McElhanney

TRANS-CANADA HIGHWAY AVALANCHE MITIGATION

GLACIER NATIONAL PARK

Year Completed: 2020
Entering Firm: McElhanney Ltd.
Role of Entering Firm: Prime Consultant
Technical Subconsultant: Dynamic Avalanche Consulting Ltd.

Prepared for the Canadian Consulting Engineering Awards 2021
Submitted by McElhanney
Category F — Special Projects

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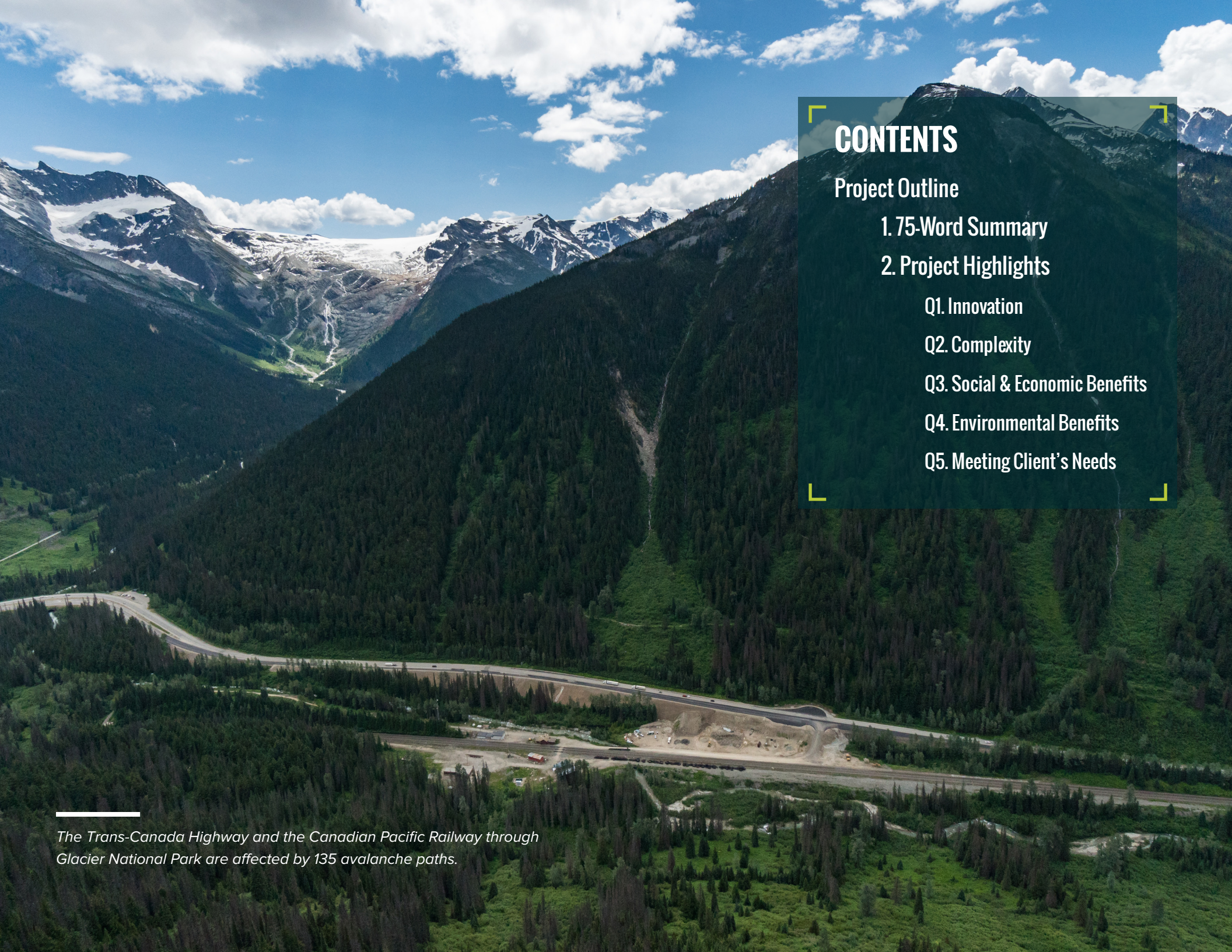

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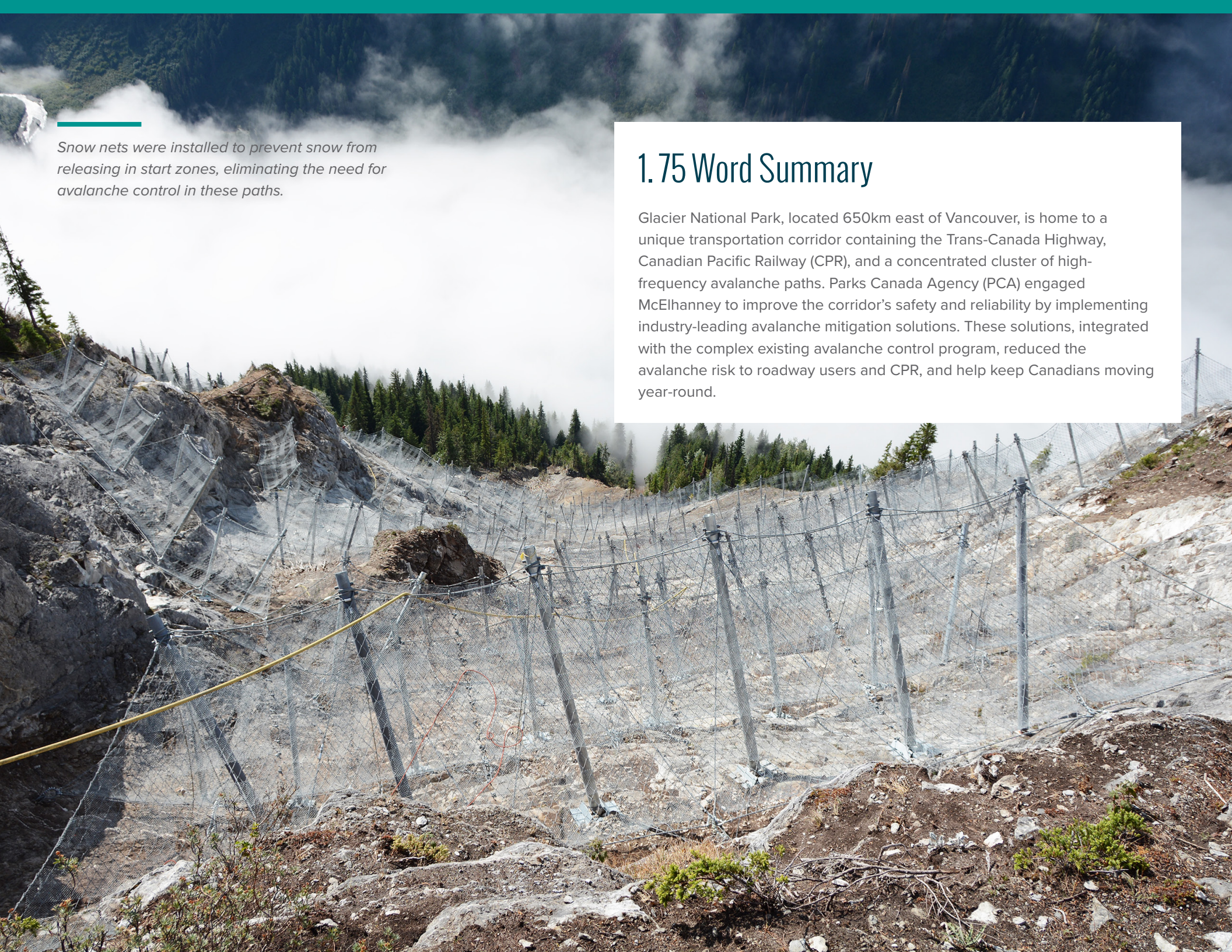
The Trans-Canada Highway and the Canadian Pacific Railway through Glacier National Park are affected by 135 avalanche paths.



Snow nets were installed to prevent snow from releasing in start zones, eliminating the need for avalanche control in these paths.

1. 75 Word Summary

Glacier National Park, located 650km east of Vancouver, is home to a unique transportation corridor containing the Trans-Canada Highway, Canadian Pacific Railway (CPR), and a concentrated cluster of high-frequency avalanche paths. Parks Canada Agency (PCA) engaged McElhanney to improve the corridor's safety and reliability by implementing industry-leading avalanche mitigation solutions. These solutions, integrated with the complex existing avalanche control program, reduced the avalanche risk to roadway users and CPR, and help keep Canadians moving year-round.

2. Project Highlights

Q1. Innovation

With PCA's (Owner's) oversight, McElhanney (Prime Consultant) partnered with Dynamic Avalanche Consulting Ltd. to develop an unprecedented avalanche mitigation program along 43.8km of the Trans-Canada Highway (TCH) through Glacier National Park (GNP). The program began with an analysis of the existing avalanche program in GNP and identification of priority avalanche mitigations. McElhanney optimized environmental and cultural resource considerations, developed unique procurement solutions, and managed construction in uniquely challenging environments to deliver a range of sustainable, innovative solutions.

McElhanney and its partners planned, designed, prepared the tender, and oversaw the construction of 2km of snow nets, which mitigate avalanches in three critical paths. There were no applicable North American design standards, so the team turned to Swiss guidelines. The netting prevents snow in the start zone from releasing and causing an avalanche, removing the need for active control. **These nets are now a leading example of how this solution can be effective in challenging terrain on a large scale.**

Avalanches from three critical paths are mitigated by roughly 2km of start zone snow netting.

A Doppler radar system used to detect avalanches in the MacDonald West Shoulder avalanche paths, which affect the TCH through GNP.

The team managed the install of 13 remote avalanche control systems (RACS), which use explosives to initiate avalanches in five key paths. This eliminated the need for PCA and the Canadian Armed Forces to conduct artillery control at the Park boundaries and allowed for concurrent control of these paths with artillery control in other areas.

McElhanney managed the design, tender, and construction of a 19.5m high reinforced earthen berm, designed specifically to reduce the likelihood of glide slab avalanches from reaching the highway and blocking the snow shed portal.

To assist avalanche forecaster decision-making, McElhanney investigated infrasound and Doppler radar technology for avalanche detection. Infrasound arrays (which detect low-frequency soundwaves produced by avalanches) and Doppler radar systems (which detect avalanche motion) had been used in small scale installations, but never on the scale necessary in GNP. McElhanney first collaborated with Montana State University and industry partners to develop a single infrasound array pilot program, which PCA confirmed assisted in control and closure decisions. McElhanney then **managed the procurement and calibration of a network of 13 overlapping infrasound arrays and four Doppler radar systems – the largest Avalanche Detection Network (ADN) of its kind in the world.**

This ADN allows forecasters to receive real-time alerts of avalanche activity, which assist forecasters in assessing avalanche hazard, timing closures, and selecting targets during control. **This network has advanced the industry's use of this technology by proving its capability on a scale and complexity not achieved before.**

Q2. Complexity

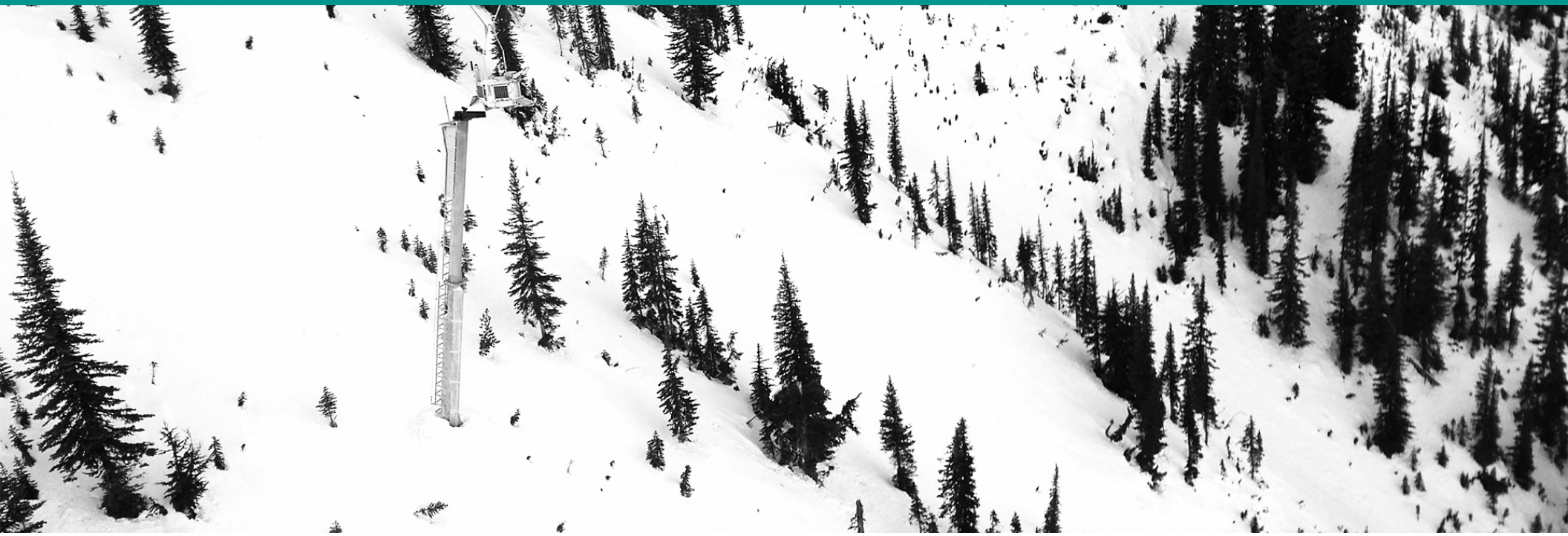
The sheer number of avalanche paths packed into Rogers Pass – all 135 of them – make it one of the most challenging goods and people movement corridors in the world to implement and maintain an effective avalanche program. The team's proposed solutions had to optimize PCA's existing complex program, which involves numerous snow sheds, static defenses and traffic ponding areas (safe traffic parking during avalanche control), separate highway and rail closure blocks, and avalanche control using two mobile 105mm Howitzer rifles firing at 270 targets from 16 overlapping gun positions.

The area is famous for steep terrain and dense forests. The team's access to remote areas to conduct their work was an ongoing challenge. McElhanney engaged certified mountain guides to escort designers into some of the most exposed sites to train field staff on rope safety. Several sites had to be searched for unexploded howitzer shells before any ground disturbance could occur.

McElhanney completed over 50 comprehensive site inspections during the design phase. The very short summer season and extreme weather, coupled with project timelines, meant there was no opportunity to recover delayed field work – McElhanney's only option was to do it once and do it right.

As no existing detailed topographic information was available for this difficult to access area, McElhanney's engineers had to rely on their site reconnaissance and expertise in LiDAR mapping techniques and data. This was vital in preventing and anticipating measurement errors from original assumed ground elevations. Despite this, construction costs remained within PCA's expectations.

Each point on this map of Glacier National Park shows a piece of McElhanney's avalanche mitigation work along the Trans-Canada Highway and the Canadian Pacific Railway, making travel safer and more effective for all.



A Geopraevent Doppler radar system detects avalanches in the MacDonald West Shoulder avalanche paths.

Q3. Social and / or Economic Benefits

"Revelstuck" is a phrase favoured by locals in the Rogers Pass area to describe the avalanche-related closures on the highway affecting people wanting to travel through nearby Revelstoke, BC. While some joke about being trapped in a beautiful alpine town as a blessing, the larger impact from the avalanche closures is significant.

McElhanney's economic analysis concluded approximately $24B of freight travels on the highway between Alberta and British Columbia per year (excluding the value of freight passing via the railway, which also has significant economic impact). **Approximately $2.7M of road freight passes through the corridor each hour, making every minute of highway closure saved by the mitigation program a considerable economic benefit.** With the reduction in avalanche risk and avalanche-related closures along the highway and railway, the transportation of people and goods is now safer and more effective along this vital link between Alberta and British Columbia.

While the benefits to the transportation corridor are obvious, it's important to recognize that GNP also attracts a large number of tourists, drawn by the pristine landscape and the Rogers Pass National Historic Site. Tourists travel along the highway in private vehicles or tour buses, and along the railway on board the famous Rocky Mountaineer. The area also attracts hikers, climbers, skiers, and mountaineers who all value a safe and reliable highway. McElhanney worked closely with PCA and the various stakeholders to develop and implement solutions that minimized the visual impact and disturbance to the natural landscape, wildlife, and corridor users.

Q4. Environmental Benefits

McElhanney adopts PCA's mandate of creating safe, sustainable projects when developing avalanche mitigation solutions. GNP is a federally protected park established in 1886. PCA's environmental team developed the environmental impact mitigations based on McElhanney's design. The mitigations were further refined collaboratively between PCA and the McElhanney team as the design was finalized, and **incorporated environmental impact considerations into all the avalanche mitigation designs and construction contracts.**

McElhanney managed the installation and calibration of 13 RACS, 13 infrasound arrays, and four Doppler radar systems, all powered sustainably through green sources like methanol fuel cells and solar panels. Furthermore, the explosives detonated with the RACS are biodegradable, so there will be no long-term waste introduced into the remote mountainous locations.

McElhanney designs reused up to 200,000m^3 of local materials (such as landslide debris) as fill materials for additional traffic ponding areas and the avalanche stopping berm. During the borrow operation, McElhanney also oversaw the expansion of two major diversion berms at the Beaver River site to help protect the area from future landslide activity.

GNP is home to some of Canada's most beloved and well-known wildlife such as grizzly bears, wolverines, elk, and owls, as well as species-at-risk such as caribou. McElhanney kept wildlife passage top of mind when developing solutions, such as the snow nets, which have regular openings to reduce intrusion into the natural route wildlife may travel.

Remote avalanche control systems (RACS) use solar power and biodegradable explosives.

Q5. Meeting Owner's Needs

PCA's objectives included the improvement of highway safety, winter highway reliability, and avalanche program efficiency. To achieve these objectives, **McElhanney and team assessed, ranked, and recommended specific mitigation options, then managed and undertook the planning, design, tender package preparation, construction supervision, and contract management of priority options. The complement of solutions implemented resulted in a reduction of the Avalanche Hazard Index by an estimated 21%, a reduction in average annual winter TCH closure time by approximately seven hours or 15%, and an estimated 14 hour decrease in average annual mobilization time for avalanche control.**

RACS installed near the GNP boundaries eliminated the need for artillery control in these areas, resulting in reduced mobilization time and cost. These areas are now controlled with RACS concurrent to artillery control in other areas of the park. Furthermore, these RACS eliminated the need for highway closure to control avalanches which only affect CPR, reducing overall highway closure time and impact to freight movement. The snow nets and stopping berm further assist by eliminating the need for avalanche control and cleanup within their paths. Meanwhile, the ADN improves the timing and control of closures along the highway thanks to increased forecaster decision support.

> ***"How do you save half a million dollars in eight hours? By making avalanche control in Rogers Pass safer, faster, and more efficient! We've installed 13 Remote Avalanche Control Systems at strategic locations to reduce closure times and supplement Howitzer operations with the Canadian Armed Forces. With over 250 potential targets, a rapid response is essential when avalanche conditions threaten the transportation corridor. During the first season with all towers operational (2017/18), highway closures were reduced by an estimated eight hours, reducing the cost to the economy by an estimated half a million dollars!"***
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> — Mount Revelstoke & Glacier National PCA Facebook page, 1 March 2019

The 19.5m high 'Mounds' avalanche stopping berm reduces the likelihood of glide slab avalanches from reaching the highway and blocking the snow shed portal.