DUDLEY CREEK – KEEPING BOTH OARS IN THE WATER

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Abstract

The Dudley Creek project is providing flood risk reduction for one of Christchurch's most vulnerable communities in the aftermath of the March 2014 floods in the Flockton Street area. A joint venture between Beca and Opus combined forces with Christchurch City Council (CCC) and Downer to form a project team to provide the solution: channel widening and a new bypass pipeline to increase flood protection for 585 properties. Improved hydraulic performance was the chief concern, with the project's challenges encompassing:

- sensitive public and stakeholder engagement
- incorporating Council's six waterway values: ecology, landscape, recreation, heritage, culture and drainage
- significant design constraints including lateral spread risks
- private access concerns
- a condensed delivery programme.

This paper presents the benefits of project team collaboration, reflecting on key lessons learnt:

1. Integration across multiple disciplines

Collaborative design across four organisations and nine disciplines requiring excellent communication and innovative approaches

2. Blurring the lines across Principal, Engineer, and Contractor organisations

Overcoming traditional contracts barriers including responsibility for risk, decisions and delays

3. Streamlining the design and procurement process to deliver the tight programme

Working together and managing relationships with the public already overwhelmed by flooding and continuing earthquake related repairs and disruptions

Keywords

Dudley Creek, flood remediation, integrated team, multidiscipline, contractor involvement

Introduction

The 2010 and 2011 Christchurch earthquakes caused considerable change to the waterways of the city, increasing peak flow water levels causing flooding and damaging infrastructure vital to the natural function of the creeks. In March 2014, flooding of homes in the Flockton Street area hit national news and affected thousands of residents. The Mayor's Flood Taskforce was set up to look for short-term measures to protect areas vulnerable to flooding. However, a longer term solution was needed for the worst affected areas. CCC engaged a project team of local experts from within Beca, Opus and EOS to deliver the Dudely Creek project; a concept design and detailed design that would reduce flood risk to pre-earthquake levels.

The project team partnered with CCC and grew to include Downer as the contractor who would construct the works.

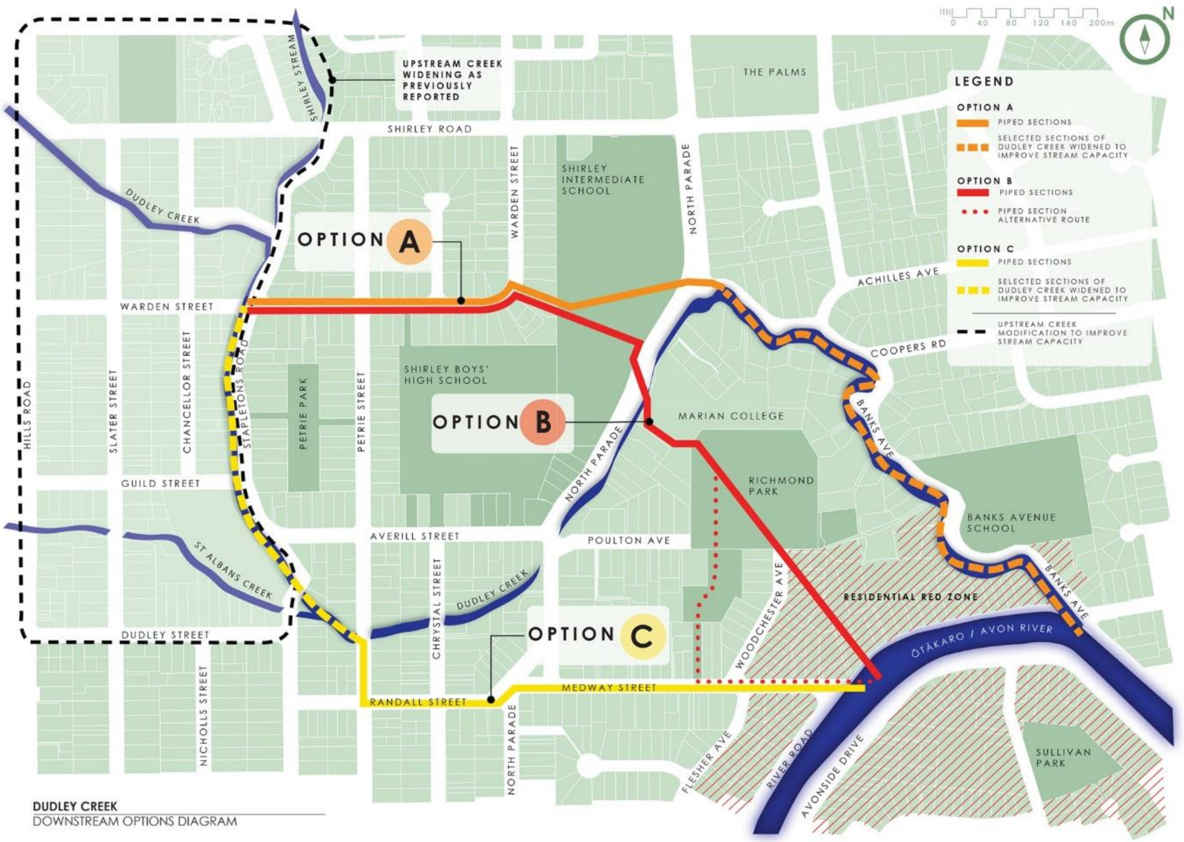

Figure 1: Dudley Creek project overview

Figure 1 gives an overview of the $48 million Dudley Creek project with the three concept options comprising channel widening and a new bypass pipeline to increase flood protection for 585 properties.

The project team faced a number of unique challenges:

- sensitive public and stakeholder engagement
- incorporating Council's six waterway values: ecology, landscape, recreation, heritage, culture and drainage
- significant design constraints including lateral spread risks
- private access concerns
- a condensed delivery programme.

This paper focusses on *how* the project team delivered their solution and gives examples, insights and lessons learnt relating to the collaborative approach adopted across multiple technical disciplines and organisations.

Integration across multiple disciplines

The multidiscipline approach

The Dudley Creek project was primarily a drainage project since the main objective was to provide flood risk reduction to vulnerable homes. However, the project team was motivated to successfully incorporate other values identified by CCC; ecology, landscape, recreation, heritage, and culture. It was therefore important that the design team included ecology, landscape architecture, and archaeology experts to provide input from the earliest phases of design right through to construction and commissioning.

Modification to the existing channel banks also required specialist geotechnical expertise as the land adjacent to the waterways in the project area (Dudley Creek, Shirley Stream and St Albans Creek) had been subject to lateral spread in the 2010 and 2011 Canterbury earthquakes. The drainage solutions provided by the project team were required to ensure that there would be no increase in lateral spread risk to properties. In order to succeed with this objective the geotechnical engineers provided input from the design outset and were able to quickly identify which design concepts would be able to satisfy the lateral spread constraint.

Structural engineers were also included right at the outset of the project to advise on design concepts relating to culverts, bypass structures, retaining walls and bridges. This involvement allowed the structural engineering team to shortlist a number of potential structure types that would be most effective for each of the applications so that the other disciplines could proceed with their design concepts with these in mind.

The primary issue of flood risk meant that the hydraulic modellers had the seat of honour at the multidisciplinary table. During each iteration of design, and even throughout construction, it was important to continually verify designs with the hydraulics team to ensure that their parameters were being adhered to and that solutions from other disciplines did not compromise the drainage performance. The hydraulic modelling also sat on the critical path as modelling results were required before preferred solutions could be developed through to detailed design. Since each other discipline was involved from the project outset it was possible for the hydraulics team to model channel geometry that conformed to the reality of design, ie low flow channels and side slopes that were preferable from an ecological perspective, or culvert structures that were buildable and effective from a structural point of view. By soliciting multidiscipline inputs into the hydraulic models, the team was able to rapidly converge on appropriate hydraulic solutions that would be supported by the other disciplines.

The headers below examine different mechanisms that enabled the multidiscipline approach to be successful.

Keeping in step from the outset

As explained above, each discipline was intentionally involved from the outset of the project. This enabled discussions to consider the full spectrum of expertise available. All members of the project team were kept informed of what the various drivers were for each discipline, allowing everybody to head in the same direction, analogous to a rowing team heading up a creek with unity of stroke and all oars in the water!

Workshops

Workshop were utilised at key points in the design process to physically get members of the team together for discussion. The workshops gave a forum for each discipline to present what was key to them and listen to what was important for the others. Workshops were run with an agenda and were typically 1.5 – 2 hours long. The workshops allowed ideas to be explored in parallel, a more efficient method than if the designs were being passed (or emailed) to the various disciplines one after another with conflicts potentially identified late in the piece requiring redesign.

Joint site visits

A benefit of having the project team working locally was being able to easily conduct site visits. Whenever possible, site visits were attended by representatives of the multi-disciplines so that the various aspects could be discussed in unison.

Site wide details

A number of site wide details were developed for the Dudley Creek project. These details were used wherever possible throughout subsequent design packages to create efficiency and consistency within the design process. The project team placed a specific multidisciplinary emphasis during the creating of each site wide detail to collate the differing design perspectives into a single solution. In each case the first time a site wide detail was developed there was a significant amount of time and effort required by each discipline. This process provided the end benefit of creating a design solution that was uniformly accepted and holistic, and could be referenced in future design packages without having to re-consult the multiple disciplines.

Freeze points

Multidiscipline designs have to satisfy many different technical criteria. A solution proffered by one team is subject to assessment from other teams to ensure it is suitable. It was important to introduce limits to the process of cross discipline consultation to ensure that the designs could progress without endless iteration. "Freeze points" were introduced in the design process to lock in certain aspects of the design so that concepts could be developed into details with confidence. These became points in time where certain aspects where unanimously agreed, such as the geometry of the creek edges, to allow detailed design of various aspects such as retaining walls, cut slopes, landscape planting and hydraulic analysis to be completed in parallel.

Streamlining the Design and Procurement Process

ECI Involvement

In the early stages of the project the team went to market to source an ECI (Early Contractor Involvement) contractor. Downer were subsequently brought on to the team to assist with design queries around constructability. By working closely with the design team, any constructability issues with designs were able to be captured early on in the process. Further value was added through identifying areas where cost savings were available or programme could be brought forward. This collaborative design approach was significantly improved with the co-location of all teams in one shared office space, enabling communication to flow with ease.

One such example of the value Downer provided was identified for a particular section of stream widening which required retaining walls on either side of the stream due to the close proximity of existing buildings. The presence of the buildings made access for construction limited and also added significant risk to the construction methodology, particularly around the driving of the retaining wall posts. A variety of options, from both the design team and Downer, were discussed at length to come up with a feasible solution. There were two alternative solutions identified as being achievable however both had potential to not work as expected. Downer were able to perform a trial of each method, thus removing any doubt and selecting a preferred option.

Figure 2: Location of trial pile driving

The ability to perform investigative site work when and as required was a significant advantage to having an ECI contractor. A large part of the design involved coordination with multiple existing services and utilities. The design team were able to access survey data for such services however certainty was provided through Downer performing early pothole and RADAR investigations. This was beneficial throughout the project, particularly with the design of the enabling works for the bypass pipeline. The bypass pipeline is a 4m wide by 2m high concrete box culvert, running 800m down the centre of the road. To accommodate such a wide footprint an early package of works identified and relocated multiple utilities and services. Significant investigative work was arranged by Downer to provide the design team with enough information such that design could accommodate all clashes early on. This reduced hold-ups during the construction phase as most services were located as expected and an appropriate design for their relocation was already prepared in advance.

There were a number of specialist construction methodologies required throughout the project. Downer understandably did not have expertise across all such areas and thus were not always able to add as much value as for other areas of the project. They were able to assist by going to market and getting feedback from sub-contractors. A potential issue with this was the sub-contractors were still competing to win the work. They had strong motivation to market their particular capability as being the best method for the required work.

Client Involvement

The client (Christchurch City Council) were also able to assist in the design and decision process. As much of the works were within their infrastructure network it was beneficial to have access to the managers for each service. This allowed the design team to discuss and capture any issues as the proposed design progressed. This benefit was particularly evident during the design and construction of two culverts on the same stretch of a highly trafficked road. The size and alignment of the culverts required an existing water main to be relocated beneath the culverts. This would require the main to be shut down during construction. Initially it was proposed to provide a temporary water main diversion while the works proceeded. This would add cost and programme delay to the project, due to the constrained nature of the alignment. Late in the design process it was identified that the existing water main was potentially not operating as intended and water was being supplied through other connections in the network. Good communication with the relevant asset owners enabled the team to perform a temporary trial shut down of the existing main to prove the theory. The network continued to work as expected and construction was able to proceed immediately, without the diversion being put in place. This saved the project both time and money.

With numerous stakeholders involved there were times where the design team had differing views to the client as to the most appropriate solution. Frequent communication between all parties throughout the entire design and construction process enabled a thorough understanding of requirements and each teams concerns to be fully understood and addressed. This occurred during the design of the bypass pipe line. From a design and construction perspective twin concrete pipes were considered the most appropriate solution. However, the client had real concerns about the ability of the pipe connections to withstand earthquake damage. Being able to openly discuss these concerns, plus the assumptions made during the design, enabled the design team to consider other alternative solutions for the pipe line. A box culvert design ensued, consisting of units ‘tied’ together with steel rods. This addressed the clients concerns while at the same time satisfied the design team of an appropriate solution.

Having the client on board also helped when considering the future use and maintenance of the works. As no pipeline of the size required for the bypass pipe in this project currently exists in Christchurch there is no current standard maintenance procedure. By discussing the project with all relevant stakeholders (the council and maintenance contractor) a likely scenario for ongoing maintenance was established. By considering these requirements appropriate access points were accommodated into the design. Additional, larger access openings were also provided as there was consensus that the

Figure 3: The integrated project team

maintenance methodology could change in the future and may require access for larger equipment.

Streamlined Design / Construction Process

Due to the magnitude of the flooding problem presented by the Flockton Basin and Dudley Creek there was a time critical requirement to have works completed to such a state as to reduce flooding by June 2017. By identifying the 'big picture' view of the problem and its design solution the team were able to break the works down in to a number of standalone work packages. In doing so, design and construction were able to progress simultaneously. Individual work packages could be designed while other packages were already fully under construction, thus speeding up the final construction programme. An unexpected benefit of this process was the ability to adjust the design for similar items based on how constructability progressed. This was beneficial for the design of culvert wing-walls, of which multiple were required throughout the project. Initial wing-walls settled after construction by up to 50mm, creating a gap between the wing-wall and culvert headwall interface. Having identified the issue with the first culvert, the design and construction methodologies were amended to prevent the same issue occurring for other culvert units.

The tight programme meant designs were being issued for tender to sub-contractors at the same time as they were being reviewed by the client and peer reviewers. This added risk to the design and procurement process as any issues picked up during the review would not be addressed in the price or methodology for the works. There could also be delay if further design was required to mitigate any issue identified. This risk was considerably mitigated through continuing communications with the client during the design phase, such that only minor issues were identified during the review process.

Construction

Construction was organised under a traditional NZS 3910 contract. This meant the 'one team' approach became slightly segmented as the contractor had to take full accountability for construction risk and the design team had to take full accountability for design decisions. Establishing a good relationship early on through the ECI process, plus the genuine desire by all parties to achieve the overlying project goal, enabled the contract to be run smoothly and fairly.

It is unlikely that other non-traditional contract arrangements would have been more beneficial to this project as there is no commercial incentive for the contractor or design consultant beyond the completion of the physical works.

Managing relationships

Working with the Public

Managing relationships with affected parties was extremely important for this project. It was made more difficult by the fact that people impacted by the works were not actually impacted by the flooding, which occurs further upstream. Added to this people were already frustrated with unresolved earthquake related insurance claims and a number of other roading remedial projects surrounding their neighbourhood. This led to some difficult consultations with affected parties.

Good communication was essential for achieving community by-in. We managed this by establishing a specific communications team. This was a Downer led team and allowed communication to be established between the public, the client, the design team and the contractor. Some difficult negotiations did have to occur, particularly around land take and private access bridges. Continued good communication, plus accommodating people's needs and requirements into the design where possible allowed the project to proceed.

The outcome of some property negotiations presented significant risk to the project and the amount of communication and ongoing negotiations required significantly more time than initially expected. This had an impact on getting design progressed to construction.

Conclusions

Multiple disciplines had to work together to successfully deliver the Dudley Creek project. Involving each discipline from the outset was key to ensure major issues were effectively addressed and differing views could be consulted before solutions were fully developed. Having a multi-discipline representation at workshops and site visits provided the benefit of discussing design issues collaboratively getting allowing the discipline teams to understand the different drivers.

Developing site wide details and using freeze points both promoted efficiency within the context of multidiscipline design.

An ECI contractor can add significant value to the design process by identifying construction constraints or cost savings early on in the design process. In complicated projects involving a range of specialist construction requirements it is difficult for the ECI contractor to add as much value in specialist areas as they do not have experience across all specialties.

Staged design and construction allows the construction programme to be reduced because design can continue while construction has commenced. It can add value to the project because unforeseen issues which may be encountered during construction of an early phase can be designed out for subsequent stages of the project.

Issuing designs for *tender in parallel with client review is risky* because issues may not be captured until after works have been priced. This has potential for large variations from sub-contractors or project delay if redesign is required.

A traditional contract arrangement worked well during the construction stage of the project due to the good relationships established between the teams and the desire by all to see the project objectives achieved. Other, *non-traditional contracts were unlikely to fit this project* because of a lack of future financial incentive for the consultant and contractor.

Members of the public can be affected by a project either directly or indirectly. It can be difficult to get some people's buy-in to a project because they may have a different world view and are *more concerned with how they are directly impacted* rather than the 'big picture' objectives of the project as a whole. Good communication and some compromise may help these people accommodate the project.

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