

THE TRANS-CANADA HIGHWAY'S KICKING HORSE CANYON
A PROJECT UPDATE, AND THE ROAD AHEAD

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Kicking Horse Canyon Project

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The Trans-Canada Highway's Kicking Horse Canyon: A Project Update, and the Road Ahead

For thousands of years people have been moving through British Columbia's Kicking Horse Canyon, beginning with the First Nations' people. Toward the end of the 19th century, the railway appeared in the Canyon followed shortly thereafter by the motor car.

Since its completion in the 1960s, the Trans-Canada Highway through the Canyon has followed a tortuous, two-lane, 26 kilometre long alignment plagued by geotechnical challenges. Nine years ago, BCMoT embarked on engineering activity to kick-start \$200 million worth of construction and, presently, is completing preliminary engineering work for a further \$765 million worth of improvements.

Improvements completed and presently underway include:

- four-laning 8 kilometres of highway to 100 km/h criteria requiring the movement of over three million cubic metres of rock and earth material
- construction of two crossings of the Kicking Horse River and the Canadian Pacific Railway: the first, the 250 metre long Yoho Bridges and the second, the 400 metre long Park Bridges reaching to heights of 90 metres over the River

Current engineering activity is focused on the following scope:

- four-laning 18 kilometres of highway to 80km/h and 100km/h criteria
- a 3 kilometre long tunnel, the longest North American road tunnel if built today
- several bridges ranging between 100 metres and 250 metres long

Fisheries, wildlife, archaeological and other environmental assessments are also underway.

With current construction scheduled for completion in 2007, BCMoT is confident that the momentum generated by recent improvements will see such activity continue, on what is proving to be one of North America's most technically challenging transportation projects.

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Introduction

For thousands of years people have been moving through British Columbia's Kicking Horse Canyon, beginning with the First Nations' people. Toward the end of the 19th century the railway appeared in the Canyon followed shortly thereafter by the motor car.

Since its completion in the 1960s, the Trans-Canada Highway (TCH) through the Canyon has followed a tortuous, 2-lane, 26 kilometre long alignment plagued by geotechnical challenges. However, commencing in 1998, the British Columbia Ministry of Transportation (BCMoT) embarked on engineering activity to kick-start \$200 million worth of construction and, presently, is completing preliminary engineering work for a further \$765 million worth of improvements.

This paper starts by introducing the reader to the Kicking Horse Canyon, and puts in context the type and volume of traffic that uses the facility. The paper then presents a chronology of engineering activity that BCMoT has embarked on over the last 15 years, followed by a description of the highway and the surrounding environment as it exists today and as it existed prior to starting recent construction in 2000. Finally, the recent and current construction works are described, including the contracting models adopted by BCMoT, and concludes with a description of the current engineering activity and BCMoT's plans for implementing this next round of improvements.

History and Setting

The Kicking Horse Canyon is located in the Rocky Mountains of southeast British Columbia, immediately east of Golden and the Purcell Mountain Range. The Canyon gets its name from the east-to-west flowing Kicking Horse River, a turbulent watercourse narrowing to several metres wide in parts and, consequently, a very popular source for recreational kayakers and commercial rafting operations. Emptying into the Columbia River in Golden, the River was so-named from the days when a member of the Palliser Expedition¹ met with unfortunate circumstances. Dr. James Hector, a geologist, naturalist and doctor on the Expedition, was kicked in the chest while attempting to catch his wandering horse. Alive, but in some pain, Hector's men tended to his wounds, and considered it appropriate to name the river, and the pass above them, in honour of the 'Kicking Horse'².

Prior to European contact, First Nations' people would likely have used the canyon corridor as a trade and transportation route. They would have travelled eastward from the Columbia River basin, as the canyon provided access to the abundant resources of the prairie bison herds. Conversely, people would have travelled westward through the

¹ The Palliser Expedition, (1857-60), was initiated by John Palliser with support from the Royal Geographical Society, and travelled from the Red River (in Eastern Manitoba) to and through the Rocky Mountains along the unsurveyed American boundary. The Expedition explored the southern passes through the Rocky Mountains, and amassed astronomical, meteorological, geological and magnetic data, and described the country, its fauna and flora, its inhabitants and its "capabilities" for settlement and transportation. Traversing six passes in the southern Rockies, the Expedition's reports (published in 1859, 1860 and 1863) and its comprehensive map (1865) were for some time the major source of information about the area. (www.ourheritage.net, May 2007).

² www.rmbooks.com, May 2007.

canyon from the prairies to participate in seasonal salmon-fishing activities along the Columbia River. Archaeology work in the canyon has also identified pre-contact stone tool-making activities in the area.

The arrival of the Canadian Pacific Railway into the Rocky Mountains in the late 19th-century brought with it numbers of Canadian and European visitors, the likes of which the Mountains had never been seen before. And as more people were introduced to the Mountains so too did their need for non-rail routes through the Mountains.

Located at the western edge of the Kicking Horse Canyon, and at the confluence of the Kicking Horse and Columbia Rivers, the Town of Golden is a town of industrial and recreational businesses including a Canadian Pacific rail yard, wood products' manufacturing, skiing, snowmobiling, river rafting, golfing and other recreational activities. Golden is a natural spot for Trans-Canada Highway motorists to stop and re-



fuel, given that the Town is 150 kilometres east of Revelstoke, 100 kilometres west of Lake Louise, Alberta and 250 kilometres west of Calgary, Alberta.

The Trans-Canada Highway is not wholly within the Province's jurisdiction in southeastern British Columbia. Twenty-six kilometres east of Golden, Yoho National Park falls under the jurisdiction of Parks Canada, while 50 kilometres west of Golden, Glacier National Park is also Parks' jurisdiction.

TCH at kilometre 7 looking west, circa 1950s

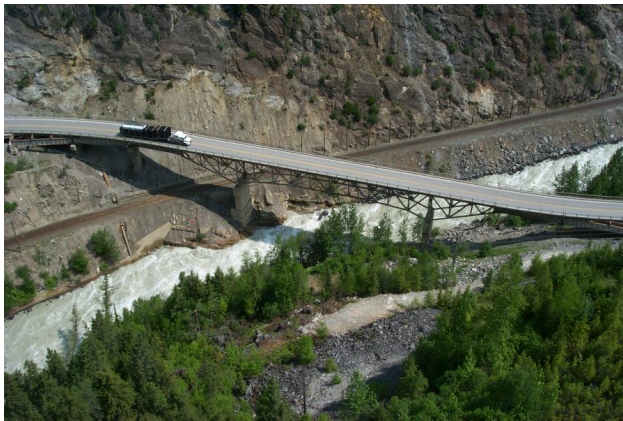
Of the several east-west highways between Alberta and British Columbia, the Trans-Canada Highway is the most heavily used. Present annual average daily traffic (AADT) totals 5 200 vehicles per day (vpd) and summer average daily traffic (SADT) volumes climb to 10 000 vpd. Based upon historical trends, AADT and SADT volumes could be expected to grow at 2.5% per annum to 8 500 vpd and 16 000 vpd, respectively. However, a 2006 Conference Board of Canada report suggests a more aggressive trend into the future³. The report concludes that one of the main reasons that Albertans do not drive to the British Columbia interior to access significant recreational opportunities is because of the poor condition of the highway through the Kicking Horse Canyon. The report suggests that with improvements to the Highway, 25 year traffic volumes could grow at 3.8% and 5.8% on AADT and SADT volumes, respectively. At these rates, AADT and SADT volumes could grow to 10 200 vpd and 24 000 vpd, respectively, by the mid-2030s.

³ Economic Impact of Reducing Travel Times to Southeastern B.C. Tourist Destinations, Conference Board of Canada for B.C. Ministry of Transportation, May 2006.

Of the 5 800 vehicles traveling on the Highway in 2006, approximately 20% of these were commercial vehicles destined for or originating from the container ports on the west coast, in Vancouver. This number of commercial vehicles, approximately 1 000 per day, holds throughout the year, for while the Canadian Pacific Railway continues to move a significant amount of freight through the Canyon on rail, the time sensitive nature of many products today demands transport by vehicle. Indeed, the value of non-BC origin exports produced by industry across Canada and moved by road through the Kicking Horse Canyon for export to non-U.S. markets around the world increased by over 50 percent in 3 years, from \$10.7 billion in 2002 to \$16.0 billion in 2006⁴.

More Recent History

In 1992, BCMoT initiated a Corridor Report that studied the TCH and alternative highway corridors between Donald, 20 kilometres west of Golden, and Yoho National Park, 26 kilometres east of Golden. The Report concluded that, immediately east of Golden, subsequent study should focus on the relative merits of improving the existing highway versus an alignment that crosses the Kicking Horse River near the Town of Golden and stays south of the river for approximately 20 kilometres.



5 Mile (Yoho) Bridge 1990s, pre-replacement.

While improvements to the TCH were carried out by BCMoT over 2 kilometres of Golden's western reach in 1996, the Highway through the Canyon remained un-studied for several years.

Then, in the summer of 1998 under the Cache Creek to the Rockies Program, BCMoT initiated functional planning and preliminary design studies along the TCH throughout the interior of British Columbia.

Included in this program was the Kicking Horse section. Picking up on the 1992 corridor report, consultants working on behalf of BCMoT developed alignment alternatives and access improvements along the TCH through the Canyon and toward Yoho National Park.

Through the winter of 1998 / 1999 BCMoT expended considerable effort to identify construction candidates through the Canyon. In the Spring of 2000 BCMoT focused on

⁴ Exports by Mode of Transport from BC Stats, Cascade Gateway data, US Department of Transportation. (Calculated using Exports by Mode of Transport by Province of Clearance, 2004 less dollar value of trans-border surface freight value by Mode Cascade Gateway Ports of Entry. Total exports less BC origin exports yields exports from rest of Canada. All values based on declared trade value).

a 3 kilometre section of the TCH, later to be called Phase 1, between kilometres 9 and 12⁵, and the Kicking Horse Canyon Project (KHCP) was born.

Highway Condition Pre-KHCP

The TCH through the Kicking Horse Canyon takes on several appearances between the Town of Golden and Yoho National Park, as illustrated below.

Town of Golden

The western most 2 kilometres are within the Town of Golden, where the existing highway gains 100 metres in elevation via an 8% grade. With a posted speed limit of 60 km/h, the highway is generally 3 lanes wide (2 lanes eastbound and 1 lane westbound), and features a cross-section more common to rural roadways with open ditches and concrete roadside barriers. There are only a couple of driveway accesses within this section, and public intersections are limited to:



- kilometre 0.0, T-intersection with Highway 95;
- kilometre 1.4, 4-way intersection with Golden Donald Upper Road / Golden View Road;
- kilometre 1.8, T-intersection with Lafontaine Road; and
- kilometre 2.4, T-intersection with Golden View Road.

Looking east at Highway 95 (foreground) and Trans-Canada Highway (background)

Sub-surface conditions are generally gravel throughout, although at the eastern limit of the Town the terrain takes on more of the Canyon appearance featuring clayey and silty till with rock outcrops.

Environmentally speaking, the biggest issue within the Town limits is the presence of wildlife and the associated risk of collisions with vehicles. While bighorn sheep, elk and moose partly contribute to this issue, the greatest risk is presented by mule deer and white-tailed deer as they ‘dart’ onto the pavement surface from adjacent ditches and terrain much to the surprise of drivers. (While the local bighorn sheep population, which moves between the Town and the canyon, has become habituated to humans and vehicles it could be suggested that the greatest risk that the sheep presents to highway traffic is when motorists slow to observe and photograph the animals). Indeed, no

⁵ BCMoT codes its highways using a Land Kilometre Inventory, or LKI. The LKI categorises provincial highways into Segments and kilometre marks. The Kicking Horse Canyon section of the Trans-Canada Highway is within Segment 0990, where LKI 0.0 (or kilometre 0) is located at the intersection of the TCH and Highway 95 within the Town of Golden, and LKI 25.9 (or kilometre 25.9) is at the western boundary of Yoho National Park. The TCH becomes a federal responsibility – under the auspices of Parks Canada – at this boundary with Yoho National Park.

section of the Trans-Canada Highway in British Columbia experiences higher collision rates than the section through Golden, at approximately 6 vehicle-animal collisions per kilometre per year. This is roughly seven times higher than the estimated number of roadkills per kilometre per year along the TCH in the province⁶.

The Canyon

Between kilometres 2 and 17, the TCH takes on a highly curvilinear alignment and, along with the highway through British Columbia's Fraser Canyon, bisects some of the most severe terrain in Canada. Between these two limits, the horizontal geometry is defined by curves with radii as low as 50 metres, requiring several advisory speed limits of 40 km/h and 60 km/h. At kilometre 6 the highway reaches an elevation of 1010 metres before descending to elevation 900 metres where it crosses the Kicking Horse River at Five Mile (Yoho) Bridge. Then, at Ten Mile (Park) bridge, at kilometre 14.3, the highway again begins a climb on a 7 percent and 8 percent grade to kilometre 17 where it generally levels off at elevation 1120 metres, at a commercial vehicle Brake Check. With a posted regulatory speed of 80 km/h, the highway within this 15 kilometre section is generally 2 lanes wide save for limited areas where auxiliary lanes were provided:



- a westbound climbing lane between kilometres 8.3 and 8.7;
- an eastbound climbing lane between kilometres 9.7 and 10.37;
- eastbound and westbound passing lanes between kilometres 11.7 and 13.1⁸; and
- an eastbound climbing lane between kilometre 14.3 and 17.0.

TCH between kilometre 4.5 and 7.5 looking east, with Kicking Horse River and Canadian Pacific Railway below and right

There is no private development within this section of the TCH, although several driveway-style intersections are scattered along the highway that provide access to the Canadian Pacific Railway line, Dart Creek Forest Service Road (kilometre 6.2), Rafter's Pullout (kilometre 12.0) , public rest area (kilometre 12.5), and Glenogle Forest Service Road (kilometre 16.8).

This section of highway, in keeping with its tortuous alignments, features the areas most challenging geotechnical conditions. Throughout the 24 kilometre rural section of the

⁶ E-mail, Bill Harper, R.P. Bio., Osiris Wildlife Consulting, May 2007

⁷ Following completion of Phase 1 construction, described later in this paper, this laning arrangement was improved.

⁸ With the start of construction on Phase 1 and Phase 2, described later in this paper, this laning arrangement was improved.

corridor, there exist low severity to high severity natural hazards in the form of rockfalls, icefalls, snow avalanches, debris torrents and erosion falls, and suffers from one of the highest incidences of rockfall along the TCH in the province.

Canyon East

The easternmost 9 kilometres of the TCH, between the Brake Check and Yoho National Park, feature generally favourable horizontal and vertical alignments. Horizontal curves of radii not less than 290 metres are provided, and the grade line does not exceed 4 percent as the TCH fluctuates between elevations 1080 metres and 1130 metres. With the more forgiving alignment, the regulatory posted speed is increased to 90 km/h, where it generally remains through Yoho National Park. The cross-section is again 2 lanes wide, with limited passing opportunities afforded through the provision of broken barrier line (centre-line, yellow pavement marking). Several driveways and intersections exist within this section providing access to woodlots (kilometres 18.1 and 20.4), rafting put-in / pull-out points (kilometres 19.4 and 25.5), and private properties (kilometre 24 and 25). Finally, public intersections exist at:

- kilometre 24.7, T-intersection with Wapta Road west;
- kilometre 25.5, T-intersection with Beaverfoot Road; and
- kilometre 25.7, T-intersection with Wapta Road east.

Natural hazards are limited in this section, with only one low severity snow avalanche path and one low severity landslide risk. However, the pavement structure suffers from numerous low to high severity pavement distortions and frost heaves, and an area of downslope instability at kilometre 23.

Wildlife is abundant in this section of the corridor, with permanent inhabitants including mule deer, white tailed deer, elk, mountain goat, black bear, coyote and grey wolf. Accordingly, collision rates are moderately high at present, averaging approximately 20 collisions per kilometre per year, the most common of which involving deer and elk in the summer months.

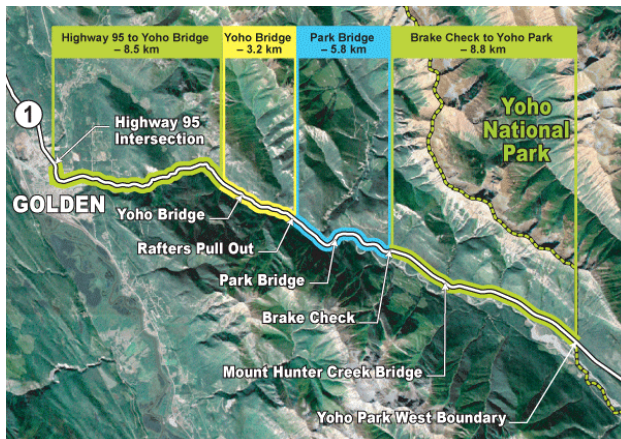
The Kicking Horse Canyon Project

As noted previously in the paper, 1998 saw the start of current interest in improving the TCH through the Kicking Horse Canyon through the initiation of functional planning and preliminary design work.

The design criteria for improvements to the TCH developed during this stage of engineering was for a 4-lane divided facility, incorporating 80 km/h geometrics within the Town of Golden and 100 km/h geometrics through the rural area of the corridor east of Town. Accesses and intersections were to be consolidated wherever possible with interchanges to be developed within the Town limits to replace existing intersections. The Five Mile (Yoho) and Ten Mile (Park) Bridges would require replacement, if not because of obvious alignment improvements then because of their vintage (having been constructed in the mid-1950s).

Project cost estimates at the completion of this stage, in 2000, put improvements to 26 kilometres of highway between \$500 million and \$1,000 million (Cdn.). In recognition of the importance of the corridor to the national economy as an access to Pacific ports, the province committed to improve the highway in partnership with the federal government of Canada.

Due to the high cost associated with the corridor improvements as a whole, the province took a strategic look to improving the corridor in phases, through investing more modest amounts of capital in partnership with the Government of Canada.



During the early stages of project implementation, the project identified the section of highway in the area of the Five Mile (Yoho) Bridge, between kilometres nine and twelve, as that which should be improved first. A steel-truss structure built in the mid-1950s, the Five Mile (Yoho) Bridge was in worse condition than its twin at Ten Mile (Park) Bridge and significant rehabilitation was necessary in order to extend its service life. Accordingly, the province focused its

initial efforts on improving the Five Mile (Yoho) bridge and its approaches. Concurrent with identification of this improvement project, the province established the following, initial phases:

- Phase 1, kilometre 9 to kilometre 12 (coloured yellow above);
- Phase 2, kilometre 12 to kilometre 17 (coloured blue above); and
- Phase 3, kilometre 0 to kilometre 9, and kilometre 17 to kilometre 26 (the 'bookends', coloured green above).

Phase 1, Five Mile Hill to Rafters' Pullout, 3 kilometres

In early 2000, on the heels of the previous functional planning and preliminary design work, BCMoT embarked on detailed design for improvements to these 3 kilometres of TCH through a conventional BCMoT-consultant design assignment. The consultant was responsible for providing structural and environmental support resources, but BCMoT retained responsibility for the geotechnical work.

The province was not able to secure sufficient funding to embark on improvements to all of Phase 1 concurrently. Rather, BCMoT took the risk of embarking on construction sufficient to develop a working area that would facilitate bridge construction. Accordingly, the Phase 1 works were packaged into three contracts as detailed below, which were delivered as funding became available:

- Contract 1: Six Mile Hill
- Contract 2: Five Mile (Yoho) Bridge and Approaches
- Contract 3: Six Mile Hill to Rafters' Pullout

Contract 1 was awarded in the spring of 2001 to Dawson Construction for approximately \$7M (Cdn.). The work involved the removal of approximately 86 000 cubic metres of rock and the installation of 4 000 square metres of rock bolting and shotcrete. This work was delivered separately from the bridge contract since insufficient funding was available to concurrently be able to commit to constructing the bridge. In addition, the design was relatively simple and permitted construction to begin while the bridge design was being finalized and while additional funding was pursued. It was completed the following year, in the spring of 2002.



Contract 2 was awarded in 2002 to Peter Kiewit Sons' Corp. for approximately \$24M (Cdn.). The work involved the construction of the highly anticipated, 270 metre long, 4 lane bridge over the Kicking Horse River and Canadian Pacific Railway line. The bridge design employed the use of delta frame piers to permit the use of conventional concrete girders for reduced cost and transportability along the winding mountainous highway. This innovative approach warranted recognition of the design by the Consulting Engineers of BC in 2003. To address one of the rockfall areas of the project, a 500 metre long rock debris protection wall reaching to a height of 14 metres was included in the contract. The wall incorporates a sacrificial upper section using styrofoam blocks and gabian baskets designed to fail in the event a design impact is received. The contract was completed in the autumn of 2004.



Contract 3 was awarded in the summer of 2004 to Emil Anderson Construction for approximately \$17M (Cdn.). The contract as tendered called for the construction of split eastbound and westbound lanes over a distance of several hundred metres. This required that the westbound lanes depart significantly from the existing highway and twice cross the Kicking Horse River via two, new bridges. However, by implementing its own value engineering proposal, the contractor developed a design that revised the alignment and replaced the bridges with a cantilevered section of roadway over the Kicking Horse River for a distance of 155 metres – the effective cantilevered width is 4.2 metres, equal to half of the westbound travel lane plus outside shoulder. The result saved the contractor and the Province over \$2M (Cdn.) and reduced the environmental

footprint. With these savings, the Province was able to provide additional dust-control and rockfall mitigation immediately west of the Five Mile (Yoho) Bridge that the initial rockfall protection had not been able to mitigate.



This change was made possible through a value engineering proposal that the Province includes in its Standard Specifications for construction, which permits a contractor to submit an alternative design to the Province after it has been awarded the work. In such instances, the Province reviews the value engineering proposal(s) and, if deemed acceptable, the contractor implements its alternative. To be considered, a value engineering proposal must be perceived by BCMoT to provide a tangible benefit such as a reduction in the Project's cost,

an improvement to the product which improves on the life cycle cost, a schedule improvement and/or a reduction in risk to BCMoT. Project savings realised by an implemented value engineering proposal are typically shared "50:50" with the Province.

The improvements to Phase 1 were completed in the Autumn of 2006, and have resulted in a far superior alignment and cross-section to that which existed previously. With a total Phase 1 project cost of approximately \$65 million (Cdn.), of which \$22.5 million (Cdn.) came from the federal government, this 2.5 kilometre section of TCH now features 4 travel lanes with 2.5 metre paved, outside shoulders. Divided by concrete median barrier, the highway incorporates 100 km/h geometrics and a new Five Mile (Yoho) Bridge crossing the Kicking Horse River and Canadian Pacific Railway.

Phase 2, Rafters' Pullout to Brake Check, 6 kilometres⁹



In 2004, again following intensive preliminary design work involving significant geotechnical investigations and an internal value engineering study, the Province initiated the procurement process for a design-build-finance-operate contract. This arrangement involved the design, construction and financing of a 5.8 kilometre section of the Trans-Canada Highway immediately east of Phase 1, including the replacement of the Park

⁹ A significant portion of the text within this section of the paper has been drawn from the Project's value for money report, [Project Report: Achieving Value for Money. Kicking Horse Canyon – Phase 2 Project](#), Partnerships British Columbia, June 2006. A complete copy of this value for money report is publicly available at www.partnershipsbc.ca

Bridge, as well as the maintenance, operation and rehabilitation of the entire 26 km section for a term of 25 years. The expected net present cost of the contract – including design, construction, maintenance and rehabilitation over 25 years – is \$166 million (Cdn.) where the capital cost alone is estimated at \$130 million (Cdn.)

Selection of the procurement method

Three procurement models – (1) a conventional delivery model, or design-bid-build, (2) a design-build model and (3) a design-build-finance-operate, or DBFO – were evaluated to determine which model had the potential to deliver the taxpayer best value for money, ie, to meet or exceed the project objectives for the best cost. The project objectives that were established by the Province included:

- improving the safety record;
- providing better customer services and access;
- delivering economic benefits;
- achieving value for money;
- optimally managing project risks;
- ensuring that the existing road serves traffic demand during construction of new improvements; and
- optimizing the asset condition over the long term.

Procurement options were evaluated using multiple qualitative and quantitative criteria. The result of this evaluation demonstrated that the DBFO model offered the best potential for value for money, with a higher overall level of benefit from the perspective of cost and qualitative benefits. This preferred DBFO scheme would see the private sector designing, building, maintaining, operating, rehabilitating and financing the highway assets (including bridges, retaining walls and other roadside features) to a predetermined set of performance standards established by the Province and embodied in a long term, binding contract. The asset, however, would remain the property of the Province.

The Province's value for money report prepared following award of the contract reports the following features of the project that made it a strong candidate for a DBFO:

- The geotechnical challenges of working in the Canyon meant that the risks associated with construction, with a relatively high probability of delays, variations and cost overruns, would be assumed by the contractor;
- By combining design and construction into one contract, it was expected that schedule savings could be gained to reduce delivery time over the estimated design-bid-build schedule of 44 months; and
- By structuring the contract as a DBFO, private sector funds adds a level of discipline that encourages innovation and efficiency in meeting or beating project schedule, minimizing traffic disruption, and developing a design that would result in better maintenance over the long term. Further, because the contractor invests its own

equity and relies on performance-based payments, the contractor has more incentive to deliver the long term outcomes the Province requires.



Based on a financial comparison, BCMoT estimated that the net present cost of the public sector reference project would be \$184 million (Cdn.), versus the DBFO contract value of \$166 million (Cdn.), a difference over the 25 year contract term of \$18 million (Cdn.) or 10% of the contract value. The Province established a maximum net present cost as part of the competitive selection process to ensure that proposals received were within the Province's fiscal restraints.

With the capital cost of the work estimated at \$130 million (Cdn.) the (federal) Government of Canada committed to contributing 50 percent of the capital cost for Phase 2 up to a maximum of \$62.5 million (Cdn.), through the Canada Strategic Infrastructure Fund. This is contributed by way of pre-completion performance payments during construction at six month intervals based on eligible costs incurred by the contractor, as verified by an independent certifier.

Selecting the preferred proponent

In May of 2004, the Province invited industry to register its interest in competing for this DBFO opportunity, to which 54 companies expressed interest. In July 2004, following a proponent meeting also scheduled that month, Requests for Qualifications were issued. Three qualified teams submitted their responses, and in October 2004 Requests for Proposals were issued to these 3 teams. Proposals were received the following June, and financial and technical sub-committee set to evaluating the respective merits of the 2 proposals received, the third consortium having withdrawn from the competition owing to other obligations to which it had recently committed¹⁰. In August 2005 the preferred proponent was identified, and in October 2005, 18 months after inviting registrations of interest, financial close was achieved and the concession contract was awarded to Trans-Park Highway Group (TPHG). And only 1 month after financial close, the Contractor had mobilized crews to commence clearing and grubbing operations.

The successful proponent is a mix of equity providers, engineers, contractors and maintenance providers. Member firms include:

- Bilfinger Berger BOT Inc.. – project manager for TPHG, and equity providers
- Flatiron Constructors Canada – general contractors
- KWH Constructors Corp – bridge girder launching

¹⁰ SNC-Lavalin Inc. was the third consortium that withdrew from the competition when it was selected as the successful bidder on the Canada Line, a \$1 billion (Cdn.) light rail transit line in Greater Vancouver.

- HMC Services – operations, maintenance and rehabilitation services provider
- Parsons Overseas Company of Canada – design management and bridge design
- Stantec Consulting Ltd. – roadway and drainage design
- Golder Associates Ltd – geotechnical and environmental design



Representing the Province throughout the process is an equally multi-disciplinary team including BCMoT and Ministry of the Attorney General staff, Partnerships BC as business, transaction and procurement manager, and Focus Corporation as Owner's Engineer and lead providers of technical evaluation sub-committee resources. In addition, a fairness auditor and conflict of interest adjudicator were retained to ensure that the evaluation process was fair, objective and appropriate.

Total procurement cost incurred by Province from date of issuance of RFP until financial close is \$4.5M (Cdn.), or 2.7 percent of the overall project value in net present cost terms. This amount is in keeping with procurement costs incurred for similar projects of this magnitude. The procurement cost includes costs associated with the owner's engineer team, geotechnical investigation, procurement advisor, financial advisor and legal advisor, BCMoT and Attorney General internal costs, the asset condition inventory study, and the \$600,000 stipend paid to the one unsuccessful proponent.

Risks, Payment and Financing

Under the contract, the concessionaire is responsible for risks associated with the following:

- Effectiveness and ability to implement the proposed design of the works;
- Construction costs, labour availability and some geotechnical conditions;
- Construction schedule;
- Price and availability of operations and maintenance resources;
- Rehabilitation of the whole section; and
- Availability and changes to the cost of financing from financial close.

Shared risks include those associated with traffic composition changes (such as more or heavier vehicles imposing damage on pavement structure), geotechnical site conditions, increases in general insurance premiums charged by the insurance industry, inflation of some OM&R risks, and others.

In exchange for assuming these risks, the contractor's rewards would be achieved through its expertise in realizing incremental value through efficiencies in designing,

building, financing and operating the project as well as through improved life-cycle planning and operations.

Total payments to the contractor are comprised of three components

- pre-completion performance payment during construction;
- availability and safety payments that are subject to deductions should the contractor's performance result in the standard of the road falling below pre-determined standards;
- traffic volume payments that are subject to the level and type of traffic on the road following construction completion; and
- end of term payment

Each month, the Province pays the concessionaire an annual service payment based upon its performance for the 25 year contract term. Under the contract the Province continues to own the infrastructure and set and monitor performance standards for the project.

Schedule

Upon award of the contract in the autumn of 2005 detailed design work commenced, followed immediately by clearing and grubbing activity. At time of writing, the grading work is complete and paving and bridge is in the final completion stages. Substantial completion is expected to be realised in late-summer of 2007, with the balance of outstanding items to be completed in 2008. In total, the contract between the Province and TPHG is for 25 years commencing October 28, 2005.



A design-bid-build delivery procurement method was originally estimated to take 44 months to deliver from start of detailed design and following all of the conventional steps through to construction completion. However, with the benefit of jointly designing the road and bridge elements, with the contractor accepting some risk associated with a construction start just weeks after starting detailed design, and with an aggressive construction schedule, the DBFO model has shaved 19 months off a more conventional delivery schedule.

At time of writing, the schedule has been further improved with the target for opening to traffic being advanced a further 3 months.

The Improvement

The alignment and structure requirements currently being constructed by the concessionaire closely mirror the Province's final preliminary design alignment that was included in the contract's request for proposal documents, and includes:

- 4 lane cross section with 2.5 metre outside, paved shoulders with 2.6 metre median divided with pre-cast concrete barrier, on a 6% grade
- a 405 metre long, steel girder bridge, with 5 concrete piers some of which reach to heights of 90 metres, and 12 000 cubic metres of concrete;
- a 90 metre rock cut at the east abutment, comprising 1 million cubic metres of excavation, 8 metre wide rock catchment ditches and 20 000 square metres of drape mesh;
- re-construction of a commercial vehicle brake check and re-construction of joint use rest area and rafters' pullout area; and
- in total, nearly 3 million cubic metres of excavation and 50 000 tonnes of asphalt concrete pavement.

The project is the 2006 recipient of the Award of Merit for project financing by the Canadian Council for Public Private Partnerships.

Phase 3, Highway 95 to Yoho Bridge and Brake Check to Yoho National Park, 18 kilometres

For a distance of 9 kilometres west of Phase 1 and 9 kilometres east of Phase 2 lies the balance of the Kicking Horse Canyon corridor, also known as Phase 3. At the time of preparing this paper, preliminary engineering work is in various states of completion for these eighteen kilometres of Trans-Canada Highway.

In keeping with the current plans for funding and implementation, Phase 3 has been divided into four segments, as follows:

- Segment 1, kilometre 0 to kilometre 1, Highway 95 and Approaches;
- Segment 2, kilometre 1 to kilometre 4, Golden Hill to West Portal;
- Segment 3, kilometre 4 to kilometre 9, West Portal to Yoho Bridge; and
- Segment 4, kilometre 17 to kilometre 26, Brake Check to Yoho National Park.

The existing conditions of each of these segments of highway have previously been described in this paper.

Segment 1, Highway 95 and Approaches

The design objectives for this segment have focused on geometric, capacity and access improvements based on 80 km/h design criteria. Wildlife mitigation options and improved bicycle and pedestrian accommodation also feature in the preliminary design, which includes:

- improved highway gradeline on Golden hill from 8 percent to 6 percent;
- access consolidation via new diamond interchange at junction of Highway 1 and Highway 95 featuring roundabout at western ramp terminals (not shown in drawing below), and closure of right-in / right-out access points;
- cross-section improved from 2 and 3 lanes to 4 lanes, with dual carriageways divided by concrete median barrier;
- provision of paved, outside shoulders throughout;
- wildlife exclusion fencing and crossing structure; and
- 4 metre wide joint-use bicycle and pedestrian path.

A drawing illustrating the design improvements is shown below, and is the product of, not only the standard engineering work necessary in developing improvement options, but also extensive consultation with the Town of Golden, stakeholders and the community at large.



The project cost for this improvement is estimated at \$28M (Cdn.), which includes an allowance for industry escalation and contingencies. The method of procurement has not yet been fixed, but is a candidate for stand-alone design-bid-build or design-build delivery.

Regardless of the delivery model adopted, improvements to this segment of the corridor will have to be carried out after Segment 2 is delivered, or concurrently. For 300 000 cubic metres of surplus excavation will be realised from the Golden Hill to West Portal project and are planned for disposal at the existing Highway 1 / Highway 95 intersection in Golden in order to facilitate construction of the interchange at this location.

Ideally the Segment 1 and 2 improvements will be completed concurrently however, owing to the resulting size of the construction contract, presently this is not a consideration.

Segment 2, Golden Hill to West Portal

The design objectives for this segment have focused on geometric and capacity improvements based on 80 km/h design criteria within the Town of Golden and 100 km/h design criteria east of the Town limits, and the Segment 1 wildlife mitigation options and improved bicycle and pedestrian accommodation carry-through into Segment 2. Improvements that feature in the preliminary design include:

- improved highway gradeline on Golden hill from 8 percent to 6 percent;
- access consolidation via new grade separated intersection at the top of Golden Hill, again including one roundabout, and closure of right-in / right-out access points;
- cross-section improved from 2 and 3 lanes to 4 lanes, with dual carriageways divided by concrete median barrier;



- provision of paved, outside shoulders throughout;
- wildlife exclusion fencing and crossing structure; and
- 3 and 4 metre wide joint-use bicycle and pedestrian path.

A drawing illustrating the design improvements is shown here, and is the product of, not only the standard option

development work that goes into interchange design but, again, extensive consultation with the Town of Golden, stakeholders and the community at large. Complete environmental assessments have also been necessary, the most significant of which have included extensive wildlife studies and archaeological impact and overview assessments.

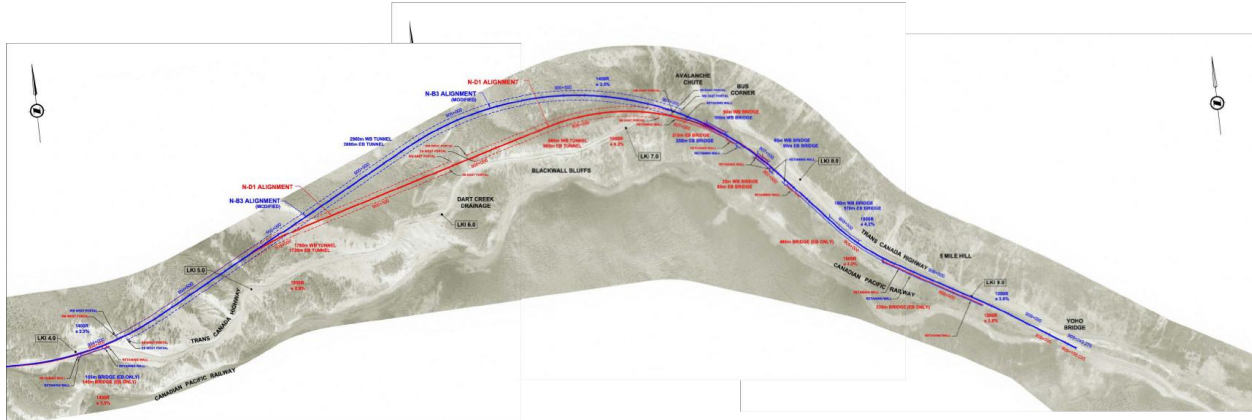
The project cost for this improvement is estimated at \$69M (Cdn.), which includes an allowance for industry escalation and contingencies. The method of procurement has not yet been fixed, but is a candidate for design-bid-build or design-build delivery.

As noted previously, improvements to this segment will have to precede, or be carried out concurrent, with Segment 1 improvements owing to the planned earthworks strategy. Alternatively, the Segment 2 improvements could be completed concurrent with adjoining (easterly) Segment 3 improvements. However, owing to the sheer scale of improvements anticipated for Segment 3, to be described next, it is presently anticipated that Segment 3 will be the final section of the corridor to receive improvements. Rather than waiting until such time as these improvements are carried out, Segment 2 has been 'carved off' of the Canyon in anticipation of funding being made available.

Segment 3, West Portal to Yoho Bridge

Without a doubt, one of the most challenging sections of Trans-Canada Highway in the Province outside of the Fraser Canyon! This paper has previously described the existing challenges and problems over throughout this 5 kilometre section of road, challenges that, in order to be overcome, require significant structural considerations in the form of bridges, wall, cantilevered roadway sections and/or tunnels.

In keeping with the balance of the KHCP design objectives, improvements for this segment have focused on geometric and capacity improvements based on 100 km/h design criteria. Lowering the design speed in order to reduce estimated costs is pointless, for any effort targeted at improving the geometrics and cross-sections requires significant rock cuts, and associated slope stabilization, or structures and/or tunnels.



Owing to the highly variable sub-surface conditions, extensive geotechnical investigations have including test holes, test pits and seismic surveys, access locations for which have often required helicopter access. Environmental studies have also featured in the preliminary engineering, and have included comprehensive wildlife (flora and fauna) assessments and archaeological impact and overview assessments. Fortunately, with the Kicking Horse River over 100 metres below the alignment over the majority of the Segment, there is little fisheries impact and standard sediment and drainage features implemented during construction and throughout operations will sufficiently protect the river's fish habitat.

Several preliminary design options continue to be explored, with two such options featuring the longer tunnel considerations illustrated below. Currently, preliminary design options commonly feature:

- gradeline improvements ranging between 3 percent and 5 percent through tunnel sections, and not greater than 6 percent over open roadway sections;
- horizontal alignment improvements sufficient to meet 100 km/h criteria;
- cross-section improved from two and three lanes to four lanes, with dual carriageways divided by concrete median barrier;
- provision of paved, outside shoulders throughout;
- rock catchment, snow avalanche and slope stabilization throughout, where warranted by geotechnical conditions; and
- wildlife exclusion fencing outside of tunnel sections.

Owing to the rural nature of the corridor, and the significant engineering challenges, public input to alignment selection, while it has been obtained, has not necessarily shaped the design. However, a stakeholder liaison committee has been struck with representation from a comprehensive cross-section of user groups, so that third-party concerns and suggestions can be considered during design development. In mentioning a sample of such groups, the liaison committee includes representatives from the local rafting community, cyclists, local wildlife conservation groups, CP Rail, emergency services and the Golden Chamber commerce.



The project cost for improvements to these 5 kilometres of highway is estimated to be in the order of \$600M (Cdn.), again including an allowance for industry escalation (assuming construction in the next several years) and contingencies. Due to the size and nature of the facility being contemplated the operations, maintenance and rehabilitation costs are very significant, and the delivery team is considering the impact of the life cycle costs in the project development.

The method of procurement also remains a challenge to the delivery team, and is an unknown at present. Considerations playing into the selection of the preferred delivery method are numerous, and include:

- how to consider the life cycle issues in whatever model of procurement
- how to deal with risks and come to an appropriate risk sharing arrangement
- how to obtain industry input and a competitive bid
- how to capture industry innovation
- dealing with this segment recognizing the existing Concession
- ensuring fairness in our procurement process

Segment 4, Brake Check to Yoho National Park

Last, but not least, the 9 kilometre section at the east of the Project rounds out the section of Trans-Canada Highway to be improved under the Kicking Horse Canyon Project. The design objectives for this segment have focused on geometric and capacity improvements based on 100 km/h design criteria throughout, and include:

- horizontal alignment improvements to meet 100 km/h geometrics;
- access improvements via a new grade separated intersection with Wapta and Beaverfoot Roads just east of the Yoho National Park boundary;
- cross-section improvements to 4 lanes, with paved shoulders throughout; and
- wildlife exclusion fencing and crossing structures.

A sample drawing illustrating the design improvements are shown below, and also have been the product of consultation sessions with area residents and stakeholders, the most significant of which has been the local rafting association. Complete environmental assessments have also been necessary, with wildlife studies once again being the focus of most of this effort.



The project cost for these improvements is estimated at \$66M (Cdn.), including an allowance for industry escalation and contingencies. The method of procurement has not yet been fixed, but is a candidate for design-bid-build or design-build delivery.

There are many attractive features associated with this project that make it a natural for improvement, including the stand-alone nature of the works, the fact that the improvements provide for an excellent transition to the soon-to-be completed Phase 2 works, and how the benefits to be derived from the construction of wildlife exclusion fencing and horizontal and cross-section improvements will be immediately realised.

Closure

It is little wonder that improvements to the Kicking Horse Canyon have been a half-century in the waiting given the immense challenges presented by the terrain through which the highway traverses, and one wonders if the concerns and anxieties of today's engineers and constructors match those of the Canadian Pacific Railway's pioneers of over 100 years ago. However, with recent, significant provincial and federal investments in over one-third of the corridor, the BCMoT is confident that the associated momentum generated by these recent works will see a continuation of investment and activity on what is proving to be one of North America's most technically challenging and breathtaking transportation projects.