SH18 HOBSONVILLE DEVIATION AND SH16 BRIGHAM CREEK EXTENSION
A design and construct case study

G Daniel, MBA, BEng, MICE, CEng, ANZIM. Senior Construction Manager - Aurecon New Zealand Ltd, danielg@ap.aurecongroup.com (Presenter)

M Johnson, BSc, CEng, MICE. Project Management Services Manager - NZTA

D Loe, BSc (Civil), MIPENZ(Civil), CPEng, CEng(UK), MICE. Contract Manager – HEB Construction Ltd.

G Smith, BEng (Hons), MIEAust. Executive - Design Manager - Aurecon

ABSTRACT

The SH18 Hobsonville Deviation and SH16 motorway extension are key components of Auckland's motorway network. As part of the strategic Western Ring Route series of motorway projects, the project will provide a sustained macro-economic contribution to local, regional and national growth and prosperity. In particular it will support the Northern Strategic Growth Area in north-western Auckland. The project will also improve network resilience by providing an alternative north-south route to SH1. The New Zealand Transport Agency (NZTA) procured delivery of this project by way of a design and construct contract that enabled added value to be obtained from the contractor's input to the design process.

This paper:

- provides an overview of the project including its strategic contribution to regional and national growth and prosperity;
- discusses advantages and disadvantages of design and construct contracts for large scale highways projects, particularly the challenge of managing the contractor's detailed design so that it meets the client's expectations;
- Identifies key innovations on the project including the use of MX design tools and optimal geotechnical design that lead to substantial savings in construction time and cost;
- Discusses how these capital cost savings afforded an enhanced pavement specification and other additional operational benefits.

SH18 HOBSONVILLE DEVIATION AND SH16 BRIGHAM CREEK EXTENSION
A design and construct case study

INTRODUCTION

The SH18 Hobsonville Deviation and SH16 Brigham Creek Extension are key components of Auckland's motorway network that will (i) support development of strategic growth areas in Massey-Hobsonville and Albany, (ii) improve network resilience by providing an alternative north-south route to SH1 and (iii) support growth of the Auckland regional and national economies. Delivery of this project was procured by the New Zealand Transport Agency (NZTA) by way of a design and construct contract which enabled added value to be obtained from the contractor's input to the design process.

This paper:

- provides an overview of the project including its strategic contribution to regional and national growth and prosperity;
- discusses advantages and disadvantages of design and construct type contracts for large scale highways projects and briefly reviews the history of their application in NZ and overseas;
- Identifies key innovations on the project including the use of MX design tools and optimal geotechnical design that lead to substantial savings in construction cost;
- Discusses how these capital cost savings afforded an enhanced pavement specification and other whole of life benefits.

PROJECT OVERVIEW

Figure 1 – Auckland Western Ring Route (source: NZTA)

The SH18 Hobsonville Deviation is 6 km of new four-lane motorway being constructed in the north-western area of metropolitan Auckland. It is part of the New Zealand Transport Agency's 'Western Ring Route' series of projects which, when completed, will provide an alternative to the existing SH1 north-south route linking Manukau to the North Shore via west Auckland (Figure 1 refers).

The SH18 Deviation includes a motorway to motorway interchange with SH16 and four interchanges with local and arterial roads at Hobsonville Road, Trig Road, Brigham Creek Road and Buckley Avenue. The project also includes a 3 km extension of the existing SH16 motorway northwards towards Kumeu – the Brigham Creek Extension. Both parts of the project pass through rolling, predominately rural land just beyond the existing urban limits. The layout of the project is shown in Figure 2 and includes seven new bridges.

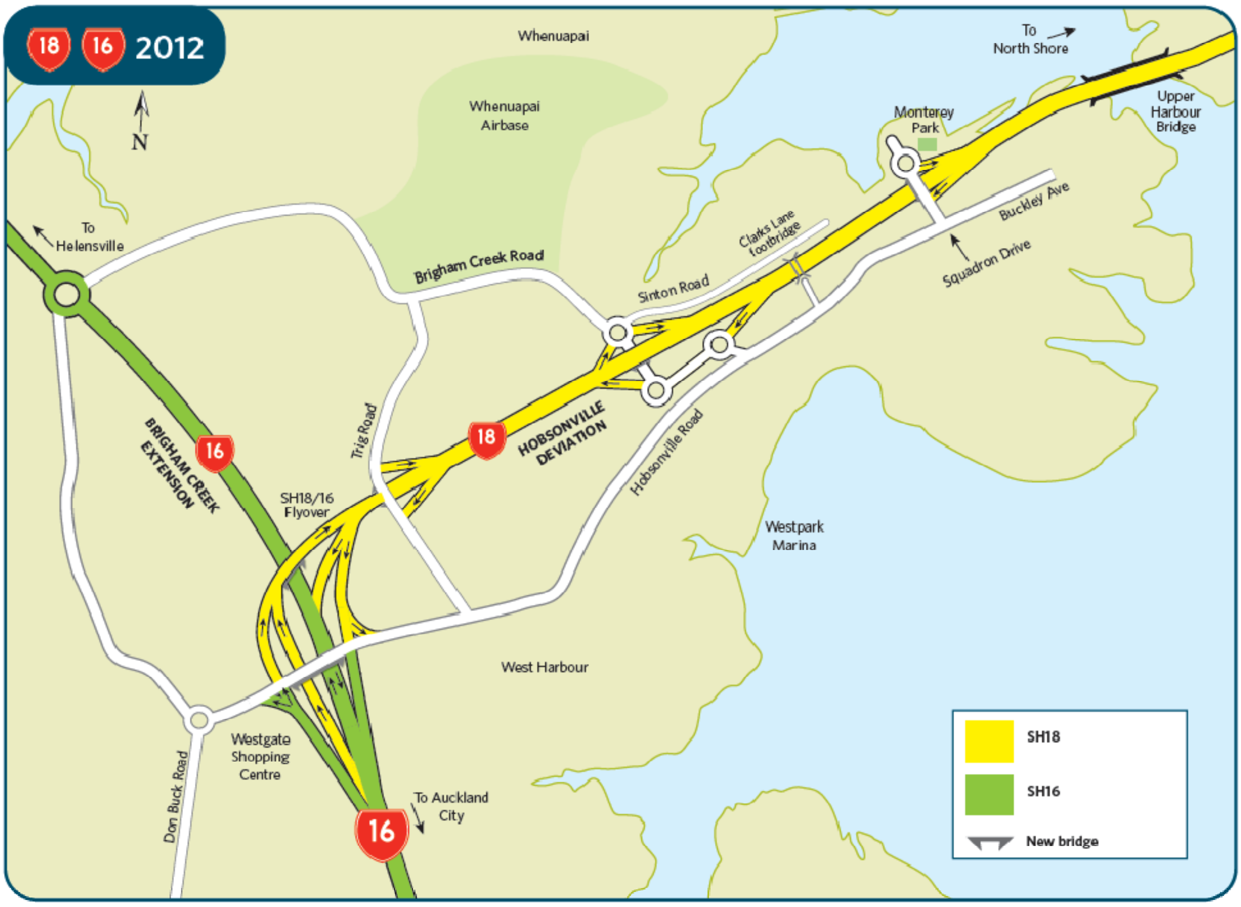

Figure 2 – Hobsonville Deviation and SH16 Brigham Creek Extension (source: NZTA)

The expected daily traffic flows in 2021 along the Hobsonville Deviation will be approximately 66,000 vehicles per day.

The primary benefits expected to arise from this project are:

- As part of the Western Ring Route, provide an alternative north-south route to the existing SH1 and harbour bridge, taking pressure off that route and improving network resilience[1]
- As part of the regional strategic freight route, provide improved connections to/from Glenfield, Albany, Westgate and other regional freight generators and attractors[2]
- Provide access via interchanges with existing local and arterial roads to support development of the Northern Strategic Growth Area (NORSGA) in Massey-Hobsonville[3]
- Relieve congestion on the existing Hobsonville Road allowing that road's functions to be revised and improved, i.e. local access, pedestrian routes, incorporation of a Quality Transit Network (QTN) as part of the Auckland regional Passenger Transport Network Plan[4], cycling routes[5], urban amenity, etc.

All these benefits are expected to contribute to local and regional economic growth and prosperity.

NZTA obtained designation for the route in 2001.

[1] ARC (2010)
[2] Ibid
[3] ARCG (2007)
[4] ARTA (2006)
[5] ARTA (2007)

PROCUREMENT ROUTE – DESIGN AND CONSTRUCT (D&C)

Although D&C contracts have been used in the commercial building and process industries for many years they have only been used relatively recently for highway projects in New Zealand.

The history of using design and construct contracts for highways projects overseas varies between countries. In Scotland the first D&C contract was let for a bridge project during the mid-1970s and a £30 million project (NZ$62.5 million) for a motorway interchange near Glasgow Airport was undertaken in 1989.[6] England followed in the early 1990s, driven by the need to respond to National Audit Office concerns about massive cost overruns on the Department of Transport's construction projects and the Conservative government's Private Finance Initiative (PFI) that sought to transfer risk and management skills from the public to private sectors.[7] Under PFI the D&C concept for highways was extended further to Design, Build, Finance and Operate (DBFO) contracts.

In the United States the D&C approach was not widely used among state Departments of Transport up until the late 1990s but then increased substantially during the first decade of the new millennium.[8]

In Australia D&C has been used on highways projects for approximately the last 20 years and is now a well established procurement method, particularly in the eastern states, Queensland, New South Wales and Victoria.

Closer to home the first highways D&C contract procured by Transit NZ (now NZTA) was the SH20A link to Auckland International Airport completed in 1996. A significant problem of ground settlement of the constructed embankments occurred on this contract and it was some years before another project was procured using this delivery mechanism. The Rangiriri to South of Ohinewai Four-Laning project commenced in 2001 and was completed in 2003 at a cost of NZ$24million. This was followed by the Auckland Central Motorway Junction (CMJ) started in 2003 and completed in 2006 and costing NZ$140 million. A summary of projects procured by Transit NZ / NZTA by way of D&C is in Table 1 below.

Table 1 – History of NZTA D&C Highways Projects[9]

Project Name	Timeframe	Value
SH20/SH20A Auckland Airport Link	1995 - 1997	NZ$30 million
SH1 Rangiriri to South of Ohinewai Four-Laning	2001 - 2003	NZ$24 million
Auckland Central Motorway Junction	2003 - 2006	NZ$140 million
SH20-1 Manukau Extension	2006 - 2010	NZ$210 million
SH29 Tauranga Harbour Link Stage 2	2007 - 2010	NZ$137 million
Hobsonville Deviation	2008 - 2011	NZ$200 million
Christchurch Southern Motorway Stage 1	2009 - 2013	NZ$140 million

The question arises: why use D&C contracts when the industry has managed to deliver highways projects (with varying degrees of success) using the traditional design-bid-construct method for many decades? Within New Zealand, procurement and delivery of highways projects is required to satisfy the Land Transport Management Act section 25(1) which requires:

> *"procurement procedures that are designed to obtain the best value for money spent by approved organisations and persons, having regard to the purpose of this Act."*

The NZTA responded to these requirements, firstly with implementation of the Competitive Pricing

[6] Hodgson (1995)
[7] Ibid
[8] McCrary, Gebken and Hill (2010)
[9] Information from various sources – see references below.

Procedures in 1997, then with publication of the Procurement Manual in July 2009. This latter document recognises that there is no "one size fits all" method of procurement. The decision on which method to use should be determined within the context of an organisation's overall procurement strategy, the appropriate allocation of risk to each contracting party and how best value might be obtained. Risk and value are inter-related and, among other things depend on the scale, complexity and certainty of scope for each particular project. The Manual provides guidelines on what form of procurement could be appropriate. Figure 3 illustrates the general concept of selecting different delivery models according to varying scale and risk.

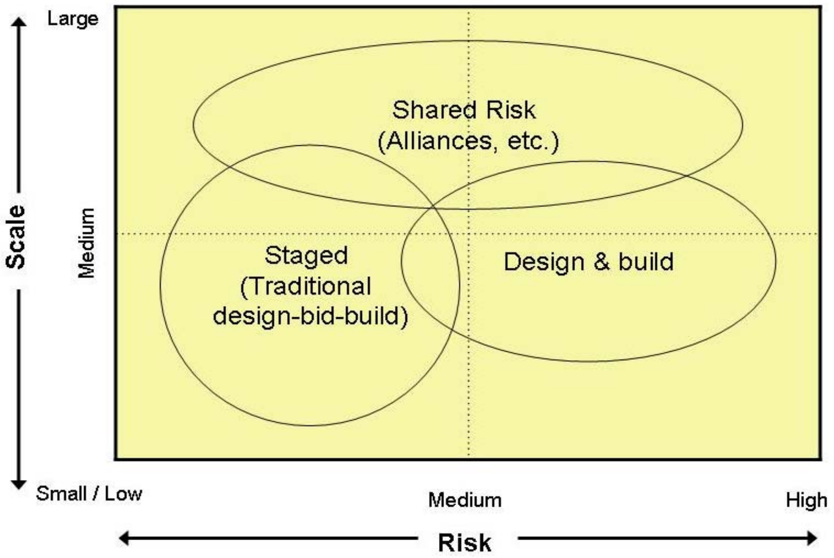

Figure 3 - NZTA illustration of the situations in which traditional staged, design and build and shared risk delivery models may be used [10]

Design and construct contracts can have the following advantages over traditional design-bid-construct contracts:

- More risks are transferred from the client to the contractor giving the client greater certainty of outturn cost but this comes at a price, i.e. the contractor will include an additional risk premium within the tender price;
- Risks can be allocated to the party in the best position to manage them, e.g. design management and buildability are transferred to and shared by the contractor and designer;
- Early involvement of the contractor during the design phase provides more opportunities for innovation and efficiency, e.g. design to suit the contractor's preferred plant, materials and methods;
- D&C avoids the need to consider and adopt alternative designs which can save time and money, i.e. when a contractor's tendered alternative design is adopted the client's original design effectively becomes abortive work;
- The contractor can proceed with construction of completed elements of the design concurrently with other design activities thus saving time;

However D&C contracts can have disadvantages as described below.

- Apart from producing the specimen design and principal's requirements, the client has reduced control and influence over the design process. This can lead to a disconnect between the client's expectations and the final delivered works.
- The contract is usually let on the basis of the contractor's tender design which is generally

[10] NZTA (2009)

only 10 – 20% complete. This leaves another 80 – 90% of assumptions which carry varying degrees of uncertainty and therefore risk for all parties. For the client the risk is uncertainty of the detailed outcomes and for the contractor and designer the risk is uncertainty of outturn costs.

- Contractors' tendering costs are high due to having to prepare and submit a tender design with no certainty of success. These costs have to eventually be recovered and thus become an industry overhead. For this reason D&C contracts are normally only considered appropriate for large projects where economies of scale can justify high tendering overheads. The NZTA has recently mitigated some of the tenderers' costs by offering to purchase the intellectual property from unsuccessful bids and providing it to the successful contractor who may then choose to adopt it into the detailed design.
- The size and maturity of a particular construction market may be unable to accommodate the transfer of risk from client to contractors that D&C entails, i.e. the market needs to have sufficient number of contractors and design consultants that are large enough to absorb the increased risk of financial losses from a D&C contract. These suppliers also need to have well developed systems to manage their increased risk exposure. If there are insufficient large, mature suppliers in the market then the client will likely receive less competitive tenders and thereby reduced value.
- In ceding management of the design consultant to the contractor the client is arguably at greater risk of design quality failures leading to substandard assets. However, whether the client or contractor is better equipped to manage the design consultant is dependent on each organisation's project governance and management expertise.

For the Hobsonville Deviation project a number of factors contributed to the decision to use D&C as the delivery model. Firstly the project has the necessary scale to justify the tendering overheads. Economies of scale were further enhanced by the decision to include the SH16 Brigham Creek extension in the project which also provided the contractor with more flexibility to achieve balanced earthworks cuts and fills. Secondly, although the project is reasonably complex, it is located within a predominately green field site where the risks are well understood and it was expected that there would be plenty of opportunities for contractor innovation. Thirdly the client and the local construction industry had gained experience of working under D&C conditions for progressively larger projects since 1995, i.e. the market was considered mature enough to support this large D&C project.

The procurement process was similar to that undertaken for the Central Motorway Junction.[11] The general conditions of contract are NZS3910: 2003 amended with various special conditions. To ensure the quality of the design the contractor was required to engage an independent checking consultant in addition to the design consultant. A "Principal's Advisor" performs the duties of the Engineer to review and accept design submissions. During construction, quality of the physical works is assured by the contractor's quality plan, on site verification and certification by the design consultant and monitoring by the Principal's Advisor.

A specimen design and Principal's Requirements were prepared by a consultant engaged by the client, NZTA. An expression of interest process led to three shortlisted tenderers being invited to submit tenders. Interactive meetings were held with each tenderer, their designers and the client to assist the tenderers to gain understanding of the client's requirements and expectations. The submitted tenders were evaluated using the Price Quality Method (Special) that included a supplier quality premium and tangible price adjustments.

The client's estimate was $201 million and the winning tender submitted by HEB Construction Ltd was significantly lower at $163 million. The project organisational arrangements are shown in Figure 4.

[11] Corbett and Edmonds (2005)

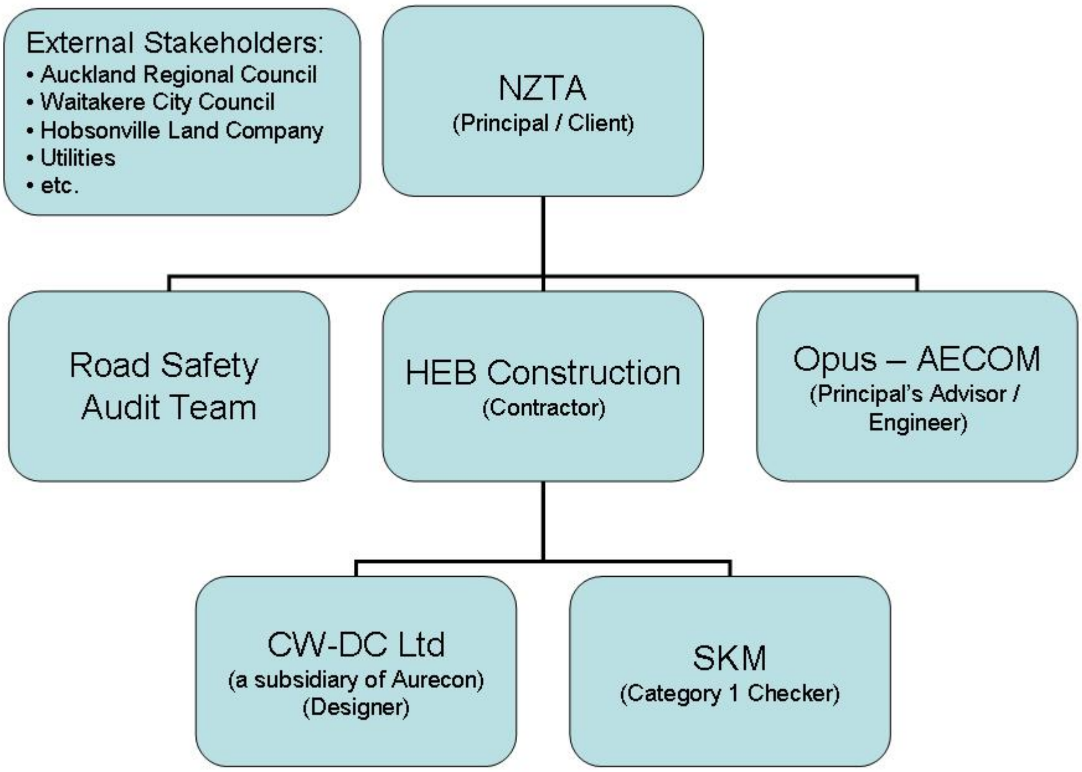

Figure 4 - Project Organisation

KEY INNOVATIONS AND PROCESSES

The contractor and designer recognised a number of risks (threats and opportunities) which could be managed through innovative engineering and project management practices. Three of the most significant are discussed in this paper:

- Earthworks
- Pavement
- Client acceptance of design.

Earthworks

Early in the tender design period, the contractor and designer carried out facilitated "blue sky" and value engineering workshops. From these it became apparent that a key success factor would be the earthworks design. Significant savings would be gained by completing the earthworks one season ahead of the client's envisaged programme. The contractor's team therefore sought to design and plan efficient earthworks operations by optimising the mass haul through close coordination of the geometric and geotechnical design disciplines.

Ground conditions presented the biggest risk transferred from the client to the contractor. The site is characterised by Puketoka sediments overlying the East Coast Bays formation of inter-bedded sandstones and mudstones. A detailed geotechnical investigation was carried out following contract award to supplement the early investigations undertaken by the client. Information from a total of 105 bore holes, 205 hand and machine auger holes and 125 trial pits was used to develop the geological model. It was found that the quality of material (defined by variance to the optimum moisture content) for use as embankment fill and to form the road subgrade in excavated cuts decreased progressively with depth. Of the 1.5 million m^3 initially estimated to be excavated, detailed geological modelling determined that approximately one third was close to optimum moisture content and could be used directly for embankment fills. Another third was suitable for conditioning by drying back and, where necessary, lime stabilised. The remaining was considered too wet and therefore used for landscape bunds and buttress fills.[12] The aim was to achieve a balance of cuts to fills and thereby avoid the considerable cost of disposal off site. A further factor identified as being critical to success was the need to avoid hauling material across three existing local roads that crossed the route. The design team therefore aimed to balance cut to fill volumes within each zone between these road crossings.

A digital terrain model was prepared using proprietary Bentley MX software in order to optimise the highway alignment and earthworks design. Geological data was coded into the MX model in order to account for 16 areas of differing geological profiles, each with four different material strata depths categorized by suitability for fill and bulking factors. Two types of fill were also incorporated into the model – structural fill for road embankments and landscape fills – together with the different pavement depths.

Once the model was developed it was possible to generate new earthworks volumes within about two hours following an alignment alteration when previously this would have taken up to a week without the aid of 3D design tools. The design team were able to rapidly evaluate numerous alignment options taking into consideration updated geotechnical information and changes to the contractor's preferred construction methodology. The geotechnical data and 3D model also assisted the functional and aesthetic design of landscaping including noise bunds.

This process of optimised design managed to achieve the two critical aims of balanced cuts and fills across the whole project and within the haul zones between the local side roads. Optimising the geometric and geotechnical designs also enabled the replacement of over 800m of bored pile retaining walls originally included in the client's specimen design with 300m of soil nail walls which reduced cost and risk for the contractor.

Pavement

Given the expected variability in subgrade CBR strengths several different pavement specifications were developed which provided the contractor with a "draw of recipes" from which to choose depending on the measured in situ CBRs. One example of the sixteen different pavement specifications used is shown in Table 2. The subgrade improvement layers (SIL) were either a layer of imported Woodhill sand or lime / cement stabilisation of the in situ subgrade soils.

Table 2 – Example pavement specification used for SH18 motorway

Type O Pavement B1				
Subgrade CBR (California Bearing Ratio)	Subgrade Improvement Layer (SIL) Depth (mm)	TNZ Mix15HF thickness (mm)	AC20 thickness (mm)	Beam deflection target prior to 1st AC layer (mm)
1	500	60	205	2.20
2	350	60	180	2.35
3	250	60	165	1.65
5	0	60	170	1.60
7	0	60	155	1.50
10	0	60	140	1.40

In practice weaker subgrades were encountered than expected, exceeding the risk allowance that the contractor had made. However the D&C contract provided the contractor flexibility to respond to this risk. In order to mitigate the emerging threat of weaker subgrades, subgrade stabilisation was implemented which was cost effective in that it avoided increasing the earthworks quantities and enabled enhanced CBR values to be obtained. The increased cost of improving the subgrade was offset by the cheaper pavement that could be built and the net outcome was better quality pavement.

[12] Clapper (2010)

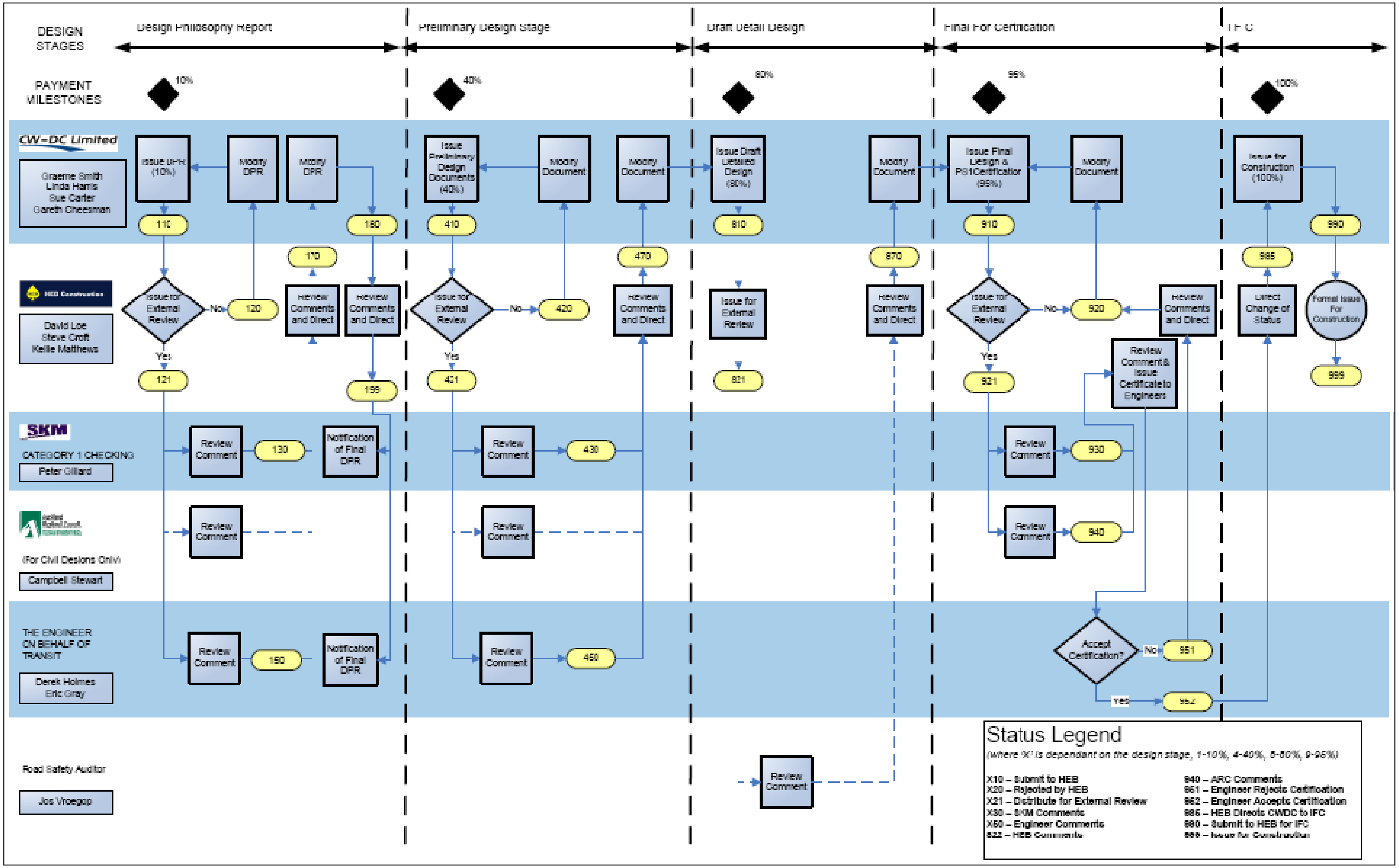

Figure 5 - Detail design review process that illustrates the five submission stages and various checks and approvals

Client acceptance of design

A D&C contract transfers the risks and responsibilities for managing the design to the contractor, including the risk of difficulty in obtaining the client's acceptance of the detailed design. The Principal's Requirements required submissions of the design to the Principal's Advisor (Engineer) for acceptance at only two key milestones:

- A Design Philosophy Report – early in the process prior to commencement of detailed design;
- A final submission after completion of checks by the independent checking consultant (Category 1 Checker) and road safety auditor and prior to issuing drawings for construction.

Independent road safety audits were only required for the conceptual design during tender and the final design submission.

The contractor and designer considered there was a very high risk of the design development diverging from the client's, Principal Advisor's and road safety auditors' expectations with the consequent disagreements leading to delays and extra design costs.

In order to manage this risk it was decided to divide the project design into a number of discrete design packages, scheduled to tie in with the construction programme. A design review process was developed with five submission stages: 10%, 40%, 80%, 95% and 100% completion (Figure 5 refers). The contents and intent of each submission point were defined in a detailed design management plan.

Over 150 design packages were submitted in this manner and a web based document management system, INCITE, was used to manage the submissions and provide instant reporting of the status of each package. Although it required more effort on the part of the design team, this process worked well in providing a "no surprises" approach and providing the client with visibility of the design development. Flexibility in the process was allowed for some simple design packages by skipping the 40% submission stage to save time and effort. To assure effective team work the contractor and designer's staff worked together in a dedicated project office during the detailed design phase. Design management was kept simple with the contractor directly engaging only one design consultant who in turn engaged several specialist subconsultants.

Employed directly by the contractor, the Category 1 Design Checker brought value to the checker's role by being part of the process early on - not just coming in at the end. The checker attended weekly design meetings, was provided visibility of the design programme and was engaged to help resolve problems when they arose.

ENHANCED BENEFITS

Having a tender price substantially lower than the budgeted estimate, the client was in a position to afford some changes that increased the benefits to be gained from the project including:

- Improved pavement specification;
- Additional lanes for the SH16 Brigham Creek Extension;
- Improved sight distances at the Hobsonville interchange.

Improved pavement specification

The client originally specified an unbound granular flexible pavement for which the expected traffic load of 66,000 AADT would have been towards the upper limit normally recommended for this type of pavement. The client decided to change the pavement specification to deep lift asphalt which has improved rut resistance leading to a longer design life and reduced maintenance. This type of pavement also provides an environmental benefit of reduced road noise.

Additional lanes for SH16

The specimen design for the SH16 Brigham Creek Extension included one lane, future proofed for two lanes, and a bus shoulder in each direction which was expected to provide sufficient capacity until 2016 when the carriageway would require an additional lane in each direction. The client decided to add the additional lanes to the scope of the current project, not only because of the capacity benefits, but also in the interest of improving safety by eliminating a long stretch of single lane highway that could encourage "undertaking" on the bus shoulder. Adding lanes to an operating motorway in the future would have been more expensive than under the current "green field" conditions.

Improved sight distances at the Hobsonville interchange

At the tender stage all tenderers highlighted the potential for significant savings to be gained by relaxing the Principal's Requirements for the vertical curve of the motorway through the Hobsonville interchange. The client granted a departure during the tender process and the tenderers made their 'Certificate A' submissions accordingly. However following tender award it became evident that concerns raised by the Road Safety Auditors during the tender period were not being satisfactorily addressed in the contractor's design. Due to the horizontal geometry at the interchange, the minimum standards necessary to navigate the tight constraints compounded the reduced standard for the vertical curve. Because all tenderers had proposed similar, unresolved solutions the client elected to 'buy back' the original departure as a safety enhancement. It was recognised that the Principal's Requirements may give a number of minimum standards but two minimum standards taken together do not necessarily contribute to a best practice solution.

Urban Design

High quality urban design, amenity and landscaping are now community expectations of highway projects. The Principal's Requirements stipulated a high standard of urban design for the Clarke's Lane footbridge that was expected to be a prominent landscape feature. The contractor and designer responded to this brief with an elegant cable stay bridge design.

Urban design for other elements of the project was recognised in the tender evaluation criteria but left relatively open to interpretation by the tenderers. The successful contractor's design team included an architectural and urban design practice, Jasmax, who developed enhanced solutions including "green" retaining walls, wavy keystone retaining walls, noise walls and extensive planting. The cost of the urban design enhancements was 1.5 to 2.0% of the tender price which the contractor considered worth including as a point of difference to help win the contract.

CHALLENGES AND THEIR RESOLUTION

Few, if any, major transportation projects proceed without a hitch. For this project the following challenges and how each was resolved are discussed:

- SH18 – SH16 motorway merge;
- Rising steel prices;
- Roles and responsibilities.

SH18 to SH16 motorway merge

The interchange between the two highways includes a high speed, four to three lane merge of traffic travelling southbound from both SH16 and SH18 towards the Auckland CBD. This merge passes over a crest curve below the Hobsonville interchange bridge which presented design challenges to achieving safe inter-visibility between the two merging lanes. To flatten this crest curve would have significantly increased the earthworks excavation and required higher retaining walls and abutments below the bridge, all of which would have substantially increased cost. Two merge concepts were considered: dropping the left hand, outside lane as is commonly done overseas or merging the centre two lanes for which there are existing examples in New Zealand. It was decided to adopt the centre merge because in order to accommodate a left hand drop the nearby southbound on ramp from Hobsonville Road would have had to be extended by several hundred metres, requiring land outside the existing designation.

During detailed design a problem arose with differing interpretations and application of the Principal's Requirements and referenced design standards for the minimum required stopping sight distance (SSD) for traffic approaching and travelling through the merge. The contractor's designer and independent checker had a common interpretation that differed from those of the Principal's Advisor and the safety audit team – three different interpretations in total. Various attempts were made to find applicable standards and similar examples overseas and refine the geometric model in order to reach agreement. Unfortunately there was no clear right or wrong answer and the problem became one of conflicting interpretations and opinions on what constitutes "best practice". The situation was finally resolved by the client accepting the contractor's design.

This problem demonstrates how the Principal's Requirements (PRs), as a key component of a D&C contract document, should clearly express what the client wants and to what standard. D&C contracts are normally "hard money" lump sum contracts that transfer significant risk to the contractor. PRs that contain ambiguities, uncertainty or elements that are subject to confirmation and interpretation by the Principal's Advisor and/or other parties are problematic. References to industry guidelines and "best practice", if not specified as mandatory, can be open to different professional interpretations by the contractor's designer, independent checker, road safety auditor and Principal's Advisor. A significant amount of technical expertise and management effort is often required to resolve these differences of interpretation and opinion.

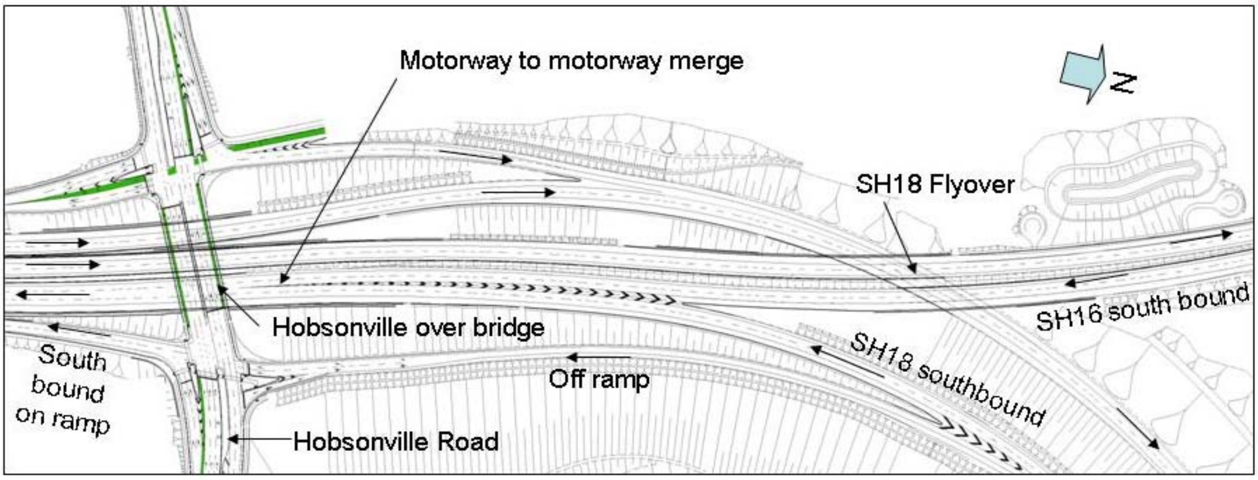

Fig. 6 - SH18 to SH16 motorway merge

Rising steel prices

The contractor's tender design included a steel bridge for the flyover that will take eastbound traffic from SH16 onto SH18. This bridge includes horizontal and vertical curves with super-elevation that makes its design and construction relatively complex. The tender was priced in late 2007, following which there was a surge in global steel prices. Although the contract included cost fluctuation provisions, the contractor considered these insufficient to cover the cost of the steel price increase and instead elected to redesign the bridge as a post-tensioned concrete structure. The D&C contract provided the contractor more flexibility to do this, i.e. in order to change the design in a traditional construct only contract the contractor would have had to propose and pay for an alternative design that the client might not accept.

The concrete structure also provided the client with the benefit of reduced whole life maintenance costs.

Team roles and responsibilities

A key factor in the success of the project was the combined performance of the project team, namely the:

- Designer

- Contractor
- Category 1 Design Checker
- Road Safety Auditor
- Engineer to the Contract (Principal's Advisor), and
- Principal (client).

The contract conditions and Principal's Requirements placed various obligations on all these parties to review, check, verify, inspect, monitor, audit, certify, accept and/or approve the design and the physical works. (The exception being the Principal, however various NZTA staff carried out some review and checking activities via the Principal's Advisor). Clearly there was potential for confusion and conflict to arise with checkers checking the checkers! Some of the team were not used to working under a D&C contract with roles subtly different to those in a traditional design-bid-construct contract. Hence on a number occasions review comments were arguably preferential engineering requests rather than contractual requirements. Similar issues were encountered when D&C contracts were first utilised by the UK Highways Agency during the 1990s.[13] However on this project these issues were highlighted early and quickly resolved.

The contract included partnering provisions in order to avoid and if necessary manage and resolve conflicts within the project team. A Project Management Board with senior representatives from each of the main organisations met regularly and provided a forum to which significant problems could be elevated for discussion and resolution.

CONCLUSION

The SH18 Hobsonville Deviation and SH16 Brigham Creek Extension are expected to be completed by the contracted date of 30th Sept 2011, well in advance of the advertised date of 2012. The project is also on track to be completed close to the client's original budget even allowing for the purchase of significant extra works that will provide whole life benefits.

At a micro-economic level the project demonstrates the successful application of a design and construct form of contract to procure a major piece of transportation infrastructure. Key factors in this success include the required scale to make a D&C contract economic and the appropriate allocation of risk between the client, contractor and designer. Working together as an integrated team and exploiting available technologies enabled the contractor and designer to produce an optimised, buildable design that reduced risks to all parties. The resultant knowledge and experience gained by all persons involved in the project will positively contribute to the capability of New Zealand's transport infrastructure services industry.

Figure 7 – SH18 Hobsonville Deviation under construction passing through Auckland's Northern Strategic Growth Area

[13] Hodgson 1999

REFERENCES

ARC (2010). *Regional Land Transport Strategy 2010-2040*, Auckland Regional Council, April 2010. http://www.arc.govt.nz

ARCG (2007). Growing Smarter – The Auckland Region in the 21st Century, An Evaluation of the Auckland Regional Growth Strategy 1999. Auckland Regional Growth Forum, July 2007. http://www.arc.govt.nz

ARTA (2006). *Passenger Transport Network Plan 2006-2016*, Auckland Regional Transport Authority, November 2006

ARTA (2007). *Sustainable Transport Plan*, Auckland Regional Transport Authority, February 2007

CLAPPER, L. (2010). Working together to improve Auckland's motorways. *Business Review Australia,* 8th July 2010. http://www.businessreviewaustralia.com/company-reports/heb-construction-ltd

CORBETT, P.W. and EDMONDS, M.A. (2005). Upgrading of Central Motorway Junction, Auckland. *Proceedings of the Institution of Civil Engineers – Bridge Engineering,* Volume 158, March 2005, Issue BE1, pp 25-36.

DOUGLAS, M.J., TOURELL, F.J. and MELROSE, H. (1995). Major trial of a design and build project at Auckland, New Zealand. *Routes – Roads,* No. 288, World Road Association (PIARC), September 1995.

FCC-SH1. *State Highway 1 Four Laning.* Fletcher Construction, (date unknown). http://www.fletcherconstruction.co.nz/project.php?project_id=181&archived=yes

FCC-CNJ. Central Motorway Junction (CMJ) Stage 2. Fletcher Construction, (date unknown). http://www.fletcherconstruction.co.nz/project.php?project_id=304&archived=yes

HODGSON, G.J (1995). Design and build – effects of contractor design on highway schemes. *Proceedings of the ICE - Civil Engineering*, Volume 108, Issue 2, May 1995, pages 64 – 76.

HODGSON, G.J (1999). Highways Agency Design and Build Conditions of Contract. *Proceedings of the ICE – Transport,* Volume 135, February 1999, pp 17-28.

McCRARY, S.W., GEBKEN, R.J. and HILL, B.M. (May 2010). Longitudinal Study of Innovative Contracting Practices in State Departments of Transportation. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, Volume 2, Issue 2, pp. 113-119.

NZTA. *Western Ring Route Project Summary Statement*, New Zealand Transport Agency, January 2010. http://www.nzta.govt.nz/projects/completing-wrr/docs/201001-wrr-project-summary-statement.pdf

NZTA. *SH18 Hobsonville Deviation and SH16 Brigham Creek Extension,* New Zealand Transport Agency, 6 Dec 2010. http://www.nzta.govt.nz/projects/hobsonville/index.html

NZTA (2009). *Procurement manual for activities funded through the National Land Transport Programme,* July 2009 (amended Nov 2009). http://www.nzta.govt.nz

NZTA (2010). *State Highway Portfolio Procurement Strategy 2010.* August 2010. http://www.nzta.govt.nz

WCC. *Urban Growth in Northern Waitakere.* Waitakere City Council, (date unknown), http://www.waitakere.govt.nz/abtcit/cp/norsga.asp

ACKNOWLEDGEMENTS

The authors wish to acknowledge the following for their assistance in preparing this paper and/or contributing to the success of the project:

- Gareth Cheeseman, Jonathan Hind, Richard Lauren, Alastair MacRitchie and Ian Sloane of Aurecon NZ Ltd

- Steve Croft of HEB Construction Ltd
- Rachel Kirk of the NZTA
- Derek Holmes and Muir Coup of Opus Consultants
- Geoff Heaton of AECOM.