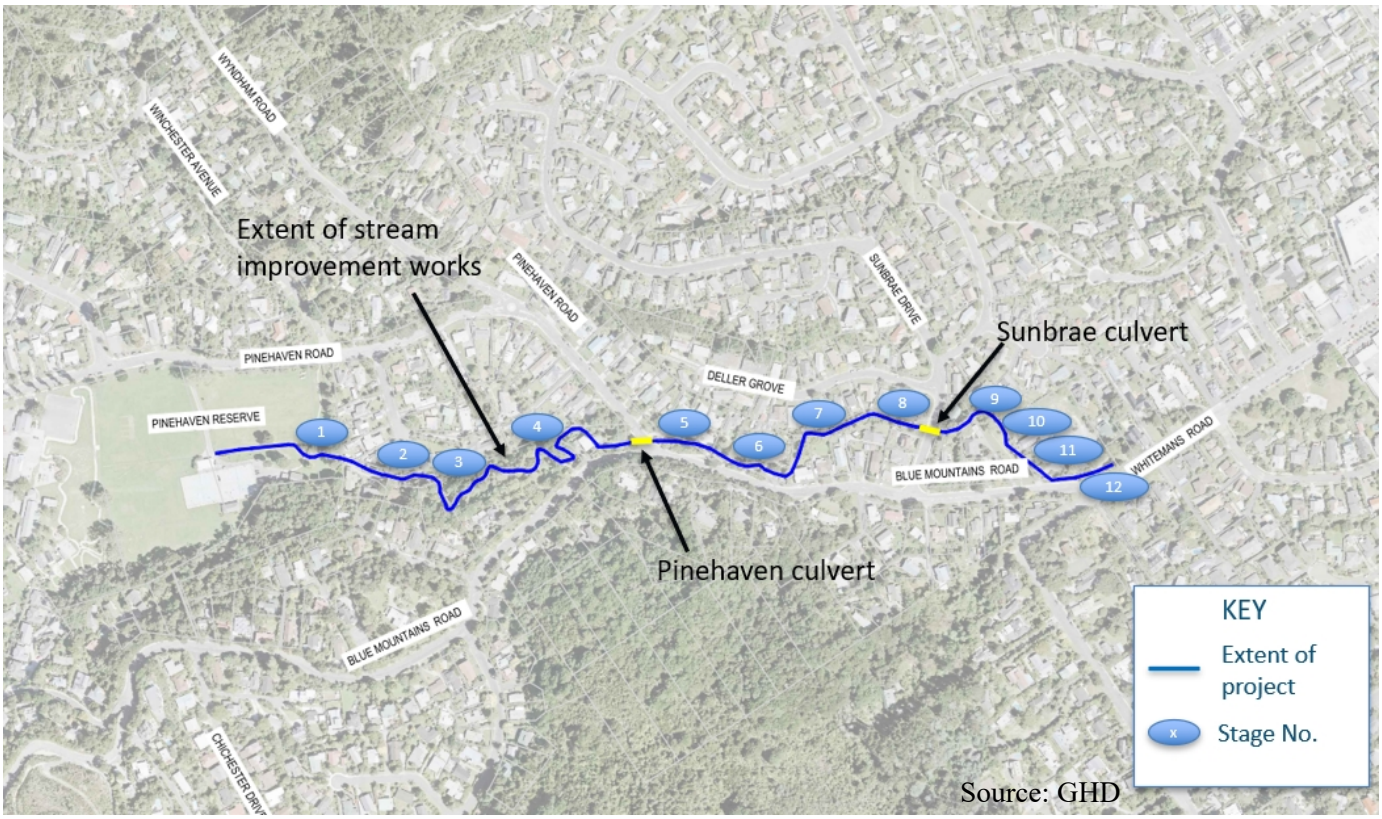
- To reduce the risk of injury or harm from fast or deep flowing water in Pinehaven Stream and its tributaries;
- To provide improved capacity and an effective and efficiently functioning stormwater infrastructure in the stream and its tributaries to a 4% Annual Exceedance Probability (AEP) flood event level, which will also contribute to the management of flood risk to habitable floor levels up to the predicted peak 1% AEP flood level;
- To integrate overland flow paths into the wider stormwater network; and
- To enable efficient and effective construction and ongoing maintenance of all structures and stream improvements.

Jacobs completed extensive stormwater modelling which was used to assess and validate various stream improvement initiatives. In May 2020, Jacobs delivered a detailed design report which included the following stream improvements works between Pinehaven Reserve and 48 Whitemans Road:

- The replacement of two culverts (Pinehaven and Sunbrae culverts)
- Stream widening to 915 metres of the stream using battered slopes
- Stream widening to 321 metres of the stream using retaining walls (redi-rock walls)
- Property purchase and demolition
- Replacement of 14 pedestrian and vehicle bridges
- Reinstatement and landscaping for approximately 41 private properties

The complete works were divided in stages (termed Stage 1 to 12) as illustrated in Figure 2 below. The total project budget to complete the works was established in 2018 at $19.25M.

Figure 2: Extent of works



1.3 MODELLING MAPS

The outputs from the stormwater modelling works are included in Appendix A and B. These include a comparison of the predicted flood extents (both existing state and after improvements) for a 4% AEP (1 in 25 year event) and a 1% AEP (1 in 100 year event).

These maps show the design solution provides significant reductions in both the extent and depth of flood waters. It is important to note that the project objectives were not met for all properties.

1.4 CONSENTING

Consent for the stream improvement works was granted on 4th of September 2020. The consent was publicly notified with members of the local community holding strong views either in support of, or opposed to, the project.

Stream ecology was considered as part of the project and impacts on indigenous birds. Although an urbanised area, there are remnants of indigenous forest in both the upper and lower catchments. With regard to the design, the intent was to preserve the natural alignment where possible and only realigning the stream in one location to straighten two sharp corners.

2 PHASE 1 AND 2 WORKS

The initial construction phase (termed Phase 1) was completed in June 2022. This phase included the demolition of properties in Blue Mountains Road and Sunbrae Drive which were two flood prone properties and the installation of Pinehaven culvert and Sunbrae culvert.

The installation of new culverts at Pinehaven Road and Sunbrae Drive required the full closure of both local roads resulting in large detours over a 3 month period. Considerable engagement with local residents was required to keep the local community up-to-date on the progress of works and the changes to road layouts.

Figure 3: Aerial Image of Pinehaven culvert construction

Figure 4: View from within Pinehaven culvert (with old culvert in the background)

Phase 2 includes the construction works in Willow Park (Stage 9 and 10 from the Jacobs design) which is programmed to commence in June 2023. These works include stream widening through a combination of new redi-rock walls and improved battered slopes.

Figure 5: Sunbrae culvert with redi-rock walls (starting point for Phase 2)

3 BUDGET SHORTFALL

Following the completion of Phase 2, works will move to a Phase 3 which includes improvement works in the area around 28 Blue Mountains Road. The Steering Group has committed $5.4M to this next phase of works. The works under Phase 1 to 3 include construction of two culverts and 3 of the 12 stages of stream improvements (25% of total works). The remaining works include the final 9 stages of stream improvement (75% of total works).

With no additional funding currently committed to this project, there is a significant short-fall and a large portion of the works cannot be completed without additional funding.

The confirmed budget is not sufficient for the proposed design solution and the significant escalation in labour and material costs over recent years has exacerbated the issue.

It was agreed with Wellington Water that there was a need for a value engineering exercise which commenced in May 2020.

4 VALUE ENGINEERING

4.1 WHAT IS VALUE ENGINEERING?

Value engineering is defined in the Cambridge English Dictionary as *"the process of reducing the costs of producing a product without reducing its quality or how effective it is".*

Value Engineering is used by many industries to improve project/product quality, reduce project/product cost and maximise the cost-benefit ratio for the stakeholder.

In the context of this project, value engineering was considered a potential tool to reduce costs whilst still achieving the required project objectives.

4.2 WHY CONSIDER VALUE ENGINEERING?

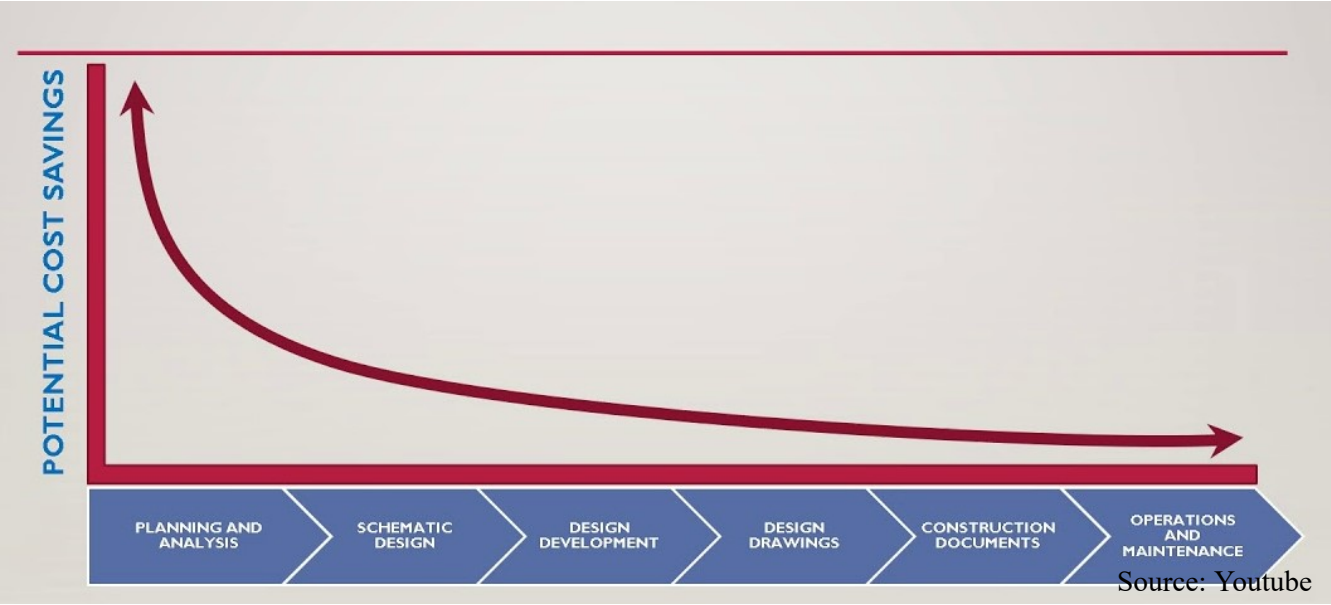
As an alternative to value engineering, there was the option of seeking additional funds to progress the project in accordance with the design intent or the option of ending the project without achieving the desired objectives for some reaches of the stream. Value engineering provided an opportunity to scrutinize the design while not compromising on the project objectives. This enabled strong collaboration between stakeholders through multiple workshops with stakeholders having the opportunity to shape the final design solutions and better understand their investment decision.

4.3 WHEN DOES VALUE ENGINEERING HAVE VALUE?

On most occasions, value engineering takes place after the completion of the design process, but is best performed before the design is conducted to allow the design team to incorporate alternative materials and methods prior to finalising the design.

As illustrated in Figure 6 (below), the potential for cost savings decreases significantly as a project progresses.

Figure 6: Potential for Cost Savings

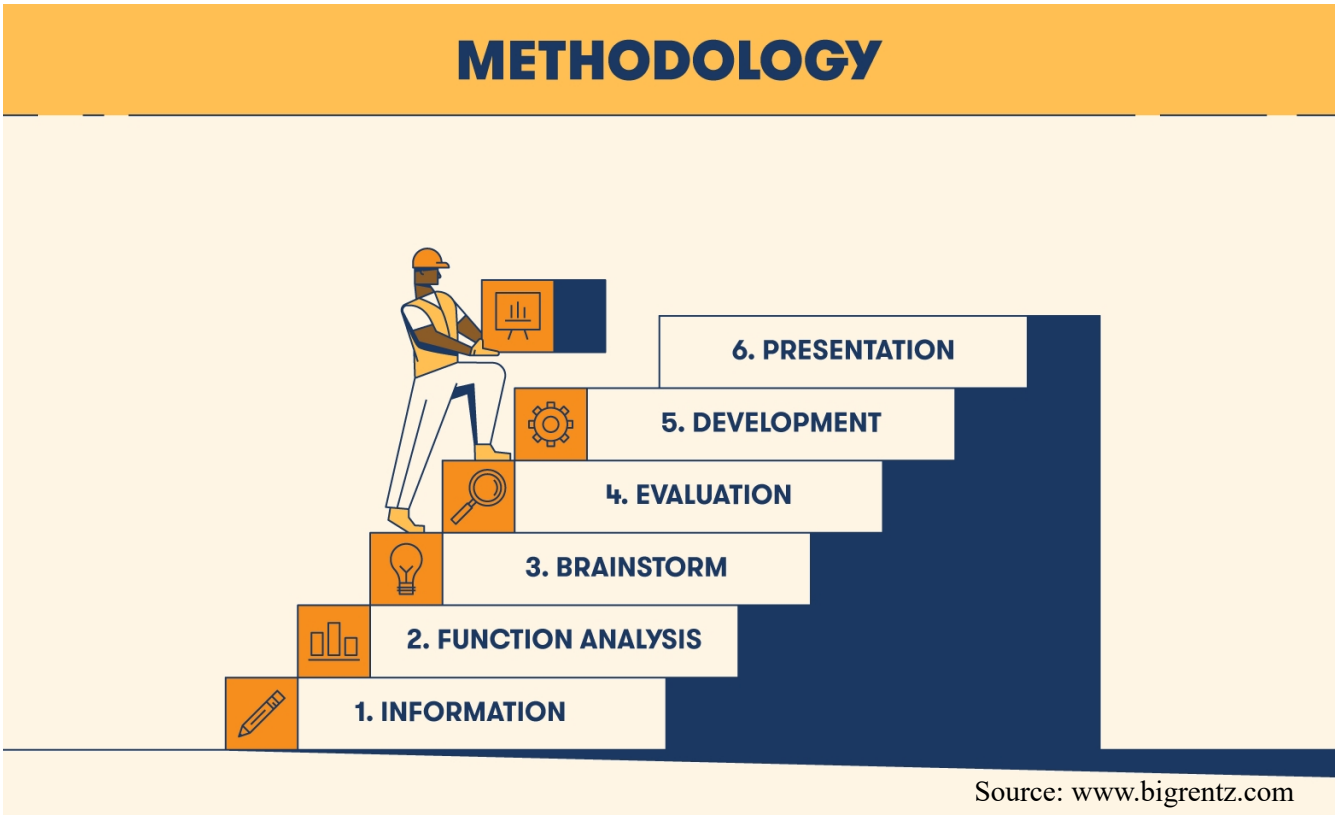


For the Pinehaven project, the value engineering exercise only commenced following the completion of the detailed design. With the publicly notified consents already lodged, there was no appetite from the Steering Group to vary any design aspects related to the channel improvement works as this could potentially trigger a new consent process. So instead, the project team considered other value engineering initiatives.

4.4 THE VALUE ENGINEERING PROCESS

Value engineering can involve various steps with Figure 7 (below) detailing a typical approach.

Figure 7: The value engineering process



Pulling together all the design and site specific information is a typical first step followed by a functional analysis. The purpose of the functional analysis is to confirm the functional elements that must be met as part of the required project objectives. For this project, maintaining stream flows in the stream for a 4% AEP and no habitable floor flooding for a 1% AEP were key project objectives.

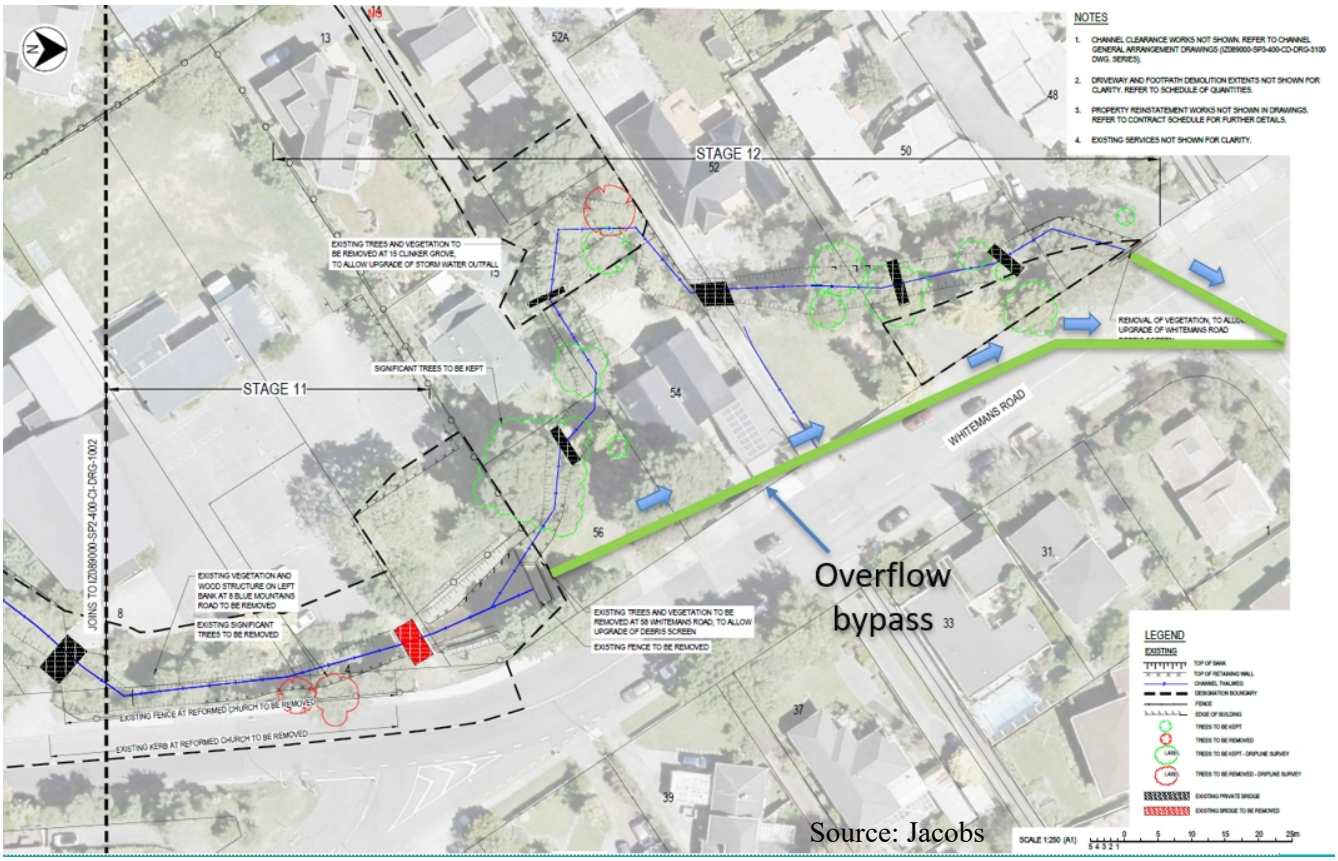
Bringing together the stakeholders for brainstorming sessions is a common third step and several value engineering workshops were held for this project. Various options were evaluated at these workshops and the final approvals were sought from the Steering Group following their review of reports and modelling maps.

4.5 VALUE ENGINEERING INITIATIVES

Some of the initial value engineering initiatives were proposed by Jacobs as part of their assessment in July 2020. There were nine initiatives which related to removal of elements from scope (that did not impact objectives) and the simplification of structural elements and reinstatement. The majority of these initiatives were not recommended and although this reduced the potential project cost savings, this process validated the need for these original design elements.

The key initiative that was supported by the project team was the removal of the two downstream stages from the project (Stage 11 and Stage 12). In these reaches of the stream there is an overflow bypass that directs peak stream flows through a 2.1 m diameter stormwater pipeline (see Figure 8 below). The stormwater modelling works confirmed that the removal of Stage 11 and 12 from the project would cause the stream levels to increase immediately upstream (in Willow Park) however this issue could be mitigated by increasing flood wall levels in this area.

Figure 8: Design drawing for Stage 11 and 12



Source: Jacobs

The removal of Stage 11 and 12 from the project provided significant cost savings for the project and a more sustainable solution due to the significant reduction in earthworks and materials for stream retaining structures.

5 INCREMENTAL PROJECT FUNDING

5.1 BACKGROUND

For this project the initial budget was insufficient to complete the full stream improvements and over time the project has gained additional funds for specific reaches of the stream as part of the value engineering works. With this incremental project funding, it is important that the prioritization of works is carefully considered.

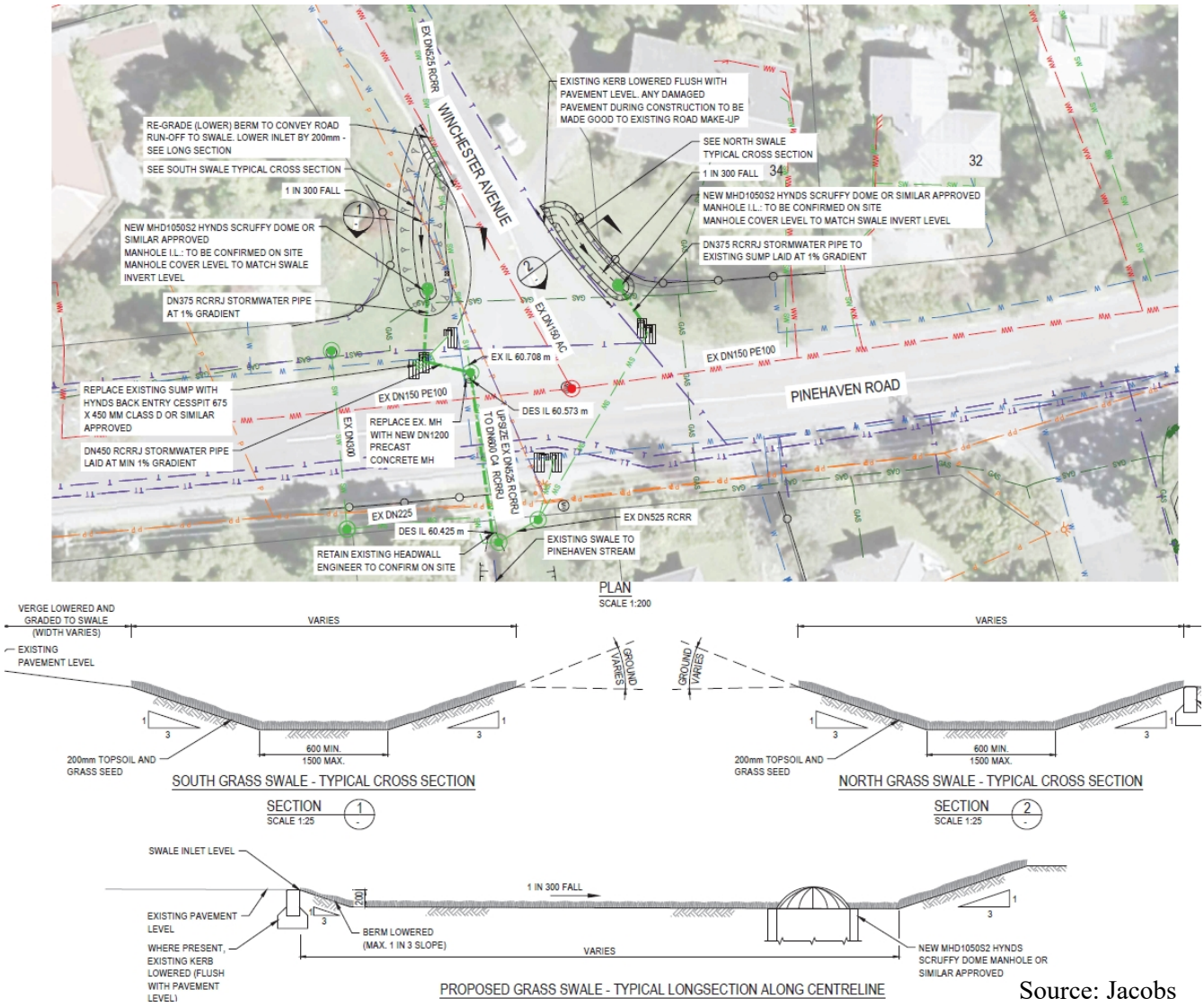
5.2 ASSESSMENT APPROACH

In GHD's assessment on the priority of stream improvement works, an important consideration is that the completed works to not create any choke points / adverse effects to other stream reaches. Another consideration is that works are not completed in a piecemeal fashion leading to potential legacy issues in future improvement or maintenance works.

5.3 RESULT

Through stormwater modelling works, some of the largest overall reductions in property flood risk could be achieved by making improvements to the upstream stormwater intakes. The trade-off with this option is that it will enable greater flows to enter the stream leading to increased flood risk to any downstream reaches yet to see improvement works completed. Despite the large overall benefit from this option, the decision was made to only complete these improvement works after downstream improvements were completed.

Figure 9: New stormwater intake design



Source: Jacobs

6 CONCLUSIONS

The Pinehaven stream improvement design was a robust solution that would significantly reduce the risk of property damage due to flooding. The confirmed project budget was mis-aligned with the actual funds required to complete the project. The significant escalation in labour and material costs over recent years only exacerbated this issue.

The further a project progresses, the harder it is to affect change. The full understanding of the budget short-fall was realised at the completion of the detailed design and this limited the ability to alter the design and still meet consent conditions.

Value engineering is an effective tool to assess potential initiatives which can reduce project costs whilst still meeting project objectives. Although this value engineering exercise should have been completed earlier, it was still possible to achieve significant project savings by removing two stages of the project from the overall scope.

There are outstanding stream improvement works yet to be completed in this project and value engineering will continue to be an effective project tool recommended for other projects.

ACKNOWLEDGEMENTS

I would like to acknowledge Jacobs for their involvement in the original design and ongoing modelling support. Also a thanks to Wellington Water for their strong collaboration with GHD as we work towards a significant reduction in flood risk in Pinehaven Stream.

REFERENCES

Donnnelly, C. 2018. *Value Engineering Presentation Video Version.* [Online Video]. Available: Value Engineering Presentation Video Version - YouTube. [Accessed 07/04/2023].

Farish, D. 2020. *Pinehaven Stream Improvements – A Detailed Design Report.* Jacobs Solutions Inc.

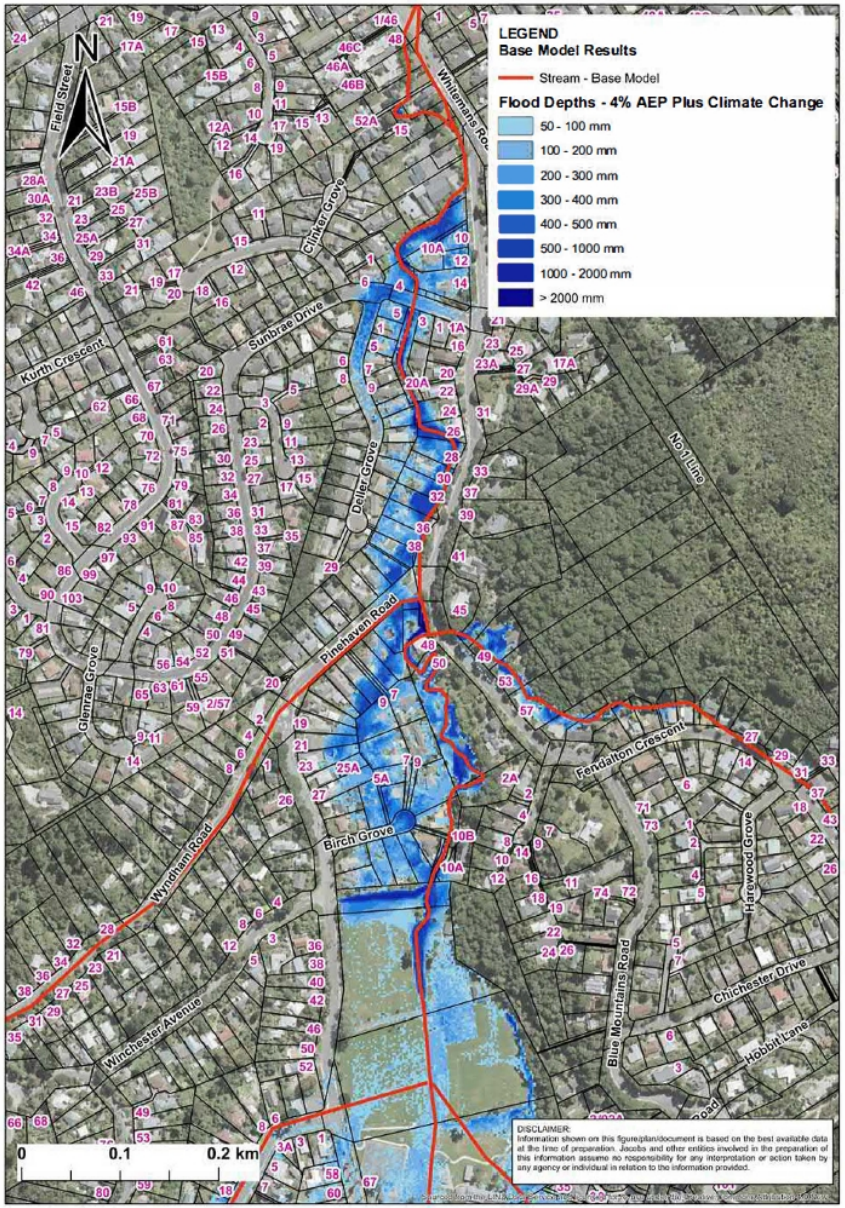
Kinley, P. 2019. *Pinehaven Stream Improvements – Flood Hazard Assessment.* Jacobs Solutions Inc.

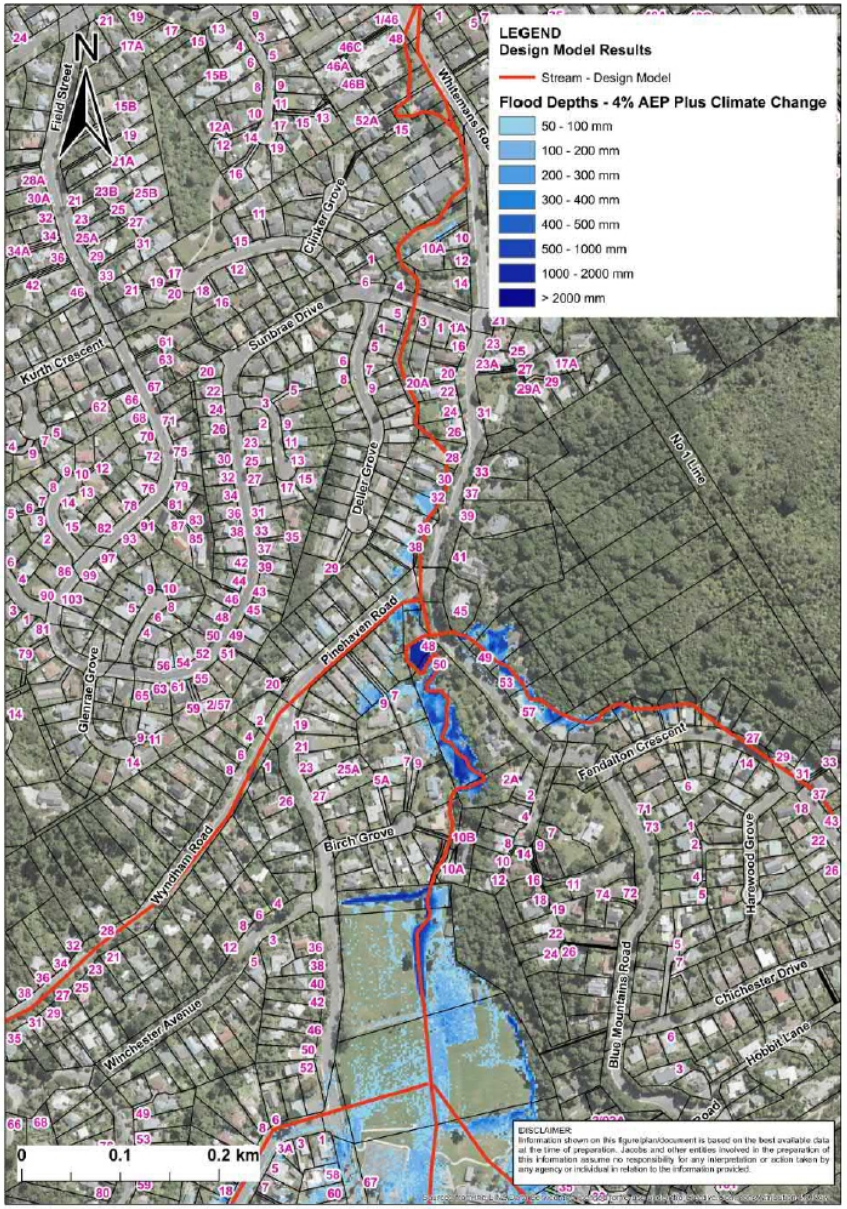
Pinehaven Dec 1976. 1976. Available: Flood, 1976; Silverstream; Brigade series; Pinehaven | Upper Hutt City Library (recollect.co.nz). [Accessed 07/04/2023].

Spinks, J. 2020. *Pinehaven Stream Improvements – Value Engineering Initiatives.* Jacobs Solutions Inc.

What is Value Engineering in Construction. 2020. [Online]. Available: *What is Value Engineering in Construction? | BigRentz*

APPENDIX A – JACOBS FLOOD MAPS FOR A 4% AEP (BASE MODEL AND DESIGN MODEL)





APPENDIX B – JACOBS FLOOD MAPS FOR A 1% AEP (BASE MODEL AND DESIGN MODEL)