Bridging the North: Innovations, Lessons Learned, and Multi-Disciplinary Insights in Northern Bridge Design and Construction

David A. MacLaggan, MScE, P.Eng.
Regional Bridge Lead – Canada West & Territories
Stantec Consulting Ltd.
Edmonton, AB
David.MacLaggan@stantec.com

Paper prepared for the session Transportation Structures
2026 Transportation Association of Canada (TAC) Conference & Exhibition
Winnipeg, Manitoba

Abstract

Bridges in the Canadian North are essential lifelines for remote and Indigenous communities, support resource development, and strengthening national connectivity and sovereignty. The Canadian North is witnessing and further anticipating growth and investment in bridge infrastructure, driven by expanding economic opportunities, evolving security priorities, and the vision of the Arctic Economic and Security Corridor. Drawing from both recent and a strong history of northern bridge projects, this paper discusses innovations, lessons learned, and the multi-disciplinary approach needed to deliver successful bridge projects and will be needed to support future development in the harsh and unique conditions of the North. Notable projects such as the Inuvik to Tuktoyaktuk all-season highway and route planning for the MacKenzie Valley Highway, Arctic Economic and Securities Corridor, and Grays Bay Road and Port corridor demonstrate the balance of technical and economic feasibility, environmental stewardship, and the integration of local and Indigenous engagement. Bridge design in the North requires resilience to extreme weather, efficient material use, and adaptability to complex geotechnical challenges like permafrost, requiring advanced foundation solutions such as adfreeze piles and thermoprobes. Tender preparation must clearly outline technical requirements, risk mitigation strategies, and regulatory compliance, setting up effective frameworks for construction administration and resident engineering oversight. In the remote North, owners, engineers, and contractors face logistical hurdles involving material transport and workforce mobilization. Material prefabrication and modular construction play roles in overcoming geographic isolation, enabling efficient delivery, reducing on-site assembly times, and minimizing environmental impacts. Hydrotechnical and environmental engineering are significant components of projects that span water bodies and sensitive ecosystems with early involvement of these disciplines being important. Rehabilitation and replacement programs for these critical structures use inspections and targeted interventions to extend service life and the safety of the crossing with examples provided from recent projects such as the Trout and Redknife River Bridges and Oscar and Miller Creek Bridges. Throughout all phases, meaningful engagement with Indigenous communities remains fundamental, promoting mutual understanding, incorporating traditional knowledge, and supporting social and economic benefits. Ultimately, Bridging the North is not just an engineering challenge but a nation strengthening pursuit, balancing technical and economic feasibility, environmental responsibility, and community collaboration. A pursuit to deliver resilient infrastructure that enables northern communities to thrive, supports resource and economic development, and national security.

Background and Northern Context

Northern and Arctic Canada is experiencing renewed focus on strategic infrastructure development to enhance connectivity, economic opportunity, and national security. Proposed major projects like the Mackenzie Valley Highway (MVH), Arctic Economic and Security Corridor (AESC), and Grays Bay Road and Port (GBRP) reflect a vision to strengthen Canada's northern transportation grid and link remote communities to markets and services year-round (**Figure 1**).

Figure 1. Proposed Recent Northern Routes/Corridors



Source: Stantec Consulting Ltd.

Historically, remote communities in the Northwest Territories (NWT) and Nunavut (NU) have relied on seasonal ice roads or ferries for part of the year, leaving them isolated during spring and fall freeze-up and break-up periods. Other communities that are only accessible by land via a winter road for several months of the year, must rely on air transportation for the remainder of the year. This limited land access has significant social and economic implications—residents face periodic shortages of essential goods and services, and industries and governments endure costly logistics for resource development and defense operations.

Bridges are essential lifelines of northern transportation corridors, with winter and all-season road networks across often challenging terrain. The strategic importance of northern bridges and highways cannot be overstated: reliable year-round crossings improve safety, reduce supply chain costs, facilitate mining and energy projects, and bolster sovereignty by asserting presence in remote northern area. For example, the 140 km long Inuvik–Tuktoyaktuk all-season highway completed in 2017 extended the Dempster Highway to the Arctic coast, requiring eight new bridges and dozens of large culverts to overcome rivers and permafrost features while providing an uninterrupted land route to the Arctic Ocean.

Similarly, completion of the proposed MVH, AESC, and GBRP will provide remote communities with year-round access to essential good and services, support resource (critical minerals and oil and gas) and economic development, promote reduction in supply chain costs, and strengthen national security and sovereignty through a long-term presence, faster deployment of personnel, and enhanced monitoring of the Northwest Passage.[1]

Realizing these transformative benefits requires overcoming formidable engineering challenges. Northern bridge projects confront extreme cold conditions, permafrost soils prone to thaw settlement, dynamic river ice forces, and remote logistics that complicate construction and maintenance, with shorter and often winter construction seasons. Projects face remote access, often only during a short winter season, or at times even no access requiring the project team to visit the site and conduct investigations via helicopter. They demand a multidisciplinary approach: structural engineers must ensure resilient and constructable designs; geotechnical specialists must address permafrost and foundations; hydrotechnical engineers must account for high flows, ice jams, and scour; roadway engineers must integrate bridges into safe alignments often in fill-only (no or limited cut) vertical profiles to avoid permafrost disturbance; environmental scientists and regulators must protect ecosystems and help secure approvals; while partnering with the local communities to help advance their priorities and incorporating traditional knowledge into the projects. Each discipline contributes critically to the project's overall success.

Bridging the North is not only a technical endeavor but also a nation-building effort that strengthens Canada's resilience and prosperity in its northern frontiers.

Multidisciplinary Delivery

To navigate the unique and challenging aspects of northern bridge engineering to be able to achieve the transformative benefits we are striving for as a nation, requires a multidisciplinary deliver from a technically excellent and northern design team. This team can often be made up of eight or more disciplines such as structural, highway, survey, utilities, drainage, geotechnical, hydrotechnical, and various environmental specialist with consultation and engagement being critical to all. The design process typically requires an iterative approach, as each discipline affects the others, often weighing desired technical benefits and design criteria versus economical realities. While each of these disciplines could be the subject of an extensive discussion in how they affect a structural bridge design project, below are a few key considerations from several disciplines that can have a significant impact on bridge design and construction.

Roadway/Highway Considerations: Northern bridge projects seldom stand alone—they are part of longer roadway/highway alignments that must be engineered together with the crossing. New alignments should seek to avoid or minimize bridges located on horizontal curves or with skew to simplify the design and construction. The team will need to consider if the highway and bridge are in areas of permafrost that may face high settlements and be in a fill-only location with limited cuts to achieve the vertical profile. In areas where there may be steep grade leading to the crossing, this can often result in large amounts of fill and longer bridges to allow for the highway geometric vertical curve criteria to be met for the desired design speed. The desired highway design criteria then need to be weighed against the cost of achieving it and iteratively consider, for example, if a lower design speed and tighter vertical curve that results in a shorter bridge structure with less fill may be more economical.

The vertical profile of the highway and how it relates to the existing topography and elevations of the area being crossed has a direct influence on the overall length of the structure, which then may influence or dictate the structural alternatives (e.g. steel versus concrete girders, number of spans, etc.). Often in new highway studies, the route is narrowed down to a 1 km wide corridor, often only considering horizontal alignment, with subsequent iterations further defining and narrowing the corridor to say 100 m, and ultimate the final horizontal alignment. Given the significant impact the vertical alignment has on the length and type of structure, it is critical to consider the vertical alignment of the highway, which dictates the bridge deck elevations, as early as possible within the design process.

Hydrotechnical Considerations: Rivers in the North demand careful hydrotechnical analysis to accommodate extreme flows and dynamic ice processes. Consideration for floating ice and ice jam risks are more common and more commonly governs in rivers in the north. This is in comparison to southern Canada where typically ice jamming is not a concern. While ice jams do occur in southern Canada (Red River and Athabasca River are notable examples), it is not as common. Specific to the NWT, many watercourse crossings are along roads that are close enough to the Mackenzie River that they are at risk of backflooding due to ice jamming on the Mackenzie River. Developing practical crossing designs while considering this risk can be challenging, especially in areas where historic ice jam observations may not be available. This is a situation where indigenous knowledge may be extremely useful to understand past risks in the area.

Hydrologic estimates to inform hydrotechnical bridge design are often based on hydrometric gauge data along the watercourse or within a similar hydrologic area. As compared to the south, hydrometric gauges in the north are fewer, typically have a shorter period of record and are focused on the larger watercourses. This introduces uncertainty in the hydrology and subsequent hydrotechnical design recommendations. This is of particular concern in the medium sized watercourses that are smaller than most gauge stations in the north but still too large to use techniques like the rational method. Engineers often employ a variety of techniques to analyze the site and develop recommended design flows.

Another more recent observation is that climate change has the potential to change the hydrology faster in the north than the south. This also introduces the potential for geohazards which can influence channel geomorphology and items such as channel migration and erosion – all items that must be considered for crossing design.

Regarding scour and erosion protection, bridge abutment protection often calls for angular riprap stone. This can sometimes be challenging to source in the north but also may have to be increased in size to offer the same level of protection to withstand ice forces which can shift and displace riprap causing weak points in the armouring that can result in damage to the bridge structure during subsequent events.

Ultimately, one of largest influences the hydrotechnical engineering has on the bridge is the design high water or high ice elevation that dictates the minimum elevations of the underside of the girders based on the desired freeboard (freeboard being the distance between the high water/ice elevation and the underside of the girder). While the Canadian Highway Bridge Design Code (S6) specifies a minimum freeboard of 1.0 m, a freeboard of 1.5 m is used in the NWT for example, to provide additional conservatism.[2] It is important to have early collaboration between the hydrotechnical, roadway, and bridge team as each influence the elevation of the bridge deck surface and structure below.

Geotechnical Considerations: Permafrost and frost-susceptible soils are a fundamental geotechnical concern for northern bridges. Beneath an insulating active layer, permafrost can be ice-rich and prone to significant thaw settlement if disturbed. Bridge design must either avoid permafrost degradation or mitigate its effects. Bridge foundations in areas of permafrost often utilize adfreeze piles which are typically steel pipe piles allowed to freeze into permafrost, with an annulus that is typically sand slurry, temperature/season dependent for freezeback/loading time, and very sensitive to permafrost temperature and future thaw/degradation. Thermosyphon piles are also sometimes utilized as an addition to adfreeze piles by providing passive or active cooling to mitigate permafrost thaw, and may require additional monitoring/maintenance. Traditional driven or cast in place concrete piles are sometimes utilized, typically in areas where permafrost has thawed, but difficulties can result if permafrost is still present. More typically, given the extend of bedrock, rock socketed piles with a steel pile or H-pile grouted into a drilled hole into the bedrock is utilized. Consideration is needed for the type of grout to utilize with varying temperatures from the ground surface down to often near or below freezing at the rock socket. Geomorphic considerations are required as well, with many landslide potential locations within the territories, with bridges on or near these instabilities.

One of the more significant geotechnical considerations that needs to be accounted for during a bridge project is the access and timing of the geotechnical investigation. It is not uncommon for there to only be access during the winter months along a seasonal winter road or potentially no access at all, with some drilling rigs being flown in via helicopter, with tree clearing often being required.

Regulatory and Permitting Overview: Northern projects must adhere to stringent environmental regulations and are closely reviewed for impacts on fish, wildlife, and traditional land use. While not an all-inclusive list, for a bridge related project, the overall team needs to be aware that the environmental team will conduct various desktop and field based investigations that will be used to create, for instance in the NWT, a Project Description Report that will support applications to various land and water boards for obtaining land use permits and water licenses. Archaeological impacts must also be considered with the team submitting a desktop Archaeological Overview Assessment (AOA), which would be submitted to the Culture and Heritage Division of GNWT-ECE (at Prince of Wales Northern Heritage Centre [PWNHC]) for review. For areas considered to be of high archaeological site potential, particularly relatively undisturbed landforms, the AOA may recommend a field-based Archaeological Impact Assessment (AIA).

The Fisheries Act applies to projects that have the potential to cause harmful alteration, disruption, or destruction of fish habitat, death of fish, deposition of deleterious substances, or interruption of flow that affects fish passage. DFO has developed standards and codes of practice to support compliance with the Fisheries Act.[3] For works that do not meet DFO's established Codes of Practice, a Request for Review is to be submitted. The Fisheries Protection Program, maintained by DFO and its collaborative partners, is responsible for the review of projects to determine if a non-compliance with the Fisheries Act is likely to occur. Where DFO determines that non-compliance is unlikely, a Letter of Advice may be issued to provide guidance to the proponent on mitigations that should be implemented to avoid non-compliance with the Fisheries Act. If the review determines a noncompliance is unavoidable, DFO will notify the proponent that a Fisheries Act Authorization (FAA) is required before works can proceed.

Bridges often also require an application for approval to Transport Canada, submitted under the Navigation Protection Program under the Canadian Navigable Water Act.

As it relates to bridge projects, the main regulatory and permitting consideration is the timeframe to conduct field-based investigations, which are often weather (e.g. snow and frost free) and access dependent, the regulatory review and processing timelines, and the multiple jurisdictions and regulators. The regulatory and permitting process is typically on the critical path of the project's schedule with ample amounts of float being recommended.

Consultation and Engagement: For northern based projects, it is recommended and best practice that consultation and engagement occur early in the life cycle of a project to allow for that information to be incorporated into the design. A follow-up meeting with the stakeholders should take place later in the project to inform them of any incorporated information and to provide an update on the design prior to it being sent for regulatory review. Team members should strive for ongoing communication throughout the life of the project. At the center of any consultation and engagement, which drives project success, is relationship building and partnering. Ultimately the bridge projects that are designed and constructed are for the public and the strengthening of our northern communities and nation. For us to collectively be successful in this pursuit, we must understand the viewpoints of the various stakeholders and collaborate and partner through continuous relationship building throughout the project.

Remote Construction Access/Logistics Considerations: The remote construction environment in the North shapes design decisions as much as technical requirements. Construction access is limited—many bridge sites are reachable only by winter road or air or limited by ferry and ice crossings. This influences material selection and construction sequencing. Designs often incorporate modular and prefabricated elements that can be transported and assembled quickly such as pre-cast concrete deck panels, abutments, and pier caps. Concrete pours, if required, must consider cold-weather measures like insulated forms and heated enclosures, or even on-site batch plants to ensure supply in remote areas.

Material availability and the time frame to obtain the material on site also needs to be considered in design and construction. Given the remote nature of the sites, quality control and assurance is critical to maintaining schedule as obtaining replacement materials that do not meet the design or specification requirements can easily lead to longer project delays than would be faced in the southern provinces.

The equipment required to perform inspections also needs to be considered, with the availability or ability of under bridge inspection vehicles (e.g. snooper truck) to reach the site often requiring innovative solutions such as rope access inspection teams.

Traffic accommodation during construction is another critical element: since detour routes are often nonexistent in remote areas, projects must maintain traffic on the existing route or via temporary detours and bridges. The flow of traffic, goods, and services must be maintained. Innovative solutions include staged construction (e.g. building a new bridge in halves while using the old structure for one lane of traffic), temporary bypasses built with culverts over embankment or rented modular bridges for detours.

Case Studies of Northern Bridge Projects

To reinforce some of the unique and challenging multidisciplinary aspects of northern bridge engineering, to be able to achieve the transformative benefits we are striving for as a nation, four recent case studies are examined below with **Figure 2** indicating their approximate location with the NWT.

Figure 2. Bridge Case Study Locations



Source: Google Earth, Image IBCAO, Image Landsat / Copernicus, Data LDEO-Columbia, NSF, NOAA

Oscar Creek Bridge Relocation

The Oscar Creek Bridge is a 66 m single span steel bridge built in 2005 along the Mackenzie Valley Winter Road (MVWR) approximately 30 km northwest of Norman Wells (**Figure 3**). The bridge was never put into service as the creek meandered and cut off the south approach. The approaches are also not suitable for a future all-season roadway. The project involves the re-alignment of the MVWR, the relocation of the Oscar Creek Bridge, along with the crossing of two smaller tributaries (south and north).

Figure 3. Current Oscar Creek Bridge

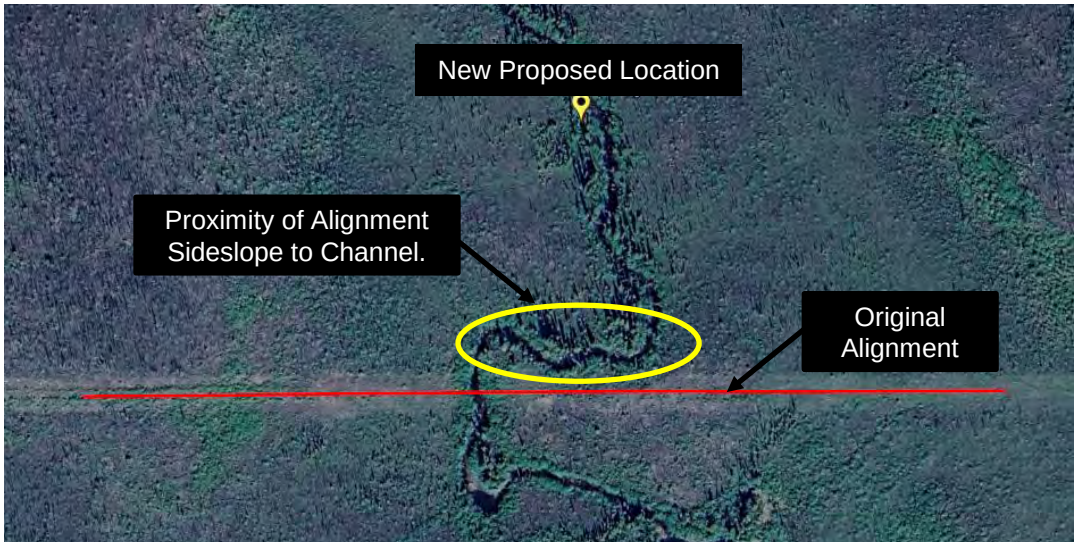


Source: Stantec Consulting Ltd.

To maximize the use of prefabricated materials to promote faster construction (remote and short construction season while the winter road is open January through March), the design involves the dismantling and re-erection of the existing steel girders with a new precast full-depth concrete deck. Although the bridge is currently on a winter road with winter road grades, the bridge will be constructed at what could be the future all-season highway elevation at this crossing to minimize or eliminate future modifications of the structure when the MVWR is converted to an all-season highway.

Due to the re-routing, the project also involves the crossing of two small tributaries. The north tributary had an initial alignment previously proposed, but when the full multi-disciplinary team investigated the crossing, it was decided to move the proposed crossing to the north along a straighter stretch of water. The original proposed location had hydrotechnical concerns that the tributary could meander and cut off access to the roadway. Additionally, as this location will require the use of fills only (no cuts) to avoid the disturbance of the permafrost, the geometry was such that the roadway sideslope fills would have overlapped with the water in the oxbow (**Figure 4**). This is an excellent example where a full multidisciplinary team (bridge, roadway, geotechnical, and hydrotechnical) were required to collaborate to obtain the solution.

Figure 4. Original and Proposed North Tributary Location



Source: Google Earth, Image 2026 Airbus

The project also involved strong engagement with support from the various communities of Norman Wells and Fort Good Hope with community members excited at the prospect of bridges that could possibly extend the winter road season and be one step closer to a future all-season conversion of the MVWR.

It is an exciting and hopeful thought that someday, in the near future, members of the community and the public will be able to travel on this segment of highway year-round and experience not only the economic benefits that would results from an all-season highway, but also able to experience the beauty that this location offers, but few have been able to see outside of when the winter road is open. **Figure 5** is an image of Oscar Creek at the proposed crossing location looking northeast toward the Franklin Mountains.

Figure 5. Proposed Oscar Creek Crossing



Source: Stantec Consulting Ltd.

Miller Creek Bridge Replacement

The Miller Creek Bridge replacement involves the replacement of an existing 3.6 m diameter culvert, located on the Yellowhead Highway No. 3 approximately 30 minutes west of Yellowknife, with a new three span (14-16-12 m) bridge structure founded on bedrock. The existing culvert is sagging at its center (with uplift at the ends), with an inability to pass the recommended 1:100 year water flows, and also presents safety and maintenance issues with settlements resulting in the barriers spreading and sinking below the elevation of the roadway (**Figure 6**).

Figure 6. Existing Miller Creek Culvert Crossing



Source: Stantec Consulting Ltd.

With the necessity to maintain the flow of traffic and accommodate the movement of goods and services, as the existing culvert extends out beyond the fills more than required, the approach will be to bring in some additional fill and utilize the existing culvert to create a detour beside the current crossing. The new bridge will be constructed with a new channel alignment, and once the bridge is completed, the existing culvert will be decommissioned.

Another challenge of the project was the geotechnical investigation. There was a previous geotechnical investigation conducted, but due to equipment challenges the boreholes were not able to terminate into bedrock. Recognizing this challenge, a special drilling rig was brought up from the southern provinces to drill this challenging terrain. Also, due to project scheduling and availability, the drilling needed to occur in winter with the team facing temperatures down to -50 degrees Celsius.

Redknife River Bridge Replacement

The Redknife River crossing is located along HWY 1 approximately 5 hours southwest of Yellowknife. The current crossing consists of three 4.5 m diameter culverts and headwalls that were nearing the end of their service life and were also perched with high flow velocities during some seasons, preventing the passage of fish. The culverts are being replaced with a 71 m long single span concrete deck on steel girder bridge. To allow for a faster installation and minimizing the use of on-site cast-in-place concrete, the deck was designed as a full-depth precast deck panel. The project underwent close fisheries related examination given the sensitive nature of the in-stream works. The team worked closely with the Department of Fisheries and Oceans to review the in-stream work window timing to allow for removal of the culverts in the fall near the end of the construction season.

To allow for movement of goods and services on this critical highway, the team designed the new crossing to be located just north of the existing roadway centerline allowing for the use of the existing culverts as the detour until the bridge is constructed. The roadway vertical profile was also adjusted to meet current design criteria. **Figure 7** displays the new steel girders erected just over top of the existing culverts.

Figure 7. Redknife River Bridge Erection



Source: Stantec Consulting Ltd.

Trout River Bridge Rehabilitation

The Trout River Bridge (**Figure 8**) is a 61 m out-to-out, three-span major bridge structure on Mackenzie Highway (No. 1) built in 1969 over the Trout River in the Northwest Territories, providing a link between the communities of Enterprise and Jean Marie River. It is part of a key all-season highway corridor in the region, supporting the movement of essential goods, emergency services, and community travel. Its uninterrupted operation is vital to the economic and social well-being of the Northwest Territories, enabling access to food, fuel, medical care, employment, and construction materials for ongoing territorial development.

Figure 8. Trout River Bridge



Source: Stantec Consulting Ltd.

When significant structural deterioration was first discovered—with the Government of Northwest Territories' (GNWT) Highway Office receiving a report of loud noise emanating from the bridge—the Structures Asset Management Team conducted a visual inspection and reported areas of severe cracking and spalling in the concrete soffit at the joints of both ends of the span. The bridge was reduced to one-lane alternative traffic and faced with risk of closure to heavy vehicles, making a tremendous impact for residents, industry, and supply chains across the North. The GNWT contacted the project team to mobilize an inspection team to conduct an OSIM (Ontario Structure Inspection Manual) inspection of the structure with the aid of an under-bridge (snooper) inspection vehicle. The results of the inspection indicated that the structure required rehabilitation to maintain the safe passage of vehicles and extend the service life of the structure. A load evaluation was also conducted that indicated that the structure could not support legal highway loads or needed overloads. The project's objective was to restore full legal and overload capacity, extend the bridge's service life, and provide a safe, durable, and cost-effective crossing capable of supporting the region's long-term needs.

To support the GNWT over the full lifecycle of the project, the project team carried out survey, inspection, assessment, load rating, preliminary engineering, detailed rehabilitation and strengthening design, tendering, resident engineering, and post-construction support. Rehabilitation measures

included deck joint and deck end replacement, partial depth deck repair, surface preparation and coating, strengthening, and scour repair extending the service life of the bridge and restoring the bridge to full legal highway live loads and the ability to pass permit overloads.

A structural analysis and load evaluation was performed for the existing Trout River Bridge, aided using finite element analysis software. The analysis showed that the structure had insufficient capacity to carry full legal highway loads. Rather than closing the structure—an action that would have severely disrupted northern supply chains—the team developed a traffic control strategy through analyzing data and recommended alternating single-lane traffic passage of legal and overload vehicles at reduced speeds of 40 km/hr. This solution avoided the closure of the structure to larger vehicles that carried important goods and equipment, preserving economic activity and avoided costly detours.

Recognizing the importance of maintaining traffic flow during construction and its impacts to the economy, the rehabilitation of the deck and deck joints was engineered for staged construction with the single-lane alternative traffic passage approach. Knowing that wide-permit vehicle loads would typically be requested through the summer construction season, our team utilized our local knowledge to create informed special provisions by requiring the Contractor to accommodate wide-permit vehicle loads passage during different construction stages to avoid needing to deny any permit requests, or delaying major construction projects and avoiding potential financial claims.

To permit the passage of highway legal loads, strengthening plates (**Figure 9**) were designed to be installed along the underside of the truss non-composite stringers, floor beams, and girder end spans utilizing an underslung work deck. These strengthening plates arrived pre-drilled, match drilling the holes in the bridge to allow for proper fit-up and avoid hole misalignment. Compared to other solutions that required the need for grout or concrete, this approach allowed for work to proceed in cold temperatures without the need for heating and hoarding.

Figure 9. Typical Bolted Strengthening Plates Accessed via Suspended Platform



Source: Stantec Consulting Ltd.

It was noted during the inspection that the east upstream corner of the headslope has been impacted by high water flows, leaving a nearly vertical toe approximately 2.5 m high near centreline and 4.0 m at the furthest upstream corner. Given the need to repair the scour but still promote symmetry in the aesthetics of the bridge, a similar detail to the west headslope scour protection was adopted with the installation of a toe wall to help contain the rip rap on the flat sandstone bedrock allowing for the projection of the bridge infrastructure (**Figure 10**).

Figure 10. Riprap and Toe Wall Repairing East Headslope



Source: Stantec Consulting Ltd.

Leveraging our local environmental team's knowledge of the area and drawing on past project experience, it was known that migratory birds are present in and around the bridge structure. To proactively address this, our team incorporated clear special-provision language alerting the Contractor to this and assigning responsibility for appropriate preparation. This included mobilizing before the nesting period to prevent active nests from forming and providing anti-nesting devices, as well as engaging a wildlife specialist should an active nest be observed. During the mobilization, an active nest was in fact identified, posing a potential delay to the project. As the special provision had already established the Contractor's responsibility and outlined mitigation expectations, the Contractor was able to promptly retain a wildlife specialist and implemented appropriate measures. As a result, construction proceeded without significant disruption while complying with environmental regulations and protecting local wildlife.

The team's in-depth knowledge of the bridge structure and actively supporting in review meetings while collaborating with the Contractor and GNWT allowed us to assist in urgent overload vehicle permit

applications during rehabilitation. In many cases, the team provided technical reviews and recommendations within hours of receiving a request, making sure that essential goods and equipment could continue moving through the region without delay. These efforts demonstrate strong collaboration and commitment to the project with the goal to provide northern infrastructure resilience.

As a key all-season link on the Mackenzie Highway, the bridge serves as a lifeline for communities west of Jean Marie River, including Fort Simpson and those farther north. A closure would have severed their direct connection to eastern communities such as Yellowknife, forcing an impractical detour through British Columbia. By maintaining the functionality throughout construction, this project safeguarded the mobility and well-being of residents, protected critical supply routes, and supported the broader economic stability of the Northwest Territories. The ability to continue accommodating wide and heavy permit loads was particularly important for ongoing and future infrastructure development.

Conclusion

The above case studies illustrate that bridging the North is not a typical civil engineering exercise, but a specialized field requiring innovation at the intersection of multiple disciplines and engagement. For engineers, it means expanding beyond core technical skills to incorporate climate science, logistical planning, and community relations. For instance, structural solutions alone are insufficient if geotechnical and hydrological conditions are not concurrently addressed.

Bridges are the backbone of Canada's emerging northern and Arctic transportation corridors, enabling vital year-round access and driving social, economic, and strategic outcomes. For future northern bridge projects to be successful it will require the team to possess multidisciplinary technical excellence with a deep understanding of the northern context, with considerations of remote and winter access, constructability, and environmental stewardship underscored by close indigenous, community, and client partnership.

Bridging the North is not only a technical endeavor but also a nation-building effort that strengthens Canada's resilience and prosperity in its northern frontiers. Each bridge that we rehabilitate, replace, or build new, incrementally pushes us toward the vision of a connected Canada and a pursuit to deliver resilient infrastructure that enables northern communities to thrive, supports resource and economic development, and national security.

References

[1] Office of the Prime Minister of Canada. "Prime Minister Carney announces ambitious new plan to defend, build, and transform the North | Prime Minister of Canada". [online]. Updated: 03/12/2026. [Viewed 19 May 2026]. https://www.pm.gc.ca/en/news/news-releases/2026/03/12/prime-minister-carney-announces-ambitious-new-plan-defend-build-and

[2] Canadian Standards Association. "CSA S6:25, Canadian Highway Bridge Design Code". 2025

[3] Government of Canada. Department of Fisheries and Oceans. "Project near water". [online]. Updated: 09/10/2026. [Viewed 22 September 2026]. https://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html