TWINNING OF THE TRANS CANADA HIGHWAY THROUGH BANFF NATIONAL PARK

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INTRODUCTION

The Setting

Extending from coast to coast, the Trans Canada Highway (TCH) plays an integral role in Canada's social and economic well being. For geographic and historical reasons, 200 km of its 7,500 km length passes through five national parks. One of these is Banff National Park, known worldwide for its spectacular natural resources and landscapes. At the time of the TCH's original construction within the Park in the early 1960's, little attention was given to wildlife, their habitat needs or how the highway's presence in the Park might directly alter ecosystem function.

The Situation

Spanning 6,641 square km of valleys, mountains, glaciers, forests, meadows and rivers, Banff National Park is one of the world's premier destination spots. Almost half of its area is alpine eco-region comprising rock and ice; far more hospitable for wildlife are the valley floors between mountain ranges. These same flat valleys with their favorable terrain attracted railroad and highway engineers who used them for their routes through the mountains.

The TCH within Banff National Park had long been recognized as a significant barrier to wildlife, a potential fracture zone for population connectivity, and a severe human-caused impact on the Park's natural environment. TCH twinning, carried out between 1979 and 2010, provided an important opportunity for PCA to redesign this transportation corridor, to more safely connect people to their travel destinations while also more suitably connecting ecological features.

As the TCH within Banff National Park is located within and on lands designated as "national park", responsibility for and administration and management of the TCH falls to Parks Canada Agency (PCA), whose mandate is to protect and preserve nationally significant examples of Canada's natural and cultural heritage.

Project History

Undertaken in response to rising traffic volumes, public safety and environmental concerns, each phase of TCH twinning (expansion from two to four lanes) has sparked national public interest, with early phases becoming flash points for the many divergent views about development and conservation in protected areas, and whether this activity was even in keeping with PCA's mandate. The phased approach to TCH twinning has enabled PCA to develop and adaptively improve a wide range of environmental mitigations to ensure environmental sustainability, and to carry out long term monitoring of their success. A dedicated effort to monitoring and publicly reporting on the success, in particular for wildlife, of TCH twinning has aided in turning vehemently opposed opponents of it to reluctant supporters and even advocates.

KEY ENVIRONMENTAL MITIGATIONS / INNOVATIONS

This submission focuses on the most-recently completed 23 km section of TCH twinning within Banff National Park, between the Castle Interchange and Icefields Interchange. The Castle / Icefields TCH Twinning (the Project) went into service in October, 2010. Mitigation measures associated with the Project are outlined below in relation to; Wildlife; Aquatics / Fisheries; Terrestrial – Terrain / Soils / Vegetation and, Other Mitigations / Innovations.

Wildlife

Banff National Park is home to almost all major wildlife species found in North America. Because the Park's landscape is comprised primarily of rock and ice, quality of habitat to support some species, for example grizzly bears, is extremely poor. This results in animals employing extensive ranges to seek out food. They are persistently hungry and mobile, searching for their next meal and for a mate. Highways are obstacles that must be crossed. The environment within which wildlife species live also has a direct correlation to births. Grizzlies in Banff National Park have extremely low reproduction rates and as a result, the continued maintenance of the population is precarious. Extensive efforts were taken in designing and constructing the Project to mitigate wildlife deaths caused by wildlife-vehicle collisions, and to create safe habitat connectivity and permeability across the TCH.

To mitigate wildlife mortality resulting from motor vehicle collisions and coincidentally improve motorist safety, the Project installed a 2.5 m high wildlife fence along the entire length of the highway right-of-way. A key design consideration in establishing the fence location was to minimize the amount of land alienated from use by wildlife. The Project's wildlife fence incorporated a number of innovative features to prevent breaches which can result in wildlife becoming confined in the highway right-of-way. The base of the fence was buried, to preclude animals from crawling or digging beneath. The page wire fence decreases in size from top to bottom, to discourage smaller mammals from passing through. Metal supports were installed at all fence directional changes not only for improved bracing strength but also for ease of maintenance. A high tensile wire was installed along the top border of the fence, to minimize damage from trees blow down. Gates were installed at selected intervals, to permit the both herding of wildlife and public access from inside the fence. Special pedestrian gates were designed and installed for year-round use at popular trailhead locations, Texas gates were installed on egress / ingress roads, to discourage wildlife from entering the highway right-of-way.

As the fence inhibits the cross movement of wildlife, a series of safe highway crossing opportunities were required to ensure habitat connectivity, permeability and genetic diversity. The wildlife mitigation design accomplished this, by designing and installing various sized underpass and overpass wildlife crossing structures approximately every 1.5 km along the highway. Locations for crossings, the configuration and scaling of individual crossings were determined based on the anticipated mix of species expected to use a particular crossing. Primary wildlife crossing structures, for larger numbers of large ungulates and carnivores, for example were 50-70 m wide, while secondary and tertiary crossings were, respectively, 20-25 m and 5-7 m wide. For this 23 km length of TCH twinning, five primary crossings (four of which were overpasses), two secondary bridge underpass crossings and seven tertiary culvert style underpasses were installed. All were carefully designed so that wildlife using the structures would be visually and acoustically shielded from the highway.

At major stream and river crossings, the Project took the opportunity to extend the span of structures to create additional opportunities for wildlife passage; including a 30 m width extension at the Bow River bridges east of Lake Louise, requiring pushing back the abutment of the existing bridge. To accommodate movements of small mammals and amphibians, a series of smaller culverts ranging from 400-900 mm were installed every 400 m, and openings through base of concrete barriers were installed every 50 m to facilitate highway crossings or local movements (e.g., to habitat on one or the other side of the fence). Berms placed at the edge of the highway at crossings are used to shield crossings from headlights and noise. Several existing abandoned stream culverts were also modified and repurposed to provide additional wildlife movement opportunities.

The Project also recognized the need to accommodate pedestrian movement, and to address this, two specific pedestrian crossings were designed and installed. These two pedestrian crossings have helped to deter pedestrians from unintentionally using and therefore potentially displacing wildlife from the wildlife crossings, as has happened in the past.

Aquatics / Fisheries

Aquatic and fisheries potential impacts were addressed and mitigated in accordance with not only PCA's legislative responsibilities but those of the *Fisheries Act* and its requirement to avoid harmful alteration, disruption and destruction of fish or aquatic habitat.

Working with Fisheries Canada, avoidance of in-stream activities was the primary mitigation. When in-stream works were unavoidable, then limited works were conducted within specific windows, to avoid spawning and periods of active fish movements. This entailed designing bridge structures to fully span rivers and streams, including riparian areas, to ensure important habitat remained not only for fisheries, but also for waterfowl and amphibian species that actively use these habitats.

Measures were taken to avoid or mitigate for any impacts that could result from deleterious materials entering the surface or groundwater systems, or moving into vegetated or other sensitive sites. Sedimentation and hydrocarbons were the main threats, and to manage for these, strict threshold targets were established, and continual monitoring of water quality was carried out. To minimize the potential for hydrocarbons or salt-laden runoff associated with highway operations and maintenance entering water courses, ditches associated with construction were graded to drain away from streams and rivers and into low areas where water could percolate, or into interceptor ditch blocks / settling ponds,.

For the Project, the highway alignment was carefully designed to avoid effects to existing wetlands. Any affected wetland habitat was replaced, two to one, using proven wetland restoration techniques, within borrow pits adjacent to the original (circa-1960) TCH alignment. Deadfall trees were anchored along the banks of Bow River or in back water areas, to help ameliorate damage from old TCH construction, by creating fish habitat and cover. Boulders large enough to break the high water surface were installed to provide resting or loafing spots for ducks

Project-associated construction was located a minimum of four meters back of high water, a convention that ensured that existing bank vegetation remained untouched. This approach involved, in some locations, installation of downhill retaining walls whereas a conventional construction practice might have infringed upon these sensitive areas.

As a result of the original (circa 1960) road construction, several stream reaches were rendered non-fish bearing. As part of the Project, these were redesigned and restored through re-grading and careful placement of suitably sized culverts, with natural substrate inverts. Where highway cut / fill slopes resulted in excessive stream bed grades, whole sections of new creek bed were created and naturally graded to ensure they provided favourable conditions for fish passage. As evidence of the success of these activities, within one stream, Taylor Creek, renewed use was observed by native fish species within a week of fish barriers being removed.

Terrestrial – Terrain / Soils / Vegetation

All PCA projects abide by the *Canadian National Parks Act* as well as other federal acts, regulations and conventions. In the case of vegetation, soils and terrain, PCA regulations are designed to stop the introduction of non-native plant species into park ecosystems. The *Migratory Birds Convention* has an influence, as it requires minimal forest disturbances during nesting season of neotropical migrants. The *Species At Risk Act* addresses rare, endangered or threatened species, and must be respected.

The Project mitigated bird-related impacts by scheduling tree clearing between September and April. The extent of clearing was minimized through a two-step approach whereby initial clearing was kept to within the theoretical neat top of backslope, and then a final adjustment was made for slope rounding, fencing or clear zones. In the vicinity of wildlife stream crossings, existing vegetation was protected from damage during construction. Rare and endangered vegetation species were studied and monitored, to ensure locations were known and avoided.

Measures were taken to avoid the introduction of non-indigenous plant species. Specific blended seed mixes of native grasses found in Banff National Park were specified and used. Mitigation measures employed to address invasive weeds included the requirement for all construction equipment used on the Project to be pressure washed of potential weed-infested soil before arriving at the job site.

To control weeds, imported topsoil was not permitted on the Project, and instead great care was taken to retain and reuse the very thin layers of existing “Rocky Mountain topsoil” materials. Due to its poor composition to support growth, the Project amended the native soil by chipping and composting tree limbs and grubbing materials resulting from the widened TCH right-of-way. These chips were composted by stockpiling, adding water and nitrogen through manure and fertilizer, and then turning regularly over the course of the Project life, before mixing with the native topsoil. The use of this natural material as an amendment had the added benefit of not wasting materials through burning, which would have generated greenhouse gases and air particulate emissions.

Being located within a national park, very careful attention was given to overall visual aesthetics. Top-of-cut-slope rounding and modulated cut slope faces were created to better blend and match the existing topography. The alignment was carefully selected to incorporate existing exposed rock outcrops and cuts, and to avoid the need for upslope retaining walls. Highway grades, horizontal alignments, ditch bottom widths, side slope angles and use of “snake pits” within the disturbed right-of-way were all methods employed to create a balanced embankment cut / fill and avoid creation of borrow pits outside of the right-of-way. Gravel pits created for aggregate production will be rehabilitated by infilling with waste materials from construction. The resulting cells will create a combination of habitat conditions including protected grazing locations for ungulates, as well as ephemeral ponds and wetlands that will subsequently be used by a range of wildlife. Collectively these measures help to further reduce the overall disturbance footprint for the Project.

Other Mitigations / Innovations

Over the 30-year span of various phases of TCH twinning within Banff National Park, PCA has used an adaptive management approach, learning from each phase. Each successive phase’s design has then been adjusted or modified, based on continued monitoring of initiatives, but also drawing on the experiences of others, and taking a holistic, adaptive approach.

To ensure that best mitigation measures were incorporated into the Castle / Icefields TCH Twinning, the Project’s designers moved away from prescriptive mitigations and adopted a “desired end result performance” approach for making environmental specifications. Contractors and consultants were invited to put efforts into developing and designing specific environmental protection plans (EPPs) that described how they would achieve sets of identified objectives. PCA appointed a full-time environmental surveillance officer to the Project, to work closely with contractors and consultants on designs and implementation plans, and to ensure overall compliance with the EPPs. Prior to working on the Project, all contractor and consultant employees were required to attend environmental training sessions that covered key topics such as national park regulations, proper waste management to avoid attracting wildlife, and avoiding wildlife conflicts. Training sessions also focused on specific commitments associated with the EPPs.

During construction, designs, construction sequencing and construction practices were evaluated on a daily basis and any required modifications were made in a proactive manner. Because the Project involved construction within a National Park, continual attention was given to ensuring that environmental issues were dealt with and EPPs were followed.

Throughout construction, measures were taken to minimize the Project’s greenhouse gas emissions. All old concrete reinforcing and other miscellaneous steels were collected and recycled. All old asphalt surfaces were lifted, milled, stockpiled and then reused within Banff National Park. Contractors were strongly encouraged to use E10 and low sulphur diesel fuels in their equipment. Brush materials and tree limbs generated by the Project were chipped and recycled, and not burned.

MITIGATION / INNOVATION EFFECTIVENESS

The objectives of TCH twinning were threefold: to improve motorist safety, reduce highway wildlife mortality while still meeting requirements for habitat permeability, and improve the flow of goods and services on Canada’s national highway. None of the three objectives was considered to be more important than the others.

For this Project and for previous phases of TCH twinning within Banff National Park, designs concentrated on reducing fatalities and accident rates while reducing travel times due to traffic congestion. Motorist safety and flow improvements are measured conventionally by means of accidents statistics, travel time, and service interruptions. In the case of environmental mitigation, designing and constructing mitigation measures, and then evaluating and measuring their effectiveness are more difficult and elusive.

As a result of fencing alone and based on direct measurements from this Project and from previous TCH twinning within Banff National Park, wildlife mortality caused by vehicle collisions has dropped by 95% for ungulates and 80% overall for all species. Eleven different species of large mammals found within Banff National Park have used 24 wildlife crossings more than 240,000 times since formal monitoring began in 1997 (and this figure does not include uses by small mammals). As a result of the current Project's addition of 16 new wildlife crossings, including four primary overpasses, and a number of improvements to aquatic ecosystem connectivity, wildlife mortality rates are expected to further drop and wildlife use of crossings to further increase. During construction in 2010, animals were observed using the new structures shortly after installation, before they had even been landscaped.

In relation to the crossing structures and based on 13 years of continuous monitoring, it is clear that multiple years are required to gain an accurate understanding of wildlife movement patterns. Wildlife in general took a number of years to adjust to regular use of the crossings. Usage of the structures is a learned behavior and tends to increase considerably once structures have been in place for at least a few years, in particular as they become used by second and third generation offspring. A year or two of monitoring after construction would have provided the wrong conclusions about their long-term success.

Certain structures that were located in known major crossing points have achieved, over time, greater usage than had been predicted or expected. There does appear to be minor correlation that some species such as cougars and black bears gravitate toward underpass structures but in general no one type of structure is preferred by any one species based on long term monitoring.

In addition to direct measurements of connectivity by means of recording wildlife passages, genetic interchange across areas of TCH twinning within the Park has also been confirmed using DNA tracking methods. Hair samples from both males and females of various species have been obtained on both sides of the twinned TCH, confirming that many individuals are moving back and forth, which also confirms that, over time, improved genetic diversity is being achieved.

To date, the continuous monitoring results have generated a significant number of peer-based scientific papers and technical reports, which have greatly advanced the knowledge and understanding of road ecology and context-sensitive design related to the use of fences and crossing structures.

Financial Implications

It is estimated that environmental mitigation measures as outlined herein add perhaps 33% more to the overall cost of what a more conventional highway twinning project within similar terrain might cost. The majority of these additional costs are associated with the wildlife-related mitigation measures. For this Project, fencing of both sides of the TCH cost about $150,000 per km. The large primary overpass structures traversing all four lanes of highway cost approximately $5.5 million per location. Secondary underpass bridge structures to address a four lane configuration cost about $3 million each, while tertiary crossings, on average, cost less than $750,000 each. The remainder of the mitigation measures were either completed at comparatively low costs or had no direct costs, but rather simply represented a better and more environmentally-conscious way of designing and conducting the Project.

The return on investment for these mitigations is difficult to accurately quantify. Prior to fencing being installed in earlier phases (circa 1980), approximately 150 ungulates were killed each year on the TCH within Banff National Park. Statistics indicate that the average wildlife / vehicle property damage results in costs in the range of $3000 to $4000. Costs increase greatly if a vehicle's occupants are injured or killed.

Whatever the measurement tool, there are severe long-term ecological implications from continuing losses to wildlife populations resulting from highway vehicle-caused deaths and redirected movements and behaviours. Failure to maintain a threshold productivity / mortality ratio that ensures continued survival for some species such as grizzly bears can have a drastic overall impact on the entire food chain and long-term ecological viability.

In combination with the destruction or loss of habitat, negative effects can also affect one of the key reasons why every year large numbers of visitors come to Banff National Park – to learn about and experience the Park's spectacular natural environment.

Project Legacy

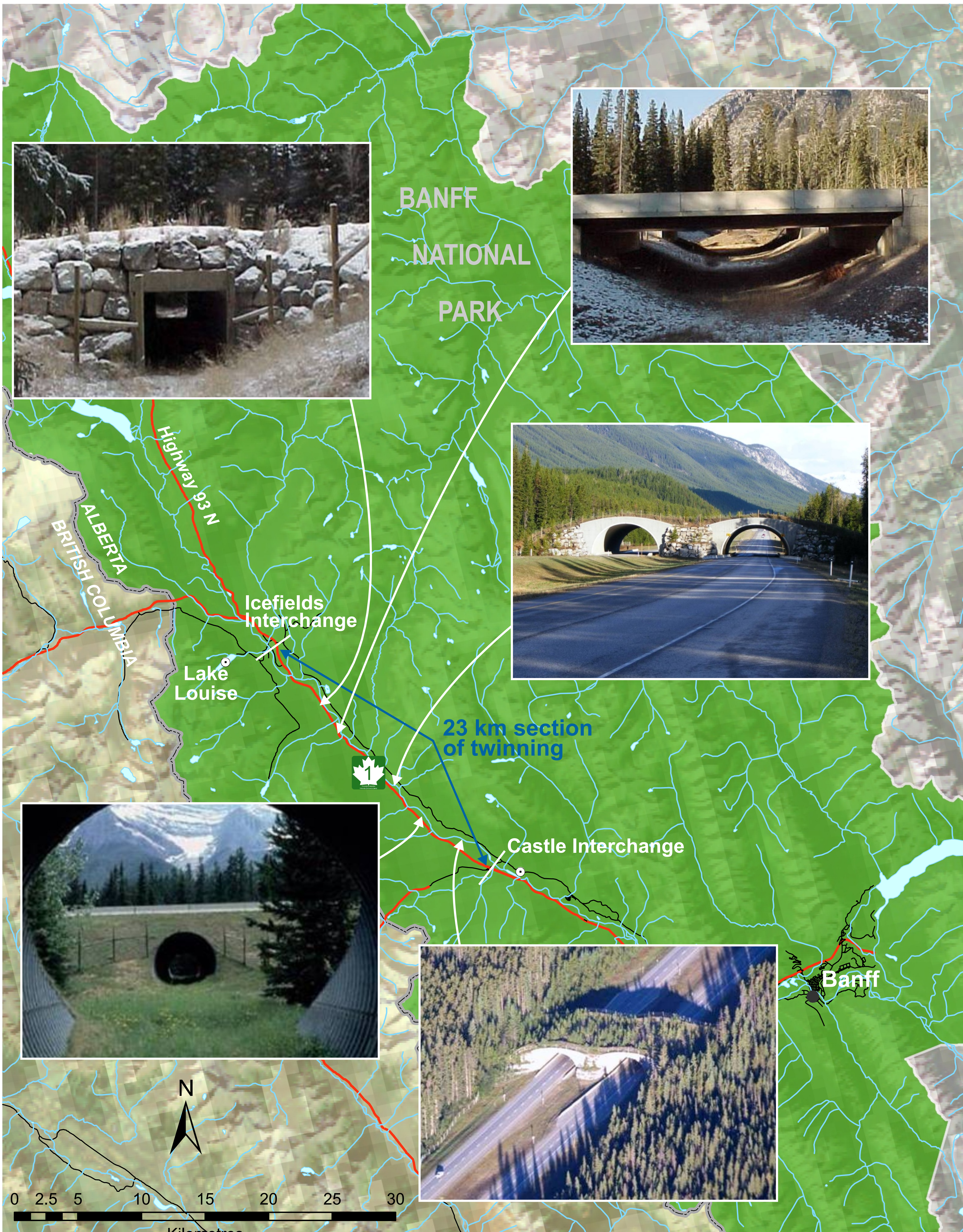
It is a formidable challenge to design, build and maintain a major four-lane divided highway that has the potential to fragment the Rocky Mountain landscape and result in a continuing toll on wildlife and the environment. As demonstrated in the Castle / Icefields TCH Twinning, as well as earlier phases of TCH twinning within Banff National Park, modern highways can be constructed and operated in highly sensitive environments but only if they are very carefully designed, with considerable effort expended to address environmental issues.

Supported by engineering and biologist consultants and advisors, PCA designed and has implemented successful innovations using highway fencing, wildlife underpasses and overpasses, and other wildlife mitigation measures. Because of these pioneering wildlife-related mitigation measures pioneered in Banff National Park, and augmented by 13 years of continuous monitoring, the use of wildlife fences and wildlife crossing structures has become increasingly common elsewhere in North America. Banff National Park's stature as a world-renowned national park has helped to further elevate the importance of the scientific contributions that have been generated. The results have furthered our collective knowledge about the applied science of road ecology and design, in particular, for the many other geographic areas where vehicle-caused wildlife mortalities and ecosystem fragmentation need more effective solutions.

Over the past 30 years, the TCH within Banff National Park has undergone a metamorphosis. Through the phases of TCH twinning, and as evidenced by the wide range of successful wildlife-related mitigation measures, the TCH within Banff National Park has gone from what was an environmental liability to what now is clearly an environmental success. In particular, the recently-completed Castle / Icefields TCH Twinning serves as a showcase for future sustainable highway development.

PROJECT LOCATION

This submission focuses on the most-recently completed 23 kilometre section of twinning between Castle Interchange and Icefields Interchange that went into service in October 2010.



AERIAL VIEW

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WILDLIFE CROSSINGS

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MITIGATION

FENCING

WILDLIFE ACTIVITY

FIELD MEASUREMENT

STREAM MANAGEMENT

RESULT

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