Northern Services

Geotechnics & Permafrost
Tailings & Mine Waste
Civil Infrastructure & Hydropower
Site Assessment & Remediation
Social & Environmental
Water Management
Ports & Harbours
Offshore Geotechnical

ENGINEERING, GEO SCIENCE AND ENVIRONMENTAL SERVICES
Klohn Crippen Berger has over 60 years of participation in some of the largest and most challenging engineering projects in the world. Our commitment to excellence is the driving force behind everything we do and, as a result, we are the recipient of over 50 national and international awards for major projects.

We offer a full range of services in the mining, social, environmental, water, oil and gas, hydroelectric power, and transportation sectors. We have a strong reputation for quality service and the capacity to support a boots-on-the-ground approach.

We have worked on hundreds of mining and infrastructure projects worldwide and we consistently meet our client’s needs from conception through closure. We are currently working on projects in over 20 countries in some of the toughest climatic conditions to be found: from the deserts of Mauritania to the High Arctic of Canada and Russia.

To better serve clients in the North, KCB has formed a joint partnership with the Inuvialuit Development Corporation and the Nunasi Corporation.

KCB has formed a joint venture partnership with the Inuvialuit Development Corporation to form IEG Consultants Ltd, headquarteried in Inuvik, NWT. IEG Consultants are dedicated to the communities and people of the North West Territories, and deliver quality environmental and engineering services to industry, government and aboriginal organizations.

The Inuvialuit Development Corporation (IDC) has invested in business ventures strategically positioned to optimize each other’s success and provide return to shareholders. Today, they are a major shareholder or partner in 20 subsidiaries, including IEG Consultants, working in complementary industries and realizing complementary visions.

The challenging working conditions in Northern Canada demand exceptional business practices. Business leaders succeed in these conditions only with detailed knowledge of quality control, staff training, work safety, and environmental responsibility. IDC companies share this knowledge and follow through with superior service. IDC receives its mandate from the Inuvialuit Land Claim Agreement. This Agreement aims to make the Inuvialuit equal and meaningful participants in the national economy and society.

**OUR MISSION**
To attract, develop, and retain talented staff and quality clients who thrive on challenging projects

**OUR VISION**
Excellence, teamwork, and innovation building a better world

**OUR VALUES**
- People First
- Health & Safety
- Sustainability
- A respectful, satisfying and fun workplace

- Professionalism
- Quality
- Innovation
- Technical Excellence
Brian Rogers, Vice President, Alberta, has more than 30 years of experience in the design and construction of diverse civil resource development and water resources projects.

Harvey McLeod, Vice President, Strategic Marketing, has 40 years of experience in mine environment and water resource projects, spanning throughout Canada and internationally.

Dan Campbell is a mechanical engineer with 34 years of varied experience relating to hydroelectric projects domestically and internationally, including pump turbines and underground powerhouses.

Bill Chin is a geotechnical engineer with over 35 years of experience in the investigation, design, construction and safety evaluations of major earthfill dams for water and tailings storage, as well as for foundations of large industrial buildings.

Tom Murray has more than 37 years of experience in geotechnical engineering, including project management, geotechnical design, contract preparation and construction supervision.

Gregg O’Neill has over 30 years of experience in civil engineering design and project management with a focus on the mining and pipeline industries.

Chuck Slack is a Principal Water Resources with more than 26 years of experience in a variety of surface water engineering-related projects.

Geoff Cooper has more than 35 years of engineering experience in the fields of civil, structural, marine and rapid transit.

Tim Keegan is a senior geotechnical/geological engineer with over 29 years of experience managing operational risk associated with geotechnical hazards and design.

Greg Noack has 20 years of experience in water resources engineering and storm water management for mining, industrial and land development projects.

Warren Vincent-Lambert has 18 years of experience in mining water management and environmental investigations.

Chad Wawrinchuk is a Project Manager managing projects involving hydrocarbon, heavy metal and salinity contamination at oil and gas facilities throughout Western Canada.
We offer geotechnical design and project management services for a wide range of northern and offshore development, and have experience in the unique conditions found in the Northwest Territories, Canadian Beaufort Sea and Russian Okhotsk Sea. Our team of engineers and geoscientist has a broad range of northern experience for the development and deployment of seabed and marine resource structures, submarine pipeline and arctic exploration drilling platforms.

**Pipeline Engineering**
Pipeline design and maintenance including horizontal directional drilling, investigation and assessment of pipeline route alignments, field drilling program, and laboratory testing.

**Facilities Engineering**
Preliminary site location and investigation, construction, operation, and abandonment of facilities.

**Earthquake Engineering**
Regional assessments of seismic hazards and geotechnical design for slope stabilization works and foundations in high hazard seismic areas.

**Borrow Studies**
Investigation and assessment of gravel, sand, clay and rock borrow sources in permafrost and non-permafrost terrain for use as construction materials.

**Permafrost Engineering**
Development of solutions for structure foundations, roads, embankments, pipeline-soil interaction to minimize disturbance of sensitive permafrost terrain.

**Pipeline River Crossings**
River engineering and slope stability assessment for pipeline crossings in permafrost and non-permafrost terrain.
Experience

Paktoa, Beaufort Sea
KCB provided geotechnical engineering support to Devon Canada for their ongoing exploration program in the Canadian Beaufort Sea. This included several on-ice site investigations and the review of different platforms for year round drilling. KCB completed foundation designs and supported operations staff in the installation and monitoring of piezometers and inclinometers during the winter drilling season.

Granular Resources Inventory of Artificial Islands, Beaufort Sea
Approximately 40 million m³ of granular material have been dredged from the Canadian Beaufort continental shelf to create artificial islands or subsea berms for caisson retained islands and drilling barges.

Pile Foundations on Permafrost, NWT, Canada
KCB was retained by the Northern Canada Power Commission for a project in Inuvik involving the installation of several hundred timber piles in permafrost for the extension of a diesel electric generating station. As part of this work, KCB analyzed the carrying capacity of the piles, recommended an installation procedure, designed the pile layout and supervised construction.

Mackenzie Gas Pipeline Seismic Hazard Assessment, NWT, Canada
The Mackenzie Gas Project (MGP), is comprised of a gathering system, large-diameter mainline and natural gas liquids pipeline to bring natural gas from the Mackenzie Delta to markets in Canada and the US. KCB was retained to assess the seismicity along the entire MGP route and calculate ground-motion factors for use in the MGP pipeline design.

Fuel Storage Tank Foundations on Permafrost, Inuvik, NWT, Canada
KCB provided foundation designs for fuel storage tanks located on soil with up to 80% ice by volume. Two alternatives for tank foundation support were considered: wood piles or insulated and ventilated gravel pad.
KCB’s multi-disciplined teams include water resource, geotechnical, geochemical, civil engineering and environmental professionals that manage your project to protect the environment, and develop designs that can be efficiently built and operated. Since the 1960s, we have been providing solutions for the resources sector.

**Tailings Technologies**
Designs to reduce water management and project footprint using dewatered, paste and thickened tailings. Alternative technologies using co-disposal with waste rock, cells to limit evaporation losses, cycloning and thickening of select tailing streams and combinations of conventional tailings storage and new technologies.

**Services**

**Dam Design**
Geotechnical design of major dams, considering seismicity, seepage control, stability, natural hazards, water management.

**Environmental Design**
Integration of limiting environmental factors, such as water quality, seepage, water treatment / discharge, social concerns.

**Waste Management**

**Construction**
Focused on building a project that works for the client, QA/QC services, construction supervision/monitoring and cost control.

**Waste Rock and Water Management**
Water balance, water management and hydraulic structures associated with dams, waste dumps and open pits.

**Risk and Benefit Assessment**
Risk assessment and risk management plans for mine waste and water facilities. Benefit assessment to balance and mitigate potential risks.
Experience

**Wolverine Project, YT, Canada**
KCB developed the geotechnical, hydrological and hydrogeological design for an LLDPE lined tailings impoundment in Yukon. We were involved from the PFS phase through permitting, construction, commissioning and monitoring. KCB also designed an LLDPE lined mine rock storage facility at the site.

**Greens Creek Mine, AK, USA**
KCB was entrusted with the design, construction monitoring and geotechnical input to operation of the Tailings Area Expansion. Primary objectives were to develop solutions to store de-watered tailings in an environmentally and regulatory sensitive site, and minimize acid rock drainage and visual impacts.

**Morrison Copper / Gold Mine, YT, Canada**
KCB provided geotechnical, water management, and environmental services for the feasibility study and the Environmental Impact Assessment for this proposed 30,000 tpd open pit copper/gold mine.

**KSM Project, BC, Canada**
KCB provided engineering design of the Tailings Management Facility (TMF) for the Kerr Sulphurets Mitchell Project. As part of the EA process, KCB conducted an assessment of geotechnical, water management, and engineering characteristics of 14 alternative TMF sites and the feasibility of constructing, operating, and closing of TMFs at these sites.

**Udokan Copper Project, Russia**
Udokan deposit will become one of the world largest copper deposits having ever been developed. The deposit is located in the Kalar District of the Transbaikal Territory, where there is no any infrastructure and there are extreme climatic conditions: permafrost and high seismic activity.

**Nerco Con Mine, NWT, Canada**
KCB was retained to conduct planning studies for tailings impoundment at the Nerco Con Mine near Yellowknife, NWT. KCB’s duties included hydrology, water balance, stability assessment, preparation of construction drawings and site inspection services during dam construction.
KCB has over 60 years of domestic and international hydro and civil infrastructure experience with broad based project experience in Canada’s North.

**Hydroelectric Power**
KCB offers full engineering and environmental services for hydro projects. Our project design experience ranges from a 7 MW, single-unit project in Canada to a large 1074 MW, multi-unit project in Laos. Our professional staff, consisting of environmental scientists and geotechnical, hydrotechnical, civil, structural, mechanical and electrical engineers deliver total facility designs, including:

- **Engineering, Environmental, and Permitting Studies:** Constructing a new hydro facility or rehabilitating an existing hydro facility requires appropriate studies. KCB staff are experienced in hydrological studies, environmental and permitting studies, energy calculations and power studies, and equipment optimization studies.
- **Dams and Intake Design:** Whether the project is run-of-river with a low coanda weir and minimal storage, or a world class roller-compacted-concrete dam for flood control, irrigation, and power generation, we understand how to permit, design, and build it efficiently and economically.

**Roads and Airstrips**
Construction methods and construction material surveys appropriate for northern conditions. Design of winter roads and ice roads.

**Highways, Tunnels, and Bridges**
KCB has been provided integrated structural and geotechnical design for transportation projects for over 60 years, including design for small access roads and bridges, tunnels and retaining structures, and bridges in short, medium and long span ranges.

**Railways**
We have a long history of working with railway owners to maintain, develop and protect their network of railways.
Arctic Railway to Prudhoe Bay, AK, USA
A proposed railway was studied as an alternative to pipeline transport of oil from the Prudhoe Bay field in Alaska to Edmonton, Alberta via the northern slope of the Alaska and the Yukon and the Mackenzie River valleys. KCB was retained by CN / CP to prepare the preliminary railway grade design for 800 miles and coordinate the work of three other consulting firms involved in designing the remainder of the route.

Mayo and Wareham Dams, YT, Canada
Klohn Crippen Berger performed a dam safety review of Mayo and Wareham Dams for Yukon Energy in 2005. That review identified a potential deficiency in that the seismic hazard had not been assessed in nearly two decades, despite advances in understanding of seismic hazard in Canada.

Northern Hydro Pre-Feasibility Study, SK, Canada
This pre-feasibility study involved the assessment of hydroelectric facilities of four different sites, on two different river systems. Heads varied from 10 to 40 meters, and the mean annual discharge (MAD) varied from 40 to 350 m³/s. Watersheds range from 7500 km² to 50,000 km² for the two river catchments respectively. The purpose of these developments will be to service increase anticipated future load demand in northern Saskatchewan resulting from local mining operations and growth of local communities.

Aishihik River Power Development, YT, Canada
KCB carried out detailed engineering, preparation of tender documents, supervision of construction and project management for the building of the underground powerhouse and associated works. We also carried out site investigations, route selection, design and construction supervision for the canal.
We offer sustainable, cost effective, environmental services to support your Arctic project requirements and commitments. Our staff have extensive project experience in Canada’s north and the High Arctic. We have conducted environmental work for local, territorial, aboriginal and federal government agencies as well as industrial, military and petroleum industries.

Regulatory Permitting
Completion of the permitting processes for access, development, operation, closure and reclamation.

Baseline Studies
Biophysical assessments to define and document the pre-development site characteristics and provide a basis for assessing potential development impacts.

Environmental Site Assessments
We have managed projects from the Phase 1 study through permitting for access, implementation of remedial works and reclamation of the site.

- **Phase 1**: Non-intrusive assessment of historical and current activities to identify impacts and potential impacts on local ecology.

- **Phase 2**: Intrusive site assessment to confirm the presence and characterise the substances of concern as well as delineate impacts.

- **Phase 3**: If the results of the Phase 2 assessment indicate that significant contamination exists, a detailed intrusive site assessment is undertaken. Refines contaminant delineation and addresses outstanding issues in order to develop a remedial action plan.

- **Phase 4**: Remedial action plan to ameliorate contamination on-site, or to remove contaminants from the site. Implementation of the approved reclamation plan to achieve the target land use status.

Liability Assessments
Provision of estimated site remediation and reclamation costs for financial liability.

Regulatory Compliance
Site and regional monitoring during development, operations and post closure to confirm site compliance with regulatory approval conditions.
Experience

**Sheep Creek, YT, Canada**
We conducted an assessment following the release of hydrocarbons at the Sheep Creek Warden Station. We quantified the volume of impacted soils at the site and presented remediation options to Parks Canada. A biocell was determined to be the best available and economic option to conduct soil remediation at the site.

**Unipkat I-22, NWT, Canada**
Phase II Environmental Site Assessment of the former Unipkat I-22 well site and drilling sump. Prior to the commencement of onsite activities all required regulatory requirements were completed to access the site. Activities included the logistical and project management aspects of the project including sourcing of heliportable drilling rig, helicopter charter, and subcontractors.

**DEW Line Site Monitoring, NWT, Canada**
This project involved the collection of post construction landfill monitoring data from 23 landfills located at 6 former DEW Line sites. The DEW Line sites are located in the Inuvialuit Settlement Region of the Western Canadian Arctic. We were responsible for all project logistics including aircraft charter, remote camp accommodations, data collection, reporting, and project management.

**Johnson Point Remediation, NWT, Canada**
Clean-up of the former logistics base at Johnson Point. We were responsible for the delineation and treatment of petroleum contaminated soil and groundwater. A practical soil and groundwater treatment option was planned including a purpose-built water treatment system, to remediate contaminated groundwater before it was returned to the environment.

**West Channel Monitoring, NWT, Canada**
KCB completed a soil remediation program at the former West Channel Staging Site (tank farm) in 2003. Following remediation, KCB, the Inuvialuit Land Administration and local stakeholders agreed to a 25 year post-remediation monitoring plan for the site. KCB is responsible for conducting a groundwater monitoring and visual observation program during scheduled years until 2028.
Our social and environmental team provides comprehensive services for the management of resource and infrastructure projects, with a focus on integrating the social and environmental aspects of our designs for our clients and the community.

**Stakeholder and First Nations/Aboriginal Consultation**
Facilitating understanding, involvement, and information exchange during all project stages through use of a variety of tools and techniques such as meetings, communications materials, and open houses.

**Communications and Consultation Plans and Materials**
Developing and implementing project-specific plans and supporting communications materials, including culturally appropriate materials.

**Regulatory Consultation and Advisory Services**
Developing strategies that advance the review and regulatory approval processes. KCB has experience with federal, provincial and territorial processes in Canada and International Finance Corporation standards, World Bank guidelines, Equatorial Principles, and numerous country specific processes worldwide.

**Socioeconomic Baseline and Impact Assessments**
Characterizing pre-project social and economic conditions in the potential area of influence of a project; assessing the potential short, medium and long term effects on people, communities and economies; and developing mitigation, enhancement and monitoring strategies in concert with stakeholders and First Nations.

**Capacity Building**
Training, skills development and capacity building for local communities and First Nations/Aboriginal groups.

**Traditional Use and Traditional Ecological Knowledge**
Incorporating traditional use and traditional ecological knowledge into socioeconomic and environmental baseline and impact assessment studies.

**Corporate Social Responsibility and Sustainability**
Working with clients to integrate social, economic, and environmental considerations into corporate decision making.
Rainy River Gold Mine, ON, Canada
KCB initiated baseline data-gathering for this advanced exploration-phase gold project in 2009. In 2010 we will complete the baseline, and work with local community members and First Nations to identify means through which to enhance socioeconomic benefits, minimize effects, and develop a conceptual closure plan.

Minto Mine Phase IV Expansion, YT, Canada
Minto Explorations Ltd. is working to expand the existing open pit Minto Mine to extend the mine life through development of new surface and underground mining areas. The Mine is located on Selkirk First Nation (SFN) Category A Settlement Lands. Prior to expanding the mine, Minto must receive approval from the Yukon Environmental and Socio-economic Assessment Board (YESAB). KCB is completing the Traditional Ecological Knowledge and Socio-Economic Impact Assessment studies to support the YESAB Application.

Ruby Creek Molybdenum Mine, BC, Canada
This remote mine, located in the traditional territory of the Taku Tlingit First Nation, was approved by federal and provincial regulatory agencies. KCB led the socio environmental assessment; consulted with the community, First Nations and regulatory agencies and designed the waste management facilities. First Nations participated in project studies and we worked with First Nations to develop an adaptive management plan.

Mica Units 5 and 6, BC, Canada
KCB led the socio environmental assessment for this Project located in the overlapping traditional territory of 25 First Nations. We also advised and supported the client in consultation and regulatory activities, undertook an alternatives assessment and worked with First Nations to involve them in project studies.

Izok Lake, NWT, Canada
KCB carried out the EA and feasibility study for the tailings, waste rock and water management for this 3,000tpd open pit zinc copper project, located about 360 km north of Yellowknife. The work required a detailed assessment of the acid rock drainage characteristics of the tailings and waste rock for both operations and closure. Innovative tailings disposal techniques included assessment of vacuum filtration and freezing of the tailings to preclude ARD.
Klohn Crippen Berger’s background of water management experience is a significant advantage to our clients. We aim to assist our partners in managing water safely, from exploration, from the start of their project, through to post project closure.

**Acid Rock Drainage and Metal Leaching**
Geochemical assessment of mine waste rock and tailings. Water quality predictions for operations and closure. Limiting water quality issues and integration of controls as part of facility engineering design.

**Water Balance and Water Management**
Optimizing water recovery in arid climates and improving storage, treatment and release of water in wet climates.

**Mine Dewatering**
Design of mine dewatering systems that manage both quantity and quality of mine water. Design of depressurization systems for pit wall stability.

**Water Supply and Water Rights**
Groundwater and surface water supply and storage assessment of mine water supply.

**Hydraulic Structures**
Design and construction of diversion structures, diversion channels, spillways, sediment ponds and decant systems. Assessment of hypothetical “Dam Break” and “Tailings Run-out” effects to support Emergency Preparedness Planning (EPP).

**Environmental Design**
Water quality modelling to integrate facility engineering design with limiting environmental factors in the receiving waters, such as aquatic life or downstream water use.

**Groundwater**
Groundwater plume modelling, including dispersion modelling and absorption/attenuation models. Groundwater monitoring programs and the design and construction of groundwater remediation systems.

**Wetlands**
Design and construction of wetlands to mitigate water quality and/or to enhance aquatic habitat.
Experience

**Ekati Diamond Mine Hydrogeology, NWT, Canada**
Between 1999 and 2007, KCB investigated the hydrogeology of the Sable, Fox, Panda, Koala, and Misery pits and estimated potential mine inflows. Work included an assessment of a preliminary conceptual hydrogeological models, packer based hydraulic testing, collation of pit water balance and water quality data, revision of the pits conceptual hydrogeological models, dewatering and pressure relief requirements, and analytical and numerical modeling to assess potential mine inflows drawdown extent. By representing the complex interplay between various arrangements of cut-off ditches, sumps and pumping facilities, the revised hydrogeological models allowed KCB to optimize the drainage systems which were subsequently constructed. Additionally, these hydrogeological studies carried out by KCB allowed for further indication of permafrost and rock stability issues.

**Rose Creek Tailings Facility – PMF Flood Handling, YT, Canada**
The Rose Creek Tailings Storage Facility (TSF) is located at Faro Mine, which ceased operation some time ago. A large diversion channel was constructed adjacent to the TSF to convey flows from Rose Creek around the TSF during operation. As part of the overall closure design effort for the mine, KCB reviewed the capacity of existing diversion channel to handle the Probable Maximum Flood (PMF), and evaluated various alternatives for passing the flood through the existing channel and the tailings impoundment.

**Dawson City Dyke, YT, Canada**
The City of Dawson retained Klohn Crippen Berger to carry out site investigations, design, and construction management of a new flood control dyke at Dawson City, Yukon. The City of Dawson, located on the Yukon River, was subject to periodic floods resulting from ice jams during spring breakup. KCP carried out a detailed flood frequency analysis for both open water and ice jam floods, and developed flood plain mapping and dyke crest elevations. Winter construction using continuous fill placement was employed to prevent freezing prior to compaction, and to ensure protection for the City during the subsequent spring breakup. Construction activities included temporarily bridging the Klondike River under winter conditions to gain access to a filter gravel borrow site.
PORTS & HARBOURS
Services

For over 60 years, Klohn Crippen Berger, its affiliates and predecessor organizations have been active in the planning, design and construction of a wide variety of ports, harbours, and marine terminals. Our experience ranges from economic evaluations, structural assessments and remedial designs, through to site development, wharf design and site services for major new terminals. KCB’s background of marine engineering experience is a significant advantage to clients on port projects.

We can meet the diverse project requirements of our port and harbour clients through the following areas of expertise:

**Port Feasibility & Planning** from pre-investment and feasibility studies to site selection and conceptual design.

**Marine & Structural Engineering** ranging from dredging, reclamation works, loading ramps, piled decks, bulkheads and caisson wharves.

**Geotechnical & Environmental Engineering** including shallow and deep foundations for heavy civil structures and equipment, dynamic loading, seismic design, and ground improvement.

**Coastal & River Engineering** including aquatic construction considerations such as water levels, floods, foundation and flow considerations particular to wet structures and infrastructure.

**Construction Management Services** including field inspection, contract administration, claims negotiation, scheduling and cost estimating.
Experience

Deltaport Container Wharf and Terminal, BC, Canada
KCB was retained as prime consultant to carry out detailed engineering and contract administration for the Deltaport Berth 3 Extension project in Vancouver, Canada. This project follows up on our successful 1993 design for Berths 1 and 2 and landside terminal works at Deltaport Container Terminal, which won the Consulting Engineers of British Columbia award of excellence in 1997.

Guam Kilo Ammunition Wharf Extension, Guam
KCB was retained by the US Navy as part of the Moffatt & Nichol team in early 2006 for detailed engineering for the Kilo Ammunition Wharf Extension project on Guam, Marianas Islands. Kilo Wharf, located in the outer Apra Harbour, is the primary and most strategically important ordnance facility within the Pacific fleet area of operations. The wharf extension comprises 6 caissons of varying sizes, designed to resist seismic events plus seismic retrofit of existing caissons.

Halifax Caisson Jetty “NJ”, Nova Scotia, Canada
In 2002, the Department of National Defence decided to construct a replacement wharf for their existing timber jetties in Halifax Harbour. This new $35M marginal wharf, Jetty “NJ”, is to provide full-service berthing for Canadian Patrol Frigates and Advanced Logistic Support Carriers. KCB was selected as caisson designer for conceptual and final engineering phases, tender assistance and field review.

Esquimalt Graving Dock, BC, Canada
Esquimalt Graving Dock is the largest civilian dry dock on the west coast of the Americas. Since 1990, KCB has been retained by Public Works Canada multiple times, to carry out structural, fatigue and mechanical inspections of the 30t, 45t and 150t dockside gantry cranes at two-year intervals. Separately, KCB has been involved in mechanical assessments, performance monitoring, fatigue analyses and retrofits for all three cranes, and complete refurbishment, relocation and renewal programs for the 30t crane as the Owner’s Engineer.

Rocky Point Jetty Condition Inspection & Structural Evaluation, BC, Canada
KCB conducted a full inspection of the jetty above and below water, including: all piling, pile wraps, sheet piled, caissons, deck structure and the fender pile system.

Esquimalt Graving Dock – South Jetty Wharf Development, BC, Canada
KCB was retained by Public Works Canada to carry out detailed designs for replacement of the timber-piled South Jetty at Esquimalt Graving Dock in Victoria, BC with a new steel-piled jetty. KCB was the prime consultant, with responsibility for geotechnical, civil, structural, mechanical, electrical and marine engineering. This project depended on KCB’s knowledge of the existing facilities and our ability to incorporate state-of-art seismic solutions to satisfy the client’s expectations.
Our team of engineers and geoscientists has a broad range of northern experience for the development and deployment of seabed and marine resource structures, submarine pipelines and arctic exploration drilling platforms. We apply appropriate technology, ranging from pragmatic experience to sophisticated analytical software to developing practical and efficient design and construction procedures in order to suit our clients’ needs.

**Submarine Facilities**
Site characterization and investigations of seabed soils from ships, drilling platforms, and stable landfast ice. Geotechnical seabed instrumentation and data interpretation, ice scour indentification and pipeline burial/dredging elevations.

**Offshore Platforms**
Structures foundation design and performance monitoring for earthquake, wave, and ice loading.

**Pipelines**
Route selection, regulatory document input, terrain hazard, and integrity management / analysis. Trenching / bedrock rippability, buoyancy control, earthquake engineering, and slope remediation and design of drainage / erosion controls.

**Site Investigations, Instrumentation and Monitoring**
Soil sampling and groundwater monitoring. Instrumentation installation and monitoring programs.

**Laboratory Testing**
Standard soil testing including moisture content, grain size, permeability, Atterberg limits, specific gravity / relative densities, Proctor testing, direct shear, triaxial, and consolidation testing.

**Environmental Design**
Water quality modelling to integrate facility engineering design with limiting environmental factors in the receiving waters, such as aquatic life or downstream water use.

**Construction Management**
Field inspection, contract administration, claims negotiation, scheduling, and cost estimating.
**Experience**

**Gulf Molikpaq, Amauligak F-24, Beaufort Sea**

KCB carried out a seismic hazard evaluation, a free-field foundation seismic liquefaction assessment, a berm/Molikpaq sand core seismic liquefaction assessment and an icequake liquefaction assessment. The ice quake work was carried out using the computer programs NLSSIP and QUAD-4. This ice quake analysis was used as one guide to the densification of the sand core of the Molikpaq. The results of the analysis included an initial liquefaction assessment of the core and a dynamic amplification response curve for the entire system.

**Molikpaq Drilling Platform, Beaufort Sea**

Sakhalin Energy Investment Company Ltd. purchased the Molikpaq drilling platform for re-deployment near Sakhalin Island in eastern Russia. KCB were the geotechnical engineers for this re-deployment, which involved design and construction monitoring. The design included a seabed foundation structure stability analyses for the earthquake, ice and wave loading at the site. KCB identified and provided recommendations for suitable sand borrow material used for infilling of the Molikpaq foundation caisson and provided construction supervision services during dredge operations. KCB has also provided recommendations for the design of water wells within the sand core for the water flood facilitation.

**Arctic Geotechnology Ice Gouge Study, U.S. Naval Civil Engineering Laboratory**

KCB in conjunction with Canatec Consultants Ltd. carried out a study to investigate available information and data related to ice and seabed interaction to assist development of designs for small diameter pipelines from onshore to deepwater in Arctic environments particularly within the boundaries of Cape Prince of Wales to Demarcation Point.

**Inuvialuit Marine Mammal Observers, Beaufort Sea**

Provided support to offshore seismic programs in the Canadian Beaufort Sea. These programs involved multiple ships over a three-month period. The MMOs were required to observe and report both marine mammal and seabird sightings and provide guidance to the ships’ crews to avoid interaction with the marine mammals.