



**Education**

*B.Sc. Honours Zoology,  
University of Alberta,  
Alberta, Canada, 1972*

*M.Sc. Zoology, University  
of Alberta, Alberta, Canada,  
1974*

**Languages**

*English – Fluent*

**Golder Associates Ltd. – Edmonton**

***Principal and Senior Fisheries Biologist***

Aquatic resources specialist involved with research and environmental assessment of fish and habitat resources, and impact assessment with a focus on mining, hydroelectric, oil and gas, and linear development projects. Services provided include study design and management, collection and reporting of field investigations, input to multidisciplinary environmental impact assessments, preparation of environmental monitoring plans, development of mitigation and fish habitat compensation programs to meet client and regulatory needs. Recent projects include environmental assessments relating to potential mining developments in NWT and Nunavut and the Mackenzie Valley Gas Pipeline, as well as an aquatic productivity study on the Peace River, BC related to the proposed Site C project.

**Employment History**

***Golder Associates Ltd. – Edmonton, Alberta***

*Principal and Senior Fisheries Biologist (2001 to Present)*

Aquatic resources specialist involved with research and environmental assessment of fish and habitat resources, and impact assessment with a focus on mining, hydroelectric, oil and gas, and linear development projects. Services provided include study design and management, collection and reporting of field investigations, input to multidisciplinary environmental impact assessments, preparation of environmental monitoring plans, development of mitigation and fish habitat compensation programs to meet client and regulatory needs. Recent projects include environmental assessments relating to potential mining developments in the NWT and Nunavut, a water quality study and aquatic productivity study on the Peace River in BC, and the fisheries component of Mackenzie Valley Gas Pipeline environmental assessment.

***R.L.&L. Environmental Services Ltd. – Edmonton, Alberta***

*Principal and Co-founder (1977 to 2001)*

Conducted fisheries and aquatic environmental investigations throughout western and northern Canada for 25 years. Completed field studies and an aquatic impact assessment for part of an Initial Environmental Assessment relating to a proposed base metals mine site at Izok Lake, Northwest Territories. Provided input to the study design for the baseline studies for Echo Bay's Ulu Project in the Northwest Territories, and directed the baseline data collection for the AEC Bitumen Production Project (Cold Lake Air Weapons Range, Alberta) and the Meliadine West Gold Exploration Project near Rankin Inlet, Northwest Territories. Involved in several environmental protection and planning studies, with input to an environmental monitoring and waste compliance program for the Lupin Project gold mine (Contwoyto Lake, Northwest Territories), a fisheries habitat inventory for a large number of lakes in central Alberta (Alberta Fish and Wildlife Division), and prepared a five-year strategic plan for the fisheries component of the Mica Dam Compensation Program for BC Hydro. Managed



and wrote the fisheries and aquatic sections of the environmental information review and data gap analysis of both the upper and lower Columbia River projects for BC Hydro's water use planning process. Conducted fisheries and baseline studies for the Mackenzie Delta Producers proposed pipeline down the Mackenzie valley.

***BC Hydro – Vancouver, BC***

*Fisheries Biologist (1977 to 1979)*

Involved in the preparation of terms of reference for environmental impact studies for proposed hydro and thermal power generating stations. Other duties included monitoring consultants' work, conducting in-house field studies, and providing input to EIAs.

***Renewable Resources Consulting Services Ltd. – Edmonton,  
Alberta***

*Fisheries Biologist (1974 to 1977)*

Undertook numerous aquatic research programs entailing environmental evaluations of proposed energy developments such as hydroelectric dams (Peace Canyon Dam, Peace Site C, and the Marsh Lake Northwest Territories dam); river dredging (Mackenzie River); flood control, oil sands development, and pipeline construction (environmental code for the Mackenzie Valley pipeline).



## PROJECT EXPERIENCE – ENVIRONMENTAL MANAGEMENT

**Site C Aquatic Productivity Study**  
British Columbia,  
CANADA

Project Director, client contact, and senior reviewer for a two to three year aquatic productivity study that was initiated in spring 2010 to assess baseline aquatic productivity the Peace River system within the Site C area and downstream, and to use modelling to assess the likely changes in aquatic productivity after development of Site C. The information will be used to assess if there is a need for additional mitigation or compensation to meet DFO's no-net-loss of productive capacity. The study included water quality sampling, plankton sampling in upstream reservoirs, placement of in situ artificial substrates for monitoring of periphyton and macrobenthos productivity, and modelling the likely conditions after the development of Site C.

**Site C Water Quality Study**  
British Columbia,  
CANADA

Project Director and senior reviewer for a water quality study that initiated in the fall of 2006 to improve the baseline data set of water quality information for the Peace River and many of the tributaries between Hudson Hope and the BC/Alberta border. This work is being completed in relation to expected baseline data requirements for development of Site C. The study included placement of in situ turbidity and temperature sensors and the seasonal collection of water, vegetation and sediment samples for nutrient, hydrocarbon, metals and organochlorine analysis. This study was continued in 2007 and has been extended through 2008.

**Environmental Overview Assessment of the Implications of Locating the Site C Dam Upstream of the Moberly River**  
British Columbia,  
CANADA

An overview assessment of the implications of locating the Site C Dam on the Peace River to upstream of the Moberly River on the fish and aquatic resources, wildlife and historic resources.

**Site C Environmental Impact Statement Indicating Effects Pertinent to the Dunvegan Hydroelectric Proposal**  
British Columbia,  
CANADA

An environmental assessment of potential cumulative effects of the proposed Site C hydroelectric development in BC in combination with the proposed Dunvegan Project in Alberta. The assessment included implications on ice formation, hydrology, fisheries resources, wildlife, agriculture, soils, forestry, socio-economic and First Nations.

**Site C & E Aquatic Studies and Impact Assessment on the Peace River**  
British Columbia,  
CANADA

Fisheries and aquatic studies were undertaken on the Peace River between Hudson's Hope and the BC-Alberta boarder to provide baseline data and the basis for the assessment of potential impacts of the Site C and Site E development scenarios.



**Expert Witness  
Testimony at the Site C  
BCUC Hearings**  
British Columbia,  
CANADA

Called as an expert witness on behalf of BC Hydro to provide expert witness testimony at the BCUC hearings for the proposed Site C dam on the Peace River. The testimony was related to baseline aquatic studies and impact assessment components for the project.

**Williston and Peace  
Canyon Dams**  
British Columbia,  
CANADA

This project, conducted jointly with B.C. Hydro staff, involved a sampling program to collect total gas pressure data at two Peace River hydroelectric facilities. This was part of B.C. Hydro’s ongoing program to monitor TGP production at their major facilities.

**TDG Monitoring at  
Brilliant and Waneta  
Dams**  
British Columbia,  
CANADA

This involved a monitoring program, initiated in conjunction with B.C. Hydro studies, to document TGP levels at the Brilliant and Waneta hydroelectric projects. The studies also involved conducting TGP monitoring during operation of selected spillway gates at these facilities to determine any differences in TGP production relating to their use.

**Fisheries Studies for  
the Site One Dam on  
the Peace River**  
British Columbia,  
CANADA

Undertook preconstruction baseline fisheries studies on the Peace River between the WAC Bennett Dam and Hudson’s Hope related to the Site One (now Peace Canyon Dam).

**Keenleyside  
Powerplant Project  
Cumulative  
Environmental Effects  
Assessment: Fisheries  
and Aquatic Habitats.**  
British Columbia,  
CANADA

An assessment of the cumulative environmental effects of the installation and operation of the proposed Keenleyside Powerplant on the Columbia River near Castlegar, B.C. Impacts are discussed for hydraulic effects, entrainment, total dissolved gas pressure (TGP), load/flow shaping, and habitat losses to aquatic resources, particularly fisheries.

**Environmental  
Information Review  
and Gap Analysis  
Water Use Planning –  
Keenleyside, Mica,  
Revelstoke**  
British Columbia,  
CANADA

A comprehensive review was prepared of all documented literature and file information on fish, wildlife and recreation within the Columbia River Basin that may be affected by operations of the Mica, Revelstoke and Keenleyside facilities, and possible interactions between these environmental resources and facility operations. A summary of potential operation-related effects on fish, wildlife and recreation in the context of current facility operations, as well as potential cumulative effects caused by other existing projects in the Columbia Basin was completed; information deficiencies that hamper evaluating the nature and significance of these impacts were identified; and recommendations provided for future environmental studies to address.

**Keenleyside  
Powerplant Project:  
Assessment of  
Potential Biological  
Effects of Water  
Temperature Changes.**  
Castlegar, BC, CANADA

An assessment of the biological effects of the potential changes in the thermal regime was conducted to better understand the implications of the potential temperature changes associated with the powerplant.



**Mica Dam Unit 5  
Project**  
British Columbia,  
CANADA

Existing biological information on limnology, fish and habitat resources, and the uses of these resources, was summarized for the project area (Mica Reservoir, the upper Columbia River and its tributaries, and Revelstoke Reservoir). Potential impacts on the aquatic habitat and fisheries, including the magnitude and duration of the impacts were detailed. In addition, possible mitigation measures and recommendations for further study were identified. A short discussion of the potential incremental or cumulative impacts associated with additional units planned for Revelstoke and Mica was also provided.

**GMS Tailrace Weir  
Excavation Project:  
Fish Habitat  
Assessment**  
British Columbia,  
CANADA

An assessment was provided of the impacts of reservoir drawdown on fish habitat and tributary access. Habitat values associated with a proposed excavation project in the GMS tailrace area were also assessed and habitat mitigation/compensation/enhancement options associated with the proposed excavation project provided.

**Environmental  
Monitoring and  
Support Services**  
Alberta, CANADA

Director for a project requiring continuous sediment monitoring during emergency dredging of the North Saskatchewan River. Maintained regulatory agency liaison and mitigation planning to comply with water quality objectives. Developed fish habitat compensation strategies and satisfied reporting commitments on behalf of TransAlta.

**Lake Whitefish  
Spawning Success**  
Alberta, CANADA

An assessment was conducted of the impact of the Wabamun Power Plant thermal plume on Lake Whitefish spawning success in Wabamun Lake, Alberta.

**Water and Sediment  
Sampling Wabamun  
Lake**  
Alberta, CANADA

Project Director for study on total metal concentrations in water and sediment in the Ash Lagoon, Wabamun Lake and watershed, and reference areas.

**Socio-Economic  
Effects Of Changes In  
Traditional Resource  
Availability in the  
Athabasca River Delta  
– Fisheries Component**  
Alberta, CANADA

An evaluation was conducted of how changes from the construction and operation of the WAC Bennett Dam in the upper Peace River may have affected use of traditional fisheries resources by the ACFN.

**Libby Coordination  
Agreement  
Assessment**  
British Columbia,  
CANADA

An overview report was prepared which discussed the impacts associated with Libby Coordination Agreement operations on fish, fish habitat, and fish use in the Kootenay and Columbia River systems.

**Fish Mortality Study**  
Alberta, CANADA

Expertise was provided to resolve fish mortality in the inlet and outlet canals at the Wabamun Plant. On-site monitoring of fish collection from the intake screens was conducted in the vicinity of the Wabamun plant intake, to assist with determining the possible causes of fish mortality. Electrofishing was conducted to remove fish from the outlet canal. Intake canal velocities were also measured at the Wabamun Plant.



**Waneta Powerplant**  
Columbia River, BC,  
CANADA

A preliminary scoping document and discussion paper was prepared regarding the impacts of construction and operation on white sturgeon populations.

**Peace River Site C  
Hydroelectric  
Development: Pre-  
Construction Fisheries  
Studies**  
British Columbia,  
CANADA

This project was conducted to assess fisheries resources and utilization in the development area of a proposed hydroelectric project on the Peace River, near Fort St. John, B.C. Information collected was used to create a pre-development database to facilitate impact assessment and the identification of potential mitigation and compensation options.

**Lower Columbia River  
Fisheries Inventory**  
British Columbia,  
CANADA

Fisheries studies were conducted to increase the pre-development database of information relating to the fisheries resource, and to identify feasible mitigation and enhancement opportunities that exist in the development area of seven proposed hydroelectric facilities within the Lower Columbia River basin. A detailed inventory was conducted of existing fish populations and movement patterns within the Lower Columbia Development study area. In addition, an assessment was completed of the use of the mainstem Columbia River and tributaries for spawning, rearing and feeding by sportfish and non-sportfish species and an assessment of the extent of gas bubble trauma in fish, resulting from the high total dissolved gas levels below Hugh Keenleyside Dam.

**Load/Flow Shaping: A  
Review of  
Environmental Effects**  
British Columbia,  
CANADA

This study was conducted to provide a review of the environmental effects of hydroelectric powerplant operations on biological communities. Emphasis was placed on species in the Columbia River below Keenleyside Dam to the Canada-U.S. border. The information was used to predict the impacts of several hydroelectric projects and to assist in developing mitigation and compensation programs to reduce the impacts of existing and planned developments on the lower Columbia River basin.

## PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

**Izok Corridor Project**  
Nunavut, CANADA

Project senior advisor for the water quality and fish and fish habitat component of the MMG Izok Corridor Project. This project involves collection of additional baseline data and input to the draft environmental impact statement, as well as developing a fish habitat compensation plan for the project.

**Meliadine Gold Project  
Environmental Impact  
Statement**  
Nunavut, CANADA

Project Director responsible for oversight and planning of the preparation of a draft Environmental Impact Statement to be submitted to Nunavut Impact Review Board. Project undertaken for Agnico-Eagle Mines Ltd., who purchased the property from Comaplex Minerals Corporation.

**Phase I – Meliadine All-  
Weather Access Road  
Project Description  
and Environmental  
Assessment**  
Nunavut, CANADA

Project Director leading the preparation of an environmental assessment submitted to Nunavut Impact Review Board on behalf of Agnico-Eagle Mines Ltd. for pre-approval development of a single lane all-weather road for their advanced exploration project.



**Gahcho Kué Project**  
NWT, CANADA

Senior technical reviewer for the fish and fish habitat sections of an environmental impact statement (EIS) for a new diamond mine for DeBeers Canada in the Northwest Territories (NWT).

**NICO Project Baseline Study and EIS**  
Northwest Territories,  
CANADA

Project Director responsible for oversight and planning of continuing baseline studies and development of an environmental impact statement for the Fortune Minerals Ltd. gold/bismuth/cobalt mine in NWT.

**Meliadine West Gold Project Baseline Studies and EIS**  
Nunavut, CANADA

Project Director responsible for oversight and planning of continuing baseline studies and development of an environmental impact statement with a multi-disciplinary team for the Comaplex Minerals Corporation project north of Rankin Inlet, NU.

**Miramar Hope Bay Ltd. Doris North Project**  
Nunavut, CANADA

Designed and directed aquatic baseline studies for the proposed Doris North Gold Project located south of Cambridge Bay, NU. The project also included participation in a multi-disciplinary team to prepare an Environmental Impact Statement (EIS) that was submitted to the Nunavut Impact Review Board. This involvement included identification of mitigation options and preparation of a fisheries compensation program to offset losses to the fisheries resources. Participated in NIRB pre-hearing conferences in four northern communities and attended the NIRB hearings on behalf of the client as an expert witness relating to the aquatic disciplines. Subsequent involvement include appearing as an expert witness at the Nunavut Water Board hearings on behalf of the mining client, as well as directing long-term monitoring programs related to the development.

**Imperial Oil Cold Lake Expansion Project**  
Cold Lake, Alberta,  
CANADA

Aquatic studies of the fish community, fish habitat, lower trophic levels, and water quality for completion of the environmental impact assessment for Imperial Oil Resource Ltd.'s Mahihkan North and Nabiye developments near Cold Lake, Alberta. The development used Cyclic Steam Stimulation (CSS) technology to recover bitumen from deep formations.

**Pre-Development Aquatic Studies: Meliadine West Project**  
Nunavut, CANADA

Participated in the collection of baseline information of fish populations and aquatic nonvertebrate communities in the area of Rankin Inlet, Nunavut. In addition, fish tissues and water quality samples were collected from selected waterbodies in the study area. An assessment was conducted of waterbodies and fish populations that may be impacted by the development. Radio transmitters were implanted in selected sportfish species (Arctic char, Arctic grayling and lake trout) to determine the extent of overwintering and spawning migrations.

**Ulu Project - Aquatic Studies Program**  
Nunavut, CANADA

A detailed survey of the aquatic biological community was undertaken as part of a baseline environmental study within the area of the ULU deposit, located approximately 155 km north of the Lupin gold mine. The purpose of the study was to provide accurate pre-development baseline data on the aquatic environment of waterbodies that may be impacted by mining activities. Aspects of the study included fish and fish habitat investigations, water quality and sediment collections.



**AEC Bitumen Production Project, Air Weapons Range: Baseline Studies - Fish and Aquatic Habitat Component**  
Cold Lake, AB, CANADA

Alberta Energy Company (AEC) plans to develop a commercial scale bitumen production project from its Oil Sands Development Leases located in the Cold Lake Air Weapons Range. As a result, a baseline inventory of the aquatic biota in the vicinity of the project area was undertaken. The objectives of the 1997 baseline studies program was to inventory fish populations and aquatic habitats in waterbodies in the vicinity and immediately downstream of the development area and assess the importance of these waterbodies to these fish populations.

**Keenleyside Powerplant Project Cumulative Environmental Effects Assessment: Fisheries and Aquatic Habitats**  
British Columbia, CANADA

An assessment of the cumulative environmental effects of the installation and operation of the proposed Keenleyside Powerplant on the Columbia River near Castlegar, B.C. Impacts are discussed for hydraulic effects, entrainment, total dissolved gas pressure (TGP), load/flow shaping, and habitat losses to aquatic resources, particularly fisheries.

**Fisheries Assessment in the ULU Project Area**  
Nunavut, CANADA

Four proposed winter road routes were evaluated on the basis of engineering and environmental criteria. The aquatic habitat at each stream crossing along the proposed winter road routes as well as the fish use of these streams was assessed. In addition, preliminary limnological and fisheries surveys of four lakes were conducted.

**Waneta Powerplant**  
Columbia River, BC, CANADA

A preliminary scoping document and discussion paper was prepared regarding the impacts of construction and operation on white sturgeon populations.

## PROJECT EXPERIENCE – MINING

**Izok Corridor Project**  
Nunavut, CANADA

Project senior advisor for the water quality and fish and fish habitat component of the MMG Izok Corridor Project. This project involves collection of additional baseline data and input to the draft environmental impact statement, as well as developing a fish habitat compensation plan for the project.

**Meliadine Gold Project Environmental Impact Statement**  
Nunavut, CANADA

Project Director responsible for oversight and planning of the preparation of a draft Environmental Impact Statement to be submitted to Nunavut Impact Review Board. Project undertaken for Agnico-Eagle Mines Ltd., who purchased the property from Comaplex Minerals Corporation.

**Phase I – Meliadine All-Weather Access Road Project Description and Environmental Assessment**  
Nunavut, CANADA

Project Director leading the preparation of an environmental assessment submitted to Nunavut Impact Review Board on behalf of Agnico-Eagle Mines Ltd. for pre-approval development of a single lane all-weather road for their advanced exploration project.

**Gahcho Kué Project**  
NWT, CANADA

Senior technical reviewer for the fish and fish habitat sections of an environmental impact statement (EIS) for a new diamond mine for DeBeers Canada in the Northwest Territories (NWT).



**NICO Project Baseline Study and EIS**  
Northwest Territories,  
CANADA

Project Director responsible for oversight and planning of continuing baseline studies and development of an environmental impact statement for the Fortune Minerals Ltd. gold/bismuth/cobalt mine in NWT.

**Meliadine West Gold Project Baseline Studies and EIS**  
Nunavut, CANADA

Project Director responsible for oversight and planning of continuing baseline studies and development of an environmental impact statement with a multi-disciplinary team for the Comaplex Minerals Corporation project north of Rankin Inlet, NU.

**Pre-Development Aquatic Studies: Izok Mining Project (Port Site)**  
Nunavut, CANADA

Aquatic sampling programs were conducted to collect baseline information from an initial Environmental Impact Assessment. Fisheries programs, habitat evaluations, water and sediment quality sampling, and bathymetry were undertaken at Izok Lake and on the Arctic coast (port site). Fish tissues and sediment samples were analyzed to determine background levels if heavy metals.

**Pre-Development Aquatic Studies: Meliadine West Project**  
Nunavut, CANADA

Baseline inventory study of fish populations and aquatic non-vertebrate communities in the area of Rankin Inlet, Nunavut. In addition, fish tissues and water quality samples were collected from selected waterbodies in the study area. An assessment was conducted of waterbodies and fish populations that may be impacted by the development. Radio transmitters were implanted in selected sportfish species (Arctic char, Arctic grayling and lake trout) to determine the extent of overwintering and spawning migrations.

**Ulu Project - Aquatic Studies Program**  
Nunavut, CANADA

A detailed survey of the aquatic biological community was undertaken as part of a baseline environmental study within the area of the ULU deposit, located approximately 155 km north of the Lupin gold mine. The purpose of the study was to provide accurate pre-development baseline data on the aquatic environment of waterbodies that may be impacted by mining activities. Aspects of the study included fish and fish habitat investigations, water quality and sediment collections.

**Fisheries Investigations at the Lupin Gold Mine**  
Contwoyto Lake, NT,  
CANADA

Environmental monitoring was conducted at the Lupin Mine site to determine if there had been any major changes in metal concentrations in fish tissue in the vicinity of the decant pathway.

**Hope Bay Fish Integrated Report**  
Hope Bay, NU, CANADA

Aquatic environmental baseline information area was consolidated and synthesized from previous projects within the Doris Hinge project area. The consolidated report is intended to be used in support of an environmental impact assessment and will form the basis for future monitoring programs.



**Hope Bay Aquatic Studies**  
Hope Bay, NU, CANADA

This project is designed to address data gaps in our current understanding of the aquatic habitat and fish populations in the study area. A brief field survey was conducted during spring to document Arctic grayling spawning locations and stream habitat conditions. During late summer and early fall, a fish fence will be installed in Roberts Creek to enumerate Arctic char migrants returning from the sea. Tissue samples will be collected from 60 fish to be analyzed for metal concentrations. In addition, sediment samples will be collected in Roberts Bay and Roberts Lake to determine the present concentrations of metals and organic contaminants. The collected data will be used in the preparation of an environmental impact assessment and will form a baseline for future monitoring activities.

**Miramar Hope Bay Project – Fisheries Compensation Program**  
Hope Bay, NU, CANADA

Involved development of a fisheries compensation plan, in consultation with DFO, to enhance fish production in the Doris North project area to replace lost fish production due to the mining development. The proposed compensation plan included facilitating access of Arctic char and other species to spawning and overwintering habitats in Roberts Lake, construction of rearing habitat in Doris Lake and Roberts Bay, and enhancement of a tributary to Roberts Lake to enhance Arctic char rearing habitat.

**Miramar Hope Bay Project – Input to EIS and Expert Witness Testimony**  
Hope Bay, NU, CANADA

Involved coordination and input of the biological components to the Miramar Doris North Project Final Environmental Impact Statement submitted to the Nunavut Impact Review Board. It also included appearing on behalf of the proponent as an expert witness at the NIRB regulatory hearings.

**PROJECT EXPERIENCE – TOTAL GAS PRESSURE (TGP) INVESTIGATIONS**

**Total Dissolved Gas Analysis at Boundary Dam**  
Washington State, USA,  
CANADA

The objective of the program was to evaluate total dissolved gas loadings from Boundary Dam on the Pend d'Oreille River downstream through the Canadian portion of the river, past the Seven Mile and Waneta hydro projects, to the Columbia River back at the Canada-USA border. An empirical model was developed to provide mass balance estimates of total dissolved gas contributed by Boundary Dam to the total loadings in the Columbia River at the border.

**Revelstoke Dam TGP Investigations**  
British Columbia,  
CANADA

Monitoring of TGP levels downstream of Revelstoke Dam during specific operations and reducing the confounding effects of rapidly changing operations.

**Williston and Peace Canyon Dams**  
British Columbia,  
CANADA

This project, conducted jointly with B.C. Hydro staff, involved a sampling program to collect total gas pressure data at two Peace River hydroelectric facilities. This was part of B.C. Hydro's ongoing program to monitor TGP production at their major facilities.

**TDG Monitoring at Brilliant and Waneta Dams**  
British Columbia,  
CANADA

This involved a monitoring program, initiated in conjunction with B.C. Hydro studies, to document TGP levels at the Brilliant and Waneta hydroelectric projects. The studies also involved conducting TGP monitoring during operation of selected spillway gates at these facilities to determine any differences in TGP production relating to their use.



**Surveys in the Columbia River Basin**  
British Columbia,  
CANADA

Investigations of the seasonal changes in TGP production associated with both Mica and Revelstoke dams, Keenleyside Forebay, Robson, Birchbank, Seven Mile Dam, Waneta Dam, Duncan Dam, Kootenay Canal Plant, and Kootenay River (above Kootenay Lake) in relation to various seasonal and operational parameters.

**Input of Fisheries Information for the Columbia River**  
British Columbia,  
CANADA

Fisheries habitat and use information for the Columbia River was provided for use and input into the “Columbia Total Gas Pressure and Fisheries Analyses Computer Model” developed by Aspen Applied Sciences Ltd. This model is useful for predicting TGP levels associated with specific dam operations and flows, and identifies potential problems relating to impacted fish habitats located downstream of the dams.

**TDG Sampling Protocol and Equipment Review**  
British Columbia,  
CANADA

Establishment of sampling protocol and appropriate electronic sampling equipment used to gather information on total gas pressure (TGP) and temperature parameters.

**TDG Survey in the Columbia River Basin**  
British Columbia,  
CANADA

A survey along the Columbia, Kootenay and Pend d’Oreille rivers was undertaken during the summer of 1993 to document the dissolved gas and temperatures differences along the drainages and to identify potential factors that may cause these fluctuations.

**Keenleyside Dam (TGP) Reduction Study**  
British Columbia,  
CANADA

Total gas pressure monitoring was conducted at three locations (Keenleyside forebay, Robson, and Birchbank) during 1993 and 1994 to provide data input to an interdisciplinary study including R.L. & L. Environmental Services Ltd., Klohn-Crippen Integ, Aspen Applied Sciences Ltd., and B.C. Hydro. This study resulted in changes being implemented to the operating orders for Keenleyside Dam, thus helping to reduce downstream dissolved gas concentrations during some periods of the year.

**PROJECT EXPERIENCE – HYDROACOUSTIC ASSESSMENTS**

**Aquatic Assessment of Barge Route Options for the Mackenzie Gas Project**  
Nunavut, CANADA

Hydroacoustic data were collected during 2004 as part of the Barge Route Options of the Mackenzie Gas Project. A BioSonics Inc. Model DT-X scientific hydroacoustic echosounder was used to identify fish targets, conduct bathymetric surveys and undertake bottom substrate surveys at various locations within the Mackenzie River Delta. Bathymetric and substrate surveys were conducted to aid in determining the barge route and determining the extent of dredging, if required. Fish sampling was conducted using conventional, passive sampling methods (i.e., gill netting) and active sampling methods (i.e., hydroacoustics). Using an active sampling method, such as the BioSonics echosounder, allowed for a greater sampling area with considerably less sampling effort. The BioSonics unit recorded the geo-referenced location of each fish target and the target strength, which can be converted to the size of the fish target. Thus for each study site, estimates of fish density (fish/m2) were calculated, as well as the size distribution of fish encountered.



**Bathymetric  
Assessment of  
Forestburg Reservoir**  
Alberta, CANADA

A BioSonics DT-X scientific hydroacoustic system was use to measure bathymetry in a thermal power plant cooling reservoir in central Alberta. The reservoir was surveyed using a GPS navigations system to follow a 50 m x 50 m grid pattern. The reservoir had extensive growths of macrophytes, which provided challenges in detecting the bottom for bathymetric calculations.

**Doris North Gold  
Project Fisheries  
Baseline Surveys**  
Nunavut, CANADA

A BioSonics DT-X scientific hydroacoustic system was used to provide baseline information on bathymetry, substrate composition, and fish distribution and densities in three lakes in the vicinity of the proposed Doris North Gold Project, located approximately 150 km south of Cambridge Bay, Nunavut. Species of fish present in the waterbodies included Arctic charr, lake trout (charr), lake whitefish, cisco, least cisco, and ninespine stickleback.

**Assessment of Fish  
Entrainment at  
Keenleyside Dam**  
British Columbia,  
CANADA

A BioSonics Model 101 scientific hydroacoustic system with a single beam transducer was used to assess fish entrainment on a seasonal basis at the Hugh Keenleyside Dam near Castlegar, BC. The fixed aspect survey was conducted both during day and night to assess diel differences in fish entrainment rates. Ground truthing of fish species composition and sizes was conducted using gill nets and drift nets set in the forebay above the dam.

**PROJECT EXPERIENCE – OIL & GAS**

**Imperial Oil Cold Lake  
Expansion Project**  
Cold Lake, AB, CANADA

Aquatic studies of the fish community, fish habitat, lower trophic levels, and water quality for completion of the environmental impact assessment for Imperial Oil Resource Ltd.'s Mahihkan North and Nabiye developments near Cold Lake, Alberta. The development used Cyclic Steam Stimulation (CSS) technology to recover bitumen from deep formations.

**AEC Bitumen  
Production Project, Air  
Weapons Range:  
Baseline Studies - Fish  
and Aquatic Habitat  
Component**  
Cold Lake, AB, CANADA

Alberta Energy Company (AEC) plans to develop a commercial scale bitumen production project from its Oil Sands Development Leases located in the Cold Lake Air Weapons Range. As a result, a baseline inventory of the aquatic biota in the vicinity of the project area was undertaken. The objectives of the 1997 baseline studies program was to inventory fish populations and aquatic habitats in waterbodies in the vicinity and immediately downstream of the development area and assess the importance of these waterbodies to these fish populations.

**Mackenzie Valley  
Producers Gas  
Pipeline**  
Northwest Territories  
and Alberta, CANADA

Co-manager of the aquatics component of the Mackenzie Gas Project. Initial reconnaissance surveys followed by detailed baseline assessments were conducted to evaluate fish resources along the proposed pipeline route. Results of the initial findings from spring, summer and fall were presented in a report and will be followed by a comprehensive EIA in the up-coming year. This project involves the development of the natural gas reserves in the Mackenzie River Delta and construction of a pipeline from the new production field down the Mackenzie River valley to Alberta.



## PROFESSIONAL AFFILIATIONS

American Fisheries Society  
Alberta Society of Professional Biologists  
Canadian Society of Environmental Biologists

## PUBLICATIONS

### Other

Limnotek, Golder, and ESSA. (Project Director and contributing author). 2012. Aquatic productivity in reservoir and riverine reaches of the upper Peace River - May 2010 to July 2011. Interim Report prepared by Limnotek Research and Development Inc., Golder Associates Ltd., and ESSA Technologies Ltd. for BC Hydro. Vancouver BC. Golder Report No. 10-1373 0028-3000-Interim.  
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**Education**

*B.A.Sc. Environmental (Chemical) Engineering, University of Waterloo, Waterloo, Ontario, Canada, 2002*

**Languages**

*English – Fluent*

*Chinese (Mandarin) – Fluent*

**Calgary**

**Component Lead and Discipline Coordinator, Air Quality and Climate**

Mr. Chang is an air quality scientist in the Golder Calgary office with over 10 years of industry and consulting-related experience. He has a range of experience in air quality assessment, emissions inventory, dispersion modelling and regulatory reporting.

In the past ten years, Dennis has been managing and participating in various air quality assessment projects, including many large-scale environmental impact assessments for oil sands, mining and power projects.

Prior to joining Golder, Dennis worked for Environment Canada, Vancouver International Airport Authority, Greater Toronto Airports Authority and in the petrochemical industry. His past experience includes regulatory permit application, emissions inventory development, hazardous waste management, and regulatory compliance review.

**Employment History**

**Golder Associates Ltd. – Calgary, Alberta**

*Air Quality Scientist (2002 to Present)*

Air quality discipline lead for multi-disciplinary environmental impact assessments for oil sands, mining and other industries in Canada and internationally. Responsibilities include managing air quality assessments, developing emission inventories, conducting dispersion modelling and providing regulatory consultation for various projects.

**Golder Associates – Burnaby, British Columbia**

*Air Quality Scientist (2002)*

Air quality scientist working on numerous large Environmental Impact Assessments, gas well flaring studies and ambient air quality monitoring projects. Responsibilities included atmospheric dispersion modelling, emission calculations, environmental monitoring data analysis and technical report preparation.

**Vancouver International Airport Authority – Richmond, British Columbia**

*Environmental Assistant (Co-operative Work Term) (2001)*

Implemented and enhanced hazardous waste management programs. Evaluated contract proposals. Provided support on water quality, aircraft de-icing and air quality programs.

**W.C. Wood Company Ltd. – Guelph, Ontario**

*Environmental Coordinator (Co-operative Work Term) (2000)*

Responsible for obtaining emissions permits for two manufacturing facilities.



Conducted indoor air quality studies. Collected ambient air quality samples for analysis.

***NOVA Chemicals (Canada) Ltd. – Corunna, Ontario***

*Environmental Specialist (Co-operative Work Term) (2000)*

Prepared plant emissions inventory reports. Conducted a feasibility study of plant-wide NOX emissions reduction strategies.

***Environment Canada – Ottawa, Ontario***

*Organic Lab Technician (Co-operative Work Term) (1998)*

Analyzed PAH samples for National Air Pollution Surveillance Network (NAPS). Performed extraction of PCB and dioxin from soil and effluent samples.

***Greater Toronto Airports Authority – Toronto, Ontario***

*Project Engineer Assistant (Co-operative Work Term) (1998)*

Co-ordinated Terminal 2 Asbestos Removal Project. Provided support in budgeting for various terminal renovation projects.



**PROJECT EXPERIENCE – AIR QUALITY**

**Cenovus Pelican Lake  
Grand Rapids Project  
EIA**  
Pelican Lake, Alberta,  
Canada

Golder was retained by Cenovus Energy Inc. to prepare an Environmental Impact Assessment for the commercial expansion of an in-situ oil sands project. The assessment was completed using CALPUFF dispersion model. Responsibilities include emission inventory development, dispersion modelling and report writing.

**Cenovus Narrows Lake  
Project EIA**  
Narrows Lake, Alberta,  
Canada

Golder was retained by Cenovus FCCL Ltd. to complete an Environmental Impact Assessment for an in-situ oil sands project. Responsibilities include emission inventory development, dispersion modelling, report writing and regulatory consultation.

**EnCana Corp. Foster  
Creek Project Phase  
1D/ 1E Expansion**  
Cold Lake Weapons  
Range, Alberta, Canada

Golder was retained by EnCana to assist in an approval amendment associated with the Phase 1D/ 1E expansion at the Foster Creek commercial plant heavy oil thermal recovery. The Foster Creek Steam-Assisted Gravity Drainage (SAGD) Project was the first commercial plant of its kind in the world. Golder's work included completing the air quality assessment and noise assessment required as part of the approval amendment applications to Alberta Environment and the Alberta Energy and Utility Board. The air quality assessment involved calculating facility emissions and predicting the air quality changes using the CALPUFF dispersion model. Air quality Assessment Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**EnCana Corp.  
Christina Lake  
Amendment Phase 1C/  
1D**  
Christina Lake, Alberta,  
Canada

Golder assisted EnCana with approval amendments associated with proposed development changes at the Christina Lake Thermal Project, Phases 1C/ 1D. The amendments required air assessment, including dispersion modelling and a noise assessment to meet Alberta Energy Utility Board requirements. Air Quality Assessment Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**EnCana Corporation  
EnCana Consequence  
Modelling**  
Foster Creek, Alberta,  
Canada

As part of the Phase 1E expansion engineering design process, FCCL was considering the potential for flammable vapours to be released from selected tanks at the facility. FCCL retained Golder to determine the extent to which these flammable vapours may be dispersed towards various ignition sources located in the vicinity of the tanks. Hazard modelling was used to predict concentrations of the flammable vapours at these potential ignition sources. Responsibilities included air dispersion modelling.

**MEG Surmont Project  
EIA**  
Janvier, Alberta, Canada

Golder was retained by MEG Energy Corp. to conduct an air quality assessment for an Environmental Impact Assessment of an in-situ oil sands project. The assessment was completed using CALPUFF dispersion model. Responsibilities include management of air quality component, emission inventory development, dispersion modelling, report writing and stakeholder consultation.



**MEG Christina Lake  
Regional Project Phase  
2B Amendment**  
Christina Lake, Alberta,  
Canada

Golder retained by MEG Energy Corp. to conduct air quality assessment in support of a regulatory amendment application for an in-situ oil sands project. Responsibilities include project management, emission inventory development, dispersion modelling, report writing and regulatory consultation.

**De Beers Gahcho Kué  
Project EIS**  
Kennady Lake,  
Northwest Territories,  
Canada

Golder was retained by De Beers Canada Inc. to conduct an Environmental Impact Statement for an open pit diamond mine in northern Canada. The air quality assessment was completed using CALPUFF dispersion model. Responsibilities include management of air quality component, emission inventory development, dispersion modelling, report writing, regulatory consultation and management plans development.

**Project Mina de Cobre**  
Panama

Golder was retained to complete an Environmental Impact Assessment for a copper-molybdenum mine and associated infrastructure, including a coal-fired power plant, transmission line, roads, a pipeline and a marine port facility. The assessment was performed to meet the requirements of the Canadian Environmental Assessment Act. Responsibilities include management of air quality component, emission inventory development, dispersion modelling and report writing.

**Suncor Energy Inc.  
Millennium Coker Unit  
Assessment**  
Fort McMurray, Alberta,  
Canada

Golder was retained by Suncor Energy Inc. to aid in the preparation of the application for construction and operation of the Millennium Coker Unit (MCU) Project. The air quality component of this application involved the quantification of SO<sub>2</sub> and NO<sub>x</sub> emissions from the proposed Project. A dispersion modelling assessment of SO<sub>2</sub> emissions was performed using the CALPUFF model run in dynamic (3-D) mode. The assessment considered normal operations and two flaring scenarios. Results of the assessment were discussed in comparison with air quality criteria and in terms of likelihood of occurrence. Specific responsibilities included technical support and report preparation.

**Suncor Energy Inc.  
Firebag SAGD  
Compliance**  
Fort McMurray, Alberta,  
Canada

Golder Associates was retained by Suncor Energy Inc. to provide an ambient air quality monitoring plan for the Firebag Steam Assisted Gravity Drainage (SAGD) Project. The monitoring plan involved evaluating potential sites passive monitoring stations based on maximum ground level concentrations predicted by dispersion modelling. Responsibilities included technical support and report preparation.

**Miramar Mining  
Corporation Doris  
North Gold Project EIS**  
Bathurst Inlet, Nunavut,  
Canada

Golder Associates prepared an air quality and noise assessment for the Miramar Doris North Gold Project located near Bathurst Inlet, Nunavut. The assessment was prepared to support the Environmental Impact Study for submission to the Nunavut Impact Review Board. Responsibilities included dispersion modelling and report preparation.

**Paramount Resources  
Ltd. Cameron Hills  
Extension Project**  
Fort Liard, Northwest  
Territories, Canada

The Cameron Hills project is an oil and gas development that straddles the Alberta/ NWT border. Golder Associates was retained to complete the Developer Assessment Report (DAR) for the project. The DAR included the assessment of additional gas wells and potential future development. The air quality assessment included the preparation of a facility emissions inventory and the completion of refined dispersion modelling to determine ground-level concentrations of specific criteria compounds. Responsibilities included dispersion modelling and report preparation.



**Nimbus Projects Ltd.**  
Stettler, Alberta, Canada

Nimbus Projects, acting on behalf of Tiverton Petroleum, retained Golder Associates to assess ambient SO<sub>2</sub> concentrations resulting from the expansion of an oil battery located northeast of Stettler, AB. The air quality assessment was prepared to support an approval application. Responsibilities included emission calculation, ISC3 dispersion modelling and report preparation.

**Saputo Inc. Air Quality Assessment of the Armstrong Cheese Facility**  
Glenwood, Alberta, Canada

Golder Associates was retained by Saputo Inc. to conduct an air quality assessment of the Armstrong Cheese Facility. This assessment was completed to support the Alberta Environment (AENV) Industrial Approval Application for the facility. The assessment included an evaluation of predicted ground-level concentrations of nitrogen dioxide and particulate matter in the vicinity of the site. Responsibilities included emission calculation, dispersion modelling and report preparation.

**Quesnel Waste Incinerator**  
Quesnel, British Columbia, Canada

Golder was retained to conduct an air quality assessment of Particulate Matter (PM) from a proposed wood waste incinerator in the town of Quesnel, B.C., as part of a Phase II assessment. The PM emissions were modelled with a regional set of emissions and 3-D CALMET data set. Responsibilities included emission calculation and dispersion modelling support.

**Greater Vancouver Regional District Ashcroft Ranch Landfill EIA**  
Ashcroft Ranch, British Columbia, Canada

Golder was retained by the Greater Vancouver Regional District to provide technical support for the development of the proposed Ashcroft Ranch Landfill. The support included site design engineering and an environmental impact assessment including a comprehensive air quality and noise assessment. The air assessment included a climate and meteorological data summary, reporting of air monitoring data, assessment of criteria air pollutants, dustfall and odour assessment, as well as green house gas emission estimates. The noise assessment included a field baseline survey and model predictions of continuous and impulsive noise sources. Specific responsibilities included dispersion modelling using the CALPUFF model and report preparation.

**Paramount Resources Ltd. Sunset Battery**  
Alberta, Canada, Canada

Golder was retained by Paramount Resources Ltd. to complete an air quality assessment of the Sunset Battery. As part of this assessment Golder calculated the emissions of SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub> and ECO<sub>2</sub> from the on-site combustion sources and completed dispersion modelling of the SO<sub>2</sub> and NO<sub>x</sub> emissions. Responsibilities included emission calculation, ISC3 dispersion modelling and report preparation.

**Cargill Ltd. National Pollutant Release Inventory**  
High River, Alberta, Canada

Completed National Pollutant Release Inventory reporting for a rendering plant in High River, Alberta.

**Saskatchewan Highways and Transportation Highway Twinning Project**  
Hwy 16, Southeastern Saskatchewan, Canada

Golder was responsible for the completion of the Canadian Environmental Assessment Act Screening Report for a twinning project on a section of Highway No. 16 in Saskatchewan. The air quality component of this project included a qualitative assessment of the air and noise emissions from current and future traffic levels as well as during the construction phase. Responsibilities included vehicle emission estimation using MOBILE5C modelling software and report preparation.



**Saskatchewan  
Highways and  
Transportation  
Highway Twinning  
Project**

Wolsley, Saskatchewan,  
Canada

Golder was responsible for the completion of the Canadian Environmental Assessment Act Screening Report for the Trans Canada East Twinning Project. The project included the twinning of a 132 km section of roadway between Wolsley Saskatchewan and the Manitoba border. The air quality component of this project included a qualitative assessment of the current and future air emissions and noise from traffic as well as the air emissions and noise from the construction phase. Responsibilities included vehicle emission estimation using MOBILE5C model and report preparation.

**Anadarko Canada  
Corporation Well Test  
Flaring Assessment**

Fort Liard, Northwest  
Territories, Canada

Conducted a well-test flaring assessment of the P-16 well near Ft. Liard, NWT. The project involved the estimation of emissions from the well during the testing period and a dispersion modelling assessment to determine the resulting ground-level SO<sub>2</sub> concentrations. The well was located in complex terrain and the dispersion modelling was completed using the ISC3 model. As a result of the dispersion modelling results, a management plan was developed to determine the optimal conditions and timeframe within which the well test could proceed with minimal environmental impacts. Responsibilities included dispersion modelling and management plan development.

**Pangea Minerals  
Tuluwaka Gold Mine  
EIA**

Tanzania

Conducted an air quality assessment to estimate the ambient air concentrations of criteria air compounds resulting from the operation of the Tuluwaka Gold Project in Tanzania, Africa. Responsibilities included CALPUFF dispersion modelling and report preparation.

**Cogema Resources  
Inc. Monitoring Data  
Review and Analysis**

McLean Lake,  
Saskatchewan, Canada

Golder Associates was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the Cogema McLean uranium mine. Responsibilities included data evaluation and report preparation.

**EnCana Corp.  
Christina Lake Project  
Debottlenecking and  
Expansion**

Christina Lake, Alberta,  
Canada

Golder was retained by EnCana to assist in approval amendments associated with the Phase 1B Debottlenecking and Expansion at the Christina Lake Thermal Project. The Christina Lake Thermal Project is a SAGD project located in Alberta's Athabasca oil sands region. The work included completing the air quality and noise assessments, required as part of the approval amendment applications to Alberta Environment and the Alberta Energy and Utilities Board (EUB). The air quality assessment included establishing an air emission profile for the project, as well as determining the air quality impacts using the CALPUFF dispersion model. Air Quality Assessment Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**Syncrude Canada Ltd.  
Modelling Assessment  
of FGD Options**

Fort McMurray, Alberta,  
Canada

As part of the ongoing modifications and design considerations at the Syncrude Mildred Lake facility, Golder Associates was retained to provide an assessment of the Syncrude Emissions Reduction Project. This assessment involved modelling a variety of emission scenarios to determine the benefits associated with the installation of a Flue Gas Desulphurization (FGD) unit. Specific responsibilities included dispersion modelling and report preparation.



**Paramount Resources Ltd. Oil Well Battery Dispersion Modelling Assessment**  
Northwestern Alberta,  
Canada, Canada

Paramount Resources Ltd. (Paramount) is proposing to install a single well oil battery at the Valhalla 4-20 site, in Northwestern Alberta. The combustion equipment to be installed at this site would consist of a flare and a Waukesha engine to run the pumpjack. For this site Golder calculated the overall site emissions for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, and ECO<sub>2</sub>, completed dispersion modelling for the SO<sub>2</sub> emissions and conducted a screening level dispersion modelling study to assess the ambient H<sub>2</sub>S concentrations for two venting scenarios at the proposed 4-20 Oil Well Battery. Responsibilities included ISC3 dispersion modelling and report preparation.

**Lehigh Inland Cement Limited Substitution Fuel Project, Appeal Board Hearings**  
Edmonton, Alberta,  
Canada

Golder was retained by the proponent to provide expert witness testimony in the Environmental Appeals Board hearing of the Lehigh Inland Cement substitution fuel project approval. The work included the completion of supplementary responses and hearing preparation for the air quality component of the hearing. Specific responsibilities included hearing preparation and technical support.

**Cimarron Engineering Ltd. Well Test Flaring Assessment**  
Fort Liard, Northwest  
Territories, Canada

Performed an air quality assessment for a proposed well test and subsequent facility operations of the P-66B gas well. Facility emissions were quantified and dispersion modelling was conducted using the Industrial Source Complex (ISC3) model. Air quality predictions were compared to vegetation effects levels and ambient air quality guidelines. A flare management plan was also developed. Responsibilities included ISC3 dispersion modelling and flare management plan development.

**Paramount Resources Ltd. Air Quality Assessment**  
Cameron Hills,  
Northwest Territories,  
Canada

Conducted a modelling assessment of proposed changes to equipment at the Cameron Hills facility. This work part of ongoing support to Paramount for an EIA that was submitted to NWT regulator in 2001. Responsibilities included ISC3 dispersion modelling and report preparation.

**Weyerhaeuser Canada Limited Environmental Monitoring Program Review**  
Prince Albert,  
Saskatchewan, Canada

Conducted a review of air quality and meteorological monitoring data collected over a 10 year period at the Prince Albert pulp and paper facility. The review objective was to identify parameters that could be monitored less frequently or be eliminated from the program completely. Responsibilities include monitoring data analysis and report preparation.

**W.C. Wood Company Ltd. Comprehensive Certificate of Approval (Air) Application**  
Guelph, Ontario, Canada

Co-ordinated an emissions permit application project for two freezer manufacturing plants and one humidifier/ de-humidifier manufacturing plant. Responsibilities included project management, regulatory review, regulatory liaison, emission calculations, environmental compliance history review, and application preparation.

**NOVA Chemicals (Canada) Ltd. National Pollution Release Inventory (NPRI) Reporting**  
Corunna, Ontario,  
Canada

Participated in the 1999 NPRI reporting for NOVA Chemical's refinery and petrochemical complex. The complex supplies 30% to 40% of Canada's total requirement for primary petrochemicals. Responsibilities included project management, emission calculations, and report preparation.



**AMEC Earth and  
Environmental Limited  
Mackenzie Gas  
Pipeline EIA**  
Northwest Territories,  
Canada

As part of a consulting consortium, Golder was responsible for the completion of the air quality components of the Environmental Impact Assessment (EIA). The air quality assessment evaluated air pollutant concentrations and acid deposition resulting from cumulative emission sources across the length of the proposed pipeline, from the Mackenzie Delta in the north to Zama, Alberta in the south. Air quality predictions were made using the CALPUFF dispersion model (2-D mode). This project also included participation in the regulatory review and public hearings. Emission and Modelling Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis, hearing preparation and report preparation.

**Imperial Oil Ltd. Kearl  
Oil Sands Project**  
Fort McMurray, Alberta,  
Canada

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) of the Kearl oil sands mine for Imperial Oil. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological dataset. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan to the Cold Lake area. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsibilities included emission calculations, air dispersion modelling and data analysis.

**CEMA/ TMAC Fort  
McKay Exposures**  
Fort McKay, Alberta,  
Canada

Golder was retained by the Trace Metal and Air Contaminant (TMAC) Working Group of the Cumulative Effects Environmental Management Association (CEMA) to perform a review of a previous air dispersion modelling assessment that determined potential exposures for Fort McKay. The review included further assessment of the modelling and monitoring data. Responsibilities included data analysis.

**Syncrude Canada Ltd.  
Modelling 14-2**  
Fort McMurray, Alberta,  
Canada

Golder was retained by Syncrude to conduct a dispersion modelling assessment of sulphur dioxide (SO<sub>2</sub>) and nitrogen dioxide (NO<sub>2</sub>) emitted from a diesel production facility (14-2) using the CALPUFF model (3D-mode). The assessment was completed to support an Amendment Application for the Syncrude Emissions Reduction (SER) Project. Responsibilities included air dispersion modelling.

**Suncor Energy Inc.  
Firebag Co-Gen  
Assessment**  
Fort McMurray, Alberta,  
Canada

Suncor Energy developed amendment applications for two proposed stages at the Firebag SAGD Project. Golder was retained to assist the applications, preparing air and noise assessments for both the Stage C&E and Stage 3 applications. Responsible for air dispersion modelling.

**Suncor Energy Inc.  
Voyageur Project EIA**  
Fort McMurray, Alberta,  
Canada

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) for the Suncor Voyageur Project. The air quality sections of the EIA evaluated cumulative air pollutant concentrations and acid deposition across the Oil Sands Region, using the CALPUFF dispersion model (3-D mode). The EIA made use of Golder's regional emissions database and 3-D meteorological data set, which cover the area from Fort Chipewyan to the Cold Lake area. Responsibilities included emission calculations, air dispersion modelling and data analysis.



**Shell Canada Muskeg River Mine Expansion Project**  
Fort McMurray, Alberta, Canada

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) for the Muskeg River Mine Expansion Project for Shell Canada Limited. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological dataset. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan to the Cold Lake area. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsibilities included emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**Canadian Natural Resources Ltd. CNRL Primrose East Oil Sands Project**  
Cold Lake, Alberta, Canada

Golder was retained to prepare an Environmental Impact Assessment (EIA) for the Canadian Natural Primrose East Oil Sands Project. This Steam-Assisted Gravity Drainage (SAGD) project is an expansion of the existing Canadian Natural Primrose and Wolf Lake facilities. Air quality and noise assessments were completed as part of the EIA. Responsibilities included emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**OPTI/ Nexen Long Lake Project EIA and Update**  
Anzac, Alberta, Canada

Golder was responsible for the preparation of the Environmental Impact Assessment (EIA), the subsequent project update and additional amendments for the Long Lake Project, which included an integrated Steam-Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project update made use of the Golder regional emissions database and 3-D meteorological data set. Responsibilities included project coordination, emission calculations, air dispersion modelling, data analysis and report preparation.

**Varco International Inc. Tuboscope Nisku Plant NPRI Reporting**  
Nisku, Alberta, Canada

Golder was retained to complete the 2004 National Pollutant Release Inventory (NPRI) reporting for Tuboscope's pipe coating plant in Nisku, Alberta. Project Manager responsible for emission calculations, QA/ QC, data analysis and report preparation.

**Plains Marketing Joarcam Truck Terminal**  
Joarcam, Alberta, Canada

Plains Marketing applied to construct a truck terminal facility located on a five hectare site in Central Alberta. The facility is required to provide a collection point for locally produced crude oil for shipment through the Joarcam Pipeline system to markets in Edmonton and elsewhere. Golder was retained to provide technical input to Plains Marketing for the EUB permit. As part of this, a Noise Impact Assessment (NIA) and an air quality assessment were completed. Responsibilities included emission calculations and QA/ QC.

**Syncrude Canada Ltd. Syncrude Assessment**  
Fort McMurray, Alberta, Canada

Golder was retained by Syncrude to complete a dispersion modelling assessment of hydrogen sulphide and ammonia releases during an emergency at the Mildred Lake Upgrader complex. Responsible for QA/ QC.



**Enbridge Inc. Stonefell Terminal**  
Strathcona County,  
Alberta, Canada

Enbridge was developing the Stonefell Terminal to provide terminal and pipeline services to BA Energy's Heartland Upgrader, which is also under development in the Heartland Industrial Area in Strathcona County near Fort Saskatchewan. This project consisted of a noise impact assessment and an air quality assessment for the AEUB application. Responsible for emission calculations.

**Suncor Energy Inc. Firebag Odour Assessment**  
Fort McMurray, Alberta,  
Canada

Suncor requested Golder assistance with the identification and control of odour issues at the Firebag Facility. Golder performed preliminary monitoring at the Firebag site to identify potential sources of odour and helped to address this issue. Ongoing work has led to Golder being asked to develop an on-site fugitive emissions inventory. Responsibilities included data analysis.

**Golder Associates Ltd. Emissions Database**  
Calgary, Alberta,  
Canada

Golder developed an air emissions database containing emission sources from north-eastern Alberta. The data includes hundreds of sources and covers general air quality and health assessment related compounds. This database is used for environmental assessments for the projects in the Oil Sands Region. Project Manager responsible for emission calculations and QA/ QC.

**Federated Cooperative Ltd. Refinery Expansion**  
Regina, Saskatchewan,  
Canada

Federated Cooperative Ltd. retained Golder to conduct an air quality assessment of its refinery outside of Regina, Saskatchewan in support of a regulatory application for expansion. The refinery is operated by a subsidiary company called Consumers' Cooperative Refineries Ltd (CCRL) and presently processes approximately 90,000 barrels of crude per day. Project Manager responsible for report preparation, air dispersion modelling, emission calculations, QA/ QC and senior review of emissions.

**Nexen Long Lake Project**  
Long Lake, Alberta,  
Canada

Nexen retained Golder to conduct an air quality assessment of the cogeneration units at Long Lake Phase 1 project. During the cogen start-up period, which was expected to last for three months, the units were expected to be run near their maximum load without any steam injection for NOX control. Nexen wanted to know if the higher NOX emission rates would result in non-compliance of the Alberta Ambient Air Quality Objectives. Project Manager and Emission Coordinator responsible for air dispersion modelling, emission calculations and report preparation.

**Canadian Natural Resources Ltd. CNRL Kirby Project**  
Cold Lake, Alberta,  
Canada

Golder was retained by Canadian Natural Resources to provide an update to baseline data and conduct an Environmental Impact Assessment (EIA) for the Kirby Steam-Assisted Gravity Drainage (SAGD) project. Due to the proposed changes to the project, an updated air quality assessment was prepared in support of the updated EIA. In addition, a noise impact assessment was added to the EIA. Emission Coordinator responsible for emission calculations, QA/ QC, Senior Review and report preparation.

**OPTI Canada Inc. Long Lake H2S Modelling**  
Anzac, Alberta, Canada

Golder provided air quality emissions and modelling support to OPTI Canada for various design modifications at the Long Lake SAGD Upgrading complex. Responsibilities included emission calculations.



**Canadian Natural Resources Ltd. CNRL Primrose East Follow-up**  
Cold Lake, Alberta, Canada

Golder prepared an Environmental Impact Assessment (EIA) for the Canadian Natural Primrose East Oil Sands Project. The project is an expansion of the existing Canadian Natural Primrose and Wolf Lake development. Golder provided on-going support to regulator and stake holder inquiries. Responsibilities included emission calculations.

**Shell Canada Energy Athabasca Oil Sands Project EIA**  
Fort McMurray, Alberta, Canada

Shell Canada is expanding their Athabasca Oil Sands Project in four phases. Each expansion will include new mining areas and produce 90,000 bbl/d of bitumen per expansion. Expansions 2 and 3 are expansions of Jackpine Mine. Expansions 4 and 5 are a separate project located north of Muskeg River Mine. Golder was retained to prepare the Environmental Impact Assessment (EIA) for all expansions as well as AENV and ERCB application documents. Emission Coordinator responsible for report preparation, emission calculations, QA/ QC and senior review of emissions.

**Regional Issues Working Group (RIWG) NOX BATEA Assessment**  
Fort McMurray Region, Alberta, Canada

AENV is currently undertaking a process to review the BATEA technologies for NOX emissions from stationary sources in the region North of Fort McMurray. The Golder Air Team was retained by RIWG to assess the effects of different NOX control technologies on ground level NOX and PAI predictions. Responsibilities included emission calculations.

**Suncor Energy Inc. Firebag 1 to 4 SRU Redesign Project**

Golder was retained to perform an air quality in support of an engineering study for the Firebag Stages 1 to 4 sulphur recovery unit (SRU). This involved emissions determination and modelling of normal operations and upset conditions. Responsibilities included emission calculations, QA/ QC and senior review of emissions.

**Canexus Chemicals Canada Limited Partnership Chlor-Alkali Plant Transportation Emissions Inventory**  
Vancouver, British Columbia, Canada

Golder was retained to prepare transportation emission inventories for the Canexus Chlor-Alkali Plant Technology Conversion Project, located on the Burrard Inlet in Vancouver. This involved two emission inventories, a current operation emission inventory and post conversion emission inventory. This report was a supplement to the emissions information already provided to the Vancouver Port Authority. Responsibilities included emission calculations and report preparation.

**Advantage Oil and Gas Ltd. Sweetgrass Assessment**  
Sweetgrass, Alberta, Canada

Advantage Oil and Gas retained Golder to provide air dispersion modelling predictions of ground-level sulphur dioxide (SO2) concentrations from the proposed operation of the Sweetgrass sour gas facility flare. The modelling was requested to provide information to interested stakeholders during the application process. Emission and Modelling Coordinator responsible for QA/ QC and data analysis.

**Anadarko Canada Corp. East Liard Gas Gathering System**  
Deh Cho Region, Northwest Territories, Canada

Anadarko proposed to build a pipeline to link the existing Chevron K-29 well site with the existing Anadarko A-68 well site, north of Fort Liard, Deh Cho Region, NWT. Golder completed both the air quality and noise assessment for the dehydration and compression facility at the start of the pipeline, and the compressor station situated along the pipeline. Responsibilities included emission calculations, air dispersion modelling and data analysis.



**TransAlta Utilities Corp. Keephills Approval Renewal**  
Wabamun Lake, Alberta, Canada

Golder was retained by TransAlta Utilities Corp. to prepare an Environmental Enhancement and Protection Act (EPEA) renewal application for the Keephills Generating Station. The air component included a review of all air quality monitoring and pollution control equipment at the facility in support of the renewal application. Assistance in developing the project description was also provided. Responsibilities included QA/ QC.

**Fossil Water Catalyst Facility Air Assessment**  
Fort Saskatchewan, Alberta, Canada

Fossil Water proposed a catalyst recycling facility near Fort Saskatchewan, Alberta. Golder was retained to provide an assessment of air quality and to assist with various application components. Responsibilities included emission calculations, air dispersion modelling, data analysis and report preparation.

**Varco International Inc. Tuboscope Coating Plant NPRI**  
Nisku, Alberta, Canada

Golder was retained by Varco to complete the 2005 National Pollutant Release Inventory (NPRI) reporting for the Tuboscope Nisku coating plant near Edmonton. Project Manager responsible for emission calculations and report preparation.

**Riverside Forest Products Ltd. National Pollutant Release Inventory**  
Various Locations, British Columbia, Canada

Completed 2002 and 2003 National Pollutant Release Inventory reporting for five wood processing facilities throughout British Columbia.

**Riverside Forest Products Ltd. Air Permit Amendment**  
Armstrong, British Columbia, Canada

Golder was retained by Riverside Forest Products Ltd. to complete an air quality assessment for the addition of a new veneer dryer at the Armstrong veneer/ plywood plant. The work included the preparation of a facility emission inventory and dispersion modelling using the SCREEN3 dispersion model. Project Manager responsible for emission calculations, air dispersion modelling, data analysis and report preparation.



**TRAINING**

**CALPUFF Training Course**

*Earth Tech Inc., 2004*

**Greenhouse Gas Verification Using ISO 14064**

*Canadian Standards Association, 2011*

**Verifying Greenhouse Gas Intensity Baselines**

*Canadian Standards Association, 2007*

**Communication**

*Golder U, 2011*

**Health & Safety Module 2**

*Golder U, 2006*

**Health & Safety Module 1**

*Golder U, 2006*

**Project Management**

*Golder U, 2005*

**Technical Writing**

*Golder U, 2004*



- Education:** Ph.D., Benthic Ecology, University of Victoria, Victoria, BC, 1979  
M.Sc., Biological Oceanography, 1976  
B.Sc., Marine Biology, 1974
- Affiliations:** Member, American Water Works Association  
Member, North American Benthological Society  
Member, American Society for Testing and Materials  
Charter Member, Estuarine Research Federation  
Member, Society of Environmental Toxicology and Chemistry (SETAC)  
Member, Water Environment Federation
- Awards:** Founders Award, Society of Environmental Toxicology and Chemistry, 2001  
USEPA Region 10 award - resolving environmental issues, Port Valdez, Alaska, 1996
- Languages:** English and Spanish fluent; Portuguese, Italian and German - reading ability
- Publications:** Over 220 journal articles and book chapters, 3 edited books  
Over 400 technical reports  
Over 300 presentations at meetings
- Experience:**
- |                |  |                            |
|----------------|--|----------------------------|
| 2004 – Present | <b>Golder Associates Ltd.</b>  | <b>Burnaby, BC</b>         |
|                | <i>Senior Environmental Scientist, Principal</i>   |                            |
|                | Responsibilities include directing, designing, and managing environmental studies in Arctic, temperate, and tropical ecosystems. Primary areas of technical expertise are in monitoring, ecotoxicology, risk assessment, and aquatic ecology. Areas of specialisation include contaminated sediments, weight of evidence assessments, aquatic effects monitoring programs, oil and inorganics fate and effects, especially PAH and selenium. |                            |
| 1979 – 2004    | <b>EVS Environmental Consultants</b>   | <b>North Vancouver, BC</b> |
|                | <i>Senior Environmental Scientist/Owner</i>  |                            |
|                | Responsibilities included directing, designing, and managing environmental studies in Arctic, temperate, and tropical ecosystems. Primary areas of expertise and responsibilities were monitoring, ecotoxicology, risk assessment, and aquatic ecology. Areas of specialisation included sediment weight of evidence assessments, organics and inorganics.   |                            |
| 1977 – 1979    | <b>Environment Canada/Dept. Fisheries and Oceans</b>   | <b>Victoria, BC</b>        |
|                | <i>Independent Contractor</i>  |                            |
|                | Conducted independent research on aquatic oligochaete distributions in the Fraser River and assessed metal body burdens in aquatic benthos from various areas. Published several papers and one book chapter based on this work.   |                            |
| 1976 – 1979    | <b>University of Victoria</b>  | <b>Victoria, BC</b>        |
|                | <i>Teaching and Research Assistant</i>   |                            |



**PROJECT RELATED EXPERIENCE – ECOTOXICOLOGY/TOXICITY TESTING**

**Ecotoxicology**

**North and South America, Europe, Australasia**

- Directed development and source evaluation studies of chemical contaminants in water and sediment.
- Designed, directed and conducted studies involving sewage treatment plants, mining, manufacturing, pulp and paper, wood processing, hazardous waste disposal, landfill operations, oil and gas, smelting and food processing.
- Conducted pioneering toxicity studies in Arctic, temperate, and tropical ecosystems.

**Toxicity Testing**

**North and South America, Europe, Australasia**

- Nationally and internationally recognised expert in ecotoxicology.
- Developed and verified national and international bioassessment protocols for measuring/predicting toxicity and bioaccumulation.

**Example Publications**

**International Peer-Reviewed Literature**

Landrum, P.F., P.M. Chapman, J. Neff and D.S. Page. 2012. Evaluating the aquatic toxicity of complex organic chemical mixtures: Lessons learned from polycyclic aromatic hydrocarbon and petroleum hydrocarbon case studies. *Integr. Environ. Assess. Manage.* 8: 217-230.

Landis, W.G. and P.M. Chapman. 2011. Well past time to stop using NOEL/LOELs. *Integr. Environ. Assess. Manage.* 7(4): vi-viii.

Chapman, P.M., B.G. McDonald, H.M. Ohlendorf and R. Jones. 2009. A conceptual selenium-management model. *Integr. Environ. Assess. Manage.* 5: 461-469.

Chapman, P.M. and J. Anderson. 2005. A decision-making framework for sediment contamination. *Integr. Environ. Assess. Manage.* 1: 163-173.

Chapman, P.M. and M.J. Riddle. 2005. Toxic effects of contaminants in polar marine environments. *Environ. Sci. Technol.* 38: 200A-207A.

McDonald, B.G. and P.M. Chapman. 2002. PAH phototoxicity – An ecologically irrelevant phenomenon? *Mar. Pollut. Bull.* 44: 1321-1326.

Chapman, P.M., H. Bailey, and E. Canaria. 2000. Toxicity of total dissolved solids (TDS) from two mine effluents to chironomid larvae and early life stages of rainbow trout. *Environ. Toxicol. Chem.* 19: 210-214.

Wang, F. and P.M. Chapman. 1999. The biological implications of sulfide in sediment - a review focusing on sediment toxicity. *Environ. Toxicol. Chem.* 18: 2526-2532.

Chapman, P.M. 1990. The Sediment Quality Triad approach to determining pollution-induced degradation. *Sci. Tot. Environ.* 97-8: 815-825.



**PROJECT RELATED EXPERIENCE – ENVIRONMENTAL RISK ASSESSMENT**

**Various Projects** **North and South America, Europe, Australasia**

- Involved in ecological risk assessment since this process was formalised in the 1980s.
- Conducted ecological risk assessments for government and industry.
- Served, at the request of the U.S. Environmental Protection Agency Risk Assessment Forum, as a peer reviewer for various Agency guidance documents.
- Published extensively on ecological risk assessment.

**Global Experience** **South America, Europe, Australasia**

- Senior Editor of the international peer-reviewed journal, Human and Ecological Risk Assessment.
- Advisory and consulting services to the governments of Australia, Peru, Indonesia, Hong Kong, ASEAN (Association of South East Asian Nations).
- Helped set up the first Master's degree in Ecotoxicology in Portugal.
- Conducted pioneering toxicity testing studies in the Arctic, North Sea, and Venice lagoons.
- Lectured, taught, and worked extensively in Europe, South East Asia, Australia, and South America (fluent in Spanish).
- Independent, external examiner for Ph.D. dissertations in Spain, Finland, Canada, the U.S., Denmark, and Australia.
- Numerous lectures and presentations to the public, high school and university classes, business and professional groups.

**Large-Project Expertise** **North and South America, Europe, Australasia**

- Responsible for synthesis of all studies conducted through NSERC (Natural Sciences and Engineering Research Council) under the Metals in the Environment Research Network (MITE-RN; [www.mite-rn.org](http://www.mite-rn.org)). MITE-RN ran for 5 years and involved 7 major Canadian Universities and over 20 Principal Investigators from those Universities plus graduate students and other collaborators.
- Provided similar services to the successor of MITE-RN, the Metals in the Holistic Environment Strategic Network (MITHE-SN); [www.mithe-sn.org](http://www.mithe-sn.org).
- Directed regional-scale risk assessments in Alaska (Port Valdez), Papua New Guinea, Indonesia (Papua), Chile, and Peru.

**Example Publications** **International Peer-Reviewed Literature**

Chapman PM. 2011. Guidance Document: Framework for Assessing and Managing Contaminated Aquatic Sites under the Federal Contaminated Sites Action Plan (FCSAP). Ottawa, ON, Canada.

Chapman PM. 2008. Canada-Ontario Decision-Making Framework for Assessment of Great Lakes Contaminated Sediment (Environment Canada and Ontario Ministry of the Environment. 2008. Canada-Ontario decision-making framework for assessment of Great Lakes contaminated sediment. Ottawa, ON, Canada)

Campbell, P.G.C., P.M. Chapman, and B. Hale. 2006. Risk assessment of metals in the environment. pp 102-131, In: Hester, R. E. and R. M. Harrison (eds.), Chemicals in the



## Resumé

**PETER M. CHAPMAN**

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Environment: Assessing and Managing Risk. Royal Society of Chemistry, Cambridge, UK.



**PROJECT RELATED EXPERIENCE – ENVIRONMENTAL QUALITY MANAGEMENT/AQUATIC POLLUTION ASSESSMENT**

**Environmental Quality                      North and South America, Europe, Australasia, Arctic**

- Intimately involved in the process and methods for developing environmental quality guidelines, both nationally and internationally.
- Advisor to the federal governments of both the United States and Canada for environmental toxicology and biomonitoring assessment policy and protocols.
- Participated in and led aspects of international (South American, European, and Australasian) monitoring development projects.
- Published extensively on the subject of environmental quality guidelines.
- Member of the International Standards Organization, representing Canada.

**Pollution Assessment                      North and South America, Europe, Australasia, Arctic**

- Developed the internationally recognised and accepted Sediment Quality Triad concept for determining pollution-induced degradation in aquatic habitats.
- Directed projects (for government and industry) for various studies involving: biological monitoring; assessment of contaminant levels (including Priority Pollutants) in tissues, sediments, and water; ecological surveys; literature reviews for ranking environmental contaminants; and bioassessment (e.g., toxicity testing).

**Dredging/Sediment Projects                      USA, Canada, and elsewhere**

- Peer reviewed the U.S. Environmental Protection Agency/Army Corps of Engineers [USEPA/USACE] “Green Book” on ocean disposal.
- Contracted author for the EPA/USACE Inland Testing Manual for Waters of the U.S.
- Designed and implemented monitoring and assessment projects for aquatic dredging in fresh, marine, and estuarine waters world-wide.

**Example Publications                      International Peer-Reviewed Literature**

Chapman, P.M., F. Wang and S.S. Caseiro. In review. Assessing sediment contamination in transitional waters. *Environ. Intl.*

Chapman, P.M. and M. Smith. 2012. Assessing, managing and monitoring contaminated aquatic sediments. *Mar. Pollut. Bull.* 64: 2000-2004.

Chapman, P.M. 2012. Management of coastal lagoons under climate change. *Estuar. Coast Shelf Sci.* 110: 32-35.

Chapman, P.M., F. Wang, D.D. Germano, and G. Batley. 2002. Porewater testing and analysis: The good, the bad and the ugly. *Mar. Pollut. Bull.* 44: 359-366.

Chapman, P.M., F. Wang, W. Adams, and A. Green. 1999. Appropriate uses of sediment quality values for metals and metalloids. *Environ. Sci. Technol.* 33: 3937-3941.

Chapman, P.M., P.J. Allard, and G.A. Vigers. 1999. Development of sediment quality values for Hong Kong Special Administrative Region: a possible model. *Mar. Pollut. Bull.* 38: 161-169.



**PROJECT RELATED EXPERIENCE – EXPERT WITNESS AND PEER REVIEW**

**Expert Witness**

**USA and Canada**

- Seven trials with testimony.
- Two trials with attendance but no testimony as cases settled.
- Two depositions (one videotaped).
- Appeared as an expert witness on nine occasions before the Northwest Territories (Canada) Water Board, on one occasion before the Nunavut (Canada) Water Board, on one occasion before the Joint Review Panel for the MacKenzie Gas Project, and on two occasions before the Joint Review Panels for oil sands developments.
- Provided expert advice, but not testimony, during five judicial or quasi-judicial Hearings in Canada.
- Clients include both government (e.g., U.S. Department of Justice) and industry.

**Peer Reviewer**

**USA, Canada, Australasia, Europe**

**Currently:**

- Peer reviewer for over 20 international scientific journals.
- Peer reviewer for American, Canadian, Australian, New Zealand, and European granting agencies.
- Senior Editor for Debates/Commentaries and Perspectives for the international, peer-reviewed journal, *Human and Ecological Risk Assessment*.
- Editor of the journal *Integrated Environmental Assessment and Management (IEAM)*
- Editorial Board of the international journal, *Marine Pollution Bulletin*.
- Member, U.S. Environmental Protection Agency, Science Advisory Board (SAB) Scientific and Technological Achievement Awards Committee.
- Member, U.S. Environmental Protection Agency FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Scientific Advisory Panel 2012.

**Previously:**

- Member, U.S. Environmental Protection Agency, Science Advisory Board (SAB): Sediment Criteria Subcommittee; and, Environmental Processes and Effects Committee.
- Member, Washington State Biomonitoring Science Advisory Board (BSAB).
- Member, Canadian Environmental Advisory Council (advised four different Canadian Ministers of Environment).
- Member, NRC Committee on the Bioavailability of Metals in Sediments.
- Member, U.S. Environmental Protection Agency, SAB, Global Climate Change Subcommittee.
- Editorial Board of the international journal, *Chemosphere*.
- Editorial Board of the international journal, *Ecotoxicology and Environmental Safety*.
- Member, Sewage Treatment Review Panel.
- Member, International Technical Advisory Panel on Ecotoxicity.
- Editorial Board of the international journal, *Environmental Toxicology and Chemistry*.



## PROJECT RELATED EXPERIENCE – METALS/OTHER INORGANICS

### Metals, Metalloids, Non-Metals North/South America, Europe, Australasia, Arctic

- Chaired 2009 SETAC Pellston Workshop on Ecological Assessment of Selenium in the Aquatic Environment; senior editor of resulting book.
- Past member of the International Technical Advisory Panel on Ecotoxicology, for nonferrous metals.
- Participated in an OECD Expert Workshop on Toxicity Testing of Metals and Metalloids as Chair of an International Expert Group.
- Participated in a Canada/European Union Expert Workshop on Persistence and Bioaccumulation of Metals and Metalloids as a speaker and workshop rapporteur.
- Participated in a World Health Organization Expert Workshop on Global Criteria for Zinc.
- Extensive experience and expertise with metals from sources including mining, smelters, sewage, and landfills.
- Extensive publications regarding metals, metalloids and non-metals fate and effects in the environment.

### Example Publications

### International Peer-Reviewed Literature

Trenfield, M.A., P.M. Chapman and R.A. van Dam. In preparation. Appropriate water quality benchmarks for uranium. *Sci. Tot. Environ.*

Chapman, P.M. 2012. 'Heavy metal' – cacophony not symphony. *Integr. Environ. Assess. Manage.* 8: 216.

Chapman, P.M., W.J. Adams, M.L. Brooks, C.G. Delos, S.N. Luoma, W.A. Maher, H.M. Ohlendorf, T.S. Presser, D.P. Shaw (eds). 2010. *Ecological Assessment of Selenium in the Aquatic Environment*. SETAC Press, Pensacola, FL, USA.

Chapman, P.M. 2008. Environmental risks of inorganic metals and metalloids: a continuing, evolving scientific odyssey. *Human Ecol. Risk Assess.* 14: 5-40.

Chapman, P.M. and A.M.H. de Bruyn. 2007. A control-chart approach to monitoring and communicating trends in tissue selenium concentrations. *Environ. Toxicol. Chem.* 26: 2237-2240.

Adams, W. and P.M. Chapman (eds). 2006. *Assessing the Hazard of Metals and Inorganic Metal Substances in Aquatic and Terrestrial Systems*. SETAC Press, Pensacola, FL.

Chapman, P.M. and F. Wang. 2000. Issues in ecological risk assessment of inorganic metals and metalloids. *Human Ecol. Risk Assess.* 6: 965-988.

Chapman, P.M., F. Wang, C. Janssen, G. Persoone, and H. Allen. 1998. Ecotoxicology of metals in aquatic sediments: binding and release, bioavailability, hazard, risk and remediation. *Can. J. Fish. Aquat. Sci.* 55: 2221-2243.



**PROJECT RELATED EXPERIENCE – SEWAGE EFFLUENT AND TREATMENT**

**Sewage North and South America, Europe, Australasia, Arctic**

- Extensive project experience assessing fate and effects of sewage effluents.
- Evaluations for cities with populations over 1,000,000 and small local discharges.
- Expert advice regarding design and placement of sewage discharges to minimise environmental concerns.
- Expert advice regarding levels of sewage treatment required relative to the receiving environment.
- Interpretative advice and studies regarding environmental effects and regulatory requirements.
- Member, Sewage Treatment Review Panel (Greater Vancouver Regional District).

**Example Publications International Peer-Reviewed Literature**

Chapman, P.M, J. Cullen, C. Garrett, J. Littlepage, T. Pedersen, D. Varela, R.W. Macdonald, R. Thomson, T. Parsons. 2008. Sewage treatment wasted – The Victoria (BC, Canada) example. *Mar. Pollut. Bull.* 56: 815-816.

Chapman, P.M. 2007. Determining when contamination is pollution – weight of evidence determinations for sediments and effluents. *Environ. Intern.* 33: 492-501.

McPherson, C.A., A.R. Tang, P.M. Chapman, L.A. Taylor and S. J. Gormican. 2002. Toxicity of 1,4-dichlorobenzene in sediments to juvenile polychaete worms. *Mar. Pollut. Bull.* 44: 1405-1414.

Chapman, P.M. 2000. Whole Effluent Toxicity (WET) Testing - usefulness, level of protection, and risk assessment. *Environ. Toxicol. Chem.* 19: 3-13.

Taylor, L.A., P.M. Chapman, R.A. Miller, and R.V. Pym. 1998. The effects of untreated municipal sewage discharge to the marine environment off Victoria, British Columbia, Canada. *Water Sci. Technol.* 38: 285-292.

McGroddy, S. and P.M. Chapman. 1997. Is mercury from dental amalgam an environmental problem? *Environ. Toxicol. Chem.* 16: 2213-2214.

Chapman, P.M., J. Downie, A. Maynard, and L. Taylor. 1996. Deodorizer residue and coal in marine sediments contaminants or pollutants? *Environ. Toxicol. Chem.* 15: 638-642.

Chapman, P.M., M.D. Paine, A.D. Arthur, and L.A. Taylor. 1996. A triad study of sediment quality associated with a major, relatively untreated marine sewage discharge. *Mar. Pollut. Bull.* 32: 47- 64.

Chapman, P.M. 1996. A test of sediment effects concentrations: DDT and PCB in the Southern California Bight. *Environ. Toxicol. Chem.* 15: 1197-1198.

Chapman, P.M., A.D. Arthur, M.D. Paine, and L.A. Taylor. 1994. Sediment studies provide key information on the need to treat sewage discharged to sea by a major Canadian city. *Water Sci. Technol.* 28: 255-261.

**JOURNAL PUBLICATIONS****[\* = Editorials or Letters to the Editor]**

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- Trenfield, M.A., P.M. Chapman and R.A. van Dam. In preparation. Appropriate water quality benchmarks for uranium. *Sci. Tot. Environ.*
- deBruyn, A.M.H., B. Wernick, C. Stefura, L. Paterson and P.M. Chapman. In preparation. Assessing effects of a freshwater oil spill on in situ development of northern pike embryos.
- Wernick, B.G., A.M.H. deBruyn, B.G. McDonald, L. Patterson and P.M. Chapman. In preparation. Short-term effects of an oil spill on the benthic invertebrate community of a lake in northern Alberta, Canada.
- Wernick, B.G., A.M.H. deBruyn, L. Patterson and P.M. Chapman. In preparation. Effects of an oil spill on the plankton community in a northern Alberta lake.
- Chapman, P.M., F. Wang and S.S. Caseiro. In review. Assessing sediment contamination in transitional waters. *Environ. Intern.*
- Neff J., D. S. Page, P.F. Landrum and P.M. Chapman. In review. Does exposure to low concentrations of weathered crude oil during incubation cause malformations, genetic damage, and mortality in embryos and larvae of Pacific herring (*Clupea pallasii*)? *Mar. Pollut. Bull.*
- Landrum, P.F., P.M. Chapman, D.S. Page and J. Neff. In press. Theoretical and case studies demonstrating implications of dose metrics under changing water concentrations for aquatic organisms exposed to organic contaminants. *Integr. Environ. Assess. Manage.*
- Wepener, V. and P.M. Chapman. 2012. The future of ecotoxicology in South Africa. *African J. Aquat. Sci.* DOI:10.2989/16085914.2012.717051.
- Landis, W.G., J.L. Durda, M.L. Brooks, P.M. Chapman, C. Menzie, R.G. Stahl Jr. and J.L. Stauber. 2012. Ecological risk assessment in the context of global climate change. *Environ. Toxicol. Chem.* 32: 1–14.
- Chapman, P.M. and M. Smith. 2012. Assessing, managing and monitoring contaminated aquatic sediments. *Mar. Pollut. Bull.* 64: 2000-2004.
- \*Chapman, P.M. 2012. Adaptation to global climate change – A bandage as the guillotine descends. *Integr. Environ. Assess. Manage.* 8: 577.
- \*Chapman, P.M. 2012. 'Heavy metal' – cacophony not symphony. *Integr. Environ. Assess. Manage.* 8: 216.
- Chapman, P.M. 2012. Management of coastal lagoons under climate change. *Estuar. Coast Shelf Sci.* 110: 32-35.
- \*Chapman, P.M. 2012. Crossing the line: Sins of omission and commission. *Mar. Pollut. Bull.* 64: 457-458.
- Caseiro, S. S., T. A. DelValls and P.M. Chapman. 2012. Considerations for integrative environmental assessments of contaminated estuarine sediments. *Man. Environ. Qual.* 23 (4): 400 – 413.



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**PETER M. CHAPMAN**

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**Education**

*M.Sc., Hydrogeology,  
University of Waterloo,  
Waterloo, Ontario, 1976*

*B.Sc. (Honours), Geology ,  
University of Alberta,  
Edmonton, Alberta, 1974*

**Golder Associates Ltd. – Burnaby**

**Employment History**

***Golder Associates Ltd. – Burnaby, BC***

*Principal (2003), Senior Hydrogeologist (1986 to Present)*

Engaged in hydrogeological investigations throughout North America, Europe, Asia, and South America. Provides senior technical review for hydrogeological aspects of water resource management, water supply, computer modelling of groundwater flow and remedial measures, design and assessment of groundwater remedial measures, contaminant hydrogeology, and mining.

***Independent Consulting Hydrogeologist – Vancouver, BC***

*Principal (1985 to 1986)*

Emphasis on groundwater resource evaluation, groundwater remedial studies, evaluation of proposed mining scenarios, computer modelling of groundwater regimes, and contaminant hydrogeology.

***SIMCO Ground Water Research Ltd. – Vancouver, BC***

*Principal (1980 to 1985)*

Emphasis on resource evaluation, environmental assessment, and computer modelling of groundwater flow and mass transport. Responsibilities included management and technical supervision of hydrogeological projects, client representation at environmental hearings, and business development.

***Golder Associates Ltd. – Vancouver, BC***

*Hydrogeologist (1979 to 1980)*

Engaged in hydrogeological investigations in mining, geotechnical, and nuclear energy industries.

***Alberta Research Council and University of Alberta – Edmonton, AB***

*Research Hydrogeologist (1973 to 1979)*

Provided technical assistance in research projects at the Alberta Research Council and at the University of Alberta. Duties included characterisation of hydrogeological regimes, conducting and analyzing pumping tests to assess aquifer properties, numerical modelling of groundwater flow in deep sedimentary basins and coal aquifers and analyses of drill stem tests.



## PROJECT EXPERIENCE – RAINWATER INFILTRATION STUDIES

**City of Chilliwack**  
Chilliwack, BC

Conducted a risk analysis of infiltration of rainwater into aquifer used by the City of Chilliwack for potable water supply. Recommended that infiltration system be installed outside of the capture zone of the aquifer and/or the water supply be chlorinated because of high risk to water quality.

**Roadway Infiltration System**  
Vancouver, BC

Development of practical and field-functional approaches for characterising the soil infiltration potential and hydrogeology for development of roadway rainwater infiltration systems. Development of practical field testing methods for assessing site infiltration potential and to provide input to design matrix of water infiltration systems.

**Rainwater Management – Steep Slopes**  
Coquitlam, BC

Conducted field investigations to evaluate the potential for rainwater infiltration to groundwater at a proposed development along the Coquitlam River. Concluded that the soils provided sufficient infiltration capacity; however, because of slope stability concerns rainwater management required a hybrid system where rainwater is allowed to infiltrate into the groundwater but the rise in the watertable is limited

**Integrated Rainwater Management**  
Delta, BC

Assessment of constraints and opportunities for rainwater infiltration at an industry development on Tsawwassen First Nation lands in Delta, BC. Included the characterization of existing groundwater quality, groundwater levels, permeability, groundwater flow directions and infiltration potential.

**Alternative Street Drainage Concept**  
Burnaby, BC

Senior review of studies to provide hydrogeological input to an alternative street concept recommendations to the City of Burnaby. Investigations were undertaken along a section of each of three City streets, namely Clinton, Carson and Watling. Test pitting and infiltration tests were undertaken at two locations along each of these streets. Criteria were used to select Clinton Street for further investigation. Investigations included drilling of boreholes and installation of monitoring wells to assess the extent of low permeability layer, the location of the watertable and groundwater flow directions.

**Gateway Program - South Fraser Perimeter Road Impacts**  
Delta, BC

Project Director of investigations that characterized existing hydrogeological conditions along portions of a proposed alignment for the South Fraser Perimeter Road. Utilized the baseline information to identify potential impacts to the current groundwater systems and identified mitigative measures for the initial road construction and long-term operational phases.

**Regional Aquifer Management**  
District of Mission, BC

Senior review of studies that provided multi-phase hydrogeological input during development of the District of Mission’s Neighbourhood One Plan, including regional-scale characterization of groundwater systems, assessment of potential local and region hydrogeological/aquifer impacts (both quality and quantity) and preparation of an interim Hydrogeology Opportunities and Constraints document. Late stages of program included detailed field testing and analysis to support on-going ISMP design/modelling, in agreement with Metro Vancouver’s Template (2005).



**Shallow Aquifer  
Infiltration - Residential  
Development**  
Agassiz, BC

Project Director on a project that involved subsurface exploration and testing program to evaluate the potential for direct disposal of rainwater to a shallow unconfined aquifer. Evaluated options for integrating proposed on-site community infiltration gallery with existing municipal piping and surface drainage systems. Proposed residential development within flood-influenced terrain.

**Rainwater Infiltration –  
UniverCity**  
Burnaby, BC

Senior review of investigations to assess the regional rainwater infiltration to groundwater for residential developments on Burnaby Mountain. Investigations included the installations of shallow wells and undertaking large scale infiltration tests throughout the study area. Modified a technique to determine macro-scale infiltration rates. This methodology has been adapted by Simon Fraser University as the required evaluation method for all developments at Simon Fraser University.

**Deep Aquifer  
Infiltration -  
Community Planning**  
Langley, BC

Acted as Project Director for a detailed site exploration and monitoring program for a large, high-density residential subdivision. Provided recommendations for rainwater infiltration using both conventional shallow structures and deep well methods. Conducted in-situ testing of two wells constructed within a deep confined aquifer and estimated the long-term sustainable infiltration rates. Predicted long-term distribution of rainwater within aquifer utilizing a Township-wide numerical model to assess potential impacts of direct aquifer recharge (DAR) using rainwater. Conducted literature review and assisted with development of a commissioned water quality monitoring program.

**City of Chilliwack**  
Chilliwack, BC

**PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF TUNNEL AND UNDERGROUND MINE DEVELOPMENT**

**Roadway Infiltration  
System**  
Vancouver, BC

Development of practical and field-functional approaches for characterising the soil infiltration potential and hydrogeology for development of roadway stormwater infiltration systems. Development of practical field testing methods for assessing site infiltration potential and to provide input to design matrix of water infiltration systems.

**Rainwater  
Management – Steep  
Slopes**  
Coquitlam, BC

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Delta, BC

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**Gateway Program -  
South Fraser Perimeter  
Road Impacts**  
Delta, BC

Project Director of investigations that characterized existing hydrogeological conditions along portions of a proposed alignment for the South Fraser Perimeter Road. Utilized the baseline information to identify potential impacts to the current groundwater systems and identified mitigative measures for the initial road construction and long-term operational phases.

**Regional Aquifer  
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District of Mission BC

Senior review of studies that provided multi-phase hydrogeological input during development of the District of Mission's Neighbourhood One Plan, including regional-scale characterization of groundwater systems, assessment of potential local and region hydrogeological/aquifer impacts (both quality and quantity) and preparation of an interim Hydrogeology Opportunities and Constraints document. Late stages of program included detailed field testing and analysis to support ongoing ISMP design/modelling, in agreement with Metro Vancouver's Template (2005).

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Development**  
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UniverCity**  
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**Deep Aquifer  
Infiltration -  
Community Planning**  
Langley, BC

Acted as Project Director for a detailed site exploration and monitoring program for a large, high-density residential subdivision. Provided recommendations for rainwater infiltration using both conventional shallow structures and deep well methods. Conducted in-situ testing of two wells constructed within a deep confined aquifer and estimated the long-term sustainable infiltration rates. Predicted long-term distribution of rainwater within aquifer utilizing a Township-wide numerical model to assess potential impacts of direct aquifer recharge (DAR) using stormwater. Conducted literature review and assisted with development of a commissioned water quality monitoring program.



<b>Kiggavik</b> Nunavut	Assessed groundwater inflows and preliminary depressurization measures to a proposed underground mine beneath permafrost in Nunavut. Included hydrogeological testing and numerical modelling for feasibility and baseline studies.
<b>Teck Corporation</b> Alaska	Conducted studies to estimate mine inflow and to assess dewatering and grouting strategies at a proposed underground mine. Included packer testing, installation of monitoring wells, water sampling, pumping tests and numerical modelling. Designed wells for the injection of treated mine water during the development of exploration decline. Providing on-going hydrogeological assessment for full mine development.
<b>Giant Mine</b> Northwest Territories	Conducted hydrogeological investigations related to an existing and a recently excavated arsenic stope. Conducted permeability testing and hydraulic head measurements in the pillar between stopes. Recommended the installation of a drainage galley beneath the two stopes to promote dewatering of the stopes. Drainage galley was nearing completion when the mine was shut-down.
<b>Winspear</b> Northwest Territories	Provide hydrogeological services to the EIS and Feasibility mine plan. Investigations have included the installation of piezometers, permeability testing and water sampling. Computer modelling was undertaken to estimate mine inflows during the exploration decline and at the planned full mine development.
<b>Pend Oreille</b> Washington	Hydrogeological investigations related to mine expansion. Investigations included permeability testing and hydraulic head measurement of proposed shaft development. Computer modelling was undertaken to estimate inflows to shaft development. Provide recommendations on mine dewatering strategies and grouting procedures.
<b>Turquoise Ridge</b> Nevada	Hydrogeological investigations to develop dewatering strategies to improve trafficability in production areas. Included 3-D visualization of underground development, geology, structure and measurements of groundwater inflow during drilling of long exploration holes. The structure and geology were correlated to high inflows in order to identify major groundwater pathways that can be intercepted and drained prior to mining.
<b>Asia Pacific</b> Thailand	Conducted pre-feasibility and feasibility hydrogeological investigations of a proposed underground potash mine. Including pumping tests, installation of monitoring wells, water sampling and numerical modelling. Estimated mine inflows and water supply potential and provided conceptual dewatering strategies.
<b>Polaris Mine</b> Cornwallis, NWT	Provided testing procedures to determine hydrogeological properties at a proposed underground mine expansion. Numerical modelling was conducted to assess mine inflow at a planned expansion.



**Raglan**  
Northern Quebec

Undertook and groundwater benchmark study that examined potential groundwater issues that could result if underground mining progressed below the permafrost zone. The quantity of inflow to this mine was of a particular concern as the ventilation in the underground is not heated. All previous mining was within the permafrost. Studies included review of thermal regime data, groundwater inflows to boreholes drilled below the permafrost, regional water level elevations of large lakes in area, geology and hydrogeologic projects with similar hydrogeologic and thermal regimes.

**Red Mountain**  
Smithers, BC

Conducted hydrogeological investigations to assess hydrogeological conditions and to estimate mine inflows to proposed underground mine.

**Westmin Resources**  
Myra Creek, BC

Characterised the groundwater regime and determined the source of acid rock drainage. Investigation included installation of wells, permeability testing and water sampling. Assisted in the design of remedial measures.

**Uranium Mine**  
Northern Saskatchewan

Developed a computer model of the groundwater regime at a proposed underground uranium mine. Analyses included assessment of mine inflows to various proposed mine plans and the effect of grouting and/or dewatering on mine inflow and water pressures.

**Potash Mine**  
Esterhazy, SK

Model analysis of groundwater regime to determine approximate location and chronology of leaks at an underground potash mine. Included analyses of several hundred drill stem tests to determine formation transmissivities and numerical modelling.

**Hudson Bay Mining  
and Smelting**  
Manitoba

A study to estimate groundwater inflow and recommend dewatering strategies in underground mines at Photo Lake and Kunoto Lake.

**Eldorado Gold  
Corporation**  
Turkey

A study to estimate groundwater inflow to a proposed underground mine and to assess the effects of mining on the groundwater and surface water regime.

**Homestake**  
British Columbia

Hydrogeological study including pumping tests, inflow mapping, structural modelling and packer testing. Groundwater inflow was estimated for the life of the mine. Dewatering wells were designed and installed. Dewatering strategies were determined.

**Snap Lake**  
Northwest Territories

Provided technical assistance on hydrogeology components of an environmental assessment and in hearings relate to project approvals and permitting. Included characterization of the regional groundwater flow regime and the prediction of the direction, travel time and contaminant transport of dissolved metals originating from the mine following closure of the mine. The environmental assessment was approved in late 2003.

**Hydro-Power  
Generation**  
Revelstoke, BC

Groundwater investigations to assess potential groundwater leakage from a small-scale hydro-electric project. Investigations have included hydro-jacking testing, permeability testing, mapping and measurement of underground inflows and computer modelling to assess potential water leakage from the project during operation.



- TVX Gold**  
Eastern Europe

Assessment of groundwater inflow to a proposed underground mine. Included the development of a computer model that was calibrated to measured inflows to preliminary mine development.
- Diavik Diamond Project**  
Northwest Territories

Providing ongoing hydrogeological investigations to determine groundwater inflows to a mine located near Yellowknife. Duties have included conducting permeability tests in deep exploratory boreholes and conducting pumping tests in the underground mine. Numerical hydrogeological modelling was undertaken to assess mine inflows, dewatering systems, dewatering strategies and remedial measures. Drainage galleries consisting of 4 to 6 drainholes were designed and installed at approximately 75 m depth intervals in the underground mine. Acted as expert witness during project approval process.
- Jullietta**  
Former U.S.S.R

Groundwater investigations at a proposed underground mine to assess groundwater inflows. Groundwater model was developed and calibrated to inflows to advanced exploration program.
- T’Sable River**  
BC

Groundwater investigations to assess groundwater inflows to an exploration decline. Investigations included flow meter testing, permeability testing, piezometer installation and computer modelling. The potential for saline water intrusion will be assessed.

## PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF WETLANDS

- Timberwest**  
Mt. Washington, BC

Provided hydrogeological review of proposed mine discharge renovation measures using natural and engineered wetlands. Treatment included enhancement of existing wetlands and construction of engineered wetlands. Presented to government regulatory agencies including DFO and Ministry of Environment.
- First Nations**  
Anahim Lake, BC

Involved in hydrogeological investigations of a natural wetland for final renovation of sewage from a First Nations village. Investigations included installation of monitoring wells, identification of separate hydrogeologic layers within the wetland, permeability testing of the peat and underlying soil layers. Analyses identified groundwater flow directions and velocities.
- Cominco**  
Pine Point, BC

Involved a hydrogeological evaluation of a natural wetland for treatment of discharge from a mine tailings pond. Involved estimates of wetland capacity and assistance with design and enhancement of the wetland.
- Ministry of Transport and Infrastructure**  
Delta, BC

Acted as senior technical review of hydrogeological aspects of the alignment of the South Fraser Perimeter Road near the west and north boundaries of Burns Bog. Included the installation of monitoring wells within the bog, identification of the various bog layers and water chemistry, water level monitoring, water sampling and permeability testing of the bog layers and underlying soils. Provided a qualified hydrogeological resource to the Ministry and presented on the hydrogeology of Burns Bog to government agencies, academic institutes and the public.



## PROJECT EXPERIENCE – LANDFILL INVESTIGATIONS

- Wildwood Landfill**  
Powell River, BC  
Provided senior technical review of groundwater monitoring program for a landfill that receives waste from the mill site. Activities include streamlining of monitoring well network, installation of recovery wells, and enhancement of collection system.
- Hartland Landfill**  
Victoria, BC  
Responsible for hydrogeologic component of a review of the environmental monitoring systems at the Hartland Landfill. Identified potential reductions in the number of groundwater monitoring wells.
- Crofton Landfill**  
Crofton, BC  
Provided senior technical review of hydrogeologic investigations of a proposed expansion of a wood ash landfill. Investigations included borehole and monitoring wells to assess groundwater flow directions and velocities. Evaluated potential impacts to nearby groundwater and surface water supplies.
- Premier Landfill**  
North Vancouver, BC  
Designed leachate collection that included horizontal drains, sumps, and pumping system. Designed monitoring well network to assess leachate collection efficiency.
- Harmac Landfill**  
Nanaimo, BC  
Provided senior technical review for an assessment of hydrogeological conditions at an existing landfill that receives woodwaste and pulp mill sludge and at a planned landfill expansion. Investigations included drilling of boreholes, packer testing, and installation of monitoring wells.
- Vancouver Landfill**  
Delta, BC  
Carried out hydrogeological investigations to determine optimum locations for wells to monitor the performance of collection system. Investigations included drilling and installation of monitoring wells.
- Cheam First Nation Landfill**  
Agassiz, BC  
Assessed hydrogeological conditions including existing groundwater flow directions, groundwater velocities, and water chemistry. Set up numerical model to assess potential future groundwater flow conditions and leachate migration. Provided recommendations on the location of wells and chemical parameters for future monitoring.
- Former Coquitlam Landfill**  
Coquitlam, BC  
Conducted hydrogeological investigations related to closeout planning and environmental risk assessment of a former demolition debris and fly ash landfill in Coquitlam. Investigations included shallow monitoring wells and water quality sampling.

## PROJECT EXPERIENCE – GROUNDWATER RESOURCE DEVELOPMENT

- Subdivision**  
Bowen Island, BC  
Acted as Senior Technical Review for groundwater resource evaluation for a subdivision on Bowen Island. Undertook installation of wells and conducted pumping tests to assess yield and water samples to assess water quality.
- Village of Pemberton Water Supply**  
Pemberton, BC  
Acted as Senior Technical review for groundwater supply options for the Village of Pemberton and provided recommendations for exploring and developing water supply wells within three areas identified as potential source sites. Completed an exploration program to characterize and evaluate the potential for constructing additional supply wells in the aquifer hosting existing Village Wells.



**Groundwater  
Modelling Study**  
Township of Langley, BC

Project Director and Senior Technical review for a comprehensive groundwater modelling study for the Township of Langley. The project consisted of assembly and review of available information concerning the Township’s geology, hydrology, and hydrogeology, the development of three-dimensional conceptual model of groundwater flow within the Township, and the construction and calibration of a three-dimensional numerical groundwater model. The model was used to delineate capture zones for municipal wells and to assess the water balance for the Township.

**Halfway Band**  
Fort St. John, BC

Conducted exploratory drilling to determine optimum location of water supply well for the Halfway Band. Included installation of production well and pumping tests to assess long-term yield. Study included well installation, pumping tests, and groundwater yield evaluation.

**Tsawwassen First  
Nation**  
Tsawwassen, BC

Acted as Project Hydrogeologist in a groundwater resource evaluation investigation. Consisted of the installation of wells and pumping tests. Identified potential source areas for groundwater.

**Stoney Creek Band**  
Vanderhoof, BC

Installed water supply well for the Stoney Creek Band as part of a village expansion. Study included well installation, pumping tests, and groundwater yield evaluation.

**Blueberry Band**  
Fort St. John, BC

Assessed groundwater yield at existing well for the Blueberry Band and installed a back-up well.

**White Bear Band**  
Regina, SK

Assessed groundwater resources at the White Bear Reserve in east central Saskatchewan. Included pumping tests and exploratory drilling to evaluate groundwater resource potential.

**Burnaby Golf Course**  
Burnaby, BC

Assessed groundwater supply potential for irrigation water for a golf course. Study included a test well drilling program.

**D.L. 749**  
Masset, BC

Evaluated groundwater supply for a community expansion on the Queen Charlotte Islands for the Massett Band. Included review of wells in the vicinity and exploratory drilling.

**Spring Water Bottling  
Company**  
Revelstoke, BC

Acted as project manager of groundwater investigations to increase groundwater yields and to provide secure groundwater supply to a spring water bottling company. Included drilling of horizontal wells to provide a secure water quality supply, assessment of total potential yield, and design and construction of structure to protect natural springs. In addition, assisted with regulatory process for approval of spring water with US federal agencies.

**City of Chilliwack**  
Chilliwack, BC

Assessed the long-term yield of an existing well field and evaluated alternative sources of groundwater supply at Sardis. Provided technical review on the installation of monitoring wells and monitoring of water chemistry.

**Groundwater  
Protection Plan**  
Chilliwack, BC

Developed a groundwater protection plan for the District of Chilliwack. Work consisted of capture zone analysis, vulnerability mapping, and a contaminant inventory. Based on the results, developed recommendations for groundwater protection measures, along with groundwater monitoring and contingency plans.



**Whistler Mountain**  
Whistler, BC

Installed a well field in bedrock at a restaurant near the top of Whistler Mountain. Carried out exploratory drilling to determine optimum well location. Evaluated long-term sustained yield from groundwater for the well field and a separate well located at the Olympic Station.

**Mount Washington**  
Courtenay, BC

Assessed groundwater supply from springs and the potential for groundwater supply from a well field. Study consisted of geophysical surveys, well installation and aquifer testing program.

**Newmont Gold Company**  
Indonesia

Assessed groundwater potential at a proposed port facility and for the village of Tonga on the island of Sumbawa in Indonesia.

**Review of Groundwater Protection Practices**  
British Columbia

Acted as senior review of non-regulatory groundwater protection practices in western developed nations on behalf of Environment Canada. Evaluated the strengths and weaknesses of the various approaches, and recommended strategies for potential application to the Fraser River Basin to complement proposed provincial groundwater legislation.

**Subdivision**  
Whitehorse, YT

Conducted exploratory drilling and pumping tests to assess the groundwater resources at a proposed subdivision near Whitehorse.

**Groundwater Resource Mapping**  
Edmonton, AB

Conducted and analysed pumping tests to assess groundwater resources in the vicinity of the City of Edmonton.

**Well Rehabilitation**  
Kamloops, BC

Evaluated the yields from wells at a Youth Detention Centre. Recommended well rehabilitation and long-term treatment measures to prevent reduction in yields in the future.

**Assessment of Highway Construction Impacts on Existing Water Wells**  
Qualicum, BC

Conducted an investigation of existing groundwater and surface water supplies along the proposed alignment of the Inland Island Highway on behalf of the Ministry of Environment to assess the potential affect of highway construction. The study involved a preliminary survey of existing water wells and surface water licenses followed by pumping testing and water quality analysis.

**Research Council of Alberta**  
Alberta

Assisted in the aquifer testing program conducted in Alberta. Included instruction of drilling and pumping test contractors, analyses of aquifer tests, and development of database for hydraulic parameters derived from the tests.

**Aquifer Testing**  
Lower Mainland, BC

Conducted testing of domestic wells to assess groundwater yield and groundwater quality for subdivision certification purposes.

**PROJECT EXPERIENCE – CREOSOTE/COAL TAR SITES**

**Expo 86**  
Vancouver, BC

Characterized the soil and groundwater contamination and assessed the groundwater regime and flow conditions. Conducted numerical modelling of groundwater flow system to assess groundwater remedial measures. Designed groundwater collection measures and the monitoring required to evaluate the performance of those remedial measures.



**Braid Street Site -  
Former Wood  
Treatment Facility**  
Coquitlam, BC

Directed groundwater modelling investigations to optimize pump and treat system to capture dissolved phase plume at a wood treatment plant influenced by ocean tides. Designed groundwater remedial measures that incorporated the effects of tidal fluctuations and seasonal changes on groundwater flow.

**Oak Street Site**  
Vancouver, BC

Directed groundwater modelling to design groundwater collection system to capture dissolved phase plume and to arrest the movement of DNAPL. The effects of ocean tides and seasonal changes in river stage were incorporated into the remedial design.

**Former Lumber Mill**  
Esquimalt, BC

Assessed the groundwater regime and contaminant plume consisting of elevated levels of chlorophenols at a former lumber mill. Modelled the groundwater regime and assessed the efficiency of various groundwater collection measures. Designed collection wells and evaluated the proposed close-out procedures.

**Meadow Avenue Site –  
Former Wood  
Preserving Facility**  
Burnaby, BC

Senior technical review of modelling to assess groundwater and NAPL remedial measures. The effects of tidal fluctuations and seasonal changes on groundwater flow conditions were included in the remedial design.

**Former Coal  
Gasification Plant**  
Vancouver, BC

Conducted computer modelling to assess remedial measures at a former coal gasification plant. Designed groundwater collection measures and evaluated the long-term groundwater chemistry for treatment design.

**BC Hydro**  
Vancouver, BC

Characterized the groundwater, soil, and NAPL contamination at a substation. Contamination originated from a former coal gasification plant located on adjacent property

## PROJECT EXPERIENCE – GROUNDWATER DEWATERING AND SEEPAGE ANALYSIS

**TransCanada Highway**  
Revelstoke, BC

Groundwater investigations to assess the design of drainage galleries for slope stability purposed on TransCanada Highway. Investigations included installation of piezometers, groundwater modelling to assess optimum location of drainage tunnels and assistance in the design of the tunnels and drains.

**Metro Vancouver**  
Coquitlam, BC

Senior technical review of hydrogeological aspects of an excavation for the Coquitlam UV facility on the Coquitlam River. Included instrumentation, hydrogeological testing and numerical modelling to assess excavation slope stability and dewatering requirements. Provided preliminary design of dewatering system for technical specifications.

**Endako Mines**  
Prince George, BC

Hydrogeological testing and instrumentation to evaluate current water pressures in the walls of an open pit mine and to predict future water pressures. Developed remedial measures consisting of horizontal drainholes to improve slope stability conditions.



- Huckleberry Mines**  
Smithers, BC  
Involved in the hydrogeological assessment of a proposed open pit expansion that would intersect a historical tailings disposal areas. Involved in the design of dewatering/depressurization systems to assist in the stabilization of the pit slopes. Included hydrogeological testing and the development of a numerical model.
- Ivanhoe Mines**  
Mongolia  
Senior technical review of hydrogeological aspects of the Oyu Tolgoi Project. Developed numerical hydrogeological model to predict seepage into a proposed open pit and to predict hydraulic heads to assess future slope stability conditions in the pit walls. Assisted in the preliminary design of dewatering/depressurization systems to improve slope stability.
- Diavik Diamond Mine**  
Lac De Gras, NT  
Senior technical review of the hydrogeological aspects of an open pit mine. Included the instrumentation and hydrogeological testing of pit slopes to evaluate the current slope stability and groundwater seepage conditions and to predict future conditions. Where required, developed dewatering/depressurization methods to improve stability of the slopes.
- Metro Vancouver**  
North Vancouver, BC  
Senior technical review of the hydrogeological aspects of the Seymour Capilano Filtration Project (SCFP). Project consisted of the installation of twin tunnels, 7 km in length, in bedrock between the Capilano Dam and the Seymour River drainage for the conveyance of raw and treated water. Assessed the potential effects to seepage and slope stability to the East Abutment of the Cleveland Dam and the west slope of Lynn Creek during construction and operations of the twin tunnels.
- GVRD**  
North Vancouver, BC  
Designed dewatering measures required to prevent uplift in the floor of a Digester during cleaning and to prevent ground settlement at a GVRD water treatment plant.
- BC Hydro**  
Castlegar, BC  
Designed and provided specifications for a drain collection system for slope stability of dam abutments at the Kootenay Canal Power Plant. Specified pre-packed screens to drain a silt slope.
- Highland Valley Copper**  
Kamloops, BC  
Providing on-going monitoring and evaluation of dewatering program at an open pit mine. There are two components to the dewatering program – deep high capacity wells to dewater highly permeable alluvial fans and vacuum assisted low capacity wells to depressurize silt and clays for slope stability purposes.
- Newmont Gold Company**  
Indonesia  
Assessed the dewatering requirements and the effects of dewatering, pit lake formation, and waste rock on groundwater and surface waters.
- Cominco Ltd.**  
Smithers, BC  
Evaluated the groundwater inflows and groundwater pressures resulting from proposed remedial measures at closure of an open pit.
- GVRD**  
Annacis Island, BC  
Developed contractor specifications and reviewed the dewatering plans for installation of permanent flow monitoring stations.
- Armenonic**  
Ecuador  
Assessed the existing tailings pond dam and proposed additions. Included recommendations for monitoring and stability improvements.



<b>Cominco Ltd.</b> Pine Point, NT	Conducted computer modelling of the groundwater regime. Assessed dewatering schedule and procedures. Included training of mine staff in model utilisation
<b>PetroCanada Ltd.</b> Chetwynd, BC	Modelled the groundwater flow regime at a proposed open pit mine to assess groundwater inflow and dewatering requirements.
<b>Westmin Resources</b> Myra Creek, BC	Characterised the groundwater regime and determined the source of acid rock drainage. Assisted in the design of remedial measures
<b>Fording Coal</b> Elkford, BC	Assessed the tailings dam leakage and designed a leakage retrieval system.
<b>Effects of Open Pit Mine on Groundwater Supply</b> Fife Lake, SK	Evaluated the impacts of an open pit coal mine in Southern Saskatchewan on the quality and quantity of groundwater at a nearby town.
<b>Polygon Development</b> Coquitlam, BC	Assessed excavation inflows at a condominium development, designed the underdrain and the dewatering plan for excavation.
<b>Mine Decommissioning</b> Whitehorse, YT	Developed computer models to assess groundwater flow following decommissioning of an underground mine. Included evaluation of changes in groundwater discharge volumes as a result of decommissioning of mine tailings and rock waste dump.
<b>Tar Sands Development</b> Fort McMurray, AB	Assessed the groundwater regime at a proposed tar sands development in Northern Alberta. Included computer model to estimate mine inflow and to develop mine dewatering strategies.
<b>Uranium Mine</b> Northern Saskatchewan	Developed computer model of groundwater regime at a proposed underground uranium mine. Analyses included assessment of mine inflows to various mine works scenarios and the effect of grouting on mine inflow and water pressures.
<b>Open Pit Coal Mine</b> Wabamum Lake, AB	Modelled the groundwater regime at a open pit coal mine to evaluate the impact of the mine on the regional groundwater system and supply.
<b>Coal Washing Reservoir</b> Gravelbourg, SK	Characterised the groundwater regime beneath a proposed coal washing reservoir. Included computer model analysis to determine the effect of high water levels in lagoon on the regional groundwater flow system and on groundwater supply.
<b>Potash Mine</b> Esterhazy, SK	Carried out model analysis of groundwater regime to determine approximate location and chronology of leaks at a potash mine. Included analysis of several hundred drill stem tests to determine formation transmissivities.
<b>Coal Aquifers</b> Alberta	Conducted a study to characterise the hydraulic parameters of coal aquifers in Alberta. Included analyses of hundreds of pumping tests to determine effect of fracturing on transmissivity and storativity of coal seams.



## PROJECT EXPERIENCE – GROUNDWATER REMEDIAL STUDIES AND ENVIRONMENTAL ASSESSMENTS

**Former Metal Tube Manufacturer**  
Annacis Island, BC

Characterised the groundwater flow, contaminant transport, and NAPLs migration. Chemicals of concern included metals, PCBs, and volatile organic compounds. Designed groundwater contaminant remedial measures.

**Expo '86**  
Vancouver, BC

Characterised the soil and groundwater contamination and assessed the groundwater regime and flow conditions. Conducted numerical modelling of groundwater flow system to assess groundwater remedial measures. Designed groundwater collection measures and the monitoring required to evaluate the performance of those remedial measures.

**Ship Yards**  
Vancouver, BC

Directed groundwater modelling investigations to assess remedial options at a shipyard adjacent to Burrard Inlet. The influences of tidal fluctuations and seawater intrusion were incorporated into the model. Modelling was used to optimise the design of the selected remedial option.

**Premier Landfill**  
North Vancouver, BC

Designed a leachate collection system and long-term monitoring system to assess leachate collection efficiency.

**Braid Street Site – Former Wood Treatment Facility**  
Coquitlam, BC

Directed groundwater modelling investigations to optimise pump and treat system to capture dissolved phase plume at a wood treatment plant influenced by ocean tides. Designed groundwater remedial measures that incorporated the effects of tidal fluctuations and seasonal changes on groundwater flow.

**Chemical Plant**  
Delta, BC

Characterised the groundwater flow regime and contamination beneath a former chemical plant. Conducted numerical modelling to assess various remedial action measures and the design of groundwater remedial measures.

**Pinetree Golf Course**  
Delta, BC

Characterised the groundwater regime and conducted computer modelling to evaluate the effect of a proposed golf course on the groundwater flow conditions.

**Oak Street Site**  
Vancouver, BC

Directed groundwater modelling to design groundwater collection system to capture dissolved phase plume and to arrest the movement of DNAPL. The effects of ocean tides and seasonal changes in river stage were incorporated into the remedial design.

**Former Lumber Mill**  
Esquimalt, BC

Assessed the groundwater regime and contaminant plume consisting of elevated levels of chlorophenols at a former lumber mill. Modelled the groundwater regime and assessed the efficiency of various groundwater collection measures. Designed collection wells and evaluated the proposed close-out procedures.

**Bell Pole Ltd.**  
Lumby, BC

Conducted stochastic computer modelling for the development of risk-based and site-specific remediation criteria. Evaluated the groundwater regime and contaminant transport at a former telephone pole dipping facility.

**Meadow Avenue Site – Former Wood Preserving Facility**  
Burnaby, BC

Provided senior technical review of modelling to assess groundwater and NAPL remedial measures. The effects of tidal fluctuations and seasonal changes on groundwater flow conditions were included in the remedial design.



<b>Former Coal Gasification Plant</b> Vancouver, BC	Conducted computer modelling to assess remedial measures at a former coal gasification plant. Designed groundwater collection measures and evaluated the long-term groundwater chemistry for treatment design.
<b>BC Hydro</b> Vancouver, BC	Characterised the groundwater, soil, and NAPL contamination at a substation. Contamination originated from a former coal gasification plant located on adjacent property.
<b>Newmont Gold Company</b> Indonesia	Characterised groundwater flow regime and chemistry at a proposed mine site. Conducted numerical modelling to assess affect of mine development on groundwater chemistry, surface water chemistry, and on the groundwater flow conditions.
<b>Jet Fuel Tank Farm</b> Richmond, BC	Characterised contamination beneath a jet fuel farm. Designed remedial measures to remove and control contaminants in subsurface.
<b>Mine Remediation and Expansion</b> Myra Creek, BC	Characterised groundwater regime and groundwater contamination at a mine on northern Vancouver Island. Determined the source of acid rock drainage. Assisted in the design of remedial measures
<b>Whonnock Lumber</b> Haney, BC	Conducted drilling and well installation program. Characterised groundwater contaminant plume consisting of chlorophenols. Developed remedial measures.
<b>Government of Saskatchewan</b> Fife Lake, SK	Evaluated environmental impacts of an open pit coal mine on the quality and quantity of groundwater at a nearby town. Consisted of well survey and collection of water samples over several years to determine the groundwater flow conditions and temporal changes in water chemistry.
<b>City of Vernon</b> Vernon, BC	Conducted groundwater modelling of a proposed waste disposal site to determine if it was sufficiently isolated from surface water bodies.
<b>Whitehorse Copper Ltd.</b> Whitehorse, YT	Carried out environmental impact assessment of a former mine site. Included modelling to assess groundwater flow conditions following mine decommissioning and close-out.
<b>Arctic and Sub-Arctic</b> Northern Canada	Assessed the environmental impact of various drilling mud disposal methods in the Canadian Arctic and Sub-Arctic.
<b>Brine Storage Pond</b> Drumheller, AB	Conducted groundwater field investigations of a proposed brine storage pond in Southern Alberta. Included evaluation of soil hydraulic conductivity and groundwater flow regime.
<b>Alberta Environment</b> Lethbridge, AB	Characterised the groundwater regime and flow conditions at the Blood Indian Reserve in Alberta. Included model studies of the impact on the groundwater system resulting from irrigation and the potential for soil salinization.



## PROJECT EXPERIENCE – COMPUTER MODEL CODE DEVELOPMENT AND ASSESSMENT

**Groundwater Transport Model,**  
**Ministry of Environment**  
British Columbia

Developed groundwater transport model that simulates the movement of a contaminant from the soil to the groundwater and the movement of the groundwater contaminant to the receptor. Model is used to develop site-specific standards under the Contaminated Sites Regulation (CSR) for British Columbia.

**Stochastic Contaminant Model,**  
**Bell Pole**  
British Columbia

Developed a stochastic model to determine risk-based remediation criteria at a former wood treatment facility.

**Multiaquifer Systems,**  
**University of Waterloo**  
Ontario

Developed a finite element model for analysis of multi-aquifer systems. Included development of analytical and one-dimensional models to represent vertical flow through aquitards.

**Fracture System,**  
**University of British Columbia**  
Vancouver, BC

Developed a computer model for randomly selected three-dimensional fracture systems.

**Evaluation of Groundwater Flow and Chemistry Models,**  
**University of Alberta**  
Edmonton, AB

Provided an inventory of available groundwater flow and chemistry models and the potential applications of the models.

## PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF OPEN PIT MINE DEVELOPMENT

**Rea Gold Company**  
Uruguay

Characterised the groundwater regime prior to mine development. Numerical modelling was conducted to assess mine inflows and depressurisation for slope stability purposes and the potential impacts of mine development of nearby surface water and groundwater supply.

**Highland Valley Copper**  
Kamloops, BC

Provided on-going monitoring, evaluation, and design of dewatering program for slope stability purposes at an open pit mine in south-central British Columbia. Presently, the dewatering system pumps a total of over 28,000 m<sup>3</sup>/day from overburden materials. Modelling conducted to assess future dewatering requirements.

**Newmont Gold Company**  
Batu Hijau Project,  
Indonesia

Assessed dewatering requirements and the effects of dewatering, pit lake formation; and waste rock, on groundwater and surface waters. Conducted numerical modelling of groundwater regime to evaluate mine inflows over life of mine.



<b>Diavik Diamond Project</b> NWT	Provided on-going hydrogeological investigations to determine groundwater inflows to a mine located near Yellowknife. Duties included conducted permeability tests in deep exploratory boreholes, design of deep groundwater sampling device, conducting a pumping test in an exploratory decline, and modelling to assess mine inflows, dewatering systems and strategies, and remedial measures. Acted as expert witness during project approval process.
<b>Cominco</b> NWT	Conducted feasibility level investigations to determine hydrogeological regime and to estimate flows to proposed open pit mine. Conducted modelling investigations to estimate inflows to proposed open pit and design preliminary dewatering process.
<b>Newmont Gold Company</b> Mesel Project, Indonesia	Provided recommendations on well installations and testing, to be conducted by the owner to characterise the hydrogeology at a mine site. Conducted numerical modelling to assess mine depressurisation for slope stabilisation.
<b>Cominco Ltd.</b> Smithers, BC	Evaluated the groundwater inflows and groundwater pressures following installation of proposed remedial measures at a closure of an open pit mine. Included numerical modelling to assess proposed closure measures.
<b>Meadowbank</b> Nunavut	Hydrogeological Lead in the Environmental assessment for gold deposit in Nunavut. Included development of Baseline studies, numerical modelling to assess effects of project on groundwater regime and pathways to other receptors.
<b>Royal Oak Mines</b> NWT	Modelling to assess pit lake formation and groundwater flow conditions under long term equilibrium conditions.
<b>Armenonic</b> Ecuador	Assessed the existing tailings pond dam and proposed additions. Included recommendations for monitoring and slope stability improvements.
<b>Teck Corporation</b> Chile	Modelling to predict pit lake formation and long-term groundwater flow conditions.
<b>Cominco Ltd.</b> Pine Point, NWT	Computer modelling of groundwater regime. Assessment of dewatering schedule and procedures. Included training of mine staff in model utilisation.
<b>PetroCanada Ltd.</b> Chetwynd, BC	Modelling of groundwater flow regime at a proposed open pit mine to assess groundwater inflow.
<b>Fording Coal</b> Elkford, BC	Assessed tailings dam leakage and designed leakage retrieval system.
<b>Effects of Open Pit Mine on Groundwater Supply</b> Fife Lake, SK	Evaluated the impacts of an open pit coal mine in Southern Saskatchewan on the quality and quantity of groundwater at a nearby town. Conducted domestic water well survey and collected water samples over two years to assess impacts.
<b>Tar Sands Development</b> Fort McMurray, AB	Assessed the groundwater regime at a proposed tar sands development in Northern Alberta. Included computer model to estimate mine inflow and to develop mine dewatering strategies.



- Open Pit Coal Mine**  
Wabamum, AB  
Conducted modelling of the groundwater regime at a open pit coal mine, to evaluate the impact of the mine on the regional groundwater system and resource.
- Coal Washing Reservoir**  
Gravelbourg, SK  
Characterised the groundwater regime beneath a proposed coal washing reservoir. Included computer model analysis to determine the effect of high water levels in lagoon on the regional groundwater flow system and on groundwater supply.
- Coal Aquifers**  
Alberta  
A study to characterise the hydraulic parameters of coal aquifers in Alberta. Included analyses of hundreds of pumping tests to determine effect of fracturing on transmissivity and storativity of coal seams.

## PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF UNDERGROUND MINE DEVELOPMENT

- Teck Corporation**  
Alaska  
Conducted studies to estimate mine inflow and to assess dewatering and grouting strategies at a proposed underground mine. Included packer testing, installation of monitoring wells, water sampling, pumping tests and numerical modelling. Designed wells for the injection of treated mine water during the development of exploration decline. Providing on-going hydrogeological assessment for full mine development.
- Giant Mine**  
Northwest Territories  
Conducted hydrogeological investigations related to an existing and a recently excavated arsenic stope. Conducted permeability testing and hydraulic head measurements in the pillar between stopes. Recommended the installation of a drainage galley beneath the two stopes to promote dewatering of the stopes. Drainage galley was nearing completion when the mine was shut-down.
- Winspear**  
Northwest Territories  
Provide hydrogeological services to the EIS and Feasibility mine plan. Investigations have included the installation of piezometers, permeability testing and water sampling. Computer modelling was undertaken to estimate mine inflows during the exploration decline and at the planned full mine development.
- Pend Oreille**  
Washington  
Hydrogeological investigations related to mine expansion. Investigations included permeability testing and hydraulic head measurement of proposed shaft development. Computer modelling was undertaken to estimate inflows to shaft development. Provide recommendations on mine dewatering strategies and grouting procedures.
- Turquoise Ridge**  
Nevada  
Hydrogeological investigations to develop dewatering strategies to improve trafficability in production areas. Included 3-D visualization of underground development, geology, structure and measurements of groundwater inflow during drilling of long exploration holes. The structure and geology were correlated to high inflows in order to identify major groundwater pathways that can be intercepted and drained prior to mining.

**Asia Pacific**  
Thailand

Conducted pre-feasibility and feasibility hydrogeological investigations of a proposed underground potash mine. Including pumping tests, installation of monitoring wells, water sampling and numerical modelling. Estimated mine inflows and water supply potential and provided conceptual dewatering strategies.

**Polaris Mine**  
Cornwallis, NWT

Provided testing procedures to determine hydrogeological properties at a proposed underground mine expansion. Numerical modelling was conducted to assess mine inflow at a planned expansion.

**Raglan**  
Northern Quebec

Undertook and groundwater benchmark study that examined potential groundwater issues that could result if underground mining progressed below the permafrost zone. The quantity of inflow to this mine was of a particular concern as the ventilation in the underground is not heated. All previous mining was within the permafrost. Studies included review of thermal regime data, groundwater inflows to boreholes drilled below the permafrost, regional water level elevations of large lakes in area, geology and hydrogeologic projects with similar hydrogeologic and thermal regimes.

**Red Mountain**  
Smithers, BC

Conducted hydrogeological investigations to assess hydrogeological conditions and to estimate mine inflows to proposed underground mine.

**Westmin Resources**  
Myra Creek, BC

Characterised the groundwater regime and determined the source of acid rock drainage. Investigation included installation of wells, permeability testing and water sampling. Assisted in the design of remedial measures.

**Uranium Mine**  
Northern Saskatchewan

Developed a computer model of the groundwater regime at a proposed underground uranium mine. Analyses included assessment of mine inflows to various proposed mine plans and the effect of grouting and/or dewatering on mine inflow and water pressures.

**Potash Mine**  
Esterhazy, SK

Model analysis of groundwater regime to determine approximate location and chronology of leaks at an underground potash mine. Included analyses of several hundred drill stem tests to determine formation transmissivities and numerical modelling.

**Hudson Bay Mining  
and Smelting**  
Manitoba

A study to estimate groundwater inflow and recommend dewatering strategies in underground mines at Photo Lake and Kunoto Lake.

**Eldorado Gold  
Corporation**  
Turkey

A study to estimate groundwater inflow to a proposed underground mine and to assess the effects of mining on the groundwater and surface water regime.

**Homestake**  
British Columbia

Hydrogeological study including pumping tests, inflow mapping, structural modelling and packer testing. Groundwater inflow was estimated for the life of the mine. Dewatering wells were designed and installed. Dewatering strategies were determined.



<b>Snap Lake</b> Northwest Territories	Provided technical assistance on hydrogeology components of an environmental assessment and in hearings relate to project approvals and permitting. Included characterization of the regional groundwater flow regime and the prediction of the direction, travel time and contaminant transport of dissolved metals originating from the mine following closure of the mine. The environmental assessment was approved in late 2003.
<b>TVX Gold</b> Eastern Europe	Assessment of groundwater inflow to a proposed underground mine. Included the development of a computer model that was calibrated to measured inflows to preliminary mine development.
<b>Diavik Diamond Project</b> Northwest Territories	Providing ongoing hydrogeological investigations to determine groundwater inflows to a mine located near Yellowknife. Duties have included conducting permeability tests in deep exploratory boreholes and conducting pumping tests in the underground mine. Numerical hydrogeological modelling was undertaken to assess mine inflows, dewatering systems, dewatering strategies and remedial measures. Drainage galleries consisting of 4 to 6 drainholes were designed and installed at approximately 75 m depth intervals in the underground mine. Acted as expert witness during project approval process.
<b>Jullietta</b> Former U.S.S.R	Groundwater investigations at a proposed underground mine to assess groundwater inflows. Groundwater model was developed and calibrated to inflows to advanced exploration program.
<b>T'Sable River</b> British Columbia	Groundwater investigations to assess groundwater inflows to an exploration decline. Investigations included flow meter testing, permeability testing, piezometer installation and computer modelling. The potential for saline water intrusion will be assessed.

## PROFESSIONAL AFFILIATIONS

- Member, Association of Professional Engineers and Geoscientists of the Province of British Columbia
- Member, Association of Professional Engineers, Geologists & Geophysicists of Alberta
- Member, Association of Professional Engineers, Geologists & Geophysicists of the Northwest Territories
- Member, International Association of Hydrogeologists

## PUBLICATIONS

### Other

Romano, C., W. Zawadzki, D.W. Chorley, D.M. Mchaina, T. Pallop, and J. Yuke. 2009. Design of open pit dewatering system – Minago Project, Grand Rapids, Manitoba. in Proceedings of 62nd Canadian Geotechnical Conference and 10th Joint CGS/IAH-CNC Groundwater Conference, Halifax, NS.

Chorley, D.W., Pesendorfer, M., Zawadzki, W., Rogers, S., Beddoes, R., Greer, S. 2009. Northwest Wall – Hydrogeological Characterization – Diavik Diamond



Mine, Northwest Territories, Canada. to be published in Proceedings of the International Conference SLOPE STABILITY 2009, Santiago, Chile.

Pesendorfer, Marc, Chorley, Don W., and Greer, Sarah. July 2008. "Flow Recession Test to Characterize Deep Hydrogeologic Regime, Northwest Territories, Canada." Water in Mining, I International Congress on Water Management in the Mining Industry, Santiago, Chile, Editor. Dr. Jacques Wiertz.

Zawadzki, Willy, Chorley Don W., Chance, Al, Scholte, John and Warnock, George. 2008. "Design of Pit Wall Depressurization System – Highland Valley Copper, Logan Lake, BC." Proceedings of Joint IAH-GNC Conference, Edmonton, AB.

Bieber, C., Moffitt, K., Chorley, Don W., Zawadzki, Willy, and Greer, S. 2007. "Detailed Evaluation of Pit Slope Stability in Fractured Rock and Kimberlite Slope – Diavik Diamond Mine, NWT." In Proceedings of 60th Canadian Geotechnical Conference and 8th Joint CGS/IAH Groundwater Conference, Ottawa, ON.

Reinson, J. R., Chorley, Don W., Rogers, S.F., Wozniewicz, J.V., and Zawadzki, Willy. 2007. "Influence of highly permeable geologic structure on inflows to A154 N/S Open Pit, Diavik Diamond Mines Inc., Lac de Gras, NWT." In Proceedings of USEPA/NGWA Fractured Rock Conference. Portland, Maine.

Bieber, C., Chorley, Don W., Zawadzki, W., and Reinson, J.R. 2006. "Hydrogeologic Data Collection and Development of Conceptual Models to Predict Mine Inflow Quantity and Quality at Diavik Diamond Mine, NWT." In Proceedings of 59th Canadian Geotechnical Conference and 7th Joint CGS/IAH Groundwater Speciality Conference, Vancouver, BC. (invited paper)

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Zawadzki, W., Chorley, Don W., and O'Hara, G. 2006. "Evaluation of Remedial Alternatives to Capture a Dissolved Phase Plume in the Presence of Seawater Wedge – Britannia Mine, British Columbia." In Proceedings of 59th Canadian Geotechnical Conference and 7th Joint CGS/IAH Groundwater Speciality Conference, Vancouver, BC. (invited paper)

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Zawadzki, W., Chorley, Don W., and O'Hara, G. 2002. "Design and Verification of DNAPL Hydraulic Containment System Adjacent to the Fraser River Estuary, British Columbia." In Proceedings of the 55th Canadian Geotechnical and 3rd Joint IAH-CNC and CGS Groundwater Specialty Conferences Ground and Water: Theory to Practice, Niagara Falls, ON.



Zawadzki, W., Chorley, D.W., and Patrick, G. 2002. "Capture Zone Design in an Aquifer Influenced by Cyclic Fluctuations in Hydraulic Gradients." *Hydrogeology Journal* 10, no. 6: 601-609.

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Sargent, N., Chorley, Don W., and Coxon, P. June 1999. "Optimization of Groundwater Quality for Municipal Supply from the Fort St. John Aquifer, British Columbia, Canada." *American Water Works Association Conference*, Chicago, Illinois.

Chorley, Don W., Richards, M., Dobr, M., Chance, A., and Amon, F. May 1998. "Dewatering of Overburden at the Valley Pit, Highland Valley Copper, Logan Lake, BC." *Proceedings of CIM Conference*, Montreal, Quebec.

Chorley, Don W., Zapf-Gilje, R., Rankin, M.G., and Garay, E. 1995. "Application of Stochastic Contaminant Groundwater Model for Development of Risk-based Remediation Criteria at a Chlorophenol Wood Treatment Operation." *Proceedings of the IAH Conference*, Edmonton, Alberta.

Chorley, Don W., Zapf-Gilje, Reidar, Conlin, Brian H., Ord, Roger S. Feb. 1992. "Groundwater modelling to assess remedial action alternatives at Pacific Place site in Vancouver, B.C., Canada." *Proceedings of the 1992 Solving Ground Water Problems with Models Conference*, Ground Water Management, vol.9, pp.247-263.

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Smith, L., Mase, C.W., Schwartz, F.W., and Chorley, Don W. 1985. "A numerical model for transport in networks of planar fractures." *Memoires - Association Internationale des Hydrogeologues Memoires - International Association of Hydrogeologists*, vol.17, no.1, pp.666-675.

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Schwartz, Franklin W., Muehlenbachs, Karlis, and Chorley, Don W. Nov. 1981. "Flow-system controls of the chemical evolution of groundwater." *Journal of Hydrology*, vol.54, no.1-3, pp.225-243, Editor: Back, William; Letolle, Rene.

Chorley, D.W. and Frind, E.O., Oct. 1978. "An iterative quasi-three-dimensional finite element model for heterogeneous multi-quitifer systems." *Water Resources Research*, vol.14, no.5, pp.943-952.



**Education**

*M.E.Des. Environmental Science, University of Calgary, 1998*

*B.Sc. (Dean's Honour List) Aquatic Ecology, University of British Columbia, 1994*

**Calgary**

**Career Summary**

Kasey is a fisheries biologist with 15 years of experience. Kasey has been involved as the project manager or fisheries discipline lead on numerous aquatic assessment projects for pipelines, roads, water intake structures, and instream construction projects on rivers throughout Alberta. Kasey has experience as the project manager for large-scale projects, including water intake monitoring programs and habitat compensation monitoring programs in the Oil Sands Region, and component lead for the baseline fisheries study and EIA for a SAGD project. Kasey has been the instream flow needs specialist and project manager on instream flow needs projects throughout Alberta, including studies on the Elbow River, Athabasca River, Sturgeon River, and the Lesser Slave River.

**Employment History**

**Golder Associates Ltd. – Calgary, Alberta**

*Associate, Fisheries Biologist (2003 to Present)*

Project manager and fisheries component lead for a range of instream flow needs studies throughout Alberta, fish and fish habitat baseline and monitoring studies in the oil sands region of Alberta, and water intake assessment studies. Manager of the Fisheries Group in the Calgary office from 2004–2006.

**Alberta Fish and Wildlife Division – Cochrane, Alberta**

*Instream Flow Needs Biologist (1998 to 2003)*

As a member of the provincial instream flow needs program, responsible for project planning and implementation of one-dimensional and two-dimensional IFN field programs, habitat modelling and data analysis of 1-D and 2-D data, collection of habitat suitability data by snorkelling, report writing, and peer reviewing external reports. Duties also included contract management of departmental projects and representing the Department as a member of several multi-disciplinary committees.

**Alberta Environmental Protection – Calgary, Alberta**

*Environmental Planner (1997 to 1998)*

Designed and implemented a recreation IFN project for the Bow River.

**Golder Associates Ltd. – Calgary, Alberta**

*Fisheries Technician (1996)*

Assisted with boat electrofishing on large rivers in Alberta and Saskatchewan.

**AGRA Earth and Environmental – Calgary, Alberta**

*Fisheries Technician (1996)*

Assisted with a walleye stocking assessment program with sampling of walleye fry in Lac la Biche.



## PROJECT EXPERIENCE – INSTREAM FLOW NEEDS

**Lesser Slave River  
Instream Flow Study**  
Slave Lake, AB, Canada

Project manager for study to define field program and to conduct River 2D hydraulic modelling for open-water and ice-covered conditions on one reach of the Lesser Slave River. Produced a technical report on field data collection and hydraulic modelling results

**Little Jackfish River  
Instream Flow Study**  
Thunder Bay, ON,  
Canada

Project manager for study to define field program and to conduct River 2D hydraulic and habitat modelling for open water conditions on one reach of the Little Jackfish River to define a minimum bypass flow for a hydroelectric development. Produced a technical report on field data collection, hydraulic and habitat modelling results and a recommendation for a bypass flow.

**Confidential Project  
Instream Flow Study**  
NWT, Canada

Technical lead to access project related flow impacts and to recommend a mitigation flow regime to reduce impacts on the fish community downstream of the project.

**Milk River Instream  
Flow Needs Study**  
Milk River, AB, Canada

Project manager for study to define study scope, select study sites, define field program, conduct River 2D hydraulic and habitat modelling and complete water quality modelling using the WASP model. Produced an integrated IFN approach with consideration of fish habitat, water quality and riparian flow needs.

**Muskeg River Instream  
Flow Needs Study**  
Muskeg River, AB,  
Canada

Project Manager for study to select study sites, collect field data and conduct River 2D hydraulic and habitat modelling at four sites on the Muskeg river to evaluate proposed changes in the flow regime. Study also consisted of dissolved oxygen modelling and an assessment of geomorphic change due to altered flows.

**Whitemud Flow Needs  
Study**  
Winnipeg MB, Canada

Project director for study to select study sites, collect field data and conduct River 2D modelling at two sites on the Whitemud River.

**Athabasca River  
Instream Flow Needs  
Scoping**  
Fort McMurray AB,  
Canada

Project manager and fisheries component lead for developing a scope of work for conducting an instream flow needs study for the Athabasca River. Planned and hosted an expert workshop for defining winter IFN requirements.

**Lesser Slave Lake  
Instream Flow Needs  
Scoping**  
Slave Lake AB, Canada

Project manager and fisheries component lead for developing a scope of work for conducting a water level needs study for the Lesser Slave Lake.

**Lesser Slave River  
Instream Flow Needs  
Scoping**  
Slave Lake AB, Canada

Project manager and fisheries component lead for developing a scope of work for conducting an instream flow needs study for the Lesser Slave River.

**North Saskatchewan  
River Instream Flow  
Needs Scoping**  
Edmonton AB, Canada

Project manager and fisheries component lead for developing a scope of work for conducting an instream flow needs study for the North Saskatchewan River.



**Sturgeon River  
Instream Flow Needs  
Scoping**  
Stony Plain AB, Canada

Project manager and fisheries component lead for developing a scope of work for conducting an instream flow needs study for the Sturgeon River.

**Marshel River Instream  
Flow Needs Study**  
Washington, United  
States

Instream flow needs specialist of the project team responsible for establishing the field program, negotiating study requirements with the regulators, conducting the PHABSIM analysis and report preparation.

**Alberta IFN  
Classification Study**  
Fort McMurray AB,  
Canada

Member of the project team to test the validity of a classification system developed for transferring IFN results from measured streams to unmeasured streams in Alberta. Duties included project management for the field program to collect data at over 40 sites in southern Alberta, data analysis, and report preparation.

**Little Spokane River**  
Washington, United  
States

Conducted a PHABSIM analysis (using the windows-based PHABWin-2002 software) on the Little Spokane River and its tributaries for the WRIA 55/ 57 Watershed Planning Unit for the purpose of re-evaluating the existing minimum instream flows.

**South Saskatchewan  
River Basin Instream  
Flow Needs Re-  
evaluation**  
Alberta , Canada

As a member of an interdisciplinary team with the responsibility of redefining the instream flow needs for the major rivers within the South Saskatchewan River Basin for the protection of the aquatic ecosystem, the team developed and applied a new approach for defining an ecosystem based IFN. The team incorporated information from fish habitat, water quality, riparian vegetation, and channel structure studies to provide an integrated IFN determination for the protection of the aquatic ecosystem for 27 different reaches within the South Saskatchewan River Basin. Specific responsibilities included conducting the fish habitat modelling using PHABWin-2002 and development of a data analysis tool for fish habitat time series evaluations, developing the integration protocol and integration spreadsheet tool, and report preparation.

**Highwood River  
Instream Flow Needs**  
Alberta, Canada

As a member of a panel of instream flow experts, conducted a re-analysis of data from previous instream flow studies on the Highwood River and developed new instream flow recommendations for that river. Also a principal author of the final report of the expert panel and developed the data analysis spreadsheet tool used in making the fish habitat recommendation.

**Kananaskis River  
Instream Flow Needs**  
Alberta, Canada

As a member of the multidisciplinary Fisheries and Recreation Enhancement Working Group and the River Fisheries sub-group, conducted an effective habitat evaluation of a hydro-peaking operation using PHABWin and WinHabTime software developed by Utah State University. The working group provided a final recommendation based on alternate scenario evaluations that incorporated elements of fish habitat and recreation requirements for both the reservoir and downstream river reach, as well as including an economic analysis for each scenario.



**Athabasca River  
Instream Flow Needs**  
Alberta, Canada

As a member of the IFN sub-group of the Surface Water Working Group within CEMA (Cumulative Environmental Management Association), provided technical expertise and advice in outlining a project strategy for determining instream flow needs on a large northern river with a particular focus on developing tools for evaluation of fish habitat under ice. Specific tasks included defining the reach boundaries and study site locations for collecting field data for use with a 2-dimensional hydrodynamic model.

**Sheep River Instream  
Flow Needs**  
Alberta, Canada

Responsible for project planning, implementation, data collection, field logistics and data analysis for an IFN study on the Sheep River. The bed topography was surveyed using a total station and the data was entered into River2D for two-dimensional hydraulic and habitat modelling. Tasks also included constructing the bed and mesh files required to run the River2D program

**Elbow River Instream  
Flow Needs**  
Alberta, Canada

Responsible for project planning, implementation, data collection, field logistics and data analysis for an IFN study on the upper Elbow River using PHABSIM. Transects were established and depth, velocity, substrate and water surface elevation data was collected at four study sites. One-dimensional modelling was conducted using the windows version of PHABSIM (PHABWin) developed by Utah State University

**Alberta Instream Flow  
Needs Classification  
Project**  
Alberta, Canada

Member of the steering committee, working group, and participant in expert workshops to develop a cost-effective, science based IFN method for Alberta. The project involves developing a classification system and a method for transferring instream flow needs from measured streams to unmeasured streams. The objective of the project is to provide water managers with a cost effective, science-based tool for defining IFN values across the province.

**Habitat Suitability  
Curve Development**  
Alberta, Canada

Collected habitat use observations by direct underwater observation in a variety of streams in southern Alberta and took measurements of habitat parameters (depth, velocity, substrate, and cover) to be used in habitat modelling. Species of interest included bull trout, mountain whitefish, cutthroat trout, rainbow trout and brown trout.

**Habitat Suitability  
Curve Workshops**  
Alberta, Canada

Assisted in organizing, compiling background information, and participating in a series of expert workshops to develop regional habitat suitability curves for use in IFN evaluations in southern Alberta.

**Recreation Instream  
Flow Needs**  
Alberta, Canada

Designed and implemented a study to evaluate recreation instream flow needs on the Bow River below a hydro-peaking dam and provided recommendations to optimize the recreational opportunities. The primary study approach involved a user survey as well as conducting a multiple flow evaluation experiment with a group of expert users.



## PROJECT EXPERIENCE – NO NET LOSS PLANS

**Shell Jackpine Mine  
Expansion NNLP**  
Fort McMurray AB

Fish and fish habitat component lead in support of obtaining project regulatory approval, EIA support and development of the detailed no-net-loss plan (NNLP). The NNLP development includes assessment of habitat losses using an HEP-type analysis, design support for a large compensation lake, and regulatory and First Nations consultation.

**Muskeg River Mine  
Expansion NNLP**  
Fort McMurray AB

Project direction providing review and oversight to evaluating multiple compensation options to support a Fisheries Act approval for an approved mine. Plan development included water quality modelling, hydrologic feasibility assessment, habitat losses and gains modelling and regulatory and First Nations consultation.

## PROJECT EXPERIENCE – BASELINE AND MONITORING STUDIES

**CNRL Compensation  
Lake Monitoring**  
Fort McMurray AB

As the project manager has been responsible for the design and implementation of a monitoring program to determine the success of constructed compensation lake habitat to satisfy requirements under the Fisheries Act.

**Shell Grosmont  
Venture**  
Wabasca AB

Provided senior review and direction for baseline field data collections and reporting to support an in-situ regulatory application for oil sands development.

**CNRL Fish Salvage**  
Fort McMurray AB

Project Manager for a fish salvage program to remove fish from a 40 km length of river and transport the fish for release in an adjacent water course.

**CNRL Fisheries and  
Aquatic Monitoring  
Program**  
Fort McMurray, Alberta,  
Canada

As the project manager, responsible for developing, planning and implementing a multi-year, multi-season fish and fish habitat monitoring program for the purpose of supporting the habitat compensation requirements as defined in the Fisheries Act authorization for the Horizon Oil Sands Project.

**CNRL Primrose East  
EIA**  
Cold Lake, Alberta,  
Canada

As the fisheries discipline lead, responsible for planning and managing a seasonal fisheries program and preparation of baseline and impact assessment reports in support of the Primrose East EIA.

**CNRL Burbot  
Monitoring Program**  
Fort McMurray, Alberta,  
Canada

As the fisheries discipline lead, responsible for planning and managing a seasonal burbot monitoring program on the Athabasca River using a wide range of sampling techniques in support of the Horizon Project.

**CNRL Tar River  
Tributary Fish Salvage**  
Fort McMurray, Alberta,  
Canada

As the project manager and fisheries discipline lead, responsible for planning and managing a fish salvage on tributaries to the Tar River and report preparation for submission to Fisheries and Oceans Canada in support of a Section 35(2) Authorization.

**CNRL Tar River Fall  
Inventory**  
Fort McMurray, Alberta,  
Canada

As the project manager and fisheries discipline lead, responsible for planning and managing the field program and reporting on a fall fisheries inventory within Reach 1 of the Tar River.



## PROJECT EXPERIENCE – RIVER WATER INTAKES

**CNRL Intake  
Monitoring**  
Fort McMurray AB

Project manager for monitoring program to evaluate the effectiveness of fish screens at excluding fish as per the design specifications at a water intake in the Athabasca River.

**Imperial Oil Resources  
Kearl Water Intake**  
Fort McMurray AB

As the fisheries component lead, responsible for preparing the fisheries assessment and compensation plan in support of an Application to Fisheries and Oceans Canada for the construction and operation of a water intake facility on the Athabasca River for the Kearl Project.

**Petro Canada Fort Hills  
Water Intake**  
Fort McMurray AB

As the fisheries component lead, responsible for preparing the fisheries assessment and compensation plan in support of an Application to Fisheries and Oceans Canada for the construction and operation of a water intake facility on the Athabasca River for the Fort Hills Project.

**CNRL Water Intake  
Fisheries Assessment**  
Fort McMurray AB

As the fisheries discipline lead, responsible for preparing the fisheries assessment and compensation plan in support of an Application to Fisheries and Oceans Canada for the construction and operation of a water intake facility on the Athabasca River for the Horizon Project.

**Albian Sands Water  
Intake Monitoring**  
Fort McMurray AB

Project manager for a fisheries and water quality monitoring program at the Albian Sands water intake on the Athabasca River. This project required monitoring and report preparation for submission to Fisheries and Oceans Canada as a requirement of Section 35(2) Authorization and Section 30 Approval.



**Education**

*Ph.D. Biology, University of Saskatchewan, Saskatchewan, 2009*

*B.A. Communication, University of Toledo, Ohio, 1992*

**Certifications**

*Bear Safety, May, 2009*

*Arctic Survival Skills, February, 2009*

*Wilderness First Aid, March, 2008*

*CPR, March, 2008*

*Firearms Possession and Acquisition, July, 2002*

**Languages**

*English – Fluent*

**Golder Associates Ltd. – Yellowknife**

***Wildlife Biologist***

Population ecology specialist involved with terrestrial wildlife assessments. Services include study design, data collection and analysis and communicating results.

**Employment History**

***University of Saskatchewan – Saskatoon, Saskatchewan***

*Graduate Research Assistant (2002 to 2008)*

Conducted original research in population ecology. Responsibilities included literature review, writing research proposals, securing funding, collecting and analyzing data and communicating results through presentations, reports, and scientific journals.

***Canadian Wildlife Service – Yellowknife, Northwest Territories***

*Contracted Biology Analyst (2008)*

Analyzed data sampled from 1907-2007 literature sources to delineate critical reproductive periods for migratory birds in the Northwest Territories and Nunavut.

***Environment Canada – Cardinal Lake, Northwest Territories***

*Contracted Research Technician (Spring to 2008)*

Conducted population and mark-recapture surveys of lesser scaup (*Aythya affinis*) and white-winged scoter (*Melanitta deglandi*) ducks in a remote arctic location southeast of Inuvik, Northwest Territories.

***Ohio Division of Wildlife – Oak Harbor, Ohio***

*Seasonal Research Technician (Fall to 2001)*

Conducted telemetry and visual surveys of laser-harassed urban Canada geese (*Branta canadensis*) at locations throughout the greater Cleveland area, Ohio.

***Delta Waterfowl Foundation – Egeland, North Dakota***

*Seasonal Research Technician (Summer to 2001)*

Conducted waterfowl population and nest surveys and monitored nests to determine productivity.

***Ducks Unlimited Inc. – Minot, North Dakota***

*Seasonal Research Technician (Summer to 2000)*

Located and monitored nests of upland nesting waterfowl to determine productivity.



## PROJECT EXPERIENCE – PROJECT EXPERIENCE

- Diavik Diamond Mine**  
Northwest Territories,  
Canada  
Comprehensive analysis report of environmental effects on wildlife in the Lac De Gras Region. March 2011.
- Gahcho Kue Diamond Project**  
Northwest Territories,  
Canada  
Planned and reported on wildlife baseline studies for caribou, grizzly bear, wolverine, raptors, and water birds supporting the Project's Environmental Impact Statement. November 2010.
- Migratory Bird Incidental Take Permit Applications**  
Northwest Territories,  
Canada  
Study for the Canadian Wildlife Service on the potential number of industry proponents and activities in Canada expected to apply for a migratory bird Incidental Take Permit. June, 2010.
- Diavik Diamond Mine**  
Northwest Territories,  
Canada  
Review and assessment of the wildlife impact predictions for the Diavik Diamond Mine using monitoring results from 1998 to 2008. March, 2010.
- L-68 Well Re-entry**  
Northwest Territories,  
Canada  
Terrestrial environmental setting survey and assessment for Canadian Forest Oil for well re-entry west of Fort Liard, NWT. December, 2009.
- Lutsel K'e Mini Hydro**  
Northwest Territories,  
Canada  
Terrestrial environmental setting survey and assessment for Northwest Territories Energy Corporation's mini hydro project on the Snowdrift River near Lutsel K'e, NWT. December, 2009.

## SUPPLEMENTAL SKILLS

### **Analytical software**

*SAS, version 9.1, JMP version 7.0, SPSS, Statistica, Programs MARK, PRESENCE and DISTANCE*

## PROFESSIONAL AFFILIATIONS

- American Ornithologists Union
- Society of Canadian Ornithologists

## PUBLICATIONS

- Refereed Journal Articles**  
Coulton, Daniel W., Robert G. Clark, David W. Howerter, Leonard I. Wassenaar and Michael G. Anderson. Costs and benefits of natal dispersal in yearling mallards *Anas platyrhynchos*. *Journal of Avian Biology*, 42 (2011), 123-133.



Coulton, Daniel W., Robert G. Clark, Leonard I. Wassenaar, David W. Howerter and Michael G Anderson. Social and habitat correlates of immigrant recruitment of yearling female Mallards to breeding locations. *Journal of Ornithology*, 152 (2011), 781-791.

Coulton, Daniel W., Robert G. Clark and Craig E. Hebert. Determining natal origins of birds using stable isotopes ( $\delta^{34}\text{S}$ ,  $\delta\text{D}$ ,  $\delta^{15}\text{N}$ ,  $\delta^{13}\text{C}$ ): Model validation and spatial resolution for mid-continent mallards. *Waterbirds*, 33 (2010), 10-21.

Coulton, D. W. , R. G. Clark, K. A. Hobson, L. I. Wassenaar and C. E. Hebert. Temporal sources of deuterium ( $\delta\text{D}$ ) variability in waterfowl feathers across a boreal-to-prairie gradient. *Condor*, 111 (2009), 255-265.

Coulton, Daniel W. and Robert G. Clark. An integrated stable isotope mark-recapture approach to modeling sources of population rescue. *Auk*, 125 (2008), 923-931.

### Conference Proceedings

Coulton, D. W. and R. G. Clark. 2009. *Reproductive experience and nest tunnel use by female mallards*. 5th North American Duck Symposium, August. Mississauga, Canada.

Coulton, D. W., R. G. Clark, D. W. Howerter, M. G. Anderson and L. I. Wassenaar. 2008. *Testing the site familiarity hypothesis by assessing consequences of natal dispersal decisions in yearling female mallards*. 126th meeting of the American Ornithologists Union, August. Portland, USA.

Coulton, D. W., R. G. Clark, C. E. Hebert, D. W. Howerter and M. G. Anderson. 2006. *Social and environmental cues influencing immigration rates of Parkland mallards*. 4th North American Duck Symposium, August. Bismarck, USA.

Coulton, D. W., R. G. Clark, C. E. Hebert and K. A. Hobson. 2006. *Sources of recruits in two prairie mallard breeding populations*. 4th North American Duck Symposium, August. Bismarck, USA.

Coulton, D. W., R. G. Clark, K. A. Hobson and S. Lariviere. 2004. *Sources of yearling recruits to local parkland mallard populations: identifying natal origin using D, 13C, and 15 N values in feathers*. 122nd meeting of the American Ornithologists Union, August. Quebec, Canada.

Coulton, D. W., R. G. Clark, K. A. Hobson and S. Lariviere. 2004. *Recruitment to local parkland mallard populations: identifying natal origin using D, 13C and 15N values in feathers*. 4th International Conference on Applications of Stable Isotope Techniques, April. Wellington, New Zealand.

Coulton, D. W., R. G. Clark, K. A. Hobson and S. Lariviere. 2003. *Exploring sources of immigrants to mallard populations by identifying natal origins of yearling birds using stable-hydrogen, -carbon and -nitrogen isotopes*. 3rd North American Duck Symposium, November. Sacramento, USA.



**Education**

*M.Sc. Applied Earth Sciences Hydrogeology and Environmental Geochemistry, University of Waterloo, Ontario, 1995*

*B.Sc. Applied Earth Sciences Geophysics, University of Waterloo, Ontario, 1992*

**Golder Associates Ltd. – Mississauga**

***Principal / Senior Hydrogeochemist***

Ken DeVos is a Principal in Golder's Mississauga office and currently manages the Mine Waste and Environment Division which consists of over 50 scientists and engineers focused on finding solutions to some of the mining industries most difficult problems. Ken has worked as task lead, project manager, and project director on Environmental Baseline Studies, Environmental Assessments and/or environmental projects related to mining in almost every province and territory in Canada as well as many foreign countries including USA, Australia and other countries in Asia, Europe, Africa and South America. Ken applies his understanding of mining and his 20 years of mining-related environmental experience to help direct the most appropriate data collection and reporting strategies, predict mining related impacts and to develop proper management strategies for mine wastes.

**Employment History**

***Golder Associates Ltd. – Mississauga, Ontario***

*Mine Waste and Environment Division Manager (2006 to Present)*

Responsible for providing strategic direction and management of a group of over 50 professionals focused on mine waste science and engineering.

***Golder Associates Ltd. – Mississauga, Ontario***

*Associate then Principal, Hydrogeochemist (2002 to Present)*

Recognized company wide technical resource in the field of mining geochemistry and hydrogeology.

***Golder Associates Ltd. – Mississauga, Ontario***

*Hydrogeochemist (1995 to Present)*

Mine environment and acid mine drainage specialist responsible for management, design, and organization of tailings, waste rock, mine water, mine waste and environmental projects. Projects are generally focused on metal mobility in soils and water, acid mine drainage, geochemistry, hydrogeochemistry, hydrogeology, environmental implications and mitigation options. Current responsibilities include development of recommendations for property management, environmental assessment/feasibility studies, and closure options for mining projects.

More specific job aspects include identifying and characterizing mine waste, conducting estimates of acid generation potential, metal mobility, radionuclide mobility, seepage, potential chemical loading, and receiving water impacts through assessment of hydrogeology, geochemistry, water quality, and hydrology data on a local and/or regional scale. Estimates of water quality implications are based on interpretation of the range of possible input data to develop ranges and/or probabilities associated with discharge chemistry values.



**Waterloo Centre for Groundwater Research – Waterloo, Ontario**

*Research Hydrogeochemist (1995)*

Conducted hydrogeologic and geochemical analysis of flow systems; developed proposals for funding; developed and constructed field and laboratory equipment.

**University of Waterloo – Waterloo, Ontario**

*Student Research Assistant (1992 to 1995)*

Organized and conducted geochemical sampling programs, supervised borehole drilling and logged split spoon samples, obtained and analysed geophysical data (Shallow seismic, EM, and resistivity) and assisted in installation of reactive barrier used in remediation of nitrate and sulphate plumes. Conducted groundwater flow and geochemical speciation modelling.

**Waterloo Centre for Groundwater Research – Waterloo, Ontario**

*Research Hydrogeochemical Technician (1990 to 1992)*

Organized and conducted geochemical sampling programs; conducted laboratory analysis for total sulphur, iron, and carbonate content; designed, developed and constructed laboratory and field sampling and testing equipment; installed drivepoint, and bundle type piezometers; obtained and logged cores through drilling and continuous coring techniques; assisted driller in hollow stem auger borehole drilling and well installation; conducted laboratory column experiments and assisted in septic system studies.

**Atomic Energy of Canada Limited – Pinawa, Manitoba**

*Hydrogeochemical Technician (1989)*

Sampled and analysed groundwater to trace flow patterns; serviced diesel engines and assisted with fracture mapping by helium injection.

**Minnova Inc. – Thunder Bay, Ontario**

*Geophysicists Assistant (1989)*

Geophysics and Geology Assistant.



## PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**De Beers Canada  
Gaucho Kué (2009 -  
Present)**  
Northwest Territories

Task lead responsible for direction and Conducted a gap analysis of geochemical and site water quality issues. This included reviewing and evaluating all available data in order to provide estimates of potential work requirements and costs associated with these aspects of the project. A cursory review of core samples and some supplementary, preliminary sampling to assess potential ARD issues related to the project was also conducted.

**Osisko- Hammond  
Reef (2010 - Present)**  
Northwestern, Ontario

Project Directo responsible for overall project implementation and quality. Task lead responsible for senior review of geochemical testing and water quality estimates in support of EIS, pre-feasibility and feasibility evaluation. Includes geochemical assessment of waste rock, tailings, plant materials, prediction of mine water quality, prediction of mine water quality, prediction of site water quality.

**Cliffs - (2010 to  
Present)**  
Northern Ontario

Responsible for contract negotiations for multimillion dollar contract for provision of integrated engineering and ESIA services for several sites in Northern Ontario.

**Dornod Uranium  
Projects EIS (2007 -  
2009)**  
Mongolia

Project Director responsible for overall project implementation and quality. Task lead responsible for senior review of geochemical testing and water quality estimates in support of EIS, pre-feasibility and feasibility evaluation to IFC standards. Includes geochemical assessment of waste rock, tailings, plant materials, prediction of mine water quality, prediction of site water quality.

**Fortune Minerals  
Engineering, Baseline  
and ESIA (2005 -  
present)**  
Nova Scotia

Project Director for engineering trade off studies responsible for integrating engineering and ESIA components of the project to minimize cost while protecting key environmental aspects of the site.

Senior Geochemist, responsible senior review of geochemical testing and water quality estimates in support of EIS and feasibility evaluation. Includes geochemical assessment of waste rock, tailings, plant materials, prediction of underground mine water quality predictions, prediction of site discharge water quality, and prediction of downstream water quality.

**Xstrata - Kabanga  
Nickel - Geochemistry  
Baseline Assessment  
and Impact  
Assessment (2007 -  
present)**  
Tanzania

As the Division Manager responsible for selection of appropriate management structure and personnel on the project, and responsible for providing key staff resources to the project. Also Senior Discipline Lead for Geochemistry and Water Quality on the project. Responsible for management for geochemical and water quality assessment of this proposed Nickel mine in Tanzania, Africa. Project involves all aspects of an environmental impact statement, including physical, biological and social. Integration with engineering services is also a key driver for the success of this project.



**De Beers Canada  
Mining (formerly  
Winspear Diamonds  
Ltd.) - (1999 - present)  
Northwest Territories**

Project Geochemist responsible for development and implementation of a large geochemical baseline assessment program, mine water quality assessment, and site water quality assessment for environmental assessment and permitting of DeBeers Canada Mining, Snap Lake diamond Project in Northwest Territories.

Provided expert witness testimony on geochemistry, mine water quality, and site water quality aspects of the project at the MVEIRB public hearings. Provided and presented technical information in public information sessions and responded to inquiries and information requests related to all geochemistry, mine water quality, and site water quality modelling aspects of the project.

The geochemical baseline assessment components of this project include: Characterization of all aspects of the site including tailings, waste rock, ore pads and construction material for acid generation potential, long and short term leachate potential, and source term water quality from each of these material through static and kinetic testing; Evaluation of on-site conditions during pre-mining and the advanced exploration project; Assess geochemistry and environmental implications of EKATI and Diavik diamond projects and compare and contrast them with respect to Snap Lake; and preparation of geochemistry baseline reports relating to land use permits, water license permits, scoping documents, feasibility documents, and the environmental impact statement.

Components of the mine water quality assessment include: Co-ordination with project hydrogeologist to implement a drilling and sample collection program in the underground workings of the advanced exploration program; Co-ordination and/or collection of port water, seepage water, sump, and discharge samples from the mine during advanced exploration to develop baseline mine water quality data; Development of expected inflow water upwelling; Development of a program to assess geochemical implications of cemented paste deposition on mine water quality under operations and at closure; Developing overall short and long term mine water quality estimates; and assessment of potential groundwater travel time and rock-water geochemical interactions at closure.

The site water quality assessment involved integrating all aspects of the proposed mine development with the baseline geological and water quality data to develop estimates of potential water quality during operations and closure. Components of the overall site water quality assessment include: Developing a thorough understanding of the overall mine plan, site plan, processing and engineering requirements, site baseline data (hydrology, hydrogeology and geochemistry), waste deposition strategies, and water requirements on site; Developing a site water quality model that integrated all of the information above in a coherent, accessible and transparent manner; Assessing the results of the water quality model and developing reasonable geochemical controls on solute migration where applicable; Assessing treatment alternatives and the final treatment scenario to develop overall site discharge and mass load estimates on Snap Lake; and, one of the interesting and technically challenging aspects of this particular part of the project included incorporating a feedback loop into the model structure such that the interaction between the discharge water, lake water, mine inflow, and mine discharge could be properly accounted for.



**Diavik Diamond Mines  
(2005)**  
Northwest Territories

Completed review of site geochemistry and mine water quality data for comparison to EA prediction values.

**Touquoy Project (2006  
- present)**  
Nova Scotia

Senior Geochemist responsible for development of geochemical testing and water quality estimates in support of feasibility evaluation. Includes geochemical assessment of waste rock, tailings, plant materials, prediction of underground mine water quality predictions, prediction of site discharge water quality, and prediction of downstream water quality.

**De Beers Canada -  
Gaucho Kué (2002)**  
Northwest Territories

Conducted a gap analysis of geochemical and site water quality issues. This included reviewing and evaluating all available data in order to provide estimates of potential work requirements and costs associated with these aspects of the project. a cursor review of core samples and some supplementary, preliminary sampling to assess potential ARD issues related to the project was also conducted.

**Taseevskoye Project  
(2007-2009)**  
Balay, Russia

Senior geochemist and water quality specialist responsible for geochemical and water quality assessment of a proposed gold mine in Balay, Russia. Project involves assessment of geochemical loading and potential acid generation from all sources of mine waste and mining on site and implementation of EIA document.

**Xioncun Project (2006-  
2008)**  
Tibet, China

Senior Geochemist responsible for senior review of geochemical testing and water quality estimates in support of IS and feasibility evaluation. Includes geochemical assessment of waste rock, tailings, plant material, prediction of underground mine water quality predictions, prediction of site discharge water quality, and prediction of downstream water quality.

**Voisey's Bay Nickel -  
Argentia Site (2003)**  
Newfoundland

Providing senior geochemical review and guidance on testing for evaluation of leach residues and selection of appropriate disposal strategies.

**Cumberland  
Resources -  
Meadowbank Project**  
Northwest Territories

Provide senior review of site water quality modelling and estimates.

**Barrick Gold - Buzwagi  
Project (2004 - present)**  
Tanzania, Africa

Senior geochemist and water quality specialist responsible for geochemical and water quality assessment of a proposed gold mine in Tanzania, Africa. Project involves assessment of geochemical loading and potential acid generation from all sources of mine waste and mining on site and implementation of EIA document.



**Tiberon Mineral Resources (2003 - present)**  
Viet-Nam

Project Manager for geochemical and water quality assessment of a proposed bismuth-tungsten mine site in Viet-Nam. Project involves assessment of geochemical loading and potential acid generation from all sources of mine waste and mining on site. All aspects of the proposed mine development were integrated with the baseline geological and water quality data to develop estimates of potential water quality during operations. Also responsible for management of project components related to risk assessment for worker health. Mitigation plans, safe work practices, and disposal options were developed for parameters of concern. Results were included in the environmental site assessment documents and bankable feasibility documents submitted to the regulating authorities.

**Aquiline Resources - Calcatreu Project (2004 - present)**  
Argentina

Senior geochemist and water quality specialist for geochemical and water quality assessment of a proposed mine in southern Argentina. Project involves assessment of geochemical loading and potential acid generation from all sources of mine waste and mining on site.

**PanAmerican Silver - Manantial Espejo Project (2003 - present)**  
Argentina

Senior geochemist and water quality specialist for geochemical and water quality assessment of a proposed mine in Southern Argentina. Project involves assessment of geochemical loading and potential acid generation from all sources of mine waste and mining on site.

**Barrick Gold - Tulawaka Gold Mine (2002-2003)**  
Tanzania

Project discipline leader/manager for geochemical and water quality assessment of a proposed gold mine in Tanzania, Africa. Project involves assessment of geochemical loading and potential acid generation from all sources of mine waste and mining on site. The geochemical baseline assessment components of this project included: Characterization of all aspects of the site including tailings, waste rock, ore pads and construction material for acid generation potential; Determining long and short term leachate potential, and source term water quality from each of these material through static and kinetic testing; Preparation of geochemistry baseline reports relating to land use permits, water license permits, scoping documents, and the environmental impact statement. The site water quality assessment involved integrating all aspects of the proposed mine development with the baseline geological and water quality data to develop estimates of potential water quality during operations and closure. The results of the water quality model were assessed and reasonable geochemical controls on solute migration were developed where applicable.

Treatment alternatives were evaluated and a site water management plan was developed to meet environmental and project objectives while minimizing project costs.

**Antamina Compañía Minera (2000)**  
Antamina, Peru

Reviewed sample suitability and organized initial test program for samples. Reviewed mass loading model for tailings impoundment for proposed copper mine.



**Boliden Apirsa S.A. -  
Los Frailes Mine (1998-  
1999)**  
Aznalcollar, Spain

Immediately following the failure of the Boliden Apirsa Tailings facility in Aznalcollar, Spain, Golder Associates was hired to help prepare a strategy and necessary information for re-opening the mine. Personal responsibilities on this project included: Co-ordinating analytical test-work on spilled tailings and soil samples; Collections of porewater samples, tailings solids, and mill tailings samples from the tailings remaining in the basin; Collection of waste rock, seepage and pit water samples from around the site; and Geochemical assessment of the remainder of the impounded tailings and waste rock on site.

**Falconbridge Limited -  
Raglan Mine (1999)**  
Ungava Peninsula,  
Northern Quebec

Reviewed acid generation characteristics, water quality and loadings from an ore pad to identify potential implications on treatment requirements and milling operations upon expansion of the pad. Considerations included: permafrost, hydrology, and the temperature of mined ore relative to ambient air.

**Norox Operating  
Company Ltd. - Jeroy  
Gold Mine (1998)**  
Kyrgyzstan

Conducted geochemical evaluation which involved the initial feasibility study of a proposed combined open pit/underground gold mine using a cyanidation circuit. Responsible for geochemical assessment component of the Environmental Impact Statement (EIS) which could be used by international lending institutions to support project financing. Assessment of available ARD data was completed along with an evaluation of environmental issues related to cyanide. Water quality and siting issues were investigated, with consideration given to discontinuous permafrost at higher elevations.

**Inco Ltd. - Voisey's  
Bay Nickel Mine (1998)**  
Newfoundland

Conducted an internal review of baseline groundwater quality and groundwater surface water data as part of the Environmental Assessment documentation for the Inco Ltd. Voisey's Bay mine site in Labrador. Provided supporting documentation related to possible operating conditions in the tailings basin.

**Asacha Gold Mine  
(1997)**  
Kamchatka, Russia

Reviewed hydrogeology and water quality of the proposed Asacha Gold Mine in northeastern Russia. The assessment focused upon chemical water quality and stream-flow impacts associated de-watering of an underground mine and construction of a tailings basin. The results of the assessment formed part of the mine feasibility study.

**Kvaerner Davy, TVX  
Gold Ltd. (1996)**  
Kasperske Hory, Czech  
Republic

Responsible for prediction of chemical loading to the receiving water for a pre-feasibility study. Several aspects of the project were coordinated and assessed in order to predict potential water quality, including: Nitrate loading to the mine water and mine water characterization; Process water characterization; Expected tailings chemistry and acid generation characteristics; Hydrology of the tailings basin and surrounding area; Background water quality assessment; Development of preliminary treatment system options and costs; Effluent water characteristics were predicted relative to applicable local and regional effluent standards to develop and recommend tailings deposition plans and treatment options.

**Teck Corporation -  
Pogo Project -  
Geochemical Review  
and Support**  
Alaska

Provided internal review and evaluation of bedrock and overburden groundwater chemistry and how it relates hydrogeological conditions at the Teck Corporation Pogo project in Alaska. Additional work involved presentation of available water quality data. Considerations at this site included permafrost.



## PROJECT EXPERIENCE – MINE CLOSURE AND REHABILITATION

- EWL Management Ltd.  
- Gordon Lake -  
Geochemical  
Evaluation for Closure  
Options (2008 -  
present)**  
Northern Ontario
- Project Director responsible for design and implementation of biological, hydrological, hydrogeology, and risk assessment programs to appropriately evaluate the Gordon Lake tailings. Responsible for integrating all aspects of the site characterization studies to provide the most effective long term remediation strategy and final closure measures to be implemented at the site.
- Madawaska Mines  
Joint Venture Ltd. -  
Geochemical  
Evaluation of Uranium  
and Radionuclide  
mobility (2005 -  
present)**  
Northern Ontario
- Senior Geochemist responsible for design and implementation of a geochemical evaluation program to evaluate uranium and radionuclide mobility and evaluate source controls and mitigation measures necessary.
- Encana Ltd. - Dyno  
Mine - Uranium  
Tailings Assessment  
(2005 - present)**  
Northern Ontario
- Senior Geochemist responsible for design and implementation of a geochemical evaluation program to characterize and evaluate uranium tailings distribution downstream of a deposition source.
- Encana Ltd. - Lorado  
Mine - Geochemical  
Evaluation for Closure  
Options**  
Northern Saskatchewan
- Senior Geochemist responsible for design and implementation of a geochemical evaluation program for the abandoned Lorado Mine uranium tailings. Responsible for site water quality modelling and evaluation including development of source term values, pathway interactions, and receiver loading estimates. Responsible for providing input and recommendations regarding remediation options, risk assessment evaluation, and possible final closure measures to be implemented at the site.
- Cameco Corporation -  
Geochemical  
Evaluation and  
Modelling (2004 -  
present)**  
Northern Saskatchewan
- Responsible for design and evaluation of ARD program for one of the Cameco waste rock dumps at their Key Lake site and for providing recommendation as to potential waste rock use and disposal options.
- Cameco Corporation -  
Geochemical  
Evaluation and  
Modelling (2003-2004)**  
Northern Saskatchewan
- Senior Geochemist responsible for geochemical modelling and evaluation of a plume and acidic mine water. Used PHREEQC and hydrogeologic software to determine potential migration characteristics and remedial measures for uranium and metals in groundwater.
- Inco Limited - Crean  
Hill Mine - Mine  
Closure, Monitoring  
Requirements (2002)**  
Northern Ontario
- Assessed potential water quality and long term monitoring requirements for closure. Reviewed existing site development, monitoring program, and water quality data. Developed monitoring program for closure.



**Inco Limited -  
Lockerby Mine - Mine  
Closure, Monitoring  
Requirements (2002)**  
Northern Ontario

Assessed potential water quality and long term monitoring requirements for closure. Reviewed existing site development, monitoring program, and water quality data. Developed monitoring program for closure.

**Inco Limited -  
Shebandowan Mine -  
Mine Rehabilitation  
Assessment, and  
Prediction of Water  
Quality ( 1999-2000)**  
Northwestern Ontario

Project Geochemist responsible for supervision of rehabilitation measures and characterization of mine waste, during mine rehabilitation and closure. Water quality and long term treatment requirements during closure/decommissioning were completed. The project also included review of available geochemical data and modelling to ensure QA/QC and proper development of mitigation strategies to best achieve regulatory compliance.

Aspects included: Ensuring proper environmental decommissioning procedures/protocols were followed; Modelling - coupled PHREEQC-V2 and GoldSim; Monitoring program development; and Assessment of treatment requirements.

The affects of seasonal temperatures fluctuation and freezing were accounted for in estimating potential treatment requirements and lime demand.

**Caribou Mines -  
Anaconda Tailings -  
Chemical Stability at  
Closures (2000)**  
New Brunswick, Canada

Supervised development of a program to assess potential impacts and closure options of two tailings ponds. Closure options investigated include in-pit disposal, capping, and underwater disposal in an alternate tailings impoundment.

**Falconbridge Limited -  
Smelter Complex -  
Preparation of Closure  
Plan and Options  
(1996-1999)**  
Falconbridge, Ontario

Lead geochemist responsible for identification and characterization of all potential sources of mine waste and chemical loadings at the Falconbridge Smelter complex near Sudbury, Ontario. This site includes: two mines, seven historic tailings areas, large slag deposits, extensive water management facilities, and the smelter complex itself. Aspects of this large, two-year project included: Assessment of Acid Mine Drainage; Assessment of potential loading from Slag and Mine waste on site; Mine Water Quality Assessment; Surface Water Quality Assessment, Groundwater Quality Assessment; Estimates of site loading and water quality predictions over time; Recommendation of mitigation and treatment strategies to ensure compliance with site discharge limits; and, writing and reviewing smelter site closure plan.

**Sudbury Contact  
Mines Ltd. - Victoria  
Creek Project -  
Geochemical  
Assessment, Closure  
Planning, Treatment  
Requirements (1999)**  
Kirkland Lake, Ontario

Factors affecting acid generation from the Waste Rock Piles were assessed, and the lime demand required to neutralize potential acid production was predicted. Potential alternative options with respect to disposal and/or treatment of potentially acid generating (PAG) waste rock assessed.

**Barrick Gold Corp. -  
Potential Acquisition -  
Investigation of  
Closure Scenarios  
(1999)**  
Brazil

Conducted an assessment of orebody geochemistry, possible closure options and possible water quality. Based on the water quality estimates and closure scenarios, a range of possible treatment costs were provided.



**Rio Algom - Lacnor,  
Nordic and Pronto  
Mines - Mine Closure  
Planning (1995-1997)**  
Elliot Lake, Ontario

Responsible for internal review and co-ordination of geochemical and water quality assessment within the project team. Aspects included a hydrogeological investigation of the effectiveness of the perimeter seepage interception ditch around Rio Algom's Nordic Mine Tailings impoundment. The seepage collection ditch was designed to re-direct tailings impacted groundwater seepage to the water treatment plant. Also responsible for co-ordinating and writing sections of the overall closure documents for these idle tailings sites.

**Barrick Gold Corp. -  
East Malartic/Barnat  
Sladen Tailings - ARD  
and Water Quality  
Assessment to  
Evaluate Closure  
(1997)**  
Northern Quebec

Assessment of acid generation potential and contaminant loading was conducted at Barrick Minerals East Malartic Tailings. The work included assessment acid: base accounting, mineralogical evaluation and elemental characterization of the tailings solids. This data was assessed in conjunction with unsaturated zone porewater and piezometer water quality data to develop potential acid generation characteristics and potential water quality loading estimates for the tailings. The assessment was used to evaluate closure options for the facility.

**Inco Limited - Victoria  
Mine - Geochemical  
Assessment for  
Closure (1997)**  
Sudbury, Ontario

Conducted geochemical assessment of waste rock, and mine site to evaluate closure options and develop a closure plan.

**Falconbridge Limited -  
New Tailings Area -  
Preparation of Closure  
Plan and Options  
(1996-1997)**  
Falconbridge, Ontario

Preparation of a closure plan for Falconbridge Limited's New Tailings Area near the Falconbridge, Ontario Smelter. This included geochemical characterization on tailings and prediction of impacts of flooding on the quality of surface water and groundwater. The closure plan was reviewed by the Ontario Government and accepted with no revisions.

**Falconbridge Limited -  
Fecunis Tailings Area -  
Assessment of Closure  
Options (1995-1996)**  
Northern Ontario

Study of options for closure of Falconbridge Limited's Fecunis Tailings Area, considering the feasibility of flooding, slimes cover, removal of tailings and perpetual treatment. Responsible for hydrogeological modelling, co-ordination of geochemical program, reporting, and assessment of chemical loadings. The geotechnical/geochemical investigation lead to a detailed assessment of capital and operating costs for the various options.

**Falconbridge Limited -  
Fault Lake Tailings  
Area - Review of  
Closure Plan and  
Options**  
Falconbridge, Ontario

Review of geochemical aspects pertaining to a closure plan for Falconbridge Limited's Fault Lake Tailings Area. Closure measures include the construction of a multi-element soil cover to reduce the rate of oxidation of existing sulphidic tailings and to mitigate impacts on regional groundwater.

## PROJECT EXPERIENCE – MINE SITE EVALUATION / TREATMENT OPTION EVALUATION

**Goldcorp - Wilanor  
Mine (2003)**  
Red Lake, Ontario

Provided internal review and advice related to arsenic issues associated with GoldCorp's Wilanor Mine property.



**Ovacik Mine -  
Assessment of HCN  
Evolution (2002)**  
UK

Assessed the potential for hydrogen cyanide gas evolution from a mine treatment/tailings pond.

**Inco Limited - Crean  
Hill Mine - Treatment  
Requirements (2001)**  
Northern Ontario

Supervised evaluation of potential treatment requirements/refinements to reduce potential lime demand. This resulted in more efficient treatment system, reduction in concentration peaks, and a reduction in lime demand and treatment costs.

**Tara Mines -  
Assessment of  
Geochemical Factors  
Affecting Dam Stability  
(1997-1998)**  
Ireland

Assessed possible geochemical factors that could affect dam stability for a proposed design for a dam raise. The major concern was the potential for filter clogging based on precipitation resulting from discharge of water. PHREEQC modelling was completed to estimate maximum mineral precipitation in the filter zone. These results were used to evaluate the effectiveness of the proposed design.

**Inco Limited - Levack  
Mine - Evaluatin of  
Source Term  
Chemistry (1998)**  
Northern Ontario

Evaluated observed changes in site runoff inconsistent with those predicted from in the existing closure plan. Evaluation program included geochemical and hydrogeological evaluation of the site, mineralogical assessment of material on site, and site hydrologic assessment. The results of the program revealed that the likely cause of the observed discrepancies was coating of available neutralising minerals with iron hydroxide formed as a result of mineral oxidation.

**Falconbridge Ltd. -  
Falconbridge and East  
Mine - Mine Water  
Characterization and  
Assessment of  
Treatment Options  
(1997)**  
Falconbridge, Ontario

Mine water seepage was assessed for metal loading potential, and the existing treatment system was re-evaluated. The analysis suggested current treatment practices were inefficient and costly. As a result an alternative treatment was suggested and implemented successfully.  
The project involved: Initial characterization of mine discharge water; MINTQA2 geochemical speciation modelling; Assessment of current treatment practices and recommendations of alternatives (active treatment vs. degassing pond); Follow-up characterization to ensure alternative treatment practices were successful.  
Effluent mine water characteristics and potential loading to the environment were also assessed as part of the much larger Falconbridge Smelter closure plan work.

**Les Mines Inmet -  
Norbec Tailings (1997)**  
Quebec

Initiated and supervised initial stages of evaluation of various cover design options on tailings water quality. Diffusion through the cover layer was assessed for a variety of cover designs using the HELP model to determine rates of diffusive oxygen transport. An oxygen diffusion coefficient was then input into an oxidation simulation program (PYROX) to determine a source loading for seepage and transport modelling. Simulations were optimized for the best possible cover design. The cover has been constructed and follow-up evaluation shows reduction in oxidation rates similar to those projected.



**MEND, Inco Limited -  
Whistle Mine - Detailed  
Waste Rock  
Characterization Study  
and Evaluation (1995-  
1996)**  
Northern Ontario

Lead geochemist responsible for development and implementation of new and existing technologies and protocols to characterize and monitor the geochemical characteristics of the waste rock pile. Aspects of this project included: Developing drilling and sampling methods suitable for use in granitic boulder laden waste rock; Field instrumentation and monitoring of the waste rock for temperature, oxygen concentration and carbon dioxide concentration at multiple depth intervals; Detailed assessment of acid generating characteristics, and determination of the chemical mass loadings originating from the waste rock pile; Piezometers installed in the base of the waste rock and at the foot of the pile were assessed to identify potential seepage pathways; Installation of large scale lysimeters in the waste rock to determine recharge characteristics; Geochemical speciation modelling (MINTEQA2) to determine potential buffering minerals and secondary mineral species that may affect the overall discharge water quality; Preparation of a report suitable for publication as a MEND document. The study is available as a Mine Environment Neutral Drainage (MEND) report through Energy Mines and Resources Canada.

**Inco, Falconbridge -  
Hardy and McReady  
West Mines -  
Evaluation of Non-  
Point Source Loading  
to Receiver (1996)**  
Northern Ontario

Conducted a geochemical assessment to define potential sources of "non-point source" metal contamination reporting to the Onaping River. An evaluation of groundwater associated with the Hardy and McReady West Mines, and associated mine waste deposit was completed. The project involved installation, interpretation of stratigraphy, hydrostratigraphy, groundwater flow patterns and potential sources of contamination.

**Agnico Eagle Ltd. -  
Joutel Tailings -  
Hydrogeologic and  
Geochemical  
Assessment (1996)**  
Quebec

Conducted a detailed assessment to determine the extent of existing acidic conditions in the tailings and the possibility of ongoing acid generation. The assessment included on-site measurement of sensitive geochemical parameters, collection of continuous samples through the tailings, assessment of porewater chemistry in the saturated and unsaturated zones, and hydrogeologic assessment.

**Cameco Corporation -  
Rabbit Lake Tailings -  
Geotechnical Review  
(1996)**  
Northern Saskatchewan

Completed an internal review of geochemical issues affecting groundwater flow and transport modelling that was conducted to assess the Rabbit Lake In-Pit Tailings Management Facility.

**Confidential -  
Geotechnical  
Assessment, Crisis  
Response**  
Canada

Assisted with hydrogeological and geochemical assessment of possible causes related to a dam failure and release of acid mine drainage to the environment. Historical and recent hydrologic, water quality, and hydrogeologic records were reviewed and additional on-site information was gathered to develop a range of scenarios that may have lead to the observed failure. Based on the assessment measures provided input to help engineer systems to eliminate future uncontrolled releases. Since implementation of recommendations no further uncontrolled releases have occurred.

**Confidential -  
Geotechnical Advice,  
Crisis Response**  
Canada

Provided advice on possible implications of acid spill and interactions with aquifer material in relation to observed water quality at downstream production wells.



## PROJECT EXPERIENCE – HYDROGEOLOGY

**Cameco Corporation -  
Groundwater  
Monitoring Plan  
Review (2000-present)**  
Port Hope, Ontario

Reviewed water quality issues associated with Cameco's annual groundwater monitoring review program at its upgrading facility in Port Hope. The review includes the estimation of groundwater flow directions and mass loadings beneath the facility.

**Rio Algom - Stanleigh  
Mine - Hydrogeologic  
Assessment (1996)**  
Elliot Lake, Ontario

Responsible for development of 2-D groundwater flow modelling (SEEP/W) to evaluate seepage through the various cross sections of the facility. The work completed was used to support additional 3-D modelling efforts used in the mine closure development process to estimate seepage rates in the project area. The results were presented to the Atomic Energy Board of Canada and accepted as part of the property closure plan.

**Omai Gold Mine -  
Hydrogeological  
Assessment and Mass  
Loading, Crisis  
Response (1995)**  
Guyana

Completed 2-D seepage model (SEEP/W) to assist in completion of a detailed water balance for the new No. 2 Tailings Pond, following the failure of their tailings facility. Estimated potential mass loading to the river were developed based on the seepage estimate.

**Aquarius Mine - Pump  
Test (1995)**  
Timmins, Ontario

Assisted with a pump test to define potential de-watering requirements in a deep alluvial aquifer.

**Jannock Properties -  
Pump Test and Water  
Quality Evaluation**  
Mississauga, Ontario

Organized and conducted a pump test and water quality testing on a former quarry filled with fly ash from thermal power generation to determine possible implications with respect to nearby site development.

## PROJECT EXPERIENCE – OTHER WORK EXPERIENCE PRIOR TO GOLDER ASSOCIATES LTD.

**Inco Limited**

Copper Cliff Tailings - Geochemical sampling, instrumentation and assessment of the "P" Area Tailings and Seepage.

**Falconbridge Limited**

Geochemical sampling and instrumentation for assessment of the geochemistry and hydrogeology of the East Mine Tailings and the Nickel Rim Tailings; and Geochemical sampling and instrumentation for assessment of the Kidd Creek Tailings.

**Agnico Eagle**

Geotechnical sampling and instrumentation for assessment of the Joutel Mine Tailings



## PROFESSIONAL AFFILIATIONS

- Member, The Association of Professional Engineers, Geologists, and Geophysicists of the Northwest Territories
- Member, The Association of Professional Engineers, Geologists, and Geophysicists of Alberta
- Member, The Association of Professional Geoscientists of Ontario
- Member, International Association of Geochemistry

## PUBLICATIONS

### Journal Articles

- DeVos, Ken. A vital tool in meeting stakeholder concerns. *CIM Magazine*, Vol. 4 - No. 1 (2009)
- DeVos, Ken and Greg Warren. Need for Balanced Approach to Exploration. *The Northern Miner*, March (2006), 3-9.

### Conference Proceedings

- DeVos, Ken and Rens Verburg. 2006. *Cemented Paste Backfill Leachate Characteristics: Snap Lake Diamond Mine*. 7th International Conference on Acid Rock Drainage, March 26-29. St. Louis, Missouri.
- DeVos, Ken and Che McRae. 2006. *ARD Geochemistry in the Developing World: Dealing with Uncertainty, Regulations, and the need for Characterization of Mine Waste*. 7th International Conference on Acid Rock Drainage, March 26-29. St. Louis, Missouri.
- DeVos, K.J., D.F. Haley, R.B. Verburg and R. Johnstone. 2003. *Evaluation of Complex Systems to develop Key Water Quality Influences at the DeBeers Snap Lake Diamond Project*. 6th International Conference on Acid Rock Drainage, July 14-17. Cairns, Queensland, Australia.
- DeVos, K.J., F. Barone and D.G. Brown. 2000. *Management of Water Quality in Flooded Tailings Impoundment*. 5th International Conference on Acid Rock Drainage, May 21-24. Denver, Colorado.
- DeVos, K.J., P. Pehme and J.P. Greenhouse. 1997. *Ground Geophysical Surveys for Mine Wastes*. Exploration '97 Fourth Decennial Conference on Mineral Exploration, September 14 - 18. Toronto, Canada.

### Other

- DeVos, K.J., Ritchie, D.G., and Bocking, K.A., 1999. Practical Considerations for Covering Sulphidic Tailings Deposits situated above the Groundwater Table. Proceedings Sudbury '99 Mining and the Environment. Sudbury Ontario. Vol. 1, pp. 291-300.
- DeVos, K.J., Bocking, K.A., and MacNamara, B., 1999. The Effect of Changes in Metallurgical Practices on Groundwater Quality at Falconbridge Limited's Smelter Site. Proceedings Sudbury '99 Mining and the Environment. Sudbury, Ontario. Vol. 2, pp. 635-644.



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Bocking, K.A., DeVos, K.J., Mikkila, B.J., and Hall, G.J. 1999. Closure Planning for the Falconbridge Limited Smelter Complex, Sudbury, Ontario - Issues and Experience. Proceedings Sudbury '99 Mining and the Environment, Sudbury, Ontario. Vol. 3, pp. 873-882.

DeVos, K.J. Petit, C., Martin, J., Knapp, R.A., and Jansens, K.J. 1997. Whistle Mine Waste Rock Study. Mine Environment Neutral Drainage (MEND) Report, Energy Mines and Resources Canada.

DeVos, K.J., Whistle Mine Waste Rock Monitoring, 1996. Presentation for: Prediction of Acid Rock Drainage, Environment Canada (MEND) Workshop. Simon Fraser University, Harbour Centre Campus, November 7-8, 1996.

DeVos, K.J. 1995. Geochemistry and Hydrogeology of a Plume of Tailings Derived Water, Copper Cliff, Ontario. M.Sc. Thesis, University of Waterloo.

DeVos, K.J., Blowes, D.W., Robertson, W.D., and Greenhouse, J.P. 1995. Delineation and Evaluation of a Plume of Tailings Derived Water, Copper Cliff, Ontario. Proceedings Sudbury '95 Mining and the Environment Sudbury, Ontario, May 28 - June 1, 1995.

DeVos, K.J., Blowes, D.W., Robertson, W.D., and Greenhouse, J.P. 1994. Delineation and Evaluation of a Plume of Tailings Derived Water, Copper Cliff, Ontario. Poster paper in: Proceedings of the Geological Association of Canada, Mineralogical Association of Canada, Waterloo, Ontario.



**Education**

*Ph.D. (p/t, suspended),  
James Cook University,  
Townsville, Queensland,  
Australia*

*B.Sc. (Hons), James Cook  
University, 1986*

**Golder Associates Ltd. – Calgary**

***Associate, Senior Water Quality Scientist***

John is a senior water quality specialist at Golder in Calgary. He has over fifteen years of experience facilitating and directing surface water quality and limnological assessments of stream, river and lake environments.

Prior to joining Golder, John spent the majority of his professional career working on the east coast of northern Australia with the Australian Centre for Tropical Freshwater Research at James Cook University. While at the Centre, John managed the consulting component of the business, as well as its analytical service laboratory, and collaborated on a number of research projects. John has extensive experience in water quality monitoring and sampling of lake environments, and the analysis and interpretation of limnological data. Other relevant project experience included seasonal assessments of irrigation supply, municipal stormwater management and recreational lakes; assessment of effects to marine and freshwater environments from metalliferous mining and refinery operations in northern Australia; and assessments of effects of agricultural runoff to rivers and streams, and tropical coastal regions of northern Australia.

Since joining Golder in 2007, John has worked as a component lead and senior technical advisor for projects involving water quality baseline and assessment studies, and environmental assessments. These projects have focussed on mining, municipal and power industries. John’s main focus has been associated with baseline and impact assessments for mining developments primarily located in northern Canada. These include the De Beers Snap Lake AEMP, the environmental impact statement for the De Beers Gahcho Kué Project, the environmental impact statement for the Fortune NICO Project, and the investigation of Tailings Lake for DIAND. Other key roles include providing technical and environmental support to the North Saskatchewan River environmental monitoring program for the City of Edmonton, and environmental assessments of uranium mine projects in Saskatchewan and Ontario.

Throughout his career, John has authored or co-authored more than 10 journal or conference publications. He has prepared numerous technical reports and been involved in a number of workshops that have focussed on water and sediment quality sampling, as well as provided project presentations to community members, stakeholders, landholders, and industry.

**Employment History**

***Golder Associates Ltd. – Calgary, Alberta***

*Senior Water Quality Scientist (2007 to Present)*

Responsible for the design, implementation, management, and interpretation of water quality investigations, including environmental baseline studies and environmental assessments (EAs); project coordination and management; report



preparation; and senior review of aquatic assessment reports.

**Australian Centre for Tropical Freshwater Research James Cook University – Townsville, Queensland**

*Senior Water Quality Scientist / Water Quality Laboratory Manager (2002 to 2007)*

Responsible for the design, implementation, management, and interpretation of commercial, municipal, and industrial water quality assessments, environmental baseline studies and EIAs, and water quality research projects. Duties included project management, staff management, report preparation, and public presentations. Concurrently managed a water quality laboratory that was responsible for water and sediment quality analysis.

**Australian Centre for Tropical Freshwater Research James Cook University – Townsville, Queensland**

*Water Quality Scientist/Chemist (1988 to 2002)*

Assisted in the design, implementation, management, and interpretation of water quality research projects. Duties included planning and undertaking field surveys, laboratory analyses of water and sediment quality analyses, and preparation of proposals and reports.

**Department of Zoology James Cook University – Townsville, Queensland**

*Research Assistant - Hydrobiologist/Chemist (1987 to 1988)*

Developed a research program for a limnological assessment of a newly formed, highly turbid reservoir. Conducted monthly surveys of water quality and lower trophic community monitoring, carried out associated laboratory work, and reported results.

**Department of Botany James Cook University – Townsville, Queensland**

*Research Assistant / Demonstrator - Plant Physiology (1986 to 1987)*

Aided in a program utilizing gel electrophoresis to map effects to amino acid distribution in C4 plants as a result of sodium deficiency. The position also demonstrated to third-year plant physiology practical classes.

**Department of Geology James Cook University – Townsville, Queensland**

*Research Assistant (1985 to 1986)*

Aided in a research program investigating the occurrence of crown-of-thorn starfish skeletal remains in vibra-core reef sediment samples collected from the Great Barrier Reef to determine outbreak frequency in recent history.



## PROJECT EXPERIENCE – MUNICIPAL ASSESSMENT

**North Saskatchewan River Monitoring Program, City of Edmonton**  
Edmonton, Alberta

A team member providing technical direction and senior review for the assessment and interpretation of the annual monitoring program examining loadings from municipal outfalls and natural tributaries to the North Saskatchewan River. This project produces two annual study reports prepared each year (2007 to 2010).

## PROJECT EXPERIENCE – REGULATORY ASSESSMENT

**De Beers Snap Lake Mine Regulatory Program (AEMP)**  
Snap Lake, Northwest Territories

A team member providing senior review and technical support to the water quality component of the annual environmental monitoring program (2008 to 2010).

**NSR Thermal Plume Delineation and Benthic Algal Survey, TransAlta Utilities**  
Calgary, Alberta

A team member providing technical support and senior review to the aquatic resources components in the assessment of the effects of thermal discharges on the growth and composition of benthic algal communities in the North Saskatchewan River (NSR) downstream of the Keephills and Sundance cooling pond blowdown discharge outfalls (2009 to 2011).

## PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**De Beers Gahcho Kué Project Environmental Impact Statement (EIS)**  
Gahcho Kué, Northwest Territories, Canada

The technical director involved in the organization, management and preparation of the EIS for the proposed Gahcho Kué diamond mine project. Responsible for the coordination of the aquatic components, and the review and integration of their submissions to the EIS (2007 to 2011/on-going).

**Fortune Mineral NICO Mine, Environmental Assessment**  
Northwest Territories

Water quality component lead responsible for identifying potential effects to streams and lakes within the local and regional study areas using modelling and assessment tools, and supporting the risk assessment of aquatic life.

**Baseline/EIS Program SilverBirch/Teck Frontier Project**  
Oil Sands, Alberta, Canada

Project Manager and Senior Water Quality Specialist involved in the organization, management and preparation of the Water Quality baseline and EIS components for the proposed Frontier Oil Sands development. Also responsible for providing support and coordination for the Pilot Plant testing program that will service the development.

**Cigar Lake Water Management EIS Cameco Corporation**  
Saskatoon, Saskatchewan

A team member involved in the organization, management and preparation of the EIS for a modification to the management of treated effluent release from the Cigar Lake Mine project. Responsible for the coordination of the assessment sections, which included submissions from other consultants, and the review and integration of their submissions to the EIS (2009/2010).



**Millennium Mine  
Project Proposal  
Cameco Corporation**

Saskatoon,  
Saskatchewan

A team member responsible for providing technical support for the environmental assessment process in the development of the project proposal for the Millennium Mine development in northern Saskatchewan in 2009.

**PROJECT EXPERIENCE – BASELINE STUDIES**

**Newmont / Miramar  
Hope Bay Project  
Annual Aquatic Study  
Program**

Hope Bay, Nunavut

A team member providing senior review and technical support to the water quality reporting component of the 2006 to 2008 annual aquatic studies program. This work included the seasonal assessment of lakes and streams within the regional study area.

**Water Quality  
Assessment,  
STRATECO Matoush  
Exploration Ramp  
Project**

Matoush, Ontario

A team member providing senior review and technical support to the baseline water quality component to the Environmental Assessment in 2009. This work included the seasonal assessment of lakes and streams within the project study area.

**SUPPLEMENTAL SKILLS**

**Research Experience**

*Areas of specific research interest include the limnology of tropical lakes and reservoirs, water quality processes, and the assessment of trophic status of tropical freshwater systems. Specific projects have included:*

*Assessment of water and sediment quality in tropical catchments on the eastern coast of north Queensland, as well as ephemeral water courses in north-western Queensland.*

*Assessment of water quality of runoff from plot and sub-catchment scale watersheds during wet season rain events and effects to receiving waters.*

*Assessing water quality during event flow conditions of coastal rivers and inshore environment using a variety of sampling strategies, including catchment-based community volunteer sampling.*

*Limnological assessments of tropical reservoirs and lakes.*

*Development of automated low-level nutrient analyses to improve the sensitivity of current analytical methods for fresh, marine and estuarine waters (e.g. nitrate, nitrite, ammonia, filterable reactive phosphorus, silica, total nitrogen and phosphorus).*

*A review of constructed wetland systems to determine more efficient removal processes of phosphorus from wastewater.*

**Consulting Experience**

*Vast experience as a water quality scientist in tropical eastern Australia with proven expertise in project design, sampling, and analyses of marine and freshwaters for a variety of water quality indicators and water/sediment and biotic interpretation and*



*assessment. General examples of projects include:*  
*Seasonal limnological assessments of watersheds within, and adjacent to, metalliferous mining and refinery operations to meet environmental regulatory requirements.*  
*Assessment of ship loading effects to bed sediment in a harbour environment to determine extent of spillage/discharge effects.*  
*Assessment of sugar mill effluent ponds and design of mitigation features to reduce odour problems.*  
*Assessment of aquatic ecosystem health elements of various environmental impact studies (e.g. coastal developments, water supply infrastructure), including water quality, sediment quality and lower trophic community quality components.*  
*Review of environmental factors for state development projects, including highway upgrades.*  
*Assessment of effects of fertilizer treatment to the quality of runoff draining sugar cane farms.*

## PROFESSIONAL AFFILIATIONS

International Water Association  
Australian Water Association  
Australian Society of Limnology

## PUBLICATIONS

### Conference Proceedings

Connor, R., J. Milsom, A. Melzer, B.M. Butler, J.W. Faithful, W. Dennison, T. Lloyd and G. Swain . 2003. *Ecosystem-based assessment and management of marine and estuarine systems at the QNI Yabulu Nickel Refinery, Townsville.* 2nd National Conference on Aquatic Environments: Sustaining our aquatic environments – Implementing Solutions. Queensland Department of Natural Resources and Mines. Brisbane, Australia.

Faithful, J.W. and D. Burrows . 2003. *From Blue to Brown: Persistently Elevated Turbidity Resulting from Damming the Tropical Burdekin River.* Ninth International Conference on River Research and Applications, July. Albury.

Faithful, J.W. and W. Finlayson . 2004. *Water quality assessment for sustainable agriculture in the Wet Tropics – A community-assisted approach.* Catchment to Reef Conference, Great Barrier Reef Marine Park Authority, March 2004. Townsville.

Lukacs, G.P., C. Perna and J.W. Faithful . 2004. *Coastal wetlands of north-eastern Australia: Condition and management interventions.* Seventh Intecol International Wetlands Conference, July. Utrecht, The Netherlands.

Taylor, J., T. Lloyd, A. Melzer and J.W. Faithful . 2004. *Conserving ecosystems and managing biodiversity in industrial land and seascapes – Yabulu Nickel Refinery experience.* Minerals Council of Australia, Inaugural Global Sustainable



Development Conference, October. Melbourne, Australia.

Cooper, M., J.W. Faithful, and G. Shields. 2005. *Sediment Dynamics of a Large Tropical River System: The Burdekin River and Lake Dalrymple, Australia*. In *10th International Symposium on the interactions between sediments and water* (eds: Faganeli, J., Ogrinc, N. & Horvat, M.). RMZ - Materials and Geoenvironment, , August -September. Bled, Slovenia.

Cooper, M., G. Shields, J.W. Faithful and J. Zhao. 2006. *Using sediment Sr/Nd isotopic ratios to determine sediment sources in the Burdekin Falls Dam, Queensland, Australia*. 16th Annual V.M. Goldschmidt Conference, August - September. Melbourne, Australia.

Brodie, J., A.G. Dekker, V.E. Brando, B. Masters, J.W. Faithful, R. Noble and K. Rohde. 2006. *Extent and duration of the algal bloom in the Great Barrier Reef lagoon following river discharge events in the Mackay Whitsunday's Region, Australia*. 13th Australasian Remote Sensing and Photogrammetry Conference: Earth Observation – from Science to Solutions, November. Canberra.

Hately, L.R., J.D. Armour, J. Brodie, J.W. Faithful, G.L. Pitt and P.N. Nelson . 2007. *Modelling, monitoring and sediment tracing in the Tully River catchment, north Queensland: a comparison of techniques*. 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December. Auckland, New Zealand.

Lewis, S.E., Brodie, J.E., Bainbridge, Z.T., Davis, A.M., Faithful, J.W., Liessman, L., Rohde, K. and Masters, B. (2008). *Herbicide residues in waterways draining sugarcane catchments of the Great Barrier Reef*. In: Proceedings of the 5<sup>th</sup> SETAC World Congress. International Society of Ecotoxicology and Chemistry. 3-7 August. Sydney, Australia.

#### Journal Articles

Walbran, P.D., Henderson, R.A., Faithful, J.W., Polach, H.A. and R.J. Sparkes (1989) *Crown-of-Thorn starfish outbreaks on the Great Barrier Reef: a geological perspective based upon the sediment record*. Coral Reefs. 8: 67-78.

Griffiths, D.J. and J.W. Faithful (1996) *Effects of the sediment load of a tropical north-Australian river on water column characteristics in the receiving impoundment*. Arch. Hydrobiol. Suppl. 113 Large Rivers 10(1-4): 147-157.

Faithful, J.W. (1997) *Phosphorus in Wetlands - A Review*. Queensland Department of Natural Resources, Brisbane. ISBN 0 7242 7414 6, 53pp.

Faithful, J.W. and D.J. Griffiths (2000) *Turbid flow through a tropical reservoir (Lake Dalrymple, Queensland, Australia): responses to a summer storm event*. Lakes and Reservoirs: Research and Management. 5: 231-247.

Faithful, J.W. and W. Finlayson (2005) *Water quality assessment for sustainable agriculture in the Wet Tropics – A community approach*. Marine Pollution Bulletin. 51: 99-112.

O'Reagain, P.J., Brodie, J., Fraser, G., Bushell, J.J., Holloway, C.H., Faithful, J.W. and D. Haines (2005) *Nutrient loss and water quality under extensive grazing the upper Burdekin River catchment, north Queensland*. Marine Pollution



Bulletin. 51: 37-50.

Bainbridge, Z.T., Brodie, J.E., Faithful, J.W., Sydes, D.A. and Lewis, S.E. (2009). *Identifying the land-based sources of suspended sediments, nutrients and pesticides discharged to the Great Barrier Reef from the Tully-Murray Basin, Queensland, Australia. Marine and Freshwater Research*, 60:1081-1090.

Mitchell, A., Reghenzani, J., Faithful, J.W., Furnas, M. and Brodie, J.E. (2009). *Relationships between land use and nutrient concentrations in streams draining a 'wet-tropics' catchment in northern Australia. Marine and Freshwater Research*, 60:1097-1108.

Brodie, J.E., Schroeder, T., Rohde, K., Faithful, J.W., Masters, B., Dekker, A., Brando, V. and Maughan, M. (2010). *Dispersal of suspended sediments and nutrients in the Great Barrier Reef lagoon during river discharge events: conclusions from satellite remote sensing and concurrent flood plume sampling. Marine and Freshwater Research*. 61:651-664.

Faithful, J.W. and D.J. Griffiths (in preparation) *The influence of season on the variability of suspended solids concentrations within a highly turbid tropical reservoir.*



## Golder Associates Ltd. – Calgary

### Career Summary

Linda Havers possesses over 20 years experience that combines community development and social program planning, social impact analysis, gender-based social analysis and public and stakeholder consultation. She has taken the lead role in developing social baselines and conducting social impact assessments of projects in the nuclear energy sector and in mining, oil sands development and linear developments in contexts as diverse as Tanzania, Vietnam, rural Washington, Canada's north and in the provinces of Alberta, Ontario and Saskatchewan. Ms Havers has worked within many regulatory frameworks including those of Canada's as well as NEPA in the U.S.A. and the IFC World Bank.

### Education

*Ph.D. Program: Resources and the Environment, completed graduate level course work and research on mining in northern Vietnam, University of Calgary, 2004-2006*

*M.A. Anthropology, University of Calgary, 1990*

*B.A. Anthropology, University of Calgary, 1984*

### Languages

*English – Fluent*

Ms Havers has recently completed various social components of a proposed uranium mine and a proposed gold mine in Kivalliq Region, Nunavut. Work here involves broad based community consultation and in depth examination of defining characteristics of community well being such as family functionality, social and cultural values and belief systems. Effects on Inuit culture is a key issue for examination. Ms Havers is currently the technical advisor on a proposed mining project in Guinea, West Africa. This project involves Human Rights Risk Assessment and planning for in-migration and other potential social effects of the project including resettlement.

Prior to her work in the mining and oil and gas sectors, Ms Havers worked in the area of program evaluation for the Government of Canada, developed community-based programs to address the needs of low income families in Calgary, and also taught various anthropology courses including Research Methods and Applied Anthropology. Ms Havers is an advocate for Participatory Community Assessment and is skilled at various kinds of social planning research such as community needs assessment, and Appreciative Inquiry.

## Employment History

### **Golder Associates – Calgary, Alberta**

*Senior Social Scientist (2005 to Present)*

Responsible for undertaking social baseline studies and social impact assessments, community development planning, and consultation programs in both domestic and international contexts. Conversant with regulatory systems in Canada and the U.S.A., as well as the International Finance Corporation (IFC) World Bank. Working in sectors such as mining, oil and gas, and energy. Provides mentorship to other social science group members.

### **Tiberon Minerals – Thai Nguyen Province, Vietnam**

*Social Specialist (contract) (2002 to 2005)*

Collected and analyzed baseline data on women's roles, incomes, and work for socioeconomic impact assessment of a mining interest in Thai Nguyen Province,



Vietnam. Contributed paper: Women and Sustainable Livelihoods in Rural Vietnam, to World bank resettlement coordinators and presented at 2004 American Council of Learned Societies Conference; developed monitoring plan with gender equality indicators; reviewed business development plans targeted to women in the project affected area; developed gender analysis questionnaire; and conducted focus group discussions.

### **Mount Royal College – Calgary, Alberta**

*Experiential Learning Specialist (1996 to 2000)*

Developed curriculum and opportunities for experiential learning, such as on-the-job training, internships, and mentor programs. Designed and conducted college-wide needs assessment focusing on students needs for various career services, educational support services, and customized job training. Responsible for accessing and interpreting labour market information and writing briefing papers on labour market and human resources topics for distribution to various stakeholders, including students, teaching faculty, and professional associations.

### **Government of Canada Human Resources Development (HRDC) – Calgary, Alberta**

*Program Consultant (1991 to 1996)*

Developed and operationalized community consultation framework with stakeholders, such as government departments, social development agencies, women's groups, education and training organizations, and local businesses. Co-authored 1996 "Strategic Plan for Calgary HRDC" after scoping, environmental scanning, stakeholder consultation, and desk review of government priorities. Developed pre-employment and employment interventions with embedded systems of monitoring and evaluation. Oversaw comprehensive evaluations of HRDC-funded job training programs and job search clubs, including those targeted specifically to people with disabilities, women returning to work, and First Nations individuals (budget for evaluations was \$1.5 million annually).

### **Greater Forest Lawn Initiative Council – Calgary, Alberta**

*Executive Director (1989 to 1991)*

Managed a community development organization aimed to further the integration in five ethnically diverse neighbourhoods. (The Council was funded by all three levels of government.) Developed grass-roots initiatives aimed at addressing issues related to poverty, settlement concerns of new immigrants, and issues of concern to youth and female-headed households.

### **Cambyr Counselling Agencies – Calgary, Alberta**

*Counsellor (1992 to 1994)*

Designed and managed a counselling and mentoring program for 20 Southeast Asian youths experiencing dislocation problems. Organized and delivered workshops on life management topics and organized job shadowing and mentoring. Contributed to journals and newsletters on the challenges faced by immigrant youth in Canada.



**PROJECT EXPERIENCE – SOCIO-ECONOMIC IMPACT ASSESSMENT**

**Socio-economic  
Impact Assessment,  
De Beers, Gahcho Kue  
Project**  
Northwest Territories,  
Canada

Technical reviewer and expert witness for the socio-economic component of an Environmental Impact Assessment at a proposed diamond mine 280 km northeast of Yellowknife, Northwest Territories. Key issues are around project effects on culture, including social disparity in and between communities, effects on community cohesion, and the long-term social and economic effects of the mine in this natural resource based economy. Provided strategic socio-economic support to this client including historical information on impact benefit agreements and socio-economic monitoring agreements. Provided briefing papers for relevant Ministers in NWT.

**Social Review of  
Socio-economic  
Impact Assessment of  
Hydroelectric  
Expansion**  
Northwest Territories,  
Canada

Performed a third party technical review of socio-economic impact assessment of hydroelectric expansion (690 km transmission line) on the Talston River, Northwest Territories. Communities potentially affected are South Slave Metis and Akaitcho and aboriginal groups in the South Slave Region. Review included Terms of Reference conformance checks and critical review of Livelihoods Framework as conceptual tool for analyzing effects.

**Agnico Eagle Mines**  
Nunavut, Canada

Responsible for social baseline programme and reporting and writing a socio-economic impact assessment and social management plan for a proposed gold mine near Rankin Inlet, Nunavut. The ESIA is to be submitted to the Nunavut Impact Review Board in 2012. Key discussion is on the pace of development and cumulative effects of mining projects on crime rates, housing and crowding and training of an Inuit workforce. Other issues of particular importance are enhancing employment opportunities and managing the potential effects on Inuit culture and economies.

**Socio-economic  
Impact Assessment,  
Uranium Mine**  
Nunavut, Canada

Responsible for preparation of social components of environmental impact assessment, to be submitted to the Government of Nunavut, for a uranium mine and access road. Work is ongoing and includes the development of social baseline study of seven communities, impact evaluation and social mitigation and monitoring for project affected people. Issues of particular importance are enhancing employment opportunities and managing the potential effects on Inuit culture and economies.

**Social Review of  
Health Baseline Report  
& Impact Assessment  
of Hydroelectric  
Project**  
Newfoundland and  
Labrador, Canada

Performed senior review of proposed hydroelectric project and its potential effects on the health and wellness of Innu communities in Labrador. Review included technical quality checks, review of methodology, logic and interpretation.



**Social Review of  
Socio-Economic  
Impact Assessment,  
Gold Mine  
Greenland**

Performed a third party technical review of socio-economic impact assessment for proposed mine development based on the Bureau of Minerals and Petroleum's Guidelines for Social Impact Assessment for Mining Projects in Greenland (2009). Review included Terms of Reference conformance checks and critical review of SIA content and methods, management strategies and public consultation processes.

**Socio-Economic  
Impact Assessment  
and Baseline, Coal  
Mine  
Olympia, Washington,  
U.S.A.**

Researched and wrote an extensive social baseline report with regard to communities and counties affected by the potential closure of a large surface coal mine in the United States of America. The baseline was developed to National Environmental Policy Act (NEPA) specifications and included extensive interviewing of stakeholders and analysis of the mines impact on local economies. Responsible for overseeing an economic impact assessment of current operations and advising on consultation approaches.

**Torex Morelos Gold  
Mine  
Mexico**

Senior advisor social impact assessment and resettlement. Role on this project involves advising resettlement planners using IFC guidance notes and the IFC Resettlement Handbook; preparation of a Resettlement Action Plan, including a baseline report on the socio-economic situation of farmers that will require resettlement due to the Project's land acquisition; provide advice and oversight of consultation with affected families.

**Socio-economic  
Strategic Advice,  
Nickel Project  
Dominican Republic**

Responsible for providing recommendations to nickel mine on socio-economic issues, opportunities and risks associated with decisions to move forward with resettlement and completion on social baseline studies and impact assessment. Work includes supervision and quality control of the work of Golder staff and sub consultants.

**Commonwealth of  
Dominica  
Dominica**

Oversaw the development of a high level social impact assessment related to options to improve surface water supply by providing an improved river intake structure on this Caribbean island that experiences frequent storms and flooding. The social component involves participating in the determination of locations based on resettlement and compensation needs and the potential for benefit by local communities. The project is funded by the Caribbean Development Bank.

**Socio-Economic  
Technical Advisor, Iron  
Ore Project  
Republic of Guinea**

Responsible for providing recommendations and technical advice of socio-economic issues, opportunities and risks associated with the development of an iron ore mine in Southeastern Guinea. Work includes advising on social baseline studies and impact assessment, resettlement planning, public consultation, supervision and quality control of the work of Golder staff and sub consultants.

**Social Baseline  
Reporting, Copper  
Mine  
Democratic Republic of  
Congo**

Reviewed social baseline data collected by sub consultants and prepared a social baseline summary report. The baseline data and social indicators were then used as a basis for evaluating socio-economic impacts of the proposed mine on several nearby villages. This assignment also involved preparing a traffic assessment and reviewing resettlement action plans and the final impact assessment.



**Socio-economic  
Impact Assessment  
and Consultation  
Planning and  
Implementation, Nickel  
Mine**  
Tanzania

Responsible for preparation of social components of an environmental impact assessment of a proposed nickel mine in Tanzania consistent with international (IFC) standards, including supervision and quality control of sub consultants locally contracted. Work included planning and carrying out consultations, development of baseline studies, impact evaluation and social management planning. A resettlement plan was updated by the social team. Review of community needs assessments and recommending community development strategies were a key facet of this project. Work was undertaken from 2007 to 2012.

**Socio-Economic  
Impact Assessment  
and Stakeholder  
Consultation, Nickel  
Mine**  
Madagascar

Summarized social baseline data collected in Madagascar by local sub consultants in areas surrounding a mining development. Reviewed public and stakeholder comments and issues and wrote report on results of consultations including identifying and detailing mitigation of effects. Project specifics included summarizing issues and consultation activities, issues matrices, and analysis. Final report on the Public Involvement Program for this project was reviewed by the International Finance Corporation (IFC) of the World Bank Group.

**Socio-Economic  
Impact Assessment,  
Tungsten Mine**  
Hanoi, Vietnam

Developed Economic Gender Equalities Indicator Survey for mine development in Vietnam as per World Bank operational directives. Carried out consultation with men and women to assess how they will be differentially affected by a new mine and resettlement and made recommendations regarding community development and mitigation measures. As part of Ph.D. requirements, developing a research program that specifically addresses impacts of mining on communities and women's livelihoods in particular and on how gender roles and responsibilities are altered.

**Social Baseline-  
Development of  
Research Tools, Gold  
Mine**  
China

Developed research approaches and instruments for a mining project in Taipingzhuang, China. Provided ongoing support and supervision to socio-economic researchers that were working on the development of social baseline that would be suitable for assessing project impacts against. Review of consultation approaches and developed strategies for developing responses to community concerns.

**Social Baseline SAGD  
Project**  
Christina Lake, Alberta,  
Canada

Developed a social baseline for subsequent evaluation of socio-economic effects for expansion to a Canadian Natural Resources Limited (CNRL) Kirby steam-assisted gravity drainage (SAGD) project in the Christina Lake, Alberta area.

**Socio-Economic  
Assessment In-situ Oil  
Sands Project**  
Christina Lake, Alberta,  
Canada

Managed a socio-economic assessment of a 75,000 bitumen barrels per day (bbpd) expansion of an in-situ operation at MEG Energy's Christina Lake, Alberta operation.

**Social Baseline Report**  
Alberta, Canada

Researched and wrote a scoping document and baseline document for Shell International on several remote First Nations communities in northern Alberta. This desktop study included a review of recent ethnography and ethno-history of the area, a gap analysis and media analysis in addition to the gathering and analysis of social baseline information.



**Socio-Economic  
Impact Assessment,  
Nuclear Plant**  
Alberta, Canada

Responsible for planning and preparation of the social components of an environmental impact assessment of Alberta's first nuclear facility. In addition to broad based consultation with various publics, including several First Nations communities, work involves public perception surveying, social baseline characterization and planning for growth strategies. The proposed facility is to be sited in northern Alberta, near several small communities with populations not exceeding 3,000. Managing the effects of a large construction workforce and operations staff are of primary importance in this assignment.

**Socio-Economic  
Impact Assessment,  
Oil Sands Projects**  
Alberta, Canada

Responsible for managing the social component of environmental impact assessments for submission to regulatory authorities in Alberta. Work included supervision of subcontracted economists and Golder staff. Provided advice to proponent on opportunities for local benefit enhancement, workforce management strategies and other aspects planning a project with a foreign construction workforce.

**Social Baseline Study,  
In-situ Oil Sands  
Project**  
Alberta, Canada

Developed social baseline for a large in-situ oil sands project in the western Athabasca region of Alberta. Project included a livelihoods approach to analyzing potential effects of project on a number of First Nation communities. Developed plan for community-based social research, training, and coaching of First Nations communities to perform much of the social baseline work and social impact assessment. Preparation of monitoring program and community development initiatives to benefit women, youth and senior members of First Nations communities.

**BC Hydro**  
British Columbia,  
Canada

Leading First Nation community assessments, as required by BCEA, for a proposed hydro project in northern BC. Community assessments are developed in collaboration with several First Nations whose right to hunt, trap and access their traditional territory may be affected by the project. Other impacts on First Nation reserve communities involve the presence of a large construction workforce and the potential for impacts on social infrastructure and community wellbeing.

**Socio-Economic  
Assessment**  
Saskatchewan, Canada

Conducted a socio-economic assessment for a new biofuels plant in Saskatchewan. The process involves participating in community consultations, developing a social baseline of affected communities, and measuring the project's impacts and benefits against it.

**Socio-Economic  
Impact Assessment,  
Hydroelectric Dam**  
Saskatchewan, Canada

Identified issues resulting from consultations and wrote baseline and socio-economic impact assessment reports for the North Saskatchewan River Water Supply Feasibility Study. This study involved identifying locations of inundated structures and estimating costs of relocation of homes and other buildings. Other effects analyzed include those resulting from the presence of a large construction workforce and overall economic effects of the proposed dam.

**Socio-Economic  
Impact Assessment,  
Gold Mine**  
Saskatchewan, Canada

Researched and wrote social baseline report and impact assessment for First Nations communities in northern Saskatchewan that are experiencing the effects of a mine expansion near La Ronge. Key issues involved employment in remote First Nations communities, transportation issues and economic development strategies.



**Socio-Economic  
Impact Assessment**  
Ontario and Manitoba,  
Canada

Responsible for social components of environmental impact assessments of ten wind farm developments in Ontario and Manitoba. Project involved profiling First Nations communities and supporting consultation efforts. Issues involved the high tourism potential in these areas, effects on property values, visual disturbance and potential for noise.

**Social Impact  
Assessment**  
Deep River, Ontario,  
Canada

Conducted research for socio-economic impact assessment of pipeline looping project in NE Ontario. Performed desk study, and scoping; interviewed affected residents and stakeholders, projected impacts and assessed as to significance using NEB 2004 filing requirements as a guide.

**Social Impact  
Assessment**  
Niagara, Ontario,  
Canada

Conducted socio-economic impact assessment regarding two pipeline compressor stations in Ontario, Canada. Worked closely with consultation specialist and client to develop, in addition to community profiles and an impact statement, an issues report and strategies for dealing with community concerns.

**Socio-Economic  
Impact Assessment,  
Nuclear New Build**  
Kincardine, Ontario,  
Canada

Responsible for management of social components of an environmental impact assessment of a proposed nuclear new build project on an existing site in Ontario. Developed tools for gathering social data, supervised Golder staff and provided senior technical review of social baseline report and socio-economic impact assessment consistent with standards set by the Canadian Nuclear Safety Commission. Special studies on the project's potential effects on tourism and public attitude research were undertaken as well as an examination of "stigma" and living near a nuclear facility.

**Socio-Economic  
Impact Assessment,  
Gas Pipelines**  
Ontario, Saskatchewan,  
Canada

Conducted research for socio-economic impact assessment of pipeline projects in northeast Ontario and near Estevan, Saskatchewan. Performed desk study and scoping initially; interviewed affected residents and stakeholders; projected impacts; and assessed as to significance using National Energy Board (NEB) 2004 filing requirements as a guide.

**Socio-Economic  
Impact Assessment,  
Natural Gas Plant**  
Sarnia, Ontario, Canada

Developed a screening level socio-economic baseline and effects assessment for a natural gas plant unit addition near Sarnia, Ontario. Assignment included stakeholder analysis and characterization of issues, estimation of economic benefits and visual effects.

**PROJECT EXPERIENCE – STAKEHOLDER CONSULTATION**

**Public Consultation  
Reporting**  
Panama

Wrote a report consolidating all consultation results during the EIA process regarding a large copper mine in Panama. Developed an ongoing stakeholder engagement program for future phases of project development.

**Consultation Planning  
and Implementation,  
Nickel Mine**  
Tanzania

Responsible for design of consultation program, development of materials and carrying out consultations with fifteen villages that are potentially affected by a proposed nickel mine. Work involved training and supervising local sub consultants and interpreters. Clarifying issues, proposing mitigations were a key part of this project as well as preparing a report for submission to Tanzanian authorities and the IFC World Bank.



**Stakeholder Consultation Reporting, Nickel Mine**  
Madagascar

Provided ongoing recording and management of issues regarding the consultation program for a large nickel mine in Madagascar. Project specifics included summarizing issues and consultation activities, issues matrices, and analysis. Final report on the Public Involvement Program for this project was reviewed by the International Finance Corporation (IFC) of the World Bank Group.

**Consultation Planning and Implementation, Nuclear Plant**  
Peace County, Alberta, Canada

Ongoing planning of consultations for a proposed nuclear facility in northern Alberta. This work has included participation in scoping and siting studies, developing consultation approaches and overall management of consultation program.

**Public Consultation Program Coordination, Wind Energy**  
Calgary, Alberta, Canada

Developed a comprehensive public consultation program regarding a wind energy project in southern Alberta. Deliverables included materials development, organization of open houses, strategy, and media relations. All activities and issues were documented for report and application to provincial and national regulatory bodies

**Stakeholder Consultation, Pipeline**  
Calgary, Alberta, Canada

Member of a team bringing planning expertise to a major Canadian pipeline company in order to better manage stakeholder relations and carry out broad stakeholder consultations in Alberta and British Columbia. Provided input into the facilitation process with landowners, municipalities, aboriginal groups, and environmental non-governmental organizations (NGOs). Planned consultation events, such as workshops and open house events.

**Community Consultation, Power Plant**  
Keephills, Alberta, Canada

Providing audit services of consultation program related to a power plant expansion in northwest Alberta. Tasks include reviewing documentation for compliance with the Energy and Utility Board and preparing the final submission to regulators.

**Consultation Support**  
Suffield, Alberta, Canada

Provided planning support and documentation of public consultations program for the Canadian Government's Department of National Defence program at Suffield, Alberta. Work involved identifying Canadian Environmental Assessment Agency (CEAA) requirements, scoping issues with regard to the reclamation program, and developing ways to engage the public.

**Consultation Support**  
Trochu, Alberta, Canada

Provided consultation support to an out-of-province wind power company for its 45 turbine project near Trochu, Alberta. Work included consultation planning and building internal capacity to carry out and lead consultations.

**PROFESSIONAL AFFILIATIONS**

International Association of Impact Assessment (IAIA)



**Education**

*M.Sc. Geology, McMaster University, Hamilton, Ontario, 2002*

*B.Sc. (Hons) Geology, McMaster University, Hamilton, Ontario, 2000*

**Languages**

*English – Fluent*

*Spanish – Fluent*

**Golder Associates Ltd. – Burnaby**

**Employment History**

**Golder Associates Ltd. – Burnaby, British Columbia**

*Geochemist – Mine Water Management Group (2008 to Present)*

**Golder Associates Ltd. – Mississauga, Ontario**

*Geochemist – Mine Waste Environmental Group (2004 to 2007)*

Responsible for mine waste characterization, acid generation/metal leaching prediction and water quality tasks that included field sample collection, laboratory coordination, data analysis and report preparation.

Worked on geochemical assessment projects in support of studies for various levels of mining: i.e., scoping studies, feasibility studies, baseline studies, environmental impact assessments (during the construction period, operations, closure/post-closure phases), permitting, operational compliance monitoring and closure plans.

Conducted studies, which included probabilistic and deterministic modelling of geochemical interactions of surface water and groundwater hydrology and water treatment related to mining environments.

Conducted field investigations including waste rock geochemical characterization, geotechnical soil/rock core logging, piezometer installation, conductivity testing and sampling in soil, rock, groundwater and surface water. Prepared proposals, budgets and schedules for large multidisciplinary and smaller-scale projects.

**Gartner Lee Ltd. – Burnaby, British Columbia**

*Geochemist (2007 to 2008)*

Responsible for geochemical and water quality studies in support of mine permit applications and other studies at the various stages of mining including baseline, scoping, feasibility, closure and site reclamation.

Presented technical results to and discussed mine water and waste management strategies with regulatory agencies.

Prepared technical reports and memorandums as part of baseline, feasibility, site reclamation and closure studies that included field sample collection, laboratory coordination, and data analysis.

Developed probabilistic and deterministic geochemical models in support of mine treatment design criteria and water management strategies.

Conducted field studies including waste rock sample collection, mini-piezometer and piezometer installation, and sampling of various media including soil, surface and groundwater.

Managed large- and small-scale projects that required budget tracking and supervision of junior administrative and GIS staff involved in related task work.

Responsible for communicating technical results and project status information to clients in a timely manner.

Prepared proposals, budgets and schedules for large, multidisciplinary and small-scale projects.

**School of Geography & Geology, McMaster University – Hamilton, Ontario**

*Sessional Lecturer (2003 to 2004)*



Crystallography and Optical Mineralogy – Fall 2003  
(Optical properties, structure, chemistry and paragenesis of rock forming minerals).

The Earth and the Environment – Spring 2003 & 2004  
(Introductory geology and environmental science course, which included a mandatory field trip).

**School of Geography & Geology, McMaster University – Hamilton, Ontario**

*Instructional Assistant (2002 to 2004)*

Supported the ongoing instructional activities of the School of Geography and Geology.

Assisted with the preparation of course materials and created rock and mineral identification labs.

Demonstrated and instructed laboratory and field techniques.

**PROJECT EXPERIENCE – MINING**

**Gahcho Kue**  
NWT, Canada

Responsible for the projection of surface site and downstream water quality for a proposed diamond mine to evaluate project impacts to surface water quality as part of the EIA. Michael was responsible for presenting and defending the water quality predictions to the MVEIRB and other stakeholders as part of the permitting process.

**Quinsam Coal**  
Campbell River, BC

Responsible for the prediction of surface site and downstream water quality resulting from an expansion to existing operations at the Quinsam Coal Mine. Water quality predictions were developed to support an amendment to the existing environmental permit and Michael was responsible for presenting and defending the water quality predictions to several regulatory bodies and non-governmental organizations as part of the permitting process.

**Xstrata Copper**  
Arequipa, Peru

Responsible for the prediction of surface water quality impacts to downstream receptors from a proposed copper mine in Southern Peru. Project work involved development of detailed pit lake and downstream receiving water quality models, interpretation and reporting of modelled results.

**PERCAN**  
Lima, Peru

Responsible for managing the environmental activities for the Peru-Canada Mineral Sectors Reform Project. Project work included authoring technical guidance documents, training of ministry staff on existing environmental guidelines and assisting the Peruvian Ministry of Energy and Mines to advance their abandoned mine site inventory. Responsible for managing a large team of technical professionals from Canada and Peru.

**Eldorado Gold**  
Efemcukuru, Turkey

Use of spreadsheet and geochemical models to predict site water quality for an underground gold mine in Turkey. Project work included development of a conceptual model based on existing documentation and creating a site-wide geochemical model that incorporated all of the proposed mine components. Simulated results supported detailed design of a water treatment plant.

**Xstrata Copper**  
Arequipa, Peru

Responsible for identification and collection of geochemical rock samples to support geochemical baseline studies as part of an Environmental Impact Assessment for a proposed open pit copper mine.



- Barrick Gold**  
Trujillo, Peru  
Responsible for identification and collection of geochemical rock samples to support geochemical baseline studies as part of an Environmental Impact Assessment for a proposed open pit gold mine.
- Newmont**  
Cajamarca, Peru  
Responsible for identification and collection of geochemical rock samples to characterize the expected environmental conditions of non-contact diversion channels. Project work included sample collection, laboratory coordination, result interpretation and documentation, which included remediation recommendations and alternatives in support of a bankable feasibility study.
- Minera Panama S.A.**  
Penonome, Panama  
Responsible for identification and collection of geochemical rock samples to support geochemical baseline studies for a proposed open pit copper mine. Assisted with baseline water quality data collection, interpretation and reporting in support of an Environmental Impact Assessment. Developed detailed site-wide water quality and receiving water quality models to predict the impacts of the project to the downstream surface water quality.
- Redfern Resources**  
British Columbia,  
Canada  
Lead geochemist responsible for documenting existing geochemical data and providing simulated water qualities in support of Environmental Management Act and Mine's Act permits. Was required to meet with regulatory agencies to present supporting documentation related to construction permit applications.
- Barrick Gold**  
Nunavut, Canada  
Lead geochemist responsible for identifying ARD issues at a closed and reclaimed mine site in Nunavut, Canada. Project work included a site visit to assess the existing conditions, collect representative samples and coordinate geochemical testing. A final document was required to present the current conditions, geochemical results and to present recommendations for further site remediation.
- Western Copper Corporation**  
Yukon, Canada  
Development of a characterization program for assessing the acid generation and metal leaching potential of mine waste materials including static and kinetic testing for an open pit gold mine in Yukon, Canada. Project work included indentifying rock core sample intercepts and coordinating testing of tailings materials to support baseline EIA studies.
- Atlantic Gold**  
Touquoy, Nova Scotia  
Development of a characterization program for assessing acid generation and metal leaching of mine waste materials including static and kinetic testing for an open pit gold mine in Nova Scotia, Canada. Project work included collection of rock core for testing, prediction of waste geochemical behavior, organizing, administering and interpreting geochemical results in support of a bankable feasibility study.
- Barrick Gold**  
Buzwagi, Tanzania  
Involved in geochemical characterization programs of mine wastes at an open pit gold mine in Tanzania including, processing and interpretation of large data set of geochemical results. Project work included developing a water quality model using GoldSim for water quality impact assessment and assisting in authoring technical sections facilitating the client's regulatory requirements in international operations for baseline and EIA studies.
- Barrick Gold**  
Alto Chicama, Peru  
Assisted with the management of ongoing kinetic geochemistry data to determine the acid rock drainage potential of waste materials. Project work included analysis and reporting of humidity cell data.



- Tiberon Minerals Ltd.**  
Nui Phao, Vietnam  
Involved in processing and interpretation of static and kinetic geochemical laboratory results for characterization of mine wastes for an open pit bismuth/tungsten mine in Vietnam. Project work included developing a site wide water quality model and assisting with authoring of geochemistry and water quality reports as a part of the client’s Feasibility Study.
- St. Andrew Goldfields Ltd.**  
Timmins, Ontario  
Assisting with the development of a field testing program which included drilling, test pitting and piezometer installation. Collected soil samples and measured hydraulic conductivities in all installations. Project work included interpretation of groundwater and surface water quality data and authoring of supporting documentation for the client’s application for a Permit to Take Water.
- DeBeers**  
Snap Lake, NWT  
Use of spreadsheet and geochemical models to predict site water quality for an underground diamond mine in NWT. Work included managing and maintaining large geochemical databases used in the development of a trend analysis model to ensure recent measured samples agree with EIA predictions.
- Teck Cominco Ltd.**  
Red Lake, Ontario  
Implemented a field program consisting of overburden drilling, piezometer installation, test pitting, and surface and groundwater sample collection to support the client’s regulatory requirements as part of the mine closure plan. Other project work included interpretation and reporting of the field testing program results.
- Antamina Mine**  
Antamina, Peru  
Assisted with the development of a GoldSim water quality model to predict metal loading from a large copper-zinc mine in northern Peru and examining drill-core data to assist with implementation of future drilling programs.
- Encana**  
Lorado Mine,  
Saskatchewan  
Developed a GoldSim water quality model to assess various remediation options of a site containing a lake under acidic conditions. Project work included processing and interpretation of static geochemistry data and assisting with authoring of technical sections.
- Kumtor Operating Company**  
Kumtor, Kyrgyzstan  
Assisted in annual updates of a tailings dam study for a gold mine in Kyrgyzstan. Project work included assessment of surface and groundwater quality data and assisting in authoring technical sections facilitating the client’s regulatory requirements in international operations for mine site effluents.
- Falconbridge Ltd.**  
Koniambo,  
New Caledonia  
Use of spreadsheet and geochemical models to predict the preliminary site water quality for a nickel mine in New Caledonia.



## TRAINING

***MEND Annual ARD Workshop***

*December 2008*

***7th International Conference on Acid Rock Drainage***

*March 2006*

***Metal Leaching and Acidic Drainage***

*Ontario Ministry of Northern Development and Mines, February 2005*

***Other Professional Development Courses***

*Project Management, 2006*

*Environmental Site Assessment, 2007*

*H&S Training (First Aid, Hazard Assessment & Risk Evaluation, Field Inspections)*

## PROFESSIONAL AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of the Province of British Columbia (APEGBC)

## PUBLICATIONS

Herrell, M.K., Salzsauler, K.A., McRae, C. A Practical Application of Mass-Balance Methods for Predicting Mine Drainage Water Quality – Climate Influences and Best Practices. Poster presentation at the 9th ICARD, Ottawa, Canada 2012.

Herrell, M.K., McRae, C., Salzsauler, K.A., Waples, J.S., 2009. Practical Application of Accelerated Methods of Acid Rock Drainage and Metal Leaching Prediction of Mine Materials. Paper presented at the 2009, Securing the Future and 8th ICARD, June 22-26, 2009, Skelleftea, Sweden.

Herrell, M.K., Dickin, A.P., Morris, W.A. 2006. A test of detailed Nd isotope mapping in the Grenville Province: delineating a duplex thrust sheet in the Kipawa-Mattawa region. Can. J. Earth Sci 43(4): 421-432.



## Education

B.A. Geography, Honours,  
Carleton University,  
Ottawa, Ontario, 1999

## Golder Associates Ltd. – Saskatoon

### **Agrologist**

Kyle Hodgson is a Professional Agrologist with over 10 years of experience in environmental consulting and project management in Alberta, British Columbia, and Saskatchewan. He has technical experience in the development, implementation, and management of projects requiring the application of multi-disciplines. Typical environmental projects have included project management for projects at contaminated sites, soil monitoring, and soil management programs for sour gas facilities, soil surveys for pipelines, mining and in-situ oil sands environmental impact assessments, pre-disturbance/baseline studies, and riparian area assessments.

## Employment History

### **Golder Associates Ltd. – Saskatchewan**

*Agrologist (2007 to Present)*

Discipline lead for the soils and terrain component of several Environmental Impact Assessments (EIAs) for potash developments in Saskatchewan. Duties involve coordinating field sampling programs, interpreting aerial photographs, mapping soils and terrain, classifying land capability, ensuring quality assurance/quality control (QA/QC) for field inspection and laboratory data, maintaining client contact, coordinating aboriginal assistants, and reporting.

Intermediate Project Manager for numerous multi-disciplinary projects for environmental screenings, assessments, and other regulatory obligations.

### **Matrix Solutions Inc. – Alberta and British Columbia**

*Project Agrologist (2001 to 2007)*

Work focused on field management of the soils components of EIAs for proposed oil sands projects (in-situ and mining). As part of Alberta Environment's approval conditions for these projects, Kyle managed the pre-development site assessments. Managed several Phase I Environmental Site Audits and remediation/reclamation of contaminated sites.

Worked for Matrix Solutions Inc. independently in Kelowna, British Columbia between August 2007 and October 2008.



## PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**various locations**  
Saskatchewan/  
Northwest Territories,  
Canada

Discipline lead for soils and terrain and closure and reclamation planning for several EIAs for mining projects on south-central Saskatchewan and various locations in Northwest Territories. Duties included coordinating field programs, completing data analysis, reporting, and technical review.

**various locations**  
Alberta, Canada

Discipline field lead for the soils and terrain component of several EIAs in the oil sands region and in central and northern Alberta, and for a pipeline in the foothills region of southern Alberta. Duties involved coordinating field sampling programs, interpreting aerial photographs, mapping soils and terrain, classifying land capability, ensuring QA/QC for field inspection and laboratory data, maintaining client contact, coordinating aboriginal assistants, and reporting. Managed all aspects for pre-development site assessments and conducted the associated soils surveys.

**various locations**  
Alberta/British Columbia,  
Canada

Responsible for conducting Phase I Environmental Site Assessments (ESAs) in Alberta and British Columbia. These involved inspecting properties for evidence of environmental issues as a result of onsite operational activities and interviewing onsite personnel regarding site operations and history. The field investigations included assessment of leases, buildings, and surrounding land. The Phase I ESAs were guided by the Canadian Standards Association protocol and involved a search of readily available records, site visits, and interviews.

## PROJECT EXPERIENCE – BIOLOGICAL SCIENCES

**various locations**  
British Columbia,  
Canada

Provided assessments, as a Qualified Environmental Professional, to ensure that development projects would not result in the harmful alteration of riparian fish habitat in British Columbia. These projects included field determination of streamside protection and enhancement areas, working with developers to establish alternate construction methods, reporting and submission to government bodies and construction and post construction environmental monitoring.

## PROJECT EXPERIENCE – CONTAMINATED LAND REMEDIATION

**various locations**  
Alberta, Canada

Conducted selection of equipment contractors for reclamation and remediation projects, contractor supervision, and approval of contractor invoices. Contractor selection was based on cost comparison, reputation, quality of work, and safety program. All contractor time tickets and invoices were subject to direct scrutiny prior to approval and payment.



**various locations**  
Alberta, Canada

Responsible for project management and field work of soil monitoring programs required at 11 Alberta gas plants under the Alberta Environment Air Monitoring Directive. The objective of these programs was to assess and monitor long term impacts to soil and vegetation due to sulphur handling and storage. Management of these programs involved preparation of work plans, cost estimates, cost tracking, scheduling, field work, reporting, and technical review.

**various locations**  
Alberta, Canada

Project manager for soil management programs, site remediation, characterization, and assessment sites at over 20 upstream oil and gas facilities.

## TRAINING

**Ground Disturbance**

*Energy Training Institute, 2010*

**Transportation of Dangerous Goods - Ground**

*Danatec, 2010*

**Workplace Hazardous Materials Information System**

*Danatec, 2008*

**1st Aid & CPR**

*Canadian Red Cross, 2007*

**H2S Alive**

*EnForm, 2007*

## PROFESSIONAL AFFILIATIONS

Saskatchewan Institute of Agrologists

Member, Canadian Land and Reclamation Association



**Education**

*B.Sc. (Honours) Biology ,  
University of  
Saskatchewan, 1990*

*M.Sc. Watershed  
Ecosystems, Trent  
University, 1995*

**Certifications**

*Certified Fisheries  
Professional, American  
Fisheries Society,  
2002*

**Golder Associates Ltd. – Saskatoon**

Amy is a Principal and senior aquatic scientist who has been with Golder for over 18 years and is experienced in study design, data analysis, project management, technical leadership, and providing strategic regulatory advice. Currently Amy's primary role with Golder is as a technical expert, project director, and project manager. She is also recognized as a Certified Fisheries Professional with the American Fisheries Society.

In 2009 Amy took on the Project Management of the De Beers Gacho Kue Diamond Project Environmental Impact Assessment, including the EIS completion and the impact review process stages involving a significant amount of public, Aboriginal, and regulatory engagement, public meetings and hearings. Between 2001 and 2008 Amy was the Project Manager of the Diavik Diamond Mine Inc. (DDMI) Aquatic Effects Monitoring Plan project, including the water license renewal process through the Wek'eezhii Land and Water board which is a regional panel of the larger MVLWB. Amy has provided project management and technical support to several other environmental assessment, fisheries and aquatic science, and regulatory requirement projects conducted by DDMI. Amy has been involved with the DDMI mine site since the completion of the original baseline programs and the EIA under the CEAA. She also has ongoing involvement with this diamond mine as the project manager for the implementation of the fish habitat compensation project.

Amy has also been involved with a large number of other mine environmental assessment projects including the Snap Lake Diamond Project EIA, Claude Resources Santoy 7 and 8 environmental assessment projects, the Falconbridge (originally) Montcalm mine permitting process, and on-going baseline studies for numerous potential developments. In 2008 Amy took on the Project Management and Technical Lead responsibilities for the environmental assessment process for Bruce Power's potential new build nuclear power generating facility in Saskatchewan.

Throughout her career at Golder, Amy has been involved with multiple Pulp and Paper Industry and Mining Industry EEM programs throughout Canada as required under the Fisheries Act regulations for these industries. She has also been involved with the design and implementation of other environmental monitoring programs at industrial sites where innovative and unique approaches to assessing changes to the environment were required.



## Employment History

### **Golder Associates – Saskatoon, Saskatchewan**

*Principal, Senior Aquatic Scientist/Project Manager (2006 to Present)*

Responsible for senior project management and direction, technical quality oversight on a wide range of aquatic and environmental assessment projects, strategic regulatory advice and risk management for clients, stakeholder consultation planning and implementing presentations and expert testimony at regulatory process hearings and environmental business development.

### **Golder Associates – Canada**

*Director, Canadian Operating Company (2004 to 2009)*

Regional Director of the Golder Associates Ltd. Board. As a Director, provided corporate governance oversight, representation and communication between senior management and Principals and Associates, and strategic advice with respect to corporate business plans and policies. Also acted as Lead Director in 2008 and carried out additional responsibilities for the management of the Board, setting the Board agenda, leading a process of Board structural changes, and co-chairing Board meetings.

### **Golder Associates – Saskatoon, Saskatchewan**

*Associate, Senior Aquatic Biologist/Project Manager (2002 to 2005)*

Responsible for aquatic biology and aquatic effects assessment with emphasis on fisheries populations and habitats. Project Manager and coordinator responsible for project design, supervision of staff, collection of fisheries data and biological samples, water quality sampling, data analysis, report preparation, and submission of applications to regulatory agencies for permits and approvals.

### **Golder Associates – Saskatoon, Saskatchewan**

*Aquatic Biologist (1994 to 2001)*

Responsible for aquatic assessments field program management, monitoring and baseline data collection, aquatic environmental impact assessment technical components for large projects.



**PROJECT EXPERIENCE – BIOLOGICAL SCIENCES**

**De Beers Canada Inc.  
Gahcho Kué Project**  
NWT, Canada

Project Manager for the De Beers Canada Inc. (DBCI) Gahcho Kué Diamond Project EIS in the NWT. This role includes a significant amount of regulatory and public engagement support, strategic planning support to DBCI, technical direction, and large scale team and financial management.

**Bruce Power**  
Saskatchewan, Canada

Project manager and technical lead for Bruce Power's feasibility and site selection studies for a potential nuclear power plant in Saskatchewan. Project included strategic planning, environmental investigations, and stakeholder engagement and information program.

**Shell Canada; Solstice  
Cellulosic Ethanol  
Facility**  
Manitoba, Canada

Project Director responsible for delivering a health, social and environmental impact assessment for a cellulosic ethanol facility. The scope of the project included baseline data collection, impact assessment, public First Nations & Metis engagement, and regulatory support. While the client decided to halt the project, the majority of the assessment was completed but not submitted to any regulatory agency.

**Shell Canada; Solstice  
Cellulosic Ethanol  
Facility**  
Manitoba &  
Saskatchewan, Canada

Project Director for project assisting with site selection for a cellulosic ethanol facility. Tasks for site selection included: water supply, GIS mapping constraints, waste disposal option, federal and provincial regulatory process, high level environmental constraints screening.

**Iogen Corporation;  
Cellulosic Ethanol  
Facility**  
Saskatchewan, Canada

Project Director for all aspects of environmental assessment and permit for a cellulosic ethanol facility including regulatory and public consultation at two different locations. While the assessments were completed, there were no submissions to any regulatory agency.

**Iogen Corporation;  
Cellulosic Ethanol  
Facility**  
Saskatchewan, Alberta,  
and Idaho, Canada &  
USA

Project Manager for a study to select a preferred location for a cellulose ethanol facility. Locations under consideration for the first facility include Saskatchewan, Alberta, and Idaho. In each location a review of regulatory requirements, environmental assessment processes, and environmental risk and sensitivities was compiled and used in conjunction with key project engineering requirements and costs to evaluate and compare sites.

**Claude Resources,  
Santoy 8 EIA**  
Saskatchewan, Canada

Project manager and senior technical lead for the environmental impact assessment of the Santoy 8 Gold Mine development. This assessment was conducted as a provincial level EIA.

**Claude Resources,  
Santoy 7 EEM**  
Saskatchewan, Canada

Project director and senior reviewer for the Santoy 7 Metal Mine Effluent Regulations, Environmental Effects Monitoring Program. Program includes study designs, monitoring programs and reporting.

**Claude Resources,  
SeaBee Mine EEM**  
Saskatchewan, Canada

Project director and senior reviewer for the Santoy 7 Metal Mine Effluent Regulations, Environmental Effects Monitoring Program. Program includes study designs, monitoring programs and reporting. This program has been ongoing since 2003 and now includes additional aspects as a magnitude and geographical event study.



**Agrium, Triton Project**  
Saskatchewan, Canada

Senior technical lead for the aquatic resources and the stakeholder engagement components of a green field potash development.

**Potash One, Legacy Project**  
Saskatchewan, Canada

Senior technical lead for the aquatic resources and the stakeholder engagement components of a green field potash development.

**SaskWater, Buffalo Pound Water Intake**  
Saskatchewan, Canada

Senior technical advisor and reviewer for the aquatics resources component for the CEEA screening and fish habitat compensation plan for a new water intake on Buffalo Pound Lake.

**City of Saskatoon Water Intake**  
Saskatchewan, Canada

Project manager and senior technical reviewer for the completion of the CEEA screening and fish habitat compensation program for the new City of Saskatoon water intake. Project director and senior technical reviewer for the fish salvage and TSS monitoring project associated with intake construction.

**AREVA Resources Canada**  
McClellan Lake,  
Saskatchewan, Canada

Project manager and senior reviewer for the environmental screening of a Uranium one survey transportation project; Receipt and Processing of McArthur River Ore at the McClellan Lake Operation. Project included environmental assessment as well as strategic advice on regulatory issues and community engagement.

**NSWRC, Regional Water Supply Feasibility Study**  
Saskatchewan, Canada

Senior Technical Lead for the environmental aspects of a feasibility study to determine the water supply potential and feasible options for economic development along the North Saskatchewan River near North Battleford, Saskatchewan. The work included cost estimates and benefit-cost analysis for selected options, environmental screening of potential impacts, and public meetings to gather stakeholder feedback.

**Diavik Diamond Mines Inc.**  
Northwest Territories,  
Canada

Project manager for the preparation of the 2006 and 2007 proposed Aquatic Effects Monitoring Program (AEMP). Also project manager for ongoing operation support projects requested by DDML in relation to their environmental programs at site. This project scope includes the preparation of the AEMP document, supporting data analysis, expert testimony, and supporting regulatory public and technical reviewer liaison.

**Saskatchewan Highways and Transportation**  
Saskatchewan, Canada

Project Manager and senior biologist for the preparation of CEEA screening reports for the twinning of Highway No. 1 and 16 in Saskatchewan. This project also included six years of follow-up as the environmental advisors to Saskatchewan Highways for: construction activities; wetland, grassland, and fish habitat compensation; ongoing permitting requirements; annual Environmental Protection Plans; annual rare and endangered species surveys; and regulatory liaison.



**Saskatchewan  
Watershed Authority**  
Saskatchewan, Canada

Project manager and senior fisheries biologist for the preparation of a Best Management Practices Manual for the Protection of Fish and Fish Habitat. The manual covers a variety of construction and maintenance activities SWA personnel conduct in or near waterbodies. The manual reviews Provincial and Federal regulations, provides Best management Practices for activities undertaken by SWA, provides fact sheets for specific types of activities, provides examples of permits and approvals, and provides Provincial and Federal agency contact information.

**Saskatchewan  
Highways and  
Transportation**  
Saskatchewan, Canada

Project manager and senior fisheries biologist for the preparation of fish habitat mitigation and compensation plans related to the Federal Fisheries Act and highway construction activities at several water body crossings. These include water body crossing for projects along Highway 55 near Shoal Lake, Highway 13 near Aneroid, Highway 21 near Maidstone; Highway 924 near Sled Lake; Highway 123 near Cumberland House; Highway 40 near Cutknife; and Highway 55 near Meadow Lake, Saskatchewan.

**Xstrata Nickel  
(formerly Falconbridge  
Limited)**  
Montcalm Mine, Ontario,  
Canada

Project Manager and senior biologist for the preparation of Environmental Effects Assessment documents and direction of field investigations related to the Montcalm Mine Project near Timmins, Ontario. Project Director for the annual monitoring programs completed as part of the Certificate of Approval for the project. Involvement included analysis of predicted effluent effects to the Groundhog River, regulatory liaison, preparation for a Terms of Reference and Detailed Study Design to fulfil Certificate of Approval requirements. In addition, submissions to the Government of Ontario Environmental Review Tribunal were prepared and submitted for this project. Project has been ongoing since 2003.

**DeBeers Canada**  
Northwest Territories,  
Canada

Task Leader for the aquatic ecosystem components of the baseline investigations, Environmental Impact Assessment, and land and water use permits for the Snap Lake Diamonds Project. Included in the aquatic ecosystem baseline surveys were: collections of fish tissues for metals analysis; fish health survey; benthic invertebrate sampling; collection of algae and zooplankton; collection of water samples; spawning surveys; fish habitat investigations; and the preparation of bathymetric maps.

**Diavik Diamond Mines  
Inc.**  
Northwest Territories,  
Canada

Project manager for the preparation of Fish Habitat Compensation Detailed Design and Habitat Monitoring Plans for the Diavik Diamond Mine at Lac de Gras, NT. This project scope includes regulatory and community liaison, preparation of detailed engineering designs for fish habitat construction, and preparation of a comprehensive fish habitat monitoring program to meet the requirements of the Federal Department of Fisheries and Oceans Authorization for the Harmful Alteration, Disruption, or Destruction of Fish Habitat issued for the project in 2000. This work has been ongoing since 2001.



**PFRA**  
Saskatchewan, Canada

Project Manager and Senior Technical Reviewer for conducting fish population surveys and aquatic habitat mapping projects in relation to construction of several proposed water control structure or changes to existing structures. These have included the Duncairn Dam and the Craven and Valeport structures. Environmental impact assessments included the use of habitat evaluation procedures (HEP) based on the development of habitat suitability indices (HSI) models for resident fish species.

**SaskWater**  
Qu'Appelle River Basin,  
Saskatchewan, Canada

Project manager and coordinator for a number of fisheries survey, habitat mapping, fish habitat compensation and environmental assessment projects on the Qu'Appelle River system. Including a channel realignment project near Lumsden, construction of a new outlet control structure on Buffalo Pound Lake, and baseline work on the Upper Qu'Appelle River related to increasing water conveyance capacity.

**Department of Fisheries and Oceans**  
Prairie Region, Canada

Project manager and primary author for the preparation of a Manuscript entitled "Life history characteristics of freshwater fisheries occurring in Manitoba, Saskatchewan, and Alberta, with major emphasis on lake habitat requirements". This manuscript was intended to form the basis of fish habitat evaluations completed in the Prairie Region as part of DFO's "Defensible Methods of Assessing Fish Habitat" under the Fisheries Act and "No Net Loss" policy.

**Fort Providence Combined Council Alliance**  
Northwest Territories,  
Canada

Project manager for the environmental scoping of a proposed bridge crossing of the Mackenzie River at Fort Providence in 2001. Continued as an advisor to the project in 2003 during the completion of an EA for the project. Project scope included aquatic and terrestrial impact scoping and community consultation related to potential effects of the bridge project.

**Department of Fisheries and Oceans**  
Prairie Region, Canada

Project manager for the modelling of river hydraulics data, in the River 2D model, related to Instream Flow Needs Assessments for the Assiniboine River.

**Manitoba Conservation**  
Manitoba, Canada

Project manager for the collection and 2D modelling of river hydraulics data and Instream Flow Needs Assessments for the Assiniboine River.

**Ainsworth Lumber Peter Ballantyne Cree Nation**  
Prince Albert,  
Saskatchewan, Canada

Project Manager for the preparation of the Project Proposal document for submission to regulatory agencies for the MeeToos Limited Partnership Lumber Finishing and Remanufacturing Facility located near Prince Albert. The Project Proposal detailed the scope of the project, reviewed the existing environment in the vicinity of the proposed project, and assessed the potential environmental impacts related to the development.



**Ainsworth Lumber  
Peter Ballantyne Cree  
Nation**  
Limestone Lake,  
Saskatchewan, Canada

Project Manager for the preparation of the Project Proposal document for submission to regulatory agencies for the MeeToos Limited Partnership Sawmill Facility located near Limestone Lake. The Project Proposal detailed the scope of the project, reviewed the existing environment in the vicinity of the proposed project, and assessed the potential environmental impacts related to the development.

**Weyerhaeuser**  
Big River,  
Saskatchewan, Canada

Project Manager for the preparation of the Project Proposal document for submission to regulatory agencies for the Weyerhaeuser Sawmill Expansion Project. The Project Proposal detailed the scope of the project, reviewed the existing environment in the vicinity of the proposed project, and assessed the potential environmental impacts related to the development.

**Manitoba Conservation**  
Manitoba, Canada

Project manager for the Instream Flow Needs Assessment of the Assiniboine River using components of Instream Flow Incremental Methodology group of models.

**SaskWater**  
Saskatchewan, Canada

Coordinated the completion of a fish population assessment on the Upper Whitesand River. The objective of the study was to investigate the possibility of carp having accessed a section of the river and the potential for this species to spread into upstream areas.

**Weyerhaeuser Canada**  
Prince Albert,  
Saskatchewan, Canada

Environmental Effects Monitoring, Cycle II. Co-ordinated preparation of the pre-design information and study design document for submission to the technical advisory panel (TAP). Project co-ordinator and field biologist for a fish tagging program to determine residence of sentinel fish species, a benthic invertebrate survey, and fish health survey on the North Saskatchewan River.

**TransGas/SaskEnergy**  
Saskatchewan and  
Manitoba, Canada

Senior aquatics technical lead for a wide range of pipeline development projects including inter-provincial pipelines requiring CEAA submissions and National Energy Board application.

**Placer Dome North  
America Ltd.**  
North-Western Ontario,  
Canada

Coordinated environmental baseline studies in 1995 and 1996 and functioned as Project Manager for aquatic monitoring surveys conducted annually (1997, 1998, 1999, and 2000) for the Musselwhite Mine. Responsible for the assessment of fish habitat, water quality, and fish populations. Detailed fish health assessments and collected fish tissues for metals analysis, collection of sediment samples for metals analysis, and collection of benthic invertebrates are conducted as part of the annual monitoring program. In addition, began a long-term study on potential effluent toxicity to early life stages of fish in the mine's receiving environment. First Nations involvement is also a key component of the annual monitoring programs and any supplemental studies conducted on site. Golder personnel act as crew leaders while providing training to First Nations technical assistants. Communications with local area residents is an ongoing component of work for this mine site.



**Cameco Corporation**  
Saskatchewan, Canada

Project Manager for the completion of a groundwater monitoring optimization study. The objectives of the study were to evaluate several ground water monitoring programs at the Rabbit Lake Mine and, where reasonable and defensible, reduce the costs of the program through sample period changes, sample parameter changes, and alterations to well configurations. The optimized program was then submitted for regulatory approval to both federal and provincial agencies. Through this project, the objectives of the monitoring program for the client and the regulatory agencies have now been addressed and the program improved from both perspectives.

**Alliance Pipeline**  
Moose Jaw,  
Saskatchewan, Canada

Supervised the completion of a fish salvage operation on Squaw Creek, resulting from an isolated crossing technique and in-stream construction activities.

**Placer Dome, Mussel  
White Mine**  
North-Western Ontario,  
Canada

Project Manager for the collection of young-of-year fish and sturgeon health assessments for the Shibogama First Nation in relation to mine effluent monitoring. Worked with this First Nations group to conduct specific monitoring programs of importance to communities in the vicinity of a gold mine.

**Weyerhaeuser Canada**  
Saskatchewan, Canada

Aquatic ecosystem Task Leader for the completion of the Weyerhaeuser Twenty-Year Forest Management Plan Environmental Impact Assessment in north central Saskatchewan. Responsible for the development and implementation of studies relating to the affects of forest harvesting operations on aquatic habitats in the northern boreal forest. This included detailed assessments on the influence of culverted road crossings on aquatic habitats and large-scale watershed investigations in harvested, burned, and unaffected areas of northern Saskatchewan forests.

**Highwood Resources**  
Northwest Territories,  
Canada

Preparation of aquatic component for the baseline survey and environmental assessment at the Thor Lake Beryllium mine site.

**Placer Dome North  
America Ltd.**  
North-Western Ontario,  
Canada

Northern pike egg fertilization and survival study in relation to potential exposure to discharge from the Musselwhite Mine. Test conducted at the Musselwhite mine.

**Diavik Diamond Mines  
Inc.**  
Northwest Territories,  
Canada

Field biologist and crew leader during the lake trout spawning program for the environmental impact statement being prepared for the Diavik mine project. Completed stream habitat impact assessment for the environmental impact assessment and no-net-loss plan.



**SaskWater**  
Pike Lake,  
Saskatchewan, Canada

Project management for a fish population survey and aquatic habitat mapping project on the South Saskatchewan River as part of a pumping and inlet works project involving a spur dyke and several bank spurs on the South Saskatchewan River. Environmental impact assessment included the use of habitat evaluation procedures (HEP) based on the development of habitat suitability indices (HSI) models for resident fish species. Project also included the preparation and execution of a fish habitat monitoring plan to fulfil requirements of a Department of Fisheries and Oceans Authorization.

**Weyerhaeuser**  
Prince Albert,  
Saskatchewan, Canada

Design and implementation of fathead minnow egg incubation experiment in varying concentrations of bleach kraft pulp mill effluent.

**Wascana Energy Inc.**  
Saskatchewan, Canada

Environmental assessment of well lease locations, pipeline corridors, access road and pipeline corridors, and associated stream crossings. Involved in the acquisition of all required permits and the preparation of mitigation plans.

**TransGas Limited**  
Saskatchewan, Canada

Development of Environmental Protection Plans and Environmental Impact Statements for pipeline developments. Environmental assessment of pipeline routes including assessments of crossings on the North Saskatchewan and South Saskatchewan Rivers. Responsible for the identification of wildlife and fish habitat concerns and development of mitigation plans associated with pipeline routes.

**Department of  
Fisheries and Oceans**  
Western Canada,  
Canada

Involved in the development of a comprehensive literature review and model concerning quantification of sediment release effects on fish and fish habitat in relation to water crossings by linear developments. This project also included developing sediment release criteria and a standardized approach to assessment and monitoring of water crossings.

**Environmental  
Monitoring**  
Saskatchewan, Canada

Responsible for development of environmental protection plans, monitoring of field activities, and mitigation operations for seismic exploration programs in environmentally sensitive areas of Saskatchewan.

**Weldwood Canada**  
Alberta, Canada

Field biologist for the collection of biomarker samples from fish for pulp and paper first cycle Environmental Effects Monitoring, 1995. Completed, detailed fish health assessments and collected fish population data.

**Syncrude**  
Northern Alberta,  
Canada

Field biologist for environmental baseline studies in the oil sands area of northern Alberta, 1995. Involved in the collection of biomarkers and samples from fish for organic contaminants and trace elements. Completed detailed fish health assessments and collected fish population data.



**Suncor Inc.**  
Northern Alberta,  
Canada

Field biologist for environmental baseline studies in the oil sands area of northern Alberta, 1995. Involved in the collection of biomarkers and samples from fish for organic contaminants and trace elements. Completed detailed fish health assessments and collected fish population data.

**Cameco Corporation**  
Saskatchewan, Canada

Environmental baseline studies for Eagle Point Expansion at Rabbit Lake Mine, 1994. Conducted detailed habitat inventory and classification, following Habitat Evaluation Procedures of the US Fish and Wildlife Service. Sampled fish for radionuclide and trace element analysis and conducted detailed fish health evaluations. Collected benthic invertebrates and sediments for radionuclide and trace element analysis. Sampling based on the requirements set out by Environment Canada and Fisheries and Oceans for Environmental Effects Monitoring (EEM).

**Cogema Resources Inc.**  
Saskatchewan, Canada

Environmental baseline studies for the Midwest Project, 1994. Conducted detailed habitat inventory and classification, following Habitat Evaluation Procedures of the US Fish and Wildlife Service. Sampled fish for radionuclide and trace element analysis and conducted detailed fish health evaluations. Collected benthic invertebrates and sediments for radionuclide and trace element analysis. Sampling based on the requirements set out by Environment Canada and Fisheries and Oceans for Environmental Effects Monitoring (EEM). Responsible for establishing permanent hydrology and water chemistry sampling stations and the collection of fish population data.

**Weyerhaeuser Canada**  
Prince Albert,  
Saskatchewan, Canada

Involved with the collection of data for Weyerhaeuser Canada, North Saskatchewan River Study, in 1991. Program included studying fish population characteristics and their movements through radio-telemetry. Also involved in the collection of data for the first cycle Environmental Effects Monitoring invertebrate program, 1994. In 1996, began a study of effluent toxicity on fish early life stages.

## TRAINING

***Project Management Professional (PMP) Certification Program***  
2012

***The Canadian Red Cross Society Standard First Aid/CPR level C***  
2008

***Theory and Concepts of the Instream Flow Incremental Methodology***  
1999

***Theory and Application of the Physical Habitat Simulation System***  
1999



## PROFESSIONAL AFFILIATIONS

- Member of the North Central Division, American Fisheries Society
- Member of the Canadian Aquatic Resources Section, American Fisheries Society
- Member of the Mid-Canada Chapter, American Fisheries Society
- Member of the Early Life History Section, American Fisheries Society

## PUBLICATIONS

### Journal Articles

- Langhorne, A.L., M. Neufeld, G. Hoar, V. Bourhis, D.A. Fernet and C.K. Minns. Life history characteristics of freshwater fishes occurring in Manitoba, Saskatchewan, and Alberta, with major emphasis on lake habitat requirements. *Can. MS Rpt. Fish. Aquat. Sci.*, 2579, xii+170p.
- Leis, A.L. and M.G. Fox. Feeding, growth and habitat associations of young-of-year walleye (*Stizostedion vitreum*) in a river affected by a mine tailings spill. *Can. J Fish. Aquat. Sc.* , 53 (11) (1996), 2408-2417.
- Leis, A.L. and M.G. Fox. Effect of mine tailings on the in situ survival of walleye (*Stizostedion vitreum*) eggs in a northern Ontario river. *Ecoscience*, 1(3) (1994), 215-222.

### Conference Proceedings

- Langhorne, A.. 2001. *Confirming Exposure of Seasonally Resident White Sucker (Catostomus commersoni) to Bleach Kraft Pulp Mill Effluent in a Northern Canadian River System*. Aquatic Toxicity Workshop, October . Winnipeg, Manitoba, Canada.
- Langhorne, A.. 2000. *Practitioner Based Decision Making Support: The (Fisheries) Desktop Tool*. Canadian Institute of Forestry Conference, October. Grande Prairie, Alberta, Canada.
- Langhorne, A.. 1998. *Assessing Ecological Effects of Aquatic Habitat Change as a Result of Timber Harvesting in the Boreal Forest: II. Environmental Impact Assessment for the Weyerhaeuser Twenty-Year Forest Management Plan*. Great Plains Fishery Workers Association 47th Annual Workshop, February. Moose Jaw, Saskatchewan, Canada.
- Langhorne, A.. 1994. *Effect of a Mine Tailings Spill on Growth, Feeding, and Habitat Selection of Young-of-Year Walleye (Stizostedion vitreum)*. 47th Annual Canadian Conference for Fisheries Research, January . Saskatoon, Saskatchewan, Canada.
- Langhorne, A.. 1993. *Effect of a Mine Tailings Spill on Walleye (Stizostedion vitreum) Egg Survival and Juvenile Habitat Use*. 46th Annual Canadian Conference for Fisheries Research, January. Peterborough, Ontario, Canada.



**Other**

Schryer, R.P., S.M. Swanson, T.A. Marchant, K. Holley, A.L. Leis, L. Steeves, B.K. Firth. 1995. Problems with collection and interpretation of sex steroid hormone data from wild fish exposed to bleach kraft mill effluents. Proceedings of the Technical Association of the Pulp and Paper Industry, Atlanta Georgia, 1995.

Disturbance and the Aquatic Environment in the Boreal Forest. Golder Associates Ltd. sponsored workshop for presentation of the results of field studies to provincial and federal regulatory personnel reviewing the Weyerhaeuser Twenty-Year Forest Management Plan Environmental Impact Assessment. January 20, 1997. Saskatoon, Saskatchewan.



**Education**

*B.Sc. Environmental Science, Royal Roads University (RRU), Victoria, BC, 2000*

*Honours Graduate Integrated Environmental Planning Technology, Selkirk College, Castlegar, BC, 1999*

**Languages**

*English – Fluent*

**Calgary**

***Air Quality Scientist***

Mr. Madland has worked as an air quality scientist in the Calgary office since 2000. He received an Environmental Planning Technology Diploma from Selkirk College in 1999 and a B.Sc. in Environmental Science from Royal Roads University (Victoria, BC) in 2000.

Chris has been involved in a wide range of projects in western and northern Canada and the Pacific Northwest United States. He has a range of experience in ambient monitoring programs including siting, permitting, installation, maintenance and reporting for the mining, manufacturing, oil and gas and the utilities sectors. He has contributed to the emissions profile development for many of the EIAs that have been produced by Golder Associates since 2000 and has coordinated the air quality component of several regulatory applications. Mr. Madland's specialty is ambient air quality and meteorological monitoring program development, operation and management.

**Employment History**

***Golder Associates – Calgary, Alberta***

*Air Quality Scientist (2000 to Present)*

Air quality scientist assisting on Environmental Impact Assessments, emission inventories and ambient air quality monitoring projects. Responsibilities include project management, air monitoring, data analysis, emission calculations, environmental management planning modelling, hearing preparation, meteorological data analysis preparation, regulatory guidance, regulatory liaison, client liaison, report peer review, report preparation and supplemental responses.

***British Columbia Hydro – Castlegar, British Columbia***

*Student Biologist (1998 to 2000)*

Participated in various reservoir and dam management programs, produced documents supporting BC Hydro's application for ISO 14001 certification.



**PROJECT EXPERIENCE – VARIOUS**

**Fortune Minerals Nico Project**  
Northwest Territories

Fortune Minerals has proposed to construct and operate the Nico Mine project approximately 160 km northwest of Yellowknife. Golder was responsible for conducting the air quality assessment for the Project. Provided technical meeting support for the Nico Project Air quality assessment.

**AMEC Earth and Environmental Limited Mackenzie Gas Pipeline EIA**  
Northwest Territories

As part of a consulting consortium, Golder was responsible for the completion of the air quality components of the Environmental Impact Assessment (EIA). The air quality assessment evaluated air pollutant concentrations and acid deposition resulting from cumulative emission sources across the length of the proposed pipeline, from the Mackenzie Delta in the north to Zama, Alberta in the south. Air quality predictions were made using the CALPUFF dispersion model (2-D mode). This project also included participation in the regulatory review and public hearings. Air Component/Discipline Lead and Emission Coordinator responsible for emission calculations, data analysis, QA/QC, hearing preparation and report preparation.

**Anadarko Canada Corp. East Liard Gas Gathering System**  
Deh Cho Region,  
Northwest Territories

Anadarko proposed to build a pipeline to link the existing Chevron K-29 well site with the existing Anadarko A-68 well site, north of Fort Liard, Deh Cho Region, NWT. Golder completed both the air quality and noise assessment for the dehydration and compression facility at the start of the pipeline, and the compressor station situated along the pipeline. Responsible for data analysis and report preparation.

**Nimbus Projects Tiverton Battle River**  
Stettler, Alberta

Nimbus Projects, acting on behalf of Tiverton Petroleum, retained Golder to assess ambient SO<sub>2</sub> concentrations resulting from the expansion of an oil battery located northeast of Stettler, Alberta. Solution gas flaring was planned to increase from 3,000 m<sup>3</sup>/day to 12,000 m<sup>3</sup>/day. Responsible for emission calculations, QA/QC, report preparation and project management.

**Imperial Oil Ltd. Kearl Oil Sands Project**  
Fort McMurray, Alberta

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) of the Kearl Oil Sands mine for Imperial Oil. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological dataset. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan to the Cold Lake area. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsible for emission calculations and QA/QC.

**Dynatec Corporation Ambatovy EIA**  
Madagascar

Golder was retained by Dynatec Corporation to complete an Environmental Impact Assessment (EIA) for a nickel/cobalt mine in Madagascar. The EIA included assessments of air quality and noise for the open pit mine, slurry pipeline, processing plant, tailings facility and port expansion. The air quality assessment included an ambient air quality component (SO<sub>2</sub>, NO<sub>x</sub> and others) as well as dust deposition, which was of particular concern in the ecologically diverse region. Responsible for emission calculations, QA/QC and data analysis.



**DeBeers Canada Inc.  
Snap Lake Monitoring**  
Snap Lake, Northwest  
Territories

The Snap Lake Diamond Mine EIA was in preparation for several years. The original development was owned by Winspear; however, DeBeers later purchased the project. In addition to the EIA, Golder was responsible for the operation and maintenance of the ambient air and meteorological monitoring at the site. Air Component/Discipline Lead and Emission Coordinator responsible for regulatory liaison, emission calculations, QA/QC, air monitoring and data analysis.

**Diavik Diamond Mines  
Inc. EIA Review**  
Lac de Gras, Northwest  
Territories

Golder was retained by Diavik Diamond Mines Inc. to complete a peer review of the original EA completed for the Diavik diamond mine in Lac de Gras, NWT. Responsible for QA/QC and report peer review.

**PCL Construction  
Management Inc. Dust  
Management Plan**  
Calgary, Alberta

Golder was retained by PCL Construction Management to provide a dust management plan for the University of Calgary, Health Research Innovation Centre project located at the Foothills Hospital. Project Manager responsible for emission calculations, air monitoring, data analysis, air/environmental management planning and report preparation.

**KeySpan Energy  
Canada Fugitive  
Emission Monitoring**  
Rocky Mountain House,  
Alberta

Golder was retained by KeySpan Energy Canada to identify sources of H2S and hydrocarbons from the Strachan gas plant through emissions monitoring. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

**TransAlta Utilities  
Corp. Centralia Mine**  
Washington

Golder completed baseline field work for TransAlta's Centralia Mine in Washington State. The project was managed out of the Golder Calgary office. However, air and noise monitoring was conducted by the Golder Gainesville office. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

**Suncor Energy Inc.  
Voyageur Project EIA**  
Fort McMurray, Alberta

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) for the Suncor Voyageur Project. The air quality sections of the EIA evaluated cumulative air pollutant concentrations and acid deposition across the Oil Sands Region, using the CALPUFF dispersion model (3-D mode). The EIA made use of Golder's regional emissions database and 3-D meteorological data set, which cover the area from Fort Chipewyan to the Cold Lake area. Responsibilities included air monitoring, data analysis and report preparation.

**Canadian Natural  
Resources Ltd.  
Primrose East Oil  
Sands Project**  
Cold Lake, Alberta

Golder was retained to prepare an Environmental Impact Assessment (EIA) for the Canadian Natural Primrose East Oil Sands Project. This Steam-Assisted Gravity Drainage (SAGD) project is an expansion of the existing Canadian Natural Primrose and Wolf Lake facilities. Air quality and noise assessments were completed as part of the EIA. Responsibilities included noise monitoring.



**BacTech Mining  
Mckinnon Creek Mine**  
Revelstoke, British  
Columbia

During early project planning BacTech Mining commissioned a meteorological monitoring program in the vicinity of a former metals mine. BacTech planned to develop a gold, lead and zinc deposit approximately 45 km north of Revelstoke, B.C. Golder was responsible for conducting the EIA, based on permitting and approval in 2006. The mine was planned to be underground and ore processing was planned to be done using a bioleach system. Project Manager responsible for air monitoring, data analysis and report preparation.

**Plains Marketing  
Joarcam Truck  
Terminal**  
Joarcam, Alberta

Plains Marketing applied to construct a truck terminal facility located on a five hectare site in Central Alberta. The facility is required to provide a collection point for locally produced crude oil for shipment through the Joarcam Pipeline system to markets in Edmonton and elsewhere. Golder was retained to provide technical input to Plains Marketing for the EUB permit. As part of this, a Noise Impact Assessment (NIA) and an air quality assessment were completed. Responsibilities included QA/QC and emission calculations.

**Advantage Oil and Gas  
Ltd. Sweetgrass  
Assessment**  
Sweetgrass, Alberta

Advantage Oil and Gas Ltd. retained Golder to provide air dispersion modelling predictions of ground-level sulphur dioxide (SO<sub>2</sub>) concentrations from the proposed operation of the Sweetgrass sour gas facility flare. The modelling was requested to provide information to interested stakeholders during the application process. Air Component/Discipline Lead and Emission Coordinator responsible for emission calculations, QA/QC, data analysis and report preparation.

**Redcliff Industries  
EPEA Renewal**  
Redcliff, Alberta

Golder was retained to assist Redcliff Industries (a fibreglass manufacturer) with their EPEA approval renewal process. The renewal application required an air quality modelling assessment. Air Component Discipline Lead and Emission Coordinator responsible for emission calculations, QA/QC, data analysis, QA/QC and report preparation.

**Canadian Natural  
Resources Ltd.  
Primrose North  
Monitoring**  
Cold Lake, Alberta

Canadian Natural Resources retained Golder to prepare an application to AENV for a continuous air quality monitoring station and four passive air monitoring stations near the Primrose North Oil Sands Facility. Responsibilities included air monitoring, data analysis and report preparation.

**EnCana Corp. Foster  
Creek Monitoring  
Program**  
Foster Creek, Alberta

Golder conducted a siting assessment in accordance with the Alberta Air Monitoring Directive for the installation of a continuous air quality monitoring trailer at the Foster Creek site. Project Manager responsible for air monitoring, QA/QC, environmental management planning model, regulatory guidance and report preparation.

**EnCana Corp.  
Christina Lake Project  
Debottlenecking and  
Expansion**  
Christina Lake, Alberta

Golder was retained by EnCana to assist in approval amendments associated with the Phase 1B Debottlenecking and Expansion at the Christina Lake Thermal Project. The Christina Lake Thermal Project is a SAGD project located in Alberta's Athabasca oil sands region. The work included completing the air quality and noise assessments, required as part of the approval amendment applications to Alberta Environment and the Alberta Energy and Utilities Board (EUB). The air quality assessment included establishing an air emission profile for the project, as well as determining the air quality impacts using the CALPUFF dispersion model. Responsibilities included emission calculations and data analysis.

**Ivanhoe Mines Inc. Oyu Tolgoi Dust Management Plan**  
Mongolia

Ivanhoe Mines Inc. needed to manage widely-dispersed fugitive dust associated with operations planned for southern Mongolia at the Oyu Tolgoi site. One of the most difficult aspects of managing dust generation in this location is the local climate. Golder developed a dust management plan that included controls and monitoring. Air Component/Discipline Lead responsible for emission calculations, data analysis, environmental management planning and report preparation.

**UEX West Bear Baseline Air Quality Monitoring**  
Northern Saskatchewan

Golder was retained by UEX to undertake environmental baseline monitoring studies at a uranium deposit in northern Saskatchewan to support a pending application to develop an open-pit mine at the site. The air and noise team designed and implemented a baseline air monitoring program for particulates radon, SO<sub>2</sub> and NO<sub>2</sub>. Air Component/Discipline Lead responsible for air monitoring, data analysis and report preparation.

**Dundee George & Goose Meteorological Monitoring**  
Bathurst Inlet, Nunavut

Golder was contracted to maintain two meteorological stations installed in August 2004 at two exploration camps near Bathurst Inlet, Nunavut. Work included calibration, repair, download and reporting of data from stations at George and Goose Lakes. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

**Catalyst Paper, Elk Falls Division Dustfall Monitoring Program**  
Campbell River, British Columbia

Golder prepared an application for a permit under the B.C. Environmental Management Act for a proposed landfill expansion at Catalyst Paper Corporation's Elk Falls mill in Campbell River, B.C. Air quality work included characterizing dustfall at the site through a monitoring program. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

**Fossil Water Catalyst Facility Air Assessment**  
Fort Saskatchewan, Alberta

Fossil Water proposed a catalyst recycling facility near Fort Saskatchewan, Alberta. Golder was retained to provide an assessment of air quality and to assist with various application components. Air Component Discipline Lead, Modelling Coordinator and Emission Coordinator responsible for emission calculations, air dispersion modelling, QA/QC, data analysis and report preparation.

**Suncor Energy Inc. Firebag Odour Assessment**  
Fort McMurray, Alberta

Suncor requested Golder's assistance with the identification and control of odour issues at the Firebag Facility. Golder performed preliminary monitoring at the Firebag site to identify potential sources of odour and helped to address this issue. Ongoing work has led to Golder being asked to develop an on-site fugitive emissions inventory. Responsible for emission calculations, air monitoring, and data analysis.

**Erco Worldwide Monitoring Data Review and Analysis**  
Saskatoon, Saskatchewan

Golder was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the ERCO Worldwide chemical production facility located in Saskatoon, Saskatchewan. This review and analysis was completed as part of a comprehensive State of the Environment report. Responsibilities included data review, analysis and report preparation.



**Siksika Environmental Ltd. Environmental Training**  
Siksika Reservation,  
Alberta

Golder was retained to provide technical training and job shadowing opportunities for selected employees of Siksika Environmental Ltd. Training was provided in the siting, operation and maintenance of ambient air monitoring equipment. Developed and delivered an introduction to air quality monitoring course.

**Miramar Mining Corporation Ambient Air Quality Monitoring**  
Bathurst Inlet, Nunavut

Miramar Mining Corporation is developing a gold mine near Cambridge Bay on Victoria Island, Nunavut. Golder was retained to provide background air quality and meteorological monitoring services in support of their permit application process. A Hi-Volume sampler and meteorological monitoring program was implemented during the summer months. Responsibilities included program development, instrument selection and procurement, installation and training of on-site staff in the maintenance of monitoring components. Also responsible for data analysis, QA/QC and reporting for this project.

**Cogema Resources Inc. Monitoring Data Review and Analysis**  
Saskatchewan

Golder was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the Cogema McLean uranium mine. Responsibilities included the coordination of data acquisition and subsequent analysis, as well as report preparation.

**Chevron Canada Ltd. M-25 Meteorological Monitoring**  
Fort Liard, Northwest Territories

This project involved implementing and managing a meteorological monitoring program at the Chevron Canada F-25 and K-29 wells near Ft. Liard in the Northwest Territories. The parameters monitored at each site included wind speed, wind direction temperature and solar radiation. Responsibilities included limited client liaison.

**EnCana Energy Christina Lake Environmental Management**  
Christina Lake, Alberta

Golder was responsible for the development of an air quality monitoring program for the Christina Lake Thermal Project in the Athabasca Oils Sands Region of Alberta. The ambient monitoring consisted of four static exposure stations and one continuous station. The program included options and recommendations for equipment purchase and monitoring station locations based on the requirements of the Alberta Monitoring Directive. Documentation was prepared to provide regulators with the information necessary to evaluate the suitability and effectiveness of the planned program. Involved in the siting of the continuous and the static stations and oversaw the installation of the monitoring program hardware. Responsible for the ongoing coordination of the program, data quality assurance and reporting.

**EnCana Energy Christina Lake Thermal Project Monitoring Program**  
Christina Lake, Alberta

An air quality and meteorological monitoring plan and on-site assessment program were conducted to evaluate facility emissions from the Christina Lake Thermal Project. The project involved the establishment of an air quality and meteorology monitoring station, interpretation of data and regular reporting and liaising with government officials on behalf of the client. Involved in the siting of the continuous and the static stations, and oversaw the installation of the monitoring program hardware. Also responsible for the ongoing management of some components of the program, data quality assurance and reporting. (2001)



**Norske Skog Inc.  
Crofton Landfill**  
Vancouver Island, British  
Columbia

Golder implemented a dust-fall and meteorological monitoring program at a water reservoir adjacent to the Norske Skog landfill in Crofton, B.C. The objective of the program was to assess the impact of dust emissions from the landfill on the water reservoir. The monitoring program consisted of monthly sampling of two dust-fall canisters, which were analyzed for dust-fall amounts and trace metal concentrations. Responsibilities included support for the field staff and siting process.

**DeBeers Canada  
Mining Inc. Snap Lake  
Diamond Mine  
Monitoring Program**  
Snap Lake, Northwest  
Territories

Golder provided ongoing support to DeBeers Canada for applications to the Government of the Northwest Territories to construct and operate an underground diamond mine in the vicinity of Snap Lake, NWT. This support included siting, installation, maintenance and calibration of equipment for monitoring programs, as well as development of standard operating procedures and environmental management plans for sample collection and completion of monitoring reports. Also responsible for annual ambient air quality and meteorological monitoring reporting, QA/QC and ongoing client support for the monitoring programs.

**Lafarge Construction  
Material Limited  
Ambient Air Quality  
Monitoring**  
Calgary, Alberta

Provided consulting services to Lafarge regarding a proposed gravel pit east of Calgary, Alberta. Work included the preparation of a monitoring plan and guidance to Lafarge on placement options for a particulate and meteorological monitoring system in the vicinity of the proposed operation. Contributed to the monitoring plan and proposal, coordinated the station siting process, procured all necessary monitoring hardware, installed and calibrated the requisite systems, QA/QC and coordinated ongoing client support and reporting.

**Domtar Canada Ltd.  
Particulate Monitoring**  
Cochrane, Alberta

Conducted short-term particulate monitoring services to Domtar Canada using hi-volume sampling devices. The objective of the work was to obtain estimates of airborne total suspended particulate (TSP) levels in the vicinity of an excavation site. Responsibilities included monitoring plan preparation equipment procurement, installation and calibration, and reporting.

**Inmet Mining  
Corporation Izok  
Meteorological  
Monitoring**  
Izok Lake, Nunavut

This project involved implementing and managing a meteorological monitoring program at the Izok Lake Project in Nunavut. The parameters monitored at each site included precipitation, wind speed, wind direction, temperature and solar radiation. The meteorological monitoring formed part of a comprehensive program designed to establish baseline hydrologic and climatic conditions at the proposed mine site. Responsibilities include supervising on-site installation of the meteorological station.

**OPTI Canada/ Nexen  
Canada Air Quality  
Modelling Course**  
Calgary, Alberta

Through the Golder Institute, Golder prepared a comprehensive two-day course designed to introduce the concepts of dispersion modelling and air quality assessment in the Oil Sands Region. The course comprised eight modules ranging in topic from oil sands history to hands-on modelling exercises using SCREEN3 and CALPUFF. Designed, constructed and demonstrated a scaled Plume Model.



**Miramar Mining  
Corporation Doris  
North Gold Project EIS**  
Bathurst Inlet, Nunavut

Golder prepared an air quality and noise assessment for the Miramar Doris North Gold Project located near Bathurst Inlet, Nunavut. The assessment was prepared to support the Environmental Impact Study (EIS) for submission to the Nunavut Impact Review Board. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC, environmental management planning and report preparation.

**OPTI Canada Inc. Long  
Lake Project EIA and  
Project Update**  
Anzac, Alberta

Golder was responsible for the preparation of the Environmental Impact Assessment (EIA) and subsequent project update for the Long Lake Project, which includes an integrated Steam-Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air pollutant concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project update made use of the Golder regional emissions and 3-D meteorological data sets, covering the area from Fort Chipewyan to south of the Cold Lake area. The use of these data sets made the update predictions consistent with the assessment approaches used on the majority of applications filed in the Oil Sands Region, as well as the work being conducted for the NOX-SOX Management Working Group (NSMWG). In addition, the use of the large study area and greater number of sources were effective in addressing all of the concerns raised by Saskatchewan Environment. Responsibilities included ambient air quality data analysis and report preparation.

**Lehigh Inland Cement  
Limited Substitution  
Fuel Project**  
Edmonton, Alberta

Golder was retained to prepare the Environmental Protection and Enhancement Act (EPEA) application for the proposed conversion of the Lehigh Inland Cement facility in Edmonton to allow the use of coal as a primary fuel. The project involved a detailed review of the facility emissions, estimation of resulting off-site concentrations, evaluation of current operations and recommendations for future mitigation. Liaison with regulators during the application process formed an integral part of the air quality assessment. Golder assisted Lehigh Inland through the hearing process and provided expert testimony. Responsibilities included calculation of fugitive emissions, report preparation and technical support of the air quality team that attended the hearings.

**Petro-Canada Oil and  
Gas Meadow Creek  
Project EIA**  
Fort McMurray, Alberta

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. The air quality component of the project evaluated acid deposition in the region as well as local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons. The CALPUFF model (3-D mode) was used for this assessment. Assisted with emissions calculations and with report preparation.

**Chevron Canada  
Resources Air Quality  
Evaluation of the K-29  
Facility**  
Ft. Liard, Northwest  
Territories

A well-test flaring assessment was completed for a proposed gas processing facility near Ft. Liard, NWT. The project involved the estimation of facility emissions and a dispersion modelling analysis of the SO<sub>2</sub> emissions from a flare. The site location was in very complex terrain and required the use of the CTSCREEN model to determine the necessary flare height that would result in no exceedances of the ambient SO<sub>2</sub> guidelines. Involvement in the project included client liaison.



**DeBeers Canada Inc.  
Diamond Mine EIA**  
Snap Lake, Northwest  
Territories

Golder completed an air quality assessment as part of a comprehensive EIA for a proposed diamond mine northeast of Yellowknife, NWT. The project involved the evaluation and selection of dispersion models, quantification of the current and future air emissions for the construction, operation and closing phases of the project. Additional support was provided to the client in response to stakeholders' questions and concerns for the technical hearing. Responsibilities included calculation of fugitive emissions, QA/QC and report preparation.

**DeBeers Canada Inc.  
Snap Lake Monitoring**  
Snap Lake, Northwest  
Territories

The Snap Lake Diamond Mine EIA was in preparation for several years. The original development was owned by Winspear; however, DeBeers later purchased the project. In addition to the EIA, Golder was responsible for the operation and maintenance of the ambient air and meteorological monitoring at the site. Responsibilities included QA/QC.

**Shell Canada Ltd.  
Jackpine Mine-Phase 1  
EIA**  
Fort McMurray, Alberta

Golder was responsible for the completion of the recent Environmental Impact Assessment (EIA) of the Jackpine Mine – Phase 1 Oil Sands mine for Shell Canada. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological data set. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan in the north to the Cold Lake area in the south. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsibilities included calculation and summary of facility and regional emissions, and report preparation.

**Government of Canada  
Public Works Air  
Quality Management  
Plan & Review  
Development**  
Esquimalt, British  
Columbia

Golder was retained to prepare a review of the air quality management and monitoring systems currently in place at the Esquimalt Graving Dock near Victoria BC. Project Manager responsible for data analysis, emission calculations, environmental management planning modelling, literature review, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**National Oilwell Varco  
National Pollutant  
Release Inventory  
(NPRI)**  
Leduc, Alberta

Golder was contracted to complete the federal 2006 National Pollutant Release Inventory (NPRI) for National Oilwell Varco. Project Manager responsible for data analysis, regulatory guidance, QA/QC, report preparation and client liaison.

**Strateco Resources  
Uranium Exploration  
Project Meteorological  
Station Installation**  
Northern Quebec

Golder was retained to install a meteorological monitoring station at the Strateco Resources base camp in northern Quebec. Component/Discipline Lead responsible for meteorological data analysis preparation, report preparation, meteorological monitoring, training and client liaison.

**DeBeers Canada Inc.  
Snap Lake Monitoring**  
Snap Lake Alberta

Golder has been responsible for the on-going operation, maintenance and support of the ambient air and meteorological monitoring at the Snap Lake site. Component/Discipline Lead responsible for air dispersion modelling, air monitoring, data analysis, emission calculations, environmental management planning modelling, meteorological data analysis preparation, regulatory liaison, QA/QC, report preparation, client liaison and training.



**Catalyst Paper Corporation Powell River Dustfall Monitoring**  
Powell River, British Columbia

Golder was retained to prepare an application for a permit under the B.C. EMA for a proposed landfill expansion at Catalyst Paper Corporation's mill in Powell River, B.C. The application included a requirement for characterizing dustfall at the site through a monitoring program. Component/Discipline Lead responsible for air monitoring, data analysis, environmental management planning modelling, meteorological data analysis preparation, regulatory guidance, regulatory liaison, QA/QC, report preparation and client liaison.

**Khan Resources Meteorological Station Installation**  
Mongolia

Golder provided baseline air quality and meteorological support to Khan Resources for a uranium mine in Mongolia. The project included training of on-site personnel to conduct the on-going portion of the program once installation was complete. Component Discipline Lead responsible for air monitoring, meteorological data analysis preparation, report preparation, meteorological monitoring, client liaison and meteorological monitoring training.

**Catalyst Pulp & Paper Crofton Dustfall Monitoring**  
Crofton, British Columbia

Golder was retained to summarize the dustfall monitoring done for Catalyst Pulp & Paper in Crofton. This data was used for their annual report. Responsibilities included air monitoring and report peer review.

**Hope Bay Mining Ltd. Doris North Gold Mine EIA**  
South of Cambridge Bay, Nunavut

Hope Bay Mining retained Golder Edmonton to provide on-going support following completion of an Environmental Impact Assessment (EIA) for their gold mine in Nunavut. The project required that Air Quality and Noise Management Plans be developed. Component/Discipline Lead responsible for air dispersion modelling, air monitoring, emission calculations, meteorological data analysis preparation, report preparation and client liaison.

**Shell Grosmont Venture In-situ Oil Sands Project Baseline Studies**  
Wabasca, Alberta

Golder was retained to complete baseline noise, air quality and meteorological data collection for the Shell Grosmont in-situ oil sands project west of Fort McMurray. Component/Discipline Lead responsible for air monitoring, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**DeBeers Canada Inc. Gahcho Kue Review**  
Gahcho Kue, Northwest Territories

Golder was retained by DeBeers to conduct a peer review of a draft Environmental Impact Assessment (EIA) for their Gahcho Kue Project. The review included the EIA methodology and all technical components, including air quality and noise. Responsibilities included report peer review.

**Alliance Pipeline Hazard Assessment**  
Saskatchewan

Golder was retained to conduct a hazard assessment of a potential accidental condensate release associated with waste heat recovery at the Alliance Kerrobert facility. Responsibilities included data analysis, hazard assessment and report preparation.

**EXH Engineering Services Ltd. Mobile Asphalt Plant Air Monitoring**  
South of Calgary, Alberta

Golder was retained to conduct a short- term volatile organic compound and polycyclic aromatic hydrocarbon emissions monitoring program for a mobile asphalt plant just south of Calgary. Project Manager responsible for air monitoring, data analysis, report preparation and client liaison.



**DeBeers Canada Inc.  
Snap Lake Diamond  
Mine Monitoring**  
Snap Lake, Alberta

Golder has been responsible for the on-going operation, maintenance and support of the ambient air and meteorological monitoring at the Snap Lake site. Ambient air monitoring compound include particulate matter (TSP, PM10, PM2.5) sulphur dioxide and nitrogen dioxide. Meteorological monitoring includes measurement of wind speed, wind direction, temperature, relative humidity, solar radiation and precipitation. Component/Discipline Lead responsible for air dispersion modelling, air monitoring, data analysis, emission calculations, environmental management planning modelling, meteorological data analysis preparation, regulatory liaison, report preparation, client liaison and training.

**Great Western  
Minerals Group Hoidas  
Lake Monitoring**  
Hoidas Lake,  
Saskatchewan

The Hoidas Lake facility (Great Western Minerals Group) is a remote rare earth elements mining exploration camp in the northwest corner of Saskatchewan. Golder conducted a baseline air quality monitoring program at the site to provide data to support a potential Environmental Impact Assessment. Component/Discipline Lead responsible for air monitoring, data analysis, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**Fortune Minerals Nico  
Mine Monitoring  
Program**  
Northwest Territories

Fortune Minerals is planning to develop an underground/open-pit mine approximately 160 km northwest of Yellowknife. Golder was retained to assist Fortune with their application to the Mackenzie Valley Land and Water Board for a Class B water license. This included technical assistance with a feasibility study for Nico Mine open pit and underground project. Ongoing work includes supporting an on-site meteorological and air quality monitoring program. Component/Discipline Lead responsible for air monitoring, data analysis, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**Confidential Client Oil  
Processing Facility  
Hazard Assessment**  
Alberta

Golder conducted a hazard assessment of a potential uncontrolled hydrogen sulphide (H<sub>2</sub>S) release from an oil processing facility under a range of meteorological conditions. Project Manager responsible for hazard assessment and report preparation.



## TRAINING

*Construction Safety Training System*

*First Aid*

*OSSA Training*

*H2S Alive*

*Cold Lake Air Weapons Range Orientation*

*Bear Awareness*

*Class 1 First Aid with Transportation Endorsement, Alberta and BC*

*Snowmobile Training*

*Helicopter Safety*

*Wilderness First Aid*

*ATV Training*

*Tower Climbing and Electrical Awareness*

*Class 1 Driver's License with Air Brake Endorsement*

*Certified Crew Supervisor – Backpack Electro-shocking*

*Swift Water Rescue and Powerboat Safety Awareness*

*Health and Safety Inspections, Module 3*

## PROFESSIONAL AFFILIATIONS

Institute of Professional Environmental Practice



**Education**

*M.Sc. Biology, York University, North York, Ontario, 1994*

*B.Sc. Biology, Honours, McMaster University, Hamilton, Ontario, 1991*

**Golder Associates Ltd. – Calgary**

Kristine is a project manager/director and senior fisheries biologist with more than 15 years of experience in aquatic and fisheries biology. She has field and office-based experience with a wide variety of projects in Alberta, British Columbia and the Northwest Territories, including fisheries inventory and impact assessment for development projects, such as oil and gas, mining, seismic operations, linear developments and hydroelectric facilities. She has experience in the assessment and mitigation of impacts from a variety of development projects on fish, fish habitat and the aquatic ecosystem. As well as dealing with the scientific and technical aspects of these types of developments, Kristine has also been involved with the regulatory approval process under the Fisheries Act and the Alberta Codes of Practice for crossings under the Water Act.

Kristine has managed the fisheries components for several large environmental impact assessment projects. For example, Kristine managed the Fish and Fish Habitat component for the De Beers Gahcho Kué Project in the Northwest Territories. In the Oil Sands Region in Northern Alberta, Kristine managed the Fish and Fish Habitat components for Shell's Jackpine Mine Expansion & Pierre River Mine Project, Suncor's Voyageur South Project and MEG Energy's Christina Lake Regional Project, among others. Kristine was also involved in impact assessment, permit approvals and hearing preparation/support for the fish and fish habitat component of the Mackenzie Gas Project.

Kristine has also been the Project Manager/Director for environmental assessment of Oil Sands Projects in Northern Alberta.

**Employment History**

***Golder Associates Ltd. – Calgary, Alberta***

*Associate. Senior Fisheries Biologist/Project Manager (2000 to Present)*

Responsible for managing projects/tasks related to environmental impact assessment, impact mitigation and management, and monitoring of proposed oil, gas and mining developments in western and northern Canada. Also responsible for senior technical advice, proposal preparation, project management, field sampling, data analysis, impact assessment, client liaison, report writing and regulatory consultation.

*Aquatics Division Manager (2008 to 2009)*

Division manager responsible for about 40 professionals in the fields of fisheries and water quality as well as support staff. The role includes the participation in the office management team, supervision of group manager's activities, financial analysis and reporting, recruiting and personnel management, as well as contribution to strategic decisions within the Division.



*Fisheries Group Manager (2006 to 2008)*

Group manager responsible for about 20 professionals (fisheries biologists and technicians). Responsibilities included scheduling and management of staff, workload allocation, recruitment, budgeting, and financial management.

***Triton Environmental Consultants Ltd. – British Columbia, Canada***  
*Biologist/Project Manager (1996 to 1999)*

Biologist for watershed inventory, fish habitat assessment and impact assessment projects. Field and office experience with a wide variety of environmental projects, including Forest Renewal BC funded lake and stream inventory, stream classification according to the Forest Practices Code and watershed restoration program. Involved with background review, data analysis and interpretation, and report writing for environmental impact assessments for large-scale industrial and mining projects. Responsible for proposal preparation, client liaison and budget tracking for selected projects. Supervised field crews in remote locations and delegated responsibility for planning and post-field data analyses. Coordinated data collection, entry and analysis and report preparation.

***Ontario Ministry of Natural Resources – Maple, Ontario***  
*Community Dynamics Biologist (1995 to 1995)*

Statistical analyses and report writing, focusing on salmonid/invertebrate interactions.

***York University, Biology Department – North York, Ontario***  
*Research Assistant / Teaching Assistant (1992 to 1994)*

Limnological assessment including sampling for crayfish, benthic invertebrates, zooplankton and aquatic plants in Lake Simcoe, Ontario. Performed laboratory experiments of crayfish respiration and crayfish predation on salmonid embryos. Modelled effects of crayfish predation rates on the lake trout population of Lake Simcoe. Maintained salmonid embryos and adult crayfish in a wet laboratory. Laboratory assistant for undergraduate courses in Comparative Vertebrate Anatomy, Biology of Animals, Ichthyology and Natural Science.

***Ontario Ministry of Natural Resources – Maple, Ontario***  
*Fisheries Resource Technician (1992 to 1993)*

Limnological, invertebrate and fish sampling. Performed measurements of crayfish distribution and calculated estimates of density.



**PROJECT EXPERIENCE – ENVIRONMENTAL IMPACT ASSESSMENT**

**Cenovus Energy  
Pelican Lake Grand  
Rapids Project**  
Wabasca, Alberta

Project Manager for the environmental impact assessment for the Cenovus Pelican Lake Grand Rapids project. Responsible for scheduling, Health and Safety, cost tracking, quality control, report review, client liaison and regulatory advice.

**Cenovus Energy  
Pelican Lake Grand  
Rapids Pre-  
Disturbance  
Assessment**  
Wabasca, Alberta

Project Director for the pre-disturbance assessment for the Cenovus Pelican Lake Grand Rapids project.

**De Beers Canada Inc.  
Gahcho Kué Project**  
Northwest Territories

Managed the fish and fish habitat component for the environmental impact statement for the project. Responsible for EIS report preparation, responses to Information Requests, attending regulatory/technical meetings, and associated follow-up work. Also involved in providing regulatory support and advice, and fish habitat compensation planning.

**Shell Canada Jackpine  
Mine Expansion &  
Pierre River Mine  
Project**  
Fort McMurray, Alberta

Managed the environmental impact assessment for the fish and fish habitat component of the project. Involved in the development of the Conceptual Compensation Plan to meet the requirement for No Net Loss of productive capacity of fish habitat, as well as follow-up work related to the project.

**ConocoPhillips,  
Surmont Expansion  
Project**  
Conklin, Alberta

Responsible for providing senior advice and direction to fish and fish habitat component lead on the completion of baseline studies and report preparation.

**MEG Energy, Christina  
Lake Regional Project  
Phase 2**  
Conklin, Alberta

Managed the completion of baseline studies and an environmental impact assessment as the fish and fish habitat component lead for the Phase 2 of the MEG Energy Christina Lake Regional Project. Involved in the preparation of responses to Supplemental Information Requests and Statements of Concern.

**Suncor Energy,  
Voyageur South  
Project**  
Fort McMurray, Alberta

As the fish and fish habitat component lead, managed the completion of baseline studies and an environmental impact assessment for the Suncor Voyageur oil sands development in the Poplar Creek and Beaver River watersheds north of Fort McMurray.

**Mackenzie Gas Project**  
Northwest Territories,  
Canada

Involved in task management, impact assessment, field planning and report preparation for the fish and fish habitat component of the Mackenzie Gas Project. Participated in the preparation of the Environmental Impact Statement and responding to Information Requests. Involved in permit approval process and hearing preparation/support. The project involves the development of the natural gas reserves in the Mackenzie River Delta and construction of a pipeline and associated infrastructure from the production fields down the Mackenzie River valley to Alberta.



**AXYS Environmental,  
ConocoPhillips  
Surmont Phase 2**  
Fort McMurray, Alberta

Managed the Fisheries component involving an update to the project description for the ConocoPhillips Surmont EIA.

**MEG Energy, Christina  
Lake Regional Project**  
Conklin, Alberta

Managed the completion of baseline studies and an environmental impact assessment as the aquatic resources component lead for the MEG Energy Christina Lake Regional Project located near Conklin, Alberta.

**Sunshine Village  
Corporation, Healy  
Creek**  
Banff, Alberta

Fish and fish habitat task manager for an environmental assessment for water withdrawal from Healy Creek for snowmaking operations at Sunshine Village in Banff National Park. Co-ordinated baseline fish and fish habitat field studies, data compilation and report preparation. Involved in regulatory liaison and providing technical advice to Sunshine.

**OPTI/Nexen, South  
Lease Baseline Project**  
Conklin, Alberta

Managed the completion of field studies as fish and fish habitat discipline lead for the OPTI/Nexen South Lease baseline studies, as a proposed expansion to the Long Lake Project.

**PetroCanada, Meadow  
Creek II Project**  
Fort McMurray, Alberta

Managed the completion of baseline studies as fish and fish habitat discipline lead for a proposed expansion to the PetroCanada Meadow Creek Project.

**Rio Alto Exploration  
(now Canadian  
Natural), Kirby Project**  
Conklin, Alberta

As the aquatic resources component lead, managed and participated in baseline aquatic studies and the completion of the environmental impact assessment for Rio Alto Exploration Ltd.'s (now Canadian Natural) Kirby SAGD development near Conklin, Alberta.

**TransAlta Utilities,  
Keephills EIA**  
Keephills, Alberta

Collected water and sediment quality samples and water quality measurements within the power plant cooling pond and other local waterbodies to provide baseline data for the impact assessment.

**True North (now UTS),  
Fort Hills Project**  
Fort McMurray, Alberta

Collected baseline inventory data in lake and stream habitats for a proposed oil sands development in the Fort McMurray area. Field studies included the collection of water quality, habitat mapping, discharge and fish inventory data.

**Taseko Mines,  
Prosperity Project  
Williams Lake,  
British Columbia**  
Williams Lake, British  
Columbia

Data analyses and impact assessment reporting for water quality data collected for the proposed Prosperity Gold-Copper project near Williams Lake, BC.

## PROJECT EXPERIENCE – LINEAR DEVELOPMENTS

**Mackenzie Gas Project**  
Northwest Territories,  
Canada

Involved in task management, impact assessment, field planning and report preparation for the fish and fish habitat component of the Mackenzie Gas Project. Participated in the preparation of the Environmental Impact Statement and responding to Information Requests. Involved in permit approval process and hearing preparation/support.



**Parks Canada,  
TransCanada Highway  
Twinning, Phase IIIB**  
Banff, Alberta

Managed completion of the fish and fish habitat component of the environmental screening for the proposed twinning of Phase IIIB of the TransCanada Highway in Banff National Park, including the collection of baseline field data at proposed watercourse crossings. The screening was required to meet requirements of the Canadian Environmental Assessment Act.

**OPTI/Nexen,  
Watercourse  
Crossings**  
Anzac, Alberta

Managed fish and fish habitat studies for pipeline and watercourse crossings in the Long Lake and Jackfish leases. Provided technical advice to OPTI/Nexen related to provincial and federal authorization requirements for their linear infrastructure and prepared applications and supplementary reports to Fisheries and Oceans for the proposed crossings.

**Paramount Resources,  
Pipeline Crossings**  
Northern Alberta

Managed studies to assess fish and fish habitat at proposed pipeline watercourse crossings associated with numerous gathering systems (e.g., Dover, Goose, Shadow, Mirage, Little Smoky and Valhalla) and prepared necessary documents for authorization of works by provincial and federal authorities.

**Alaska Gas Producers  
Pipeline Team,  
Feasibility Study**  
Calgary, Alberta

Involved in the fish and fish habitat investigation along three pipeline routes proposed by a consortium of Alaskan North Slope Gas producers. Baseline studies included reconnaissance level surveys of fish habitat along the proposed pipeline routes.

**CN Rail, Fish Habitat  
Assessments**  
Northern British  
Columbia, Canada

Fish habitat assessment of streams crossing the rail line between Houston and Prince Rupert, BC.

## PROJECT EXPERIENCE – SEISMIC OPERATIONS

**Aguila, Winter Seismic  
Monitoring**  
Mackenzie Delta,  
Northwest Territories

Provided senior advice on an aquatic monitoring project for Aguila's winter seismic program in the Mackenzie Delta.

**Chevron Canada  
Resources, Winter  
Seismic Monitoring**  
Mackenzie Delta,  
Northwest Territories

Managed aquatic monitoring projects at ChevronTexaco's winter seismic programs in the Mackenzie Delta, which involved field coordination, client liaison, data analyses and report preparation.

**DeBeers, Air Gun  
Seismic**  
Yellowknife, Northwest  
Territories

Provided technical expertise to the team involved in the preparation of a project description for a proposed air gun seismic operation in Snap Lake.



**WesternGeco, Winter Seismic Monitoring**  
Mackenzie Delta,  
Northwest Territories

Project manager for environmental monitoring of winter seismic programs conducted in the Mackenzie Delta at the WesternGeco Parsons Lake, Nuna and Titlalik seismic programs. Responsibilities included field coordination, sampling, client and regulatory liaison, data analyses and report preparation. Field studies monitored water quality during drilling operations and blast induced water overpressures during blasting. Data was collected according to protocols established by Fisheries and Oceans Canada (Western Arctic area).

**Salmo Consulting, Monitoring Data Review**  
Calgary, Alberta

Project manager for project to perform data analyses of water quality and overpressure monitoring data collected in the Mackenzie Delta during the winter of 2002. Data from multiple programs and program areas were compiled, analyzed, and summarized, in a written report, which was incorporated into a background paper on the Use of Explosives in Waterbodies for the Canadian Association of Petroleum Producers (CAPP).

**Salmo Consulting, Fish Deterrent Review**  
Calgary, Alberta

Involved in the review of fish deterrent literature and the applicability for seismic operations. A summary of the information was produced, as well as a simple study design and cost estimate for testing of potential deterrents.

**Gulf Canada Resources, Seismic Monitoring**  
Parsons Lake,  
Northwest Territories

Monitoring of summer seismic activities in Parsons Lake, NWT, including blast-induced overpressure monitoring, turbidity monitoring, and water and sediment quality sampling. A report was prepared summarizing the results of the monitoring.

## PROJECT EXPERIENCE – AQUATIC STUDIES

**Fisheries and Ocean Canada, Pathways of Effects**  
Calgary, Alberta

Managed project to conduct a literature review to provide scientific evidence for the linkages between certain physical activities and the endpoints of temperature and dissolved oxygen, as part of DFO’s “Pathways of Effects” methodology. This involved identification of linkages, database searches, selection of relevant literature and summarizing into a report.

**City of Calgary, Pine Creek Baseline**  
Calgary, Alberta

Fish and fish habitat component lead for the first phase of aquatic baseline studies of Pine Creek, a tributary to the Bow River south of Calgary. Developed study plan and coordinated field data collection.

**Fisheries and Ocean Canada, Dredging Review**  
Inuvik, Northwest Territories

Managed project to conduct a literature review on the potential physical and biological effects of dredging in the Beaufort Sea. The results of the literature review were summarized, including the aquatic organisms present in the Beaufort Seas, past dredging operation, environmental effects of dredging, mitigation and recovery, and appropriate legislation and guidelines.

**Petrobank, Coal Bed Methane Project**  
Princeton, British Columbia

Managed literature review and completion of baseline fish and fish habitat studies for a proposed coal bed methane project near Princeton, British Columbia. Seasonal studies were developed to meet the draft Code of Practice for coal bed methane operations.



**Sunshine Village Corporation, Healy Creek**  
Banff, Alberta

Task manager for project to perform bank repair and restoration to Healy Creek at the Sunshine Village base area. Prior to construction, a site visit was conducted and reports prepared for Fisheries and Oceans and Parks Canada. At the time of construction further baseline fish habitat studies were conducted, as well as monitoring of suspended sediment during construction. A report was prepared for both regulatory agencies.

**TransCanada Pipelines, Michel Creek**  
Calgary, Alberta

Prepared an assessment of the extent and significance of an inadvertent release of sediments into Michel Creek during construction of a dam and flume pipeline crossing. The assessment was requested by TCPL Legal counsel in anticipation of charges being laid under Section 36(3) of the Fisheries Act.

**Cominco Mines, Risk Assessment**  
Trail, British Columbia

Preparation of a problem formulation report for a screening level risk assessment. Responsibilities included literature review and summary, analysis of data, and report preparation.

**TransAlta Utilities, Weed Harvesting**  
Wabamun Lake, Alberta

Monitoring of weed harvesting program in Wabamun Lake, including field work and reporting. Performed fish salvage in the outlet canal of the Wabamun power plant.

**Queen Charlotte Power**  
Moresby Island, British Columbia

Collected background fisheries and limnological information for proposed hydroelectric project near Takakia and Moresby Lakes, Queen Charlotte Islands.

## PROJECT EXPERIENCE – FORESTRY

**Slocan Group, Tolko Industries and Weldwood of Canada**  
Quesnel, British Columbia

Watershed inventory in various working areas within the Quesnel TSA. Field data collection involved fish sampling and biophysical characteristics. Responsible for field logistics, data collection, analyses and report writing.

**Carrier Lumber**  
Prince George, British Columbia

Watershed inventory in the Missinka watershed. Responsible for lake inventory data collection and report writing.

**Riverside Industries**  
Chilcotin, British Columbia

Reconnaissance level lake inventories of lakes in the Chilcotin region of British Columbia. Responsible for lake inventory data collection, report writing and budgeting.

**Ministry of Environment, Lands and Parks**  
North Coast, British Columbia

Lake inventory of remote lakes on the North Coast of BC, involving bathymetric sounding, fish sampling, limnological and water sampling. Observed wildlife and identified aquatic and terrestrial plants. Responsible for budgeting, client liaison, field logistics, data collection, analyses and report writing.

**Ministry of Forests, Kalum Forest District**  
Terrace, British Columbia

Stream Survey and Riparian Classification for streams in the Nass watershed. Supervised field crews performing classification of tributary streams according to the Forest Practices Code.



**Skeena Sawmills**

Terrace, British  
Columbia

Classified fish streams, riparian management areas and wetlands in accordance to the Forest Practices Code in various watersheds on the North Coast of BC.

**International Forest  
Products**

North Coast, British  
Columbia

Inventory and classification of streams within the Kumealon Lake watershed on the North Coast of BC.

**International Forest  
Products**

Porcher Island, British  
Columbia

Involved with the report writing and editing for a large watershed restoration program report for watersheds on Porcher Island, BC.

**PROFESSIONAL AFFILIATIONS**

Member, Alberta Society of Professional Biologists (ASPB)



**Education**

*Ph.D. Civil Engineering - Fluid Mechanics, University of Canterbury, 1998*

*M.Sc. Civil Engineering - Water Resources, University of Alberta, Alberta, 1992*

*B.Sc. Civil Engineering - Co-op Program, With Distinction, University of Alberta, Alberta, 1990*

*Applied Fluvial Geomorphology, Dave Rosgen/Wildland Hydrology, 2001*

**Languages**

*English – Fluent*

**Affiliations**

*Association of Professional Engineers, Geologists and Geophysicists of Alberta*

*Association of Professional Engineers and Geoscientists of British Columbia*

*Association of Professional Engineers, Geologists and Geophysicists of Northwest Territories*

*International Association for Hydraulic Research*

*Canadian Institute of Mining, Metallurgy and Petroleum (Environment Section)*

*Canadian Water Resources Association*

**Golder Associates Ltd. – Edmonton**

**Senior Water Resources Engineer**

Dr. Nathan Schmidt has been a surface water engineer for over twenty years and with Golder Associates for almost fifteen years, ten of which have been in the Edmonton office. He is responsible for applications of hydrology, hydraulics and water management to planning and design projects.

Nathan has served as the surface water hydrology lead for a number of mining and energy EIAs, including baseline studies. He has extensive experience in river engineering and erosion and sediment control, and frequently collaborates with fisheries personnel on habitat compensation projects.

Nathan is registered as a professional engineer in Alberta, British Columbia and the Northwest Territories and Nunavut. He is the former chair of the APEGGA Environment Committee and recently completed a three-year term on the NSERC Grant Selection Committee for Civil Engineering Environment.

**Employment History**

**Golder Associates Ltd. – Edmonton, AB**

*Associate then Principal, Senior Water Resources Engineer (2002 to Present)*

Consultant and Project Manager on projects related to river engineering, hydrology, water management, and environmental impact assessment in the mining, water resources, power, forestry, and transportation market sectors.

**Golder Associates Ltd. – Calgary, AB**

*Senior Water Resources Engineer (1997 to 2002)*

Consultant and Project Manager on a variety of projects. Highlights included managing the climate and hydrology component of the Regional Aquatics Monitoring Program for five years, leading the surface water hydrology components of the CNRL Horizon Oil Sands Project EIA and Suncor Firebag In Situ Oil Sands Project EIA, and leading the Functional Design, Hydrology, and Hydraulics components of the Iron Ore Company Wabush Lake Tailings Management Project.

**University of Canterbury – Christchurch, New Zealand**

*Research/Teaching Assistant, Fluid Mechanics (1993 to 1997)*

**Alberta Transportation & Utilities – Edmonton, AB**

*Bridge Planning Engineer (1992 to 1993)*

**University of Alberta – Edmonton, AB**

*Research/Teaching Assistant, Water Resources Engineering (1990 to 1992)*

**Stanley Associates Engineering Ltd. – Edmonton, AB**

*Hydrotechnical Engineer (1990 to 1990)*





## PROJECT EXPERIENCE – ENVIRONMENTAL IMPACT STUDIES

**Giant Mine  
Remediation - PWGS  
Canada**  
Yellowknife, NT, Canada

While developing preliminary design reports for the surface water and Baker Creek remediation components of this project, provided support to the impact assessment before the Mackenzie Valley Review Board, including technical session participation and writing responses to two rounds of Information Requests.

**TOTAL E&P Canada  
Strathcona Upgrader**  
Fort Saskatchewan, AB,  
Canada

Component lead for the hydrology section of an Environmental Impact Assessment for a bitumen upgrader project. The assessment focused on disturbance to local drainage patterns, as well as the effects of water withdrawal and water intake construction on the North Saskatchewan River. The EIA was submitted to the Alberta Energy and Utilities Board and Alberta Environment.

**De Beers Canada  
Gahcho Kué Diamond  
Project**  
NT, Canada

Responsible for the hydrology components of the Environmental Impact Statement for a proposed diamond mine located east of Yellowknife in the Lockhart River basin. Tasks included baseline data collection and preparation and submission of a baseline hydrology report and Environmental Impact Statement for submission to regulatory agencies. The proposed project will drain a small subarctic lake to access diamondiferous kimberlite pipes, and a major focus of the EIS was on downstream effects of water diversion during lake draining and refilling.

**Miramar Mining Doris  
North Gold Mine  
Project**  
NU, Canada

Responsible for the hydrology components of the Environmental Impact Statement for a proposed gold mine on the Hope Bay Belt. This included an assessment of effects on a local lake due to withdrawals for water supply, development of a hydrological design basis for a fisheries compensation (No Net Loss) plan, and provision of input data for a tailings facility water balance. Done in conjunction with supplemental climate and hydrology data collection.

**Jivko Engineering –  
Mackenzie River  
Bridge**  
Fort Providence, NT

Contributed to environmental impact assessment, including study of effects of ferry crossing decommissioning on sediment deposition into the Mackenzie River and effects of bridge pier and approach causeway construction on physical habitat characteristics.

**Canadian Natural  
Resources Ltd. –  
Horizon Mine**  
Fort MacKay, AB,  
Canada

Managed the surface water hydrology component of the impact analysis for the Horizon Mine project, located northwest of Ft. Mackay, Alberta. Tasks included preparation of a report detailing baseline climate, hydrology and geomorphology, identifying changes in site hydrologic conditions and sediment yields and impact on the Athabasca River due to the project and other planned developments.

**Diavik Diamonds – Lac  
de Gras**  
NT, Canada

Project engineer responsible for developing a water balance model, calibrated to baseline site hydrological conditions, to quantify changes to Lac de Gras caused by the Diavik Diamond Mine. Conducted an impact analysis to quantify the incremental hydrologic impacts of the Diavik Diamond Mine project and the cumulative impacts of the Diavik and BHP projects. Tasks included identifying changes in site hydrologic conditions and water balance and describing changes in sediment yields and suggesting procedures for mitigating any impact on the environment. Analyzed climatic, snow survey and local stream gauging data to determine snowmelt and seasonal runoff coefficients from small watersheds on the east island and adjacent mainland in the Lac de Gras basin.



**Suncor Energy Inc. -  
Firebag In Situ Project**  
Fort MacKay, AB,  
Canada

Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain. Responsible for hydrologic components of the environmental impact study.

## PROJECT EXPERIENCE – MINE WATER

**Giant Mine - Deton Cho  
Nuna**  
Yellowknife, NT, Canada

Provided detailed design services to the care and maintenance contractor of a gold mine, to address mine water management and erosion and sediment control concerns prior to closure.

**Giant Mine  
Remediation - PWGS  
Canada**  
Yellowknife, NT, Canada

Task lead for surface water drainage and Baker Creek components of this mine closure and remediation project. Prepared preliminary design reports for the two components, including preliminary engineering designs and Class B cost estimates suitable for presentation to the Treasury Board of Canada for funding applications. The work included consultation with stakeholders including Fisheries and Oceans Canada, Environment Canada, Northwest Territories Environment and the project owner, Aboriginal Affairs and Northern Development Canada. Also developed a high-level erosion and sediment control plan for the project in care and maintenance.

**TransAlta Pit 9  
Geomorphology and  
Closure Planning**  
Duffield, AB, Canada

Senior reviewer for geomorphological characterization and mine closure drainage planning for the Highvale Mine Pit 9 in the North Saskatchewan River valley.

**PWGSC Tundra Mine  
Remediation**  
NT, Canada

Component lead for hydrological modeling at the Tundra Mine site, for a remediation project funded by Public Works and Government Services Canada. Developed a water balance model to evaluate the effects of remediation alternatives and design parameters on refilling duration and water yields in an evaporation-dominated, subarctic environment.

**Agnico Eagle  
Meadowbank Gold  
Mine Project**  
Kivalliq, NU, Canada

Senior reviewer and engineer of record for water management infrastructure. Project components included a mine surface water management plan and a submerged diffuser-style wastewater outfall. Design documents were used to support a Type A Water License application to the Nunavut Water Board.

**De Beers Snap Lake  
Project**  
NT, Canada

Hydrology and water management tasks contributing to an alternative evaluation of measures to manage and mitigate mine water inflows. Prepared a mine water management plan to satisfy regulatory requirements for the mine water license.

**Fording Coal Ltd. –  
Greenhills Mine**  
Elkford, BC, Canada

Preliminary site assessment of requirements for dam break inundation study component of Emergency Preparedness Plan for the main and west tailings dams.

**Syncrude Canada Ltd.  
– Aurora North Mine**  
Fort McMurray, AB,  
Canada

Project manager for evaluation of clean water diversion alternatives at the Aurora North mine, including outlets to Stanley Creek, the Muskeg River, Mills Creek, Fort Creek and the Athabasca River. The evaluation considered economic, environmental and technical/operational criteria to determine the best alternative. Served as project manager for the next phase of the project, which involved detailed design of ditch, pump and pipeline facilities for clean water diversion.



**Canadian Natural Resources Ltd. – Horizon Mine**  
Fort MacKay, AB,  
Canada

Manager for development of operational water management plan, closure reclamation drainage plan and conceptual design of the Athabasca River water intake. The operational water management plan included development of design criteria consistent with best management practices for oil sands mining operations, design of site-specific surface drainage, dewatering and diversion systems, development of a basal aquifer dewatering plan, development of a mine water balance for closed-circuited areas and derivation of raw water supply requirements for mining operations. The closure reclamation drainage plan involved the development of a progressive drainage plan, incorporating hydrologic and geomorphic considerations to ensure sustainability of the drainage system and landscape.

**Synchrude Canada Ltd. – Aurora North Mine**  
Fort McMurray, AB,  
Canada

Project manager for development of an operational water management plan for 10 years of mining activities, including a review of design criteria with specific application to Aurora North mine components, an assessment of surface water hydrology and drainage facilities at the mine, development of a muskeg and overburden dewatering plan and development of guidelines for sizing mine pit sumps and pumps.

**TrueNorth Energy**  
Fort McMurray, AB

Developed water management infrastructure designs for the TrueNorth Energy Fort Hills project plant site.

**Albian Sands Energy**  
Fort McMurray, AB

Update of closure reclamation drainage plan for mine components addressed in the 10-year conservation and reclamation plan. Component lead for a project to evaluate the alternatives and feasibility of release of saline basal aquifer water to surface water receiving environments.

**Quintette Coal – Deputy and Shikano Common Pits**  
Tumbler Ridge, BC

Review of hydrologic studies for this area, including derivation of design discharges for closure planning. Design of closure drainage facilities for two catchments, including feasibility-level design of a stepped spillway in bedrock for the Shikano Common pit.

**Iron Ore Company of Canada – Wabush Lake**  
Labrador City, NL,  
Canada

Task manager for hydrology and functional design components of this tailings management project. Responsible for baseline data collection and hydrological simulation model of the Wabush/Shabogamo Lake watershed, which was used to characterize baseline conditions and model the impacts of a tailings management system on the lake. Responsible for documenting and modeling ice conditions on the lake and assessing changes to the lake ice regime due to the tailings management system. Other tasks included lake bathymetry, water quality profiling, sediment sampling, infiltration testing on terrestrial tailings deposits, and training client personnel for hydrological data collection.

**Quintette Coal – Babcock Window Pit**  
Tumbler Ridge, BC,  
Canada

Prepared water management plans for the Babcock Window pit and haul road at Quintette Operating Corporation’s mine near Tumbler Ridge. Performed an analysis of available climatic and hydrologic data to determine site runoff and designed a sedimentation pond in accord with Provincial guidelines. Prepared quantity and cost estimates for construction.

**Synchrude – Beaver River Diversion**  
Fort McMurray, AB,  
Canada

Prepared feasibility-level designs for several river diversion alternatives considered during closure planning for the Mildred Lake facility north of Ft. McMurray. Prepared quantity and cost estimates based on these designs and performed a net present value analysis to compare alternatives.



**PROJECT EXPERIENCE – FISH HABITAT AND STREAM RESTORATION**

**Agnico Eagle  
Meadowbank Gold  
Mine Project**  
Rankin Inlet, NU

Senior reviewer and engineer of record for fish habitat compensation works design, developed to compensate for mine and access road development. Compensation measures included submerged reef structures in a lake environment and spawning riffles in an arctic river.

**Whitemud Creek  
Erosion Study**  
Edmonton, AB, Canada

Project manager an assessment of existing erosion and evaluation of future erosion potential under urbanized conditions. The project involved intensive data collection for approximately 40 km of stream length on Whitemud and Blackmud Creeks within the City limits. It included assessments of stream hydrology, geomorphology and valley wall instability, with the objective of identifying and prioritizing areas for application of mitigation measures.

**Big Island Lake  
Stabilization**  
Strathcona County, AB,  
Canada

Project manager responsible for establishing the pre-disturbance water level regime of a small prairie lake and performing feasibility-level design of a control structure to restore the lake level. Included field surveys, hydrological and hydraulic modeling, environmental assessment and public consultation.

**Miramar Doris North  
Gold Mine Project**  
NU, CANADA

Engineer of record for design of fish habitat compensation works at the Doris North project, developed to compensate for mine, access road and port development. Compensation measures included spawning and rearing reef structures in lake and marine environments, rearing habitat in small streams, and fish passage mitigation works.

**ASRD – Watershed  
Integrity Study**  
AB, CANADA

Senior reviewer for a project commissioned by Alberta Sustainable Resource Development (ASRD) to use GIS methods to develop fish-based Indices of Biological Integrity (IBI) for Battle River sub-watersheds. The study used source data, including urban density, road network density and agricultural use to prepare maps that predicted levels of disturbance and IBI.

**EPCOR Water Services  
– Fish Habitat  
Compensation**  
Edmonton, AB

Senior technical advisor to fish habitat compensation design for two rock riprap spurs on the North Saskatchewan River. These were developed to compensate for the effects of a new water intake structure for the E.L. Smith Water Treatment Plant.

**CN Rail – Fish Habitat  
Compensation**  
Wabamun Lake, AB,  
CANADA

Senior technical advisor to fish habitat compensation design on False Creek, at the west inlet to Wabamun Lake. The project involved bank stabilization and habitat enhancement to provide compensation for damage caused by oil released during a train derailment.

**North Saskatchewan  
Watershed Alliance**  
Edmonton, AB,  
CANADA

Hydrology and geomorphology component lead for the NSWA Instream Flow Needs (IFN) scoping study. This project was the first step in a process for watershed management under the framework of the Alberta Water for Life strategy, with the NSWA serving as the WPAC for the NSR.

**EPCOR Power –  
Keephills 3 Fish  
Exclusion**  
Keephills, AB, CANADA

Prepared a study addressing fish exclusion at two river water intakes, two cooling pond intakes and a reservoir blowdown structure. These were used to evaluate alternatives for expansion of a coal-fired power generation facility and were used as a basis for discussions with regulatory agencies.



**Provincial Watercourse Crossing Committee**  
Keephills, AB, CANADA

Senior technical advisor for a study entitled “Culvert stream crossings in Alberta – a review and evaluation of current practices” that examined legislation and regulations; standards and specifications; best management practices; education and outreach; stewardship; biological information; and landscape data. The intent of the project was to summarize and identify deficiencies in available information, and provide recommendations that might be effective in improving existing standards and procedures.

**Murray-Cheslatta Stream Restoration Scoping Study**  
Prince George, BC

Hydrology and geomorphology component lead for a literature review addressing restoration alternatives for a river system that was previously degraded by a large scale stream diversion. This work was done for the Nechako Enhancement Society.

**City of Edmonton – Clover Bar Creek Restoration**  
Edmonton, AB, CANADA

Project manager an assessment of existing erosion and evaluation of future erosion potential under urbanized conditions. Undertook an intensive site reconnaissance on 5 km of stream length, assessed erosion potential and developed recommendations for restoration of existing erosion and treatments to prevent erosion under the future, urbanized flow regime. The project included a comprehensive alternative evaluation and quantity and cost estimates for selected alternatives. Later participated in process to resolve dispute over funding responsibilities between two municipalities.

**Regional Municipality of Wood Buffalo**  
Fort McMurray, AB, CANADA

Project manager and lead engineer on a project to revitalize the Snye, a waterbody located upstream of the confluence of the Athabasca and Clearwater rivers. The Athabasca end of the Snye was blocked by causeway construction in the late 1960’s, resulting in siltation and stagnation. This project included field surveys, a hydrology study and development of a feasibility-level design for hydraulic structures to manage flow through the Snye to enhance water quality and maintain a self-scouring inlet for navigation at the Clearwater entrance.

**DFO – Nulahugyuk Creek**  
Bernard Harbour, NU

Undertook a field reconnaissance and provided hydrology and geomorphology input to a study of an Arctic stream, to determine reasons why the historic Arctic char spawning run has not occurred in recent years and to develop remedial measures.

**Foothills Model Forest – Hardisty Creek Restoration**  
Hinton, AB, CANADA

Project manager for fisheries and hydrological assessment and development of remediation measures for stream restoration and fish passage. Responsible for addressing concerns of stakeholders including industry, regulatory agencies, municipalities and environmental groups. The project included several phases, including assessment and design (2003-4), construction of stream restoration prescriptions (2004) and construction of a 1.8 m high riffle to backflood a culvert for fish passage (2005).

**PROJECT EXPERIENCE – MANUALS AND GUIDELINES**

**Alberta Gravel Pit Development BMP Guideline**  
Edmonton, AB, Canada

Served as a senior reviewer for a project to develop the Best Management Practices User Manual for Aggregate Operators on Public Land, developed for Alberta Sustainable Resource Development in collaboration with the Alberta Sand and Gravel Association.



**Agriculture Canada  
IWRM Guideline**  
Brandon, AB, Canada

Served as project manager and contributing author for development of several modules and factsheets for an Integrated Water Management Guideline being developed internally by Agriculture and Agri-Food Canada. Phase 1 of the project included developing final drafts of 7 manual modules related to integrated water management in an agricultural context, and Phase 2 of the project included developing 35 factsheets describing various indicators related to agricultural water supply reliability, drainage, water use and conservation.

**TAC National Guide to  
Erosion & Sediment  
Control**  
Ottawa, ON, Canada

Primary author and project manager for development of the TAC National Guide to Erosion and Sediment Control on Roadway Projects. This document was developed with the TAC Project Steering Committee, with review by the TAC Environmental Issues Subcommittee, the TAC Environment Council and the TAC Chief Engineer's Council, and it was subject to review and comments by Fisheries and Oceans Canada (DFO) at the regional and national levels. The intent of the document was to address erosion and sediment control regulatory issues, physical theory and risk assessment, as well as provide methods for developing erosion and sediment control plans over the life cycle of a project.

**TAC Erosion &  
Sediment Control  
Training**  
Ottawa, ON, Canada

Provided technical input into development of a one-day training course based on the TAC National Guide to Erosion & Sediment Control on Roadway Projects, and subsequently led deliveries in Vancouver, Calgary, Red Deer, Ottawa, Saskatoon, Edmonton (2), Winnipeg, Fredericton (3) and Prince George.

**Alberta Transportation  
Fish Habitat Manual**  
Edmonton, AB, Canada

Co-author of the AT&U Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta. Wrote chapter on Erosion and Sediment Control Plan, including sample plans for bridge and culvert construction, and subsequently revised the chapter on Fish Passage. Prepared factsheets describing recommended mitigation procedures.

**TAC Synthesis of  
Practice for the  
Protection of Fish  
Habitat**  
Ottawa, ON, Canada

Contributed to, and compiled, TAC's Synthesis of Practice for the Protection of Fish Habitat. This document discusses the integration of habitat issues into transportation and stream crossing planning, reviews regulatory approval requirements and presents best management practices for habitat protection, channel design, fish passage and erosion and sediment control.

**MTO Gravity Pipe  
Manual**  
Toronto, ON, Canada

Senior technical reviewer for the Ontario Ministry of Transport (MTO) Gravity Pipe Design Manual. This document considered round pipes of less than 3 m diameter, including life cycle costing and risk analysis for concrete, steel, PVC and polyethylene materials.

**DFO Culvert Guideline**  
Ottawa, ON, Canada

Contributor to the Fisheries and Oceans Canada (DFO) Guidance Document for Culvert Installation Modification and Maintenance.

**PROJECT EXPERIENCE – HYDROLOGY/HYDROGRAPHICS**

**Comaplex Meliadine  
West Project 2007-2010**  
NU, Canada

Performed a site reconnaissance was undertaken to determine station locations and locations relative to proposed mine infrastructure. Managed an annual hydrometric program and completion of the climate and hydrology components of an aquatic baseline synthesis report, including historical data and hydrological modeling to characterize long-term baseline conditions.



**North Saskatchewan River Hydrographics 2003-12**

Keepihills, AB, Canada

Project manager for hydrographic and terrestrial surveys to monitor erosion and sedimentation over a reach length of approximately 1.5 km. The project also included use of an Acoustic Doppler Current Profiler (ADCP) to measure the velocity structure of flows on ten cross-sections along the reach.

**Bruce Power Peace River NGS Baseline**

Peace River, AB

Component lead for baseline studies to support the impact assessment and potential development of a nuclear generating station on the Peace River, north of Peace River, Alberta.

**Genesee Expansion Baseline**

Genesee, Alberta, Canada

Component lead for baseline studies to support the impact assessment of a coal mine and power generating station expansion. Tasks included characterizing hydrological regime and geomorphology of local watercourses and the North Saskatchewan River.

**Miramar Doris North Hydrological Monitoring 2003-8**

NU, Canada

Responsible for the installation and operation of stream discharge and water level monitoring stations at the Project. Three stations were operated in 2003, six in 2004 and 2005, 17 in 2006 and 2007 and 18 in 2008. They were installed in stream, lake and marine environments. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime. Additional tasks included spring snowcourse surveys to measure snow depths and snow water equivalents on the range of aspects and terrain present at the project.

**De Beers Gahcho Kué Project Monitoring 2007, 2010, 2011**

NT, Canada

Managed the installation and operation of six continuous hydrometric stations. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime.

**Triex Mountain Lake Project**

NU, Canada

Component lead for manual hydrometric monitoring and site reconnaissance at a uranium mining exploration project.

**Dundee George & Goose Hydrological Monitoring 2005**

NU, Canada

Managed the installation and operation of one continuous and two manual stream discharge and lake level monitoring stations at the Dundee Precious Metals George and Goose (Back River) Project. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime.

**CNRL – Primrose and Wolf Lake Expansion Project**

AB, Canada

Responsible for initial scoping of the climate and hydrology baseline study, including definition of the local and regional study areas and identification of existing sources of data. Responsible for recommendations and cost estimates for the local climate and hydrology monitoring program.



**Oil Sands Climatic & Hydrological Monitoring 1998 to 2002**  
AB, Canada

Managed the climate and hydrology component of the Regional Aquatics Monitoring Program (RAMP). This study of various streams and lakes in the oil sands area included approximately 35 hydrometric stations and three climate stations from Janvier in the south to the Firebag River in the north. It included the Athabasca River, Muskeg River and tributaries, Birch Mountains drainages, Poplar Creek, Kearl, McClelland and Isadore's Lakes. Responsible for the collection of data from climatic monitoring stations in the area and for undertaking snow surveys in various study areas. Analysis included processing stream discharge and water level data, preparing stage-discharge rating curves and synthesizing hydrographs. All available local and regional data were compiled in a database for easy reference. Provided data support to RAMP funders and to authorized third parties, including regulatory agencies, consultants and contractors.

**Oil Sands Regional Hydrological Modeling**  
Fort McMurray, AB,  
Canada

Project manager for development of a regional hydrological (HSPF) model of the oil sands region. This model has subsequently been used as the basis for several environmental impact assessment baseline reports. The model was also used as the basis for development of design runoff curves for mine operational water management.

**De Beers Canada Mining Inc. - Snap Lake Project**  
NT, Canada

Managed the baseline hydrology study, including acquisition and processing of local snowpack, stream discharge and water level data. Responsible for the installation and operation of three stream discharge monitoring stations and one lake level monitoring station at Snap Lake.

**OPTI Canada Ltd. – Long Lake Project**  
AB, Canada

Task manager for spring 2000 snow survey. Participated in initial scoping of the climate and hydrology baseline study, including identification of existing sources of data. Responsible for recommendations and cost estimates for the local climate and hydrology monitoring program.

**Synenco Field Reconnaissance**  
AB, Canada

Led a field reconnaissance to identify potential locations for hydrometric monitoring activities to support baseline hydrological data collection. The study area was located in the Marguerite River watershed, approximately 100 km north of Fort McMurray.

**Suncor Firebag River Field Reconnaissance**  
AB, Canada

Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain.

**Syncrude Canada Ltd. - Mildred Lake**  
Fort McMurray, AB,  
Canada

Performed a regional hydrological analysis of Environment Canada–Atmospheric Environment Service precipitation and evaporation data to derive inflows to approximately 70 lakes in the region. This information was used in an environmental impact study of airborne emissions on lake water quality.

**Mackenzie River near Fort Providence**  
NT, Canada

Observed and collected field data during the period of ice breakup to be used in a study to identify factors influencing the date of river breakup. Relevant data included river stage, ice characteristics and Water temperatures.



## PROJECT EXPERIENCE – PIPELINES

### **Pipeline Crossing Overview**

Nathan has led pipeline watercourse crossing designs for oil, gas, bitumen, diluent and water pipelines, primarily in Alberta, for Shell, Enbridge, TCPL, Anadarko, Talisman and other companies. These assignments typically involve characterizing the hydrological regime at the crossing, modeling watercourse hydraulics, including scour potential, and considering the fluvial geomorphology at the crossing to assess lateral channel migration potential. The results of this analysis are used to specify pipeline burial depths, sagbend setbacks and associated mitigation measures to prevent exposure over the operating life of the pipeline. This work also typically contributes to regulatory applications and compliance, under Alberta Water Act Codes of Practice, Environmental Protection Plans and Conservation and Reclamation Plans, and support for applications under the Canada Fisheries Act, Navigable Waters Protection Act and National Energy Board Act.

## PROJECT EXPERIENCE – BRIDGES, CULVERTS AND BANK PROTECTION

### **River Crossing and Bank Protection Overview**

Nathan has led the hydrotechnical component of stream crossing assessment and design for numerous public and private organizations, including hydrotechnical designs for over a dozen highway bridges in Alberta and British Columbia, hydrotechnical assessments for dozens of sites in Alberta, river protection works in Alberta and British Columbia, and mine access road crossings in Alberta, the Northwest Territories and Nunavut. These assignments typically involve characterizing the hydrological regime at the crossing, modeling watercourse hydraulics, including scour potential, and considering the fluvial geomorphology at the crossing to assess channel stability. The results of this analysis are used to specify waterway openings, structure elevations and headslope armour requirements. Many assignments included regulatory tasks including provincial and federal agencies.

## PROJECT EXPERIENCE – EROSION AND SEDIMENT CONTROL

### **Erosion and Sediment Control Overview**

Nathan has over ten years experience at erosion and sediment control planning, regulatory compliance, guidance document preparation and training delivery. This includes assignments in northern environments, including Giant Mine care and maintenance activities, the Mackenzie Valley Winter Road and the Bluefish Hydro dam replacement project. He was the primary author of the TAC National Guide to Erosion and Sediment Control on Roadway Projects and is the current lead instructor for the associated training course.

## PROJECT EXPERIENCE – MUNICIPAL & INDUSTRIAL WATER MGMT

### **Lowe's Site Assessment Alberta, Canada**

Senior reviewer for a site assessment at proposed Lowe's big box store locations in South Edmonton Common, Stony Plain Road West, Clareview and Red Deer, including flooding and site water management issues and regulatory compliance.



**City of Edmonton  
Environmental  
Monitoring Program**  
Edmonton, AB, Canada

Project manager for the City of Edmonton’s Environmental Monitoring Program (EMP) and North Saskatchewan River (NSR) monitoring program, 2006-2012. This program included dry weather and storm event monitoring of storm sewer and combined sewer outflows, stormwater management ponds, the NSR and tributaries. A quasi-realtime monitoring program was also conducted by sampling from industrial and municipal water intakes, while considering NSR travel times.

**TrasnAlta Sundance  
NGCC Plant**  
Alberta, Canada

Senior reviewer for a stormwater management assessment of a proposed natural gas combined cycle (NTCC) power plant on the Sundance Cooling Pond, south of Wabamun Lake. Also responsible for evaluation of water supply issues from the North Saskatchewan River.

**TOTAL E&P Canada  
Strathcona Upgrader**  
Ft. Saskatchewan, AB

Served as senior technical advisor for a water intake scouting study on the North Saskatchewan River, including field studies and alternatives evaluation.

**Morris Wetland  
Hydrology**  
Alberta, Canada

Senior advisor for a study to evaluate mitigation measures required for remediation of an existing stormwater management pond, with a planned contaminated sediment remediation and conversion to a constructed wetland.

**Alta Steel Stormwater  
Management Pond**  
Alberta, Canada

Senior reviewer for a study to evaluate the performance and regulatory compliance for an industrial stormwater pond at a steel recycling facility in the City of Edmonton, discharging to Gold Bar Creek.

**Confidential Client –  
Water Supply Scoping  
Study**  
Fort Saskatchewan, AB,  
Canada

Authored a scoping study to examine water supply and wastewater disposal issues related to development of a bitumen upgrader in Alberta’s Industrial Heartland. The study examined the hydrological characteristics of the North Saskatchewan River and other potential sources of water supply and wastewater disposal. It provided a review of regulatory issues related to site development and water supply, including the draft Alberta Environment Water Management Framework, and discussed the role of regulatory and stakeholder bodies.

**Confidential Client -  
Industrial Heartland  
Water Management**  
Alberta, Canada

Reviewed stormwater management pond design for an industrial site in Alberta’s Industrial Heartland for a confidential client, provided recommendations for pond sizing and overall site water management, and completed regulatory application for stormwater management.

**Government of  
Northwest Territories  
DOT**  
Sahtu Region, NT,  
Canada

Provided hydrological data collection and analysis for eighteen watercourses along the Mackenzie Valley Winter Road to assess their viability for winter water supply. These watercourses are regulated by the Mackenzie Valley Water Board and Fisheries and Oceans Canada to prevent harm to aquatic life. The study considered site-specific data collected for the project and for previous studies, including the Mackenzie Gas Project (2002-2004) and Arctic Gas Project (1972-73), as well as long-term regional data collected by Environment Canada.

**Athabasca River Water  
Intake Construction  
Monitoring**  
Fort MacKay, AB

Project director for provision of environmental monitoring services at the Canadian Natural Resources Ltd. Athabasca River water intake. Golder monitored sediment and other water quality parameters to ensure regulatory compliance.

**Rio Tinto Alcan Facility**  
Alberta, Canada

Performed an assessment of an existing coke handling facility in Strathcona County to evaluate compliance with stormwater management regulations.



**Mackenzie Property  
Stormwater Mgmt**  
Alberta, Canada

Senior advisor/reviewer for design and permitting of remedial stormwater measures at a country residential property, after the client had been issued a remediation order by a provincial regulatory agency.

**Alberta Infrastructure  
ASAP2 School Siting  
Studies**  
Alberta, Canada

Undertook reviews of available flood hazard assessment information for 14 proposed schools in southern Alberta to establish whether they were situated above the 1:500 year flood level. This was done to determine their suitability for use as community disaster response facilities. Where necessary to fill data gaps, supplementary hydrological and hydraulic studies were performed.

**Capital Power Genesee  
Generating Station**  
Genesee, AB, Canada

Project manager responsible for hydrological and water quality studies to support permit applications for a new water licence at the Genesee Generating Station, to enhance water quality in the cooling pond. Tasks included participation in a community consultation workshop.

**Alberta Infrastructure  
P3 Hospital Siting  
Studies**  
Northern Alberta,  
Canada

Served as the project manager for siting studies of proposed P3 hospital projects in Edson, Grande Prairie and High River, and as the component lead for flood hazard assessment. The purpose of each flood hazard assessment was to establish whether the locations were situated above the 1:1000 year flood level, because these are critical disaster response facilities. Supplementary hydrological and hydraulic studies were performed at the Edson and High Prairie sites to fill gaps in the available data.

**Alberta Infrastructure -  
LETC Siting Studies**  
Fort McLeod, AB,  
Canada

Component lead for flood hazard assessment at a proposed Law Enforcement Training Centre at Fort McLeod, adjacent to the Oldman River. The work entailed desktop studies to evaluate whether proposed location was situated above the 1:500 year flood level, to confirm its suitability for use as a community emergency response location. Existing information was compiled and evaluated, and supplementary hydrological and hydraulic studies were performed.

**Alberta Infrastructure -  
ASAP3 School Siting  
Studies**  
Southern Alberta,  
Canada

Component lead for flood hazard assessments at 13 proposed schools in southern Alberta. The work entailed desktop studies to evaluate whether proposed school locations were sited above the 1:500 year flood level, to confirm their suitability for use as community emergency response locations. Existing information was compiled and evaluated, and where necessary, supplementary hydrological and hydraulic assessments were performed.

**Peace River Oil –  
Bluesky Upgrader**  
McLennan, AB, Canada

Prepared a water supply scoping study for a proposed bitumen upgrader. Evaluated surface water supply alternatives based on hydrological and ice characteristics and provided quantity and cost estimates.

**CN Rail – McLennan &  
Grande Prairie Yards**  
Alberta, Canada

Senior technical advisor for water quality assessment and remedial drainage design for a rail yard, including topographic and drainage surveys, water quality sampling conceptual and detailed design of mitigation measures.

**Hwy 679 and 749  
Drainage Study**  
High Prairie, AB,  
Canada

Project manager for assessment and remedial drainage design of two intersecting sections of rural highway. Project components included a field reconnaissance, site surveys, interviews with local residents and hydrological modeling to evaluate deficiencies in the existing system and to develop design recommendations to mitigate flooding.



**County of Vermilion River**  
Kitscoty, AB, Canada

Golder was a subconsultant to Urban Systems Limited on this water supply study for the County of Vermilion River, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and senior reviewer. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

**Prairie Farm Rehabilitation Administration**  
Barrhead, AB, Canada

Golder was a subconsultant to Urban Systems Limited on this water supply study for Barrhead County, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and was responsible for the hydrology analysis. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

**Igloo Building Products**  
Stony Plain, AB, Canada

Project manager for drainage design of an 80 ha parcel of land in the Acheson Industrial Park. The project included hydrological modeling and grading design to meet Province of Alberta and Parkland County regulations.

**Golden West Homes**  
Stony Plain, AB, Canada

Project manager for stormwater management permitting (Alberta Water Act) drainage design of an 11 ha parcel of land in Parkland County. The project included hydrological modeling to meet provincial and county regulations.

**PROJECT EXPERIENCE – SERVICE**

- 2012- NSERC Grant Selection Committee, Research Tools & Instruments
- 2011- Stollery Children's Hospital / Edmonton Rowing Club "Row for Kids" fundraiser - Co-chair (2011) then Chair (2012)
- 2009-2011 NSERC Grant Selection Committee, Civil Engineering Environment
- 2003-2010 APEGA Environment Committee (Chair, 2004-2010)
- 2002-2009 Consulting Engineers of Alberta Environment Committee
- 2004-2009 Canadian Water Resources Association, Alberta Director
- 2005 CSCE 17<sup>th</sup> Hydrotechnical Conference – Technical Program Chair and Proceedings Editor
- 2005 CWRA National Conference – Organizing Committee

**PUBLICATIONS**

Schmidt, N., D. Ciobotaru, Z. Craciunescu and L. Purcka. 2011. Hill Creek Culvert Fish Passage Remediation. Canadian Society for Civil Engineering, 20th Canadian Hydrotechnical Conference, Ottawa, 14-17 June 2011, 10 p.

Schmidt, N.P. 2009. North Saskatchewan River - Industrial Heartland Hydrology and Water Supply. Invited Presentation, Canadian Water Resources Association Workshop, 6 February 2009.

Schmidt, N.P. 2009. North Saskatchewan River - Emerging Water Supply Challenges and Mitigation. Invited Presentation, Canadian Society for Civil Engineering Luncheon, 29 January 2009.

Schmidt, N.P. 2008. Water Supply Issues at Alberta's Industrial Heartland. Invited Presentation, 2<sup>nd</sup> Annual Heavy Oil Conference, Edmonton, 29 May 2008.



Trevor, B, D. Vanderwel and N. Schmidt. 2007. Erosion Study and Risk Assessment of Whitemud and Blackmud Creeks, Edmonton, Alberta. 18<sup>th</sup> Canadian Hydrotechnical Conference, Winnipeg, Manitoba, August 22-24, 2007.

Schmidt, N. 2007. The Hardisty Creek Restoration Project. Canadian Water Resources Association National Conference, Saskatoon, Saskatchewan, June 25-28, 2007. Poster presentation.

Schmidt, N., ed. 2005. Proceedings of the 17th Canadian Hydrotechnical Conference. Edmonton, Alberta, August 17-19, 2005, 1016 p.

Schmidt, N.P., G.R. Ash, H. Wilson and C. Duane. 2004. Climate and Hydrology Data Collection for Northern Mine Development. Canadian Institute of Mining, Metallurgy and Petroleum Mining North, Edmonton, 9-12 May, 2004, 8 p.

Biftu, G., N.P. Schmidt, A. Beersing and L.F. Sawatsky. 2004. Consideration of Potential Effects of Climate Change and Resulting Hydrologic Impacts on Mine Developments. Canadian Institute of Mining, Metallurgy and Petroleum Mining North, Edmonton, 9-12 May, 2004, 8 p.

Schmidt, N.P., A. Beersing, G. Biftu and F. Ade. 2004. Application of the Hydrological Simulation Program FORTRAN (HSPF) Model to Two Large Scale Environmental Impact Assessments in Northeastern Alberta (Abstract and Presentation Only). 24th Annual Conference of the International Association for Impact Assessment, Vancouver, 25-29 April, 2004.

Doram, D., S. Tuttle, N. Schmidt, P.Keele, K. Mackenzie and C. Duane. 2004. The Canadian Natural Horizon Mine Closure and Reclamation Plan. Society for Ecological Restoration and Canadian Land Reclamation Association, SER2004 - 16th annual World Conference on Ecological Restoration, Victoria, August 24-26, 2004 (Abstract and Presentation Only).

Mackenzie, I.B., G. Herasymuik, N. Schmidt, Z. Kovats and K. Clipperton. 2004. Environmental Impact Assessments in the Alberta Oil Sands Area. Western Canada Oil Sands Summit, Calgary, Alberta, 29-30 January 2004, 25 p.

Schmidt, N.P. and R.H. Spigel. 2000. Second Mode Internal Solitary Waves I – Integral Properties. Fifth International Symposium on Stratified Flows, Vancouver, 10-13 July, 2000, 6 p.

Schmidt, N.P. and R.H. Spigel. 2000. Second Mode Internal Solitary Waves II – Internal Circulation. Fifth International Symposium on Stratified Flows, Vancouver, 10-13 July, 2000, 6 p.

Metikosh, S. and N. Schmidt. 2000. Developing and Implementing Effective Compensation Measures. Presented to Synergy for Prosperity: Consulting Engineers of Alberta, Alberta Transportation and Alberta Roadbuilders and Heavy Construction Association Annual Conference, Edmonton, March, 2000.

Bender, M., S. Metikosh, L. Sawatsky, N. Schmidt and D. Snider. 1999. Mitigation Strategies for Watercourse Habitats at New Road Crossings: Alberta Transportation and Utilities Fish Habitat Manual, Canadian Society for Civil Engineering Conference, Regina, SK, 10p.

Schmidt, N. 1992. Flow in Ice Covered Channels, M.Sc. Thesis presented to the University of Alberta, Department of Civil Engineering, 200 p.

Schmidt, N. 1997. Generation, Propagation and Dissipation of Second-Mode Internal Solitary Waves, Ph.D. Thesis presented to the University of Canterbury, Department of Civil Engineering, 400 p.

Schmidt, N., and R.H. Spigel. 1997. Advanced Flow Visualisation Techniques Used in Fluids Research, UC Research, University of Canterbury Research Committee, July 1997, pp 48-49.



**Education**

*Post-Doctoral Fellowship  
Environmental Biology &  
Ecology, Alberta Co-  
operative Conservation  
Research Unit, Edmonton,  
AB, 2006*

*PhD Environmental Biology  
& Ecology, University of  
Alberta, Edmonton, AB ,  
2005*

*MSc Biology, University of  
New Brunswick,  
Fredericton, NB, 2000*

*BSc Zoology, Honours,  
University of Guelph,  
Guelph, ON, 1996*

**Languages**

*English – Fluent*

**Golder Associates Ltd. – Edmonton**

***Applied Ecologist***

As a consultant with Golder Associates Cam has been providing advice on applied ecological projects, environmental stewardship and monitoring programs, primarily in the Canadian Prairies and the Central Canadian Arctic. Cam's projects have included cumulative effects assessments and collections of baseline data of aquatic resources as part of regulatory requirements and environmental impact statements (EIS) for new mining developments. Cam has also provided conservation plans for governmental and non-governmental agencies using habitat and population models for fish and wildlife. Results from his work guide management strategies and contribute to the preservation of critical habitats and self-sustaining populations. He is committed to team-based solutions and community outreach objectives that prioritize the persistence of our natural resources. Cam is the past-president for the Mid-Canada Chapter (MCC) of the American Fisheries Society. His recent publications are of Arctic grayling ecology and monitoring in the Alberta foothills.

**Employment History**

***Golder Associates Ltd. – Edmonton***

*Applied Ecologist (2006 to Present)*

As a consultant with Golder, Cam has been providing advice on various ecological projects and monitoring programs in Western Canada, the Canadian Arctic, and Central America. Cam's projects have included cumulative effects assessments and baseline data collections for aquatic resources as part of regulatory requirements for new mining developments. Conservation planning and initiatives are also part of his work for governmental and non-governmental contracts. These projects often include highly sophisticated analyses for modelling fish and wildlife habitat and populations.

***ACCRU (Alberta Cooperative Conservation Research Unit) –  
Edmonton, AB***

*Fish-Based Monitoring Tools (2006 to 2006)*

As a post-doctoral fellow, Cam was the lead researcher of a team of biologists from the Alberta Conservation Association, Alberta Sustainable Resource Development, and the University of Alberta. Cam's primary objective was to conduct a pilot study near Three Hills, Alberta to assess whether an effective fish-based IBI could be developed to characterize the ecological condition of small streams in the grassland ecoregion. This work has been published in the Alberta Conservation Association report series, and has been presented many times to various stakeholders and agencies throughout Alberta.

***University of Alberta – Edmonton, AB***

*Boreal Amphibian Conservation (2000 to 2005)*

Cam studied various topics related to conservation biology, boreal amphibians, ecology of beaver ponds, and population monitoring. His research included a



large-scale field program assessing population sizes of amphibians on beaver ponds. Cam also conducted a mesocosm experiment of the physiochemical factors affecting larval performance in ponds. The field work was conducted in the Weyerhaeuser Forest Management Area near Drayton Valley. Field data was supplemented with GIS-based information, for example, Cam used a novel combination of a digital elevation model, vegetation inventory data, and spatial analyst tools in ArcGIS to characterize the distribution of beaver ponds on boreal streams. This research was funded by successful grants received from the ACA Challenge Grants in Biodiversity, Canadian Circumpolar Institute, Mountain Equipment Co-op, and the Alberta Government Development Initiative. This work resulted in numerous publications, research awards and media coverage.

***University of New Brunswick – Fredericton, NB***

*Wetland Restoration (1998 to 2000)*

Cam studied the effects of wetland restoration on waterfowl populations and wildlife communities in PEI. Briefly, in the field, Cam conducted surveys for waterfowl pairs and broods, playback surveys for secretive marsh birds, and call surveys for breeding anurans. In a GIS platform, Cam measured landscape metrics for wetlands using GIS buffer and nearest neighbor functions, and georeferenced, spatially-corrected aerial photographs in ArcVIEW. This research was funded by Ducks Unlimited Canada and the Government of Prince Edward Island.

***Canadian Wildlife Service – Bay of Fundy, NB***

*Seabird Ecology (1998 to 1999)*

This position was to provide assistance for monitoring populations of seabirds and their movements via a research vessel in the Bay of Fundy during winter 1998-1999. The work led to multiple publications on the ecology of seabirds.

***Thunder Cape Bird Observatory – Lake Superior, ON***

*Migratory Bird Monitoring (1996 to 1997)*

This was a volunteer position. Primary duties were to assist with observing and banding migratory birds during their fall migration. I banded approximately 500 birds of 100 species while monitoring migrating waterfowl and raptors during fall 1996 and fall 1997.

***Trent University – Peterborough, ON***

*Forest Songbird Ecology (1996 to 1996)*

This was my first position as a research assistant. I assisted with locating nests, radio-tracking ovenbirds, and trapping insects in fragmented forests of Central Ontario. The work sparked a passion for the study of fish and wildlife that I continue to have to this day.



## PROJECT EXPERIENCE – COMMUNITY RELATIONS

**Bernard Harbour Arctic Char**  
Nunavut, Canada

Cam was the project manager for an environmental stewardship - education outreach program with the goal of maintaining the persistence of a self-sustaining population of Arctic char in Nulahugyak Creek. The project, administered by the local Hunting and Trapping Organization, was funded by multiple jurisdictions and agencies. The project engaged local youth from the community of Kugluktuk who actively participated in restoring stream connections in a small stream flowing into Bernard Harbour. Stream connectivity was restored by moving boulders and directing flows in targetted stream sections where water levels and flows were previously observed as being low. Success of the project was met by engaging over ten members of the local community and by enhancing over 150 meters of a historically signfiicant Arctic char fishery. Also, preliminary data show positive responses of Arctic char to the in-stream manipulations and the potential application of this relatively efficient technique for future conservation efforts in the region.

## PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**NICO Project**  
NWT, Canada

Cam was the lead author for the fish and wildlife (higher trophic level) components of a Developer's Assessment Report (DAR) for a new gold mine for Fortune Minerals Inc. in the Northwest Territories (NWT). Cam wrote a scientifically defensible assessment of cumulative impacts to aquatic resources and the terrestrial environment. Part of the assessment included the development and application of a winter resource selection function (RSF) for barren-ground caribou. The assessment exceeded the Terms of Reference prepared by the Mackenzie Valley Environment Impact Review Board. The EIS can be downloaded at [www.reviewboard.ca](http://www.reviewboard.ca).

**Gahcho Kue Project**  
NWT, Canada

Cam was the lead author and component lead for the wildlife sections of an environmental impact statement (EIS) for a new diamond mine for DeBeers Canada in the Northwest Territories (NWT). Cam's main role was to deliver a defensible assessment of cumulative impacts to barrenground caribou and carnivores that exceeded the Terms of Reference put forward by the Mackenzie Valley Environmental Impact Review Board. The EIS was subject to independent review of the highest level required for a development by the Review Board in NWT. The EIS was a culmination of multiple years of environmental baseline data collection and impact assessment analysis of which Cam was a key team member. Cam's work was shared with, and communicated to the local aboriginal communities in NWT. The EIS team, of which Cam was a part of, was selected for a President's Award within Golder Associates Canada Ltd. The EIS can be downloaded at [www.reviewboard.ca](http://www.reviewboard.ca).



**Legacy Project**  
Saskatchewan, Canada

Cam was a technical lead for an environmental impact statement (EIS) for a new potash mine for Potash One in southern Saskatchewan. Cam's primary roles was to oversee reporting phases and to ensure that the wildlife section met the Terms of Reference of the Saskatchewan Ministry of the Environment. Cam also led the habitat modelling components, such habitat suitability indices and resource selection functions for a suite of species of conservation concern. The project was selected for a President's Award within Golder Associates Canada Ltd. The EIS can be viewed at [www.environment.gov.sk.ca/environmentalassessment](http://www.environment.gov.sk.ca/environmentalassessment).

**Petaquilla Project**  
Colon, Panama

Cam was the 'Aquatic Resources' technical lead collecting baseline information for a new copper mine development for Teck Resources Limited in a remote tropical forest ecosystem. The work was prepared according to International Finance Corporation performance standards and was consistent with Panamanian environmental law. Data was collected on a diversity of fish and macroinvertebrate species in stream sections representing various distances to the coast.

**Back River Project**  
Nunavut, Canada

Cam was the project manager and 'Aquatic Resources' lead for a baseline study for a new gold mine for Dundee Precious Metals in the Canadian Arctic. The work met federal and territorial regulatory requirements for a future application to license the mine. Components of the work included collections of environmental and fisheries data in Goose and George lakes. The overall goal was to generate a rigorous ecological database for a future environmental impact statement.

**PROJECT EXPERIENCE – SUSTAINABLE DEVELOPMENT**

**Effects of Development  
on Barren-ground  
Caribou**  
Nunavut, Canada

The study assessed the effects of the mining sector and other developments on the behaviour and movements of caribou using a spatial dataset of collar locations combined with observations reported by local elders and hunters in Kugluktuk. Cam was the lead author of the scientific component. The study team consisted of the Kugluktuk Hunting and Trapping Organization (KHTO), and Golder Associates Ltd, and was funded by both the KHTO and the Nunavut Wildlife Management Board. A significant component of this project included community engagement and environmental stewardship. The report is being prepared for submission to the journal Rangifer.

**Conservation Planning  
in Central Ontario**  
Ontario, Canada

Cam was the lead author and project manager for a conservation assessment of surrogate species representing biodiversity and ecosystem values in the Eastern Ontario Model Forest (as part of the National Agri-Environmental Standards Initiative). Cam used GIS-based habitat suitability models to quantify the amount and configuration of habitats for various management scenarios. These scenarios were compared in population viability analyses. Linkages to, and identification of minimum habitat requirements that sustain populations above critical thresholds were determined.



**Battle River Index of Biological Integrity**  
Alberta, Canada

Cam was the lead investigator for the development and testing of a fish-based Index of Biological Integrity (IBI) for the Battle River, AB. The goal was to not only develop a bio-monitoring tool, but to also quantify the health of the Battle River. Data for this project was collected by the Alberta Conservation Association, and was part of provincial efforts for developing a fish-based monitoring tool. This work has published in the Water Quality Research Journal of Canada.

**Wolverine Monitoring at a Diamond Mine**  
NWT, Canada

Cam was the lead investigator on a study of a comparison of effects monitoring methods for wolverine at the Diavik Diamond Mine Inc.(DDMI). The primary goal was to assist DDMI with the evaluation of their wildlife management plan. Specifically, Cam examined the efficiency of measurements obtained from DNA-based mark-recapture methods, versus snow tracking methods for monitoring temporal and spatial changes in wolverine activity (2003-2006). This research is being prepared for submission to a peer-reviewed journal.

**PROJECT EXPERIENCE – TEACHING**

**University of Alberta**  
Alberta, Canada

Cam was a teaching assistant for the Department of Biological Sciences, University of Alberta (2000-2005). Cam taught undergraduate labs for Biology 108 (Introduction to Biology), Zoology 332 (Community Ecology), and Zoology 224 (Vertebrate Diversity). Cam was awarded letters of commendation for his teaching while at the university.

**University of New Brunswick**  
New Brunswick, Canada

Cam was a teaching assistant for the Department of Biology, University of New Brunswick. Cam taught undergraduate labs for Biology 1001 (Introduction to Biology) and Biology 2113 (Ecology).

**PROFESSIONAL AFFILIATIONS**

- Mid-Canada Chapter, American Fisheries Society (President 2010-11)
- American Fisheries Society (Member since 2007)
- Society for the Study of Amphibians and Reptiles (Member since 2001)
- Canadian Journal of Fisheries and Aquatic Sciences (Reviewer)
- Journal of Herpetology (Reviewer)
- Biological Conservation (Reviewer)

**PUBLICATIONS**

**Other**

Macpherson, L. M., M. G. Sullivan, A. L. Foote, and C. E. Stevens. 2012. Evaluating sampling techniques for low-density populations of Arctic grayling (*Thymallus arcticus*). *Northwestern Naturalist* 93: 120-132.

MacPherson, L. M., M. G. Sullivan, A. L. Foote, and C. E. Stevens. 2012.



Effects of culverts on stream fish assemblages in the Alberta foothills. *North American Journal of Fisheries Management* 32: 480-490.

Stevens, C., T. Council, and M. Sullivan (2010) Influences of human stressors on fish-based metrics for assessing river condition in Central Alberta. *Water Quality Research Journal of Canada* 45: 35-36.

Stevens, C.E., and C.A. Paszkowski, and A.L. Foote (2007) Beaver (*Castor canadensis*) as a surrogate species for conserving anuran amphibians on boreal streams. *Biological Conservation* 134:1-13.

Stevens, C.E., C.A. Paszkowski, and G. Scrimgeour (2007) Older is better: beaver ponds as breeding habitat for a boreal anuran. *Journal of Wildlife Management* 70:1360-1371.

Stevens, C., G. Scrimgeour, W. Tonn, C. Paszkowski, M. Sullivan, and S. Millar (2006). Quantifying the health of grassland streams in Alberta using Index of Biotic Integrity methods. Produced as technical report in the Alberta Conservation Association Report Series.

Gillies, C.S., Krawchuk, M.A., Aldridge, C.L., Hebblewhite, M., Frair, J.L., Saher, D.J., Stevens, C.E., Jerde, C.L., and S.E. Nielsen (2006) Application of random effects to the study of resource selection by animals. *Journal of Animal Ecology* 75:887-898.

Stevens, C.E., and C.A. Paszkowski (2006) Status of western toads and their use of borrow pits in the foothills of west-central Alberta. *Northwestern Naturalist* 87:107-117.

Stevens, C. E., and C. A Paszkowski (2005) a comparison of two pitfall trap designs in sampling boreal anurans. *Herpetological Review* 36:147-149.

Stevens, C.E. (2005) Role of Beaver in Amphibian Ecology and Conservation in the Boreal Foothills of Alberta. Thesis presented in partial fulfillment of requirements for Ph.D., University of Alberta, Fall 2005.

Stevens, C. E. (2005) Review of CARCNET 2005. *Canadian Association of Herpetologists* 13 (2):5.

Stevens, C. E., and C. A Paszkowski (2004) Using chorus-size ranks from call surveys to estimate reproductive activity of wood frogs. *Journal of Herpetology* 38:404-410 (Kennedy Student Award).

Eaton, B. R., S. Eaves, C. E. Stevens, A. Puchniak, and C. A. Paszkowski (2004) Deformity levels in wild populations of wood frog in 3 ecoregions of western Canada. *Journal of Herpetology* 38:283-287.

Stevens, C. E. (2004) Effects of a petroleum pipeline failure on an aquatic environment in the Alberta Foothills. Pages 4-5 in *Environmental News*, volume 4, issue 1, Beverley Levis (editor). Environmental Research and Studies Centre, University of Alberta, Edmonton, AB.



Stevens, C. E. (2004) Restored wetlands on Prince Edward Island, Canada. Pages 374-376 in *Fundamentals of Biogeography*, 2nd edition, Richard John Huggett (editor). Routledge Fundamentals of Physical Geography, NY.

Stevens, C. E., T. S. Gabor, and A. W. Diamond (2003) Use of restored small wetlands by breeding waterfowl in Prince Edward Island, Canada. *Restoration Ecology* 11: 3-12.

Stevens, C. E., and S. Gabor (2003) Waterfowl on Prince Edward Island. *Ducks Unlimited Conservator* 24(1):38.

Stevens, C. E., and C. A. Paszkowski (2003) Amphibian Research in Drayton Valley Forest Management Area, Weyerhaeuser, Canada, Ltd. Technical Report for Weyerhaeuser, Canada, Ltd., Edmonton, AB.

Stevens, C. E., S. Eaves, and C. A. Paszkowski (2003) The boreal chorus frog: groundfrog or treefrog? Page 5 in *Croaks and Trills*, volume 8, issue 1, Kris Kendall (editor). Alberta Conservation Association and Alberta Sustainable Resource Development, Edmonton, AB.

Stevens, C. E., A. W. Diamond, and T. S. Gabor (2002) Anuran call surveys on small wetlands in Prince Edward Island, Canada restored by dredging of sediments. *Wetlands* 22: 90-99.

Huettmann, F., K. MacIntosh, C. E. Stevens, T. Dean, and A.W. Diamond (2000) A mid-winter observation of a large population of Bonaparte's Gulls in the Head Harbour Passage, Passamaquoddy Bay. *Canadian Field-Naturalist* 114: 327-330.

Brooks, R.J., M. A. Krawchuck, C. E. Stevens, and N. Koper (1997) Testing the precision and accuracy of age estimation using lines in scutes of *Chelydra serpentina* & *chrysemys picta*. *Journal of Herpetology* 31: 521-529.

Huettmann, F., B. Dalzell, T. Dean, A. W. Diamond, D. MacFarlane, K. MacIntosh, L. Murison, and C. Stevens (1999) Aspects of change for wintering Razorbills (*Alca torda*) in the Lower Bay of Fundy. In *Understanding Change in the Bay of Fundy Ecosystem*, J. Ollerhead, P. W. Hicklin, P. G. Wells, and K. Ramsay (Editors). Pages 30-33.

Stevens, C. E. (1998) The PEI wetland restoration project. *New Brunswick Naturalist* 25(3):83.

Stevens, C.E. (1996) Testing the Accuracy of Age Estimation Using Lines of Scutes of *Chelydra serpentina*. Honors thesis presented in partial fulfillment of B.Sc., University of Guelph, Spring 1996.



**Education**

*B.Sc. (Honours) Zoology,  
University of British  
Columbia, Vancouver,  
British Columbia, 1988*

*M.Sc. Biology, University of  
Saskatchewan, Saskatoon,  
Saskatchewan, 1991*

*Ph.D. Biology, University of  
Saskatchewan, Saskatoon,  
Saskatchewan, 1997*

**Golder Associates Ltd. – Saskatoon**

**Senior Ecologist**

John Virgl is an Associate and Senior Ecologist with Golder Associates Ltd. in Saskatoon.

Dr. Virgl has over 15 years of domestic and international experience in the design, statistical analysis, interpretation, and practical and theoretical application of ecological studies in research and industrial projects. He has written over 40 reports and published 18 articles in refereed scientific journals on a wide range of taxonomic groups including benthic invertebrates, fish, song birds, peregrine falcons, small mammals, black bears, and tundra and woodland caribou. His expertise includes academic research and teaching, environmental impact assessment and monitoring, population modelling and risk assessment, and cumulative effects assessment.

His main area of practice is the mining industry, but he has also worked with clients in the forestry and energy sectors. John has provided his expertise to potash, uranium, diamond, gold, and base metal clients in Canada, United States, and Madagascar. Within Canada, he has worked on projects in British Columbia, Alberta, Saskatchewan, Ontario, Northwest Territories, and Nunavut. He has performed as an expert witness at several technical sessions and public hearings, and presented a number of papers at professional conferences, including the International Atomic Energy Agency. His involvement with these projects and his ongoing communication with government biologists, regulators, and communities have provided him with an understanding of the issues that are important to all stakeholder groups, including industry.

**Employment History**

**Golder Associates Ltd. – Saskatchewan**

*Associate, Senior Ecologist (1997 to Present)*

Senior ecologist involved in the technical direction of study designs, analyses, presentation, and reporting for environmental impact assessments, and environmental effects monitoring programs.

**University of Saskatchewan – Saskatchewan**

*Graduate Student and Sessional Lecturer (1996 to 1997)*

Completion of Ph.D. thesis project and lecturer for first year biology at the University of Saskatchewan.

*Graduate Student and Statistical Consultant (1996)*

Continuation of Ph.D. project and statistical consultant for caribou mark-recapture analysis for the Government of Newfoundland.



*Graduate Student (1992 to 1996)*

Fieldwork and analysis of data for Ph.D. project on population dynamics of muskrats.

*Graduate Student (1989 to 1991)*

Fieldwork and analysis of data for M.Sc. project on energetics in muskrats.

***University of British Columbia – British Columbia***

*Student and Research Assistant (1984 to 1988)*

Field work and analysis of data for honours thesis on mating behaviour in male bison. Field work and data analysis on population ecology of three-spined sticklebacks.



**PROJECT EXPERIENCE – MINING**

**Teck Coal**  
British Columbia,  
Canada  
Technical director and editor for terrestrial environment of environmental impact assessments for expansions to coal mines in the Elk Valley.

**Vale Potash**  
Saskatchewan, Canada  
Technical director and editor for environmental impact assessment for a proposed potash mine.

**Western Potash Corp.**  
Saskatchewan, Canada  
Technical director and editor for environmental impact assessment for a proposed potash mine.

**Agrium Triton Project**  
Saskatchewan, Canada  
Technical lead and editor for terrestrial environment (terrain, soils, vegetation, and wildlife) of an environmental impact statement for a proposed potash mine.

**Potash One Legacy Project**  
Saskatchewan, Canada  
Environmental assessment manager and editor for of an environmental impact statement for a proposed potash mine.

**De Beers Gahcho Kue Project**  
Northwest Territories,  
Canada  
Technical director and editor for terrestrial environment (geology, soils, vegetation, and wildlife) of an environmental impact statement for a proposed diamond mine.

**Dynatec Corporation**  
Madagascar  
Senior technical lead for baseline reporting and impact assessment of the Ambatovy and Analamay mining project on biodiversity. Project components included a mine, 200 km slurry pipeline, and tailings/processing plant facilities.

**UEX Corporation**  
Saskatchewan, Canada  
Project director and senior technical advisor for baseline data collection, reporting, and environmental impact assessment of a proposed uranium mine.

**Miramar Hope Bay Ltd.**  
Nunavut, Canada  
Senior technical lead for revising wildlife environmental impact statement and wildlife mitigation and monitoring program for Doris North Gold Mine Project.

**De Beers Snap Lake Diamond Project**  
Northwest Territories,  
Canada  
Senior wildlife biologist for ongoing monitoring program and environmental permitting.

**Diavik Diamond Mines Inc.**  
Northwest Territories,  
Canada  
Project manager and principal scientist for providing assistance with the wildlife monitoring program, analysis, and reporting.

**Fortune Minerals Ltd. NICO Project**  
Northwest Territories,  
Canada  
Technical director and editor for an environmental impact assessment for a proposed gold-cobalt-bismuth mine.



<b>Great Western Minerals Group</b> Saskatchewan, Canada	Project manager and senior technical lead for environmental studies for exploration and initial permitting phase of proposed rare earth metal mine.
<b>De Beers Fort a la Corne Project</b> Saskatchewan, Canada	Project manager and senior technical lead for environmental studies for exploration and initial permitting phase of proposed diamond mine.
<b>EnCana Corporation (Lorado)</b> Saskatchewan, Canada	Senior technical lead for terrestrial component of environmental risk assessment for reclamation of abandoned uranium tailings site.
<b>Department of Indian Affairs and Northern Development</b> Northwest Territories, Canada	Senior technical review of site remediation and associated terrestrial monitoring plans for a gold mine. Issues primarily related to contamination of water, soils and vegetation, and potential physical hazards influencing the health, behaviour, and movement of animals within the area.
<b>COGEMA Resources Inc.</b> Saskatchewan, Canada	Project manager and technical lead for the compilation and analysis of data into several Technical Information Documents that will be used for environmental assessment, licensing, and environmental effects studies. Project involved a multidisciplinary team for air, hydrology, water quality, aquatic organisms, soils and vegetation, wildlife, heritage resources, hydrogeology, radiation safety, and cumulative effects.
<b>Black Bird Mine Risk Assessment</b> Idaho, USA	Responsible for study design, statistical analysis, and reporting of post-disturbance effects of mine effluent on habitat and animal species associations and community assemblages.
<b>De Beers Snap Lake Diamond Project</b> Northwest Territories, Canada	Responsible for study design and analysis of potential local and cumulative impacts of mining activities on caribou, wolves, grizzly bears, wolverines, and avifauna. Technical task leader for wildlife, cumulative effects assessment for the project, and development of monitoring program for the project.
<b>Confidential Client</b> Northwest Territories, Canada	Review of regulatory framework in the Northwest Territories with emphasis on identifying changes due to implementation of the Mackenzie Valley Environmental Impact Review Board and the role of aboriginal groups in the environmental assessment process.
<b>BHP Billiton EKATI Diamond Mine Monitoring Program</b> Northwest Territories, Canada	Principal scientist and project manager. Responsible for statistical analysis and study design of monitoring program for caribou, grizzly bears, wolves, wolverines, breeding migratory birds and raptors, and habitat loss (1997-1998 and 2000-2003). Also played an integral part in risk analysis for determining key species/groups for monitoring.



**Phelps Dodge  
Environmental Impact  
Assessment**  
Madagascar

Statistical analysis of tropical forest species communities. Specifically, analysis of species abundance, composition, diversity, and generation of species-area curves to predict impacts from mine developments.

**Puerto Plata  
Environmental Effects  
Monitoring**  
Dominican Republic

Statistical analysis and reporting of mine effluent effects on benthic macroinvertebrates, algae, and macrophytes.

**Diavik Diamond Mine  
Environmental Impact  
Assessment**  
Northwest Territories,  
Canada

Review of statistical models for predicting impact of increased phosphorus on chlorophyll concentration and trophic structure in Lac de Gras.

**Review of statistical  
models for predicting  
impact of increased  
phosphorus on  
chlorophyll  
concentration and  
trophic structure in  
Lac de Gras**  
Ontario, Canada

Statistical analysis and reporting of the environmental effects monitoring program for benthic invertebrates.

## PROJECT EXPERIENCE – FORESTRY

**Department of  
Resources, Wildlife  
and Economic  
Development**  
Northwest Territories,  
Canada

Responsible for development of growth and yield models and stratification of yield classes for the Cameron Hills timber supply analysis.

**Prince Albert Model  
Forest Association**  
Saskatchewan, Canada

Project manager for the development of criteria and indicators for monitoring forest ecosystem change.

**Spray Lake Sawmills**  
Alberta, Canada

Involved in the analysis and interpretation of site index and height-growth curves for generating yield volumes and forecasting harvest rates.



**Involved in the analysis and interpretation of site index and height-growth curves for generating yield volumes and forecasting harvest rates**

Alberta, Canada

Statistical analysis and reporting on models developed for generated timber yield volumes in regenerated and fire origin stands.

**Weyerhaeuser Environmental Effects Monitoring**

Saskatchewan, Canada

Determination of appropriate sample size for monitoring effects of pulp mill effluent on key fish species. Analysis and recommendations regarding effects of pulp mill effluent on white suckers. Statistical analysis and reporting of mine effluent effects on benthic macroinvertebrates and sentinel fish species.

**Weldwood Grizzly Bear Habitat Suitability Index and Cumulative Effects Assessment Models**

Alberta, Canada

Responsible for reviewing and compiling literature on grizzly bear habitat suitability index and cumulative effects assessment models. Information was used to assess the efficacy of different models for project level planning and mitigation of the effects of linear disturbances on grizzly bear populations.

**Weyerhaeuser Environmental Impact Assessment**

Saskatchewan, Canada

Responsible for data management and statistical analysis of field data collected for habitat assessments for vegetation, amphibians, small mammals, birds, furbearers, and ungulates. Also involved in the writing of the environmental impact assessment and generation of habitat suitability index models.

## PROJECT EXPERIENCE – OIL & GAS

**PetroCanada Environmental Assessment**

Alberta, Canada

Conducted population viability analysis for caribou, moose, and black bear using a spatial population model that integrates landscape data with demographic estimates.

**Rio Alto Environmental Assessment**

Alberta, Canada

Conducted population viability analysis for caribou, moose, and black bear using a spatial population model that integrates landscape data with demographic estimates.

**Suncor Ltd. Environmental Impact Assessment**

Alberta, Canada

Statistical analysis and reporting of habitat assessments for songbirds and ungulates. Also involved in validation of habitat suitability index models.

**Pan Canadian Ltd. Environmental Impact Assessment**

Alberta, Canada

Statistical analysis and reporting of habitat assessments for songbirds and ungulates.



**Shell Canada Ltd.  
Environmental Impact  
Assessment**  
Alberta, Canada

Responsible for data management and statistical analysis of field data collected for habitat assessments for: birds, furbearers, and ungulates. Also included in writing of environmental impact assessment and generation of habitat suitability index models.

## PROFESSIONAL AFFILIATIONS

V.P. Finance, Graduate Student Association, University of Saskatchewan, 1991-1992  
Member, American Society of Naturalists, 1994-1996

## PUBLICATIONS

### Refereed Journal Articles

Smith, A.C., J.A. Virgl, D. Panayi and A.R. Armstrong. Effects of a diamond mine on tundra-breeding birds. *Arctic*, 58 (2005), 295-304.

Virgl, J.A., S.P. Mahoney and K. Mawhinney. Phenotypic variation in skull size and shape between Newfoundland and mainland populations of North American black bears, *Ursus americanus*. *Canadian Field-Naturalist*, 117 (2003), 236-244.

Mahoney, S.P. and J.A. Virgl. Habitat selection and demography of a non-migratory woodland caribou population in Newfoundland. *Canadian Journal of Zoology*, 81 (2003), 321-334.

Mahoney, S.P., J.A. Virgl and K. Mawhinney. Potential mechanisms of phenotypic divergence in body size between Newfoundland and mainland black bear populations. *Canadian Journal of Zoology*, 79 (2001), 1650-1660.

Virgl, J.A. and F. Messier. Assessment of source-sink theory for predicting demographic rates among habitats that exhibit temporal changes in quality. *Canadian Journal of Zoology*, 78 (2000), 1483-1493.

Larivière, S., L.R. Walton and J.A. Virgl. Field anaesthesia of American mink, *Mustela vison*, using halothane. *Canadian Field-Naturalist*, 114 (2000), 142-144.

Mahoney, S.P., J.A. Virgl, D.W. Fong and A.M. Maccharles. Evaluation of a mark-resighting technique for woodland caribou in Newfoundland. *Journal of Wildlife Management*, 62 (1998), 1227-1235.

Virgl, J.A. and F. Messier. Habitat suitability in muskrats: a test of the food limitation hypothesis. *Journal of Zoology, London*, 243 (1997), 237-253.

Virgl, J.A. and F. Messier. Population structure, distribution, and demography of muskrats during the ice-free period under contrasting water fluctuations. *Écoscience*, 3 (1996), 54-62.

Ferguson, S.H., J.A. Virgl and S.L. Lariviere. Evolution of delayed implantation and associated grade shifts in life history traits of North American Carnivores. *Écoscience*, 3 (1996), 7-17.



Virgl, J.A. and F. Messier. Postnatal growth and development in semi-captive muskrats, *Ondatra zibethicus*. *Growth, Development, and Aging*, 59 (1995), 159-169.

Virgl, J.A. and F. Messier. Evaluation of body size and condition indices in muskrats. *Journal of Wildlife Management*, 57 (1993), 854-860.

Virgl, J.A. and F. Messier. The ontogeny of body composition and morphology in free-ranging muskrats. *Canadian Journal of Zoology*, 70 (1992), 1381-1388.

Virgl, J.A. and F. Messier. Seasonal variation in body composition and morphology of adult muskrats in central Saskatchewan, Canada. *Journal of Zoology, London*, 228 (1992), 461-477.

Messier, F. and J.A. Virgl. Differential use of bank burrows and lodges by muskrats in a northern marsh environment. *Canadian Journal of Zoology*, 70 (1992), 1180-1184.

Messier, F., J.A. Virgl and L. Marinelli. Density-dependent habitat selection in muskrats: a test of the ideal free distribution model. *Oecologia*, 84 (1990), 380-385.

Melton, D.A., N.C. Larter, C.C. Gates and J.A. Virgl. The influence of rut and environmental factors on the behaviour of wood bison. *Acta Theriologica*, 34 (1989), 175-189.

**Journal Articles**

Virgl, J. and S. Larivière. Hutte ou terrier? Le dilemme du rat-musqué. *La trappe*, 1(1) (1994), 6.

Larivière, S. and J. Virgl. Le piège du rat-musqué au printemps: la science justifie telle la tradition?. *L'association des trappeurs*, 4(3) (1993), 8-9.

**Conference Proceedings**

Virgl, J.A. 2004. *An approach to cumulative effects assessment for the uranium mining industry in the Athabasca Basin Ecoregion*. 2004 Conference for the International Atomic Energy Association.

Virgl, J.A. 2004. *Linking changes in habitat availability and quality with population viability analysis: a probabilistic approach to cumulative effects assessment*. In Prediction to Practice: Environmental Assessment Follow-up. 2004 Alberta Society of Professional Biologists.

Ealey, M. and J. Virgl. 2001. *Natural regeneration on a pipeline right-of-way in the boreal forest of west-central Saskatchewan*. 7th International Symposium on Environmental Concerns in Rights-of-Way Management.

**Other**

2003. Review of Manuscript for Journal of Wildlife Management.

2002. External Examiner for Masters Thesis Defence (University of Saskatchewan).



**Education**

M.Sc. Medicinal Chemistry,  
University of Sussex, U.K.,  
1992

B.Sc. Combined Honours  
Chemistry and Biology,  
University of British  
Columbia, Vancouver, BC,  
1990

**Certifications**

Association of the Chemical  
Profession of BC -  
Professional Chemist  
(PChem)

Qualified Professional in  
Risk Assessment (Ontario)  
QPRA

**Burnaby**

**Employment History**

**Golder Associates Ltd. – North Vancouver and Burnaby, BC**  
*Associate, Senior Environmental Scientist (2004 to Present)*

Role includes conducting human health risk assessments, providing expert advice on potential health effects based on human health toxicological information; business development and marketing.

**EVS Environment Consultants – North Vancouver, BC**  
*Senior Environmental Scientist (2002 to 2004)*

Responsibilities included conducting human health risk assessments, managing and providing senior review for ecological risk assessments; business development and marketing.

**Golder Associates Ltd. – Mississauga, ON**  
*Senior Risk Assessor/Toxicologist (2001 to 2002)*

Conducted site-specific risk assessments and developed remediation criteria; peer reviewed site-specific risk assessments; developed chemical-specific toxicological criteria; provided expert advice on potential health effects based on toxicological information; project management; and risk communication.

**Ontario Ministry of the Environment – Toronto, ON**  
*Senior Regulatory Toxicologist (1999 to 2001)*

Responsibilities included reviewing site-specific risk assessments to determine compliance with the Ontario Guideline for use at Contaminated Sites, providing expert human health toxicological advice for community-based risk assessments; developing provincial air standards based on human health toxicological data; and risk communication.

**Eastern Research Group – Boston, U.S.A.**  
*Environmental Scientist (1997 to 1999)*

Provided technical advisory services to various government and corporate clients in the areas of human health risk assessment; ecological risk assessment; medicinal chemistry; and database development.

**Environment Canada – North Vancouver, BC**  
*Toxic Substances Evaluation Scientist/ Controls Program Officer (1993 to 1997)*

Evaluated the environmental toxicology of chloramine — a drinking water disinfectant — under the Priority Substance List (PSL) of Canadian Environmental Protection Act (CEPA). Project involved collecting chloramine-related toxicological data, development of a Microsoft Access database, evaluation of data and data quality, and determination of appropriate assessment endpoints. In addition, general advisory and consulting services in the area of toxicology were provided to senior management, other departmental scientists, federal/ provincial agencies, industry and the general public.



***University of British Columbia, Department of Soil Science –  
Vancouver, BC***

*Laboratory Technician, Soil Chemistry Lab (1992 to 1993)*

Conducted chemical analyses of soil and supervised graduate student experiments.



## PROJECT EXPERIENCE – HUMAN HEALTH RISK ASSESSMENT (HHRA)

**Head Technical Report  
– Human Health Risk  
Assessment**  
Melbourne, Australia

Principal Scientist responsible for planning, managing, and conducting a detailed quantitative human health risk assessment to assess the uptake of contaminants (metals, PAHs, and pesticides) from sediment by ecological receptors (three species of fish and mussels) as the result of proposed dredging activities in Port Phillip Bay, and the subsequent consumption of these fish and mussels by recreational and subsistence fisher populations. Responsibilities included providing direction for data screening, problem formulation and food chain modelling as well as conducting the HHRA, report writing, quality assurance/control, and management of budget, scope, timelines, and staff resources as well as client liaison. (2006 - 2007).

**Petaquilla Mine  
Baseline  
Environmental and  
Social Impact  
Assessment**  
Panama

Technical lead for human health component of risk assessment in support of an Environmental and Social Impact Assessment for a proposed mine development in Panama. Developed problem formulation, sampling and analysis plan, and data quality objectives for human health and terrestrial components of the project and conducted the baseline and impact case risk assessments. Primary contaminants of concern included in the assessment were metals, PAHs, PCBs, and pesticides. Key elements of study include inclusion of multiple types of traditional foods (including fish) used by three distinct populations of subsistence users, and the use of fate and transport modelling in conjunction with measured soil, sediment, surface water, fish and air data to predict future conditions. (2007 – 2010).

**Human Health Risk  
Assessment –  
Lead-Zinc Mine  
Tailings**  
Mojkovac, Montenegro

Principal Human Health Risk Assessor responsible for a multimedia screening-level risk assessment of the tailings management facility adjacent to the community of Mojkovac. The tailings management facility was constructed to manage tailings from a former lead-zinc mine. Although capped, portions of the tailings are flooded and infiltration has occurred, causing migration of metals into adjacent surface water bodies. The cap is no longer intact in other areas, causing erosion and wind-generated dust. The tailings management facilities have been used for recreational purposes including fishing and swimming. The multimedia screening-level risk assessment included the assessment of dust migration to the adjacent village and impact on soil, crops and livestock as well as ingestion of water, dermal contact with water and ingestion of fish associated with the recreational uses of the flooded portion of the site. The risk assessment was used by the World Bank to address community issues/concerns and prioritize risk management options. (2004 – 2005).



**Human Health Risk Assessment of Former Plant Nursery Operations**  
Washington, DC

Principal Human Health Risk Assessor responsible for a multimedia risk assessment of a 44-acre former plant nursery operation located in Washington. The site will be redeveloped into a passive recreational park within the US National Park system and will include a sensitive wetland area. Primary contaminants of concern included in the assessment were metals, PAHs, PCBs, and pesticides, which are currently found in site soils, sediment, groundwater, and surface water. The risk assessment was conducted to CERCLA standards and involved a complex multi-stakeholder (NOAA, Architect of the Capital, EPA, and District of Columbia Department of Health) and regulatory review process. (2002 - 2004).

**Public Health Risk Assessment for Superfund Site – Marine Corps Logistics Base Barstow**  
Barstow, CA

Scientist responsible for preparing the human health risk assessment of a drinking water supply containing elevated levels of trichloroethene, vinyl chloride, and cis-1,2-dichloroethene at Marine Corps Logistics Base. The risk assessment, which was prepared for the US Agency for Toxic Substances and Disease Registry (ATSDR), addressed both on- and off-Site impacts of the chlorinated solvents. The health risk assessment involved extensive communication with ATSDR and U.S. Marine Corps officials (1999).

**Public Health Risk Assessment for Superfund Site - Mountain Home Air Force Base**  
Mountain Home, ID

Scientist responsible for preparing the human health risk assessment of a drinking water supply containing elevated levels of trichloroethene at Mountain Home Air Force Base. The risk assessment was prepared for the US Agency for Toxic Substances and Disease Registry (ATSDR) and involved consultation with ATSDR and U.S. Army officials (1998 -1999).

**Environmental Assessment of the Lower Churchill Hydroelectric Project**  
Newfoundland

Senior Human Health Risk Assessor responsible for a human health risk assessment of baseline exposure of five communities living close to the dam site, who may be affected by consuming fish with increased mercury concentrations, which is being completed as part of the Environmental Assessment of the Lower Churchill Hydroelectric Project. The risk assessment includes the evaluation of historic and current fish tissue data as well as information for other types of traditional foods, the results of a community views analysis as well as review of area specific food preferences and exposure patterns. The risk assessment will be used to support an environmental hearing for approval of the project. (2009 – ongoing).



**Development of  
Human Health Toxicity  
Reference Values**  
North Haven, CT

Principal Human Health Toxicologist responsible for evaluating and/or developing toxicity reference values for 38 novel substances found in soil, groundwater, and surface water at a former chemical manufacturing site. The site is undergoing a US RCRA evaluation in consultation with state government. The evaluation process included determining whether toxicity reference values (TRVs) were available for a substance, conducting a comprehensive literature search to obtain current toxicological information for the substances, and then assessing the non-carcinogenic, carcinogenic, and mutagenic effects of the substances. The assessment also involved application of modifying factors to account for potential mutagenicity and carcinogenicity to existing reference values and developing oral and inhalation reference doses for chemicals which currently lack toxicity reference values. Toxicity profiles were prepared to document the assessment of each substance and provide a rationale for selection/derivation of TRVs for each substance. The TRVs were subsequently utilized to develop site-specific risk-based cleanup standards for these substances. (2006 – 2008).

**Development of  
Human Health Toxicity  
Reference Values**  
Sweden

Principal Human Health Toxicologist responsible for evaluating and/or developing toxicity reference values for four substances (2-ethyl-1-hexane, hexanal, isophorone and phorone) found in soil and groundwater at a former fabric manufacturing facility in Sweden. The project included the evaluation of existing toxicological data for these substances and also choosing chemical surrogates for substances for which insufficient data were available to derive a toxicity reference value. The project involved a review of uncertainty factors used by various organizations in their derivation of toxicological reference values including the US Environmental Protection Agency, The World Health Organization and the European Community's Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH) Programme. (2010).

**Human Health Risk  
Assessment, Oil Sands  
Mine Expansion**  
Northern Alberta

Technical lead for the human health component of a risk assessment in support of an Environmental Site Assessment Update of a proposed expanded Oils Sands Mine Development. The risk assessment was used to determine whether there would be potential human health risks associated with the expansion compared to the background scenario as well as a cumulative impacts scenario which accounted for the combined effects with other proposed projects. An air quality risk evaluation (acute, chronic, and particulate matter assessments) was conducted to evaluate the inhalation route and a multimedia risk evaluation was conducted to determine the chronic effects associated with chemicals that might be present in both air and food pathways. The main contaminants of potential concern were PAHs and metals. Human receptors in five community locations were assessed in the multimedia risk assessment. (2009 – 2010).



**Quantitative Health Risk Assessment of the First Nations Communities of Tsay Keh and Kwadacha, BC**  
Tsay Keh and Kwadacha, BC

Project manager and Senior Human Health Risk Assessor responsible for conducting a quantitative risk assessment of particulate matter for two Northern BC communities impacted by seasonal dust storms related to "draw down" effects from a large water reservoir. The quantitative assessment of fine and coarse particulate matter included the following approaches (1) SUM15/SUM25 Approach - Comparison to a Health Threshold Effect [Health Canada and Environment Canada 1999], (2) comparison to Background Concentrations (BC Lung Association 2003), and (3) comparison to key epidemiological studies focussed on health effects associated with particulate matter from crustal sources. (2009 – 2010).

**Risk Assessment of Stormwater Run-off from a Copper Mine on Native American Reserve Gardens**  
Arizona

Risk Assessor responsible for determining potential impact of human consumption of vegetables irrigated with stormwater run-off containing elevated levels of metals from a copper tailings area. Risk assessment was prepared for the Agency of Toxic Substances and Disease Registry (ATSDR) and involved consultation with ATSDR and the local Native American government. (1999).

**Human Health Risk Assessment – Impact of Landfill Leachate on Community Drinking Water Supply**  
Mission, BC

Principal Human Health Risk Assessor responsible for risk assessment of a community drinking water supply and recreational swimming area impacted by landfill leachate runoff as the result of a severe rainfall event. The primary contaminants of concern were metals, PAHs, PCBs, pesticides, and dioxin/furans. The results were presented to the local medical officer of health, who subsequently removed the non-water use advisory for drinking water and recreational purposes. (2006 -2007).

**Human Health Risk Assessment – Recreational Water Use**  
Wabamun, AB

Principal Human Health Risk Assessor responsible for risk assessment of sediment and surface water impacted by an oil spill into a large freshwater recreational lake, as the result of a train derailment. The primary contaminants of concern were PAHs, novel alkylated PAHs, and selected VOCs. The risk assessment involved the development of toxicity reference values for alkylated PAHs, as well as complex peer review and multi-stakeholder consultation process. The results were presented to the local medical officer of health, who subsequently removed the non-water use advisory for recreational purposes. (2006 – 2007).

**Human and Ecological Risk Assessment**  
Northern Saskatchewan

Project manager responsible for a human and ecological risk assessment to support an Environmental Impact Statement for the expansion of a gold mine in Northern Saskatchewan. The human and ecological risk assessment included the assessment of aquatic health for baseline and project scenarios, a quantitative assessment of terrestrial health and a quantitative assessment of consumption of fish for baseline and project scenarios by recreational users of nearby lakes. Responsibilities included liaison with other discipline leads to ensure data quality objectives for the risk assessment were met. (2009).



**Human Health Risk Assessment – Former Port Facility**  
Uranium City, Saskatchewan

Principal Human Health Risk Assessor responsible for risk assessment of a historic oil spill at a former port facility into a large freshwater lake in northern Saskatchewan. The assessment included the evaluation of sediment, fish and surface water. Recreational, residential and First Nations receptors were evaluated and operable exposure pathways included consumption of fish, dermal contact with water and sediment, dermal contact with surface water, inadvertent consumption of sediment during recreational activities and consumption of surface water as a source of potable water. The primary contaminants of concern were PAHs and alkylated PAHs. The risk assessment also involved the assessment of and modification of toxicity reference values for alkylated PAHs. The risk assessment was used to prioritize potential remedial options including whether the impacted sediment could be managed in-place. (2007 – 2010).

**Human Health Risk Assessment – Shopping Mall**  
Surrey, BC

Principal Human Health Risk Assessor responsible for risk assessment of a shopping mall impacted by a fire at a former drycleaner site. A plume of chlorinated solvents (tetrachloroethene and trichloroethene) is present beneath a portion of the shopping mall. The risk assessment involves evaluation of soil, groundwater, soil vapour and indoor air data to determine risks to building occupants and customers. The assessment also included a critical evaluation of the available toxicity reference values for trichloroethene. (2010 – ongoing).

**Site-Specific Human Health and Ecological Risk Assessment Former Power Stations**  
Niagara Falls, ON

Principal Risk Assessor responsible for conducting a site-specific human health and ecological risk assessment of a two former historic hydroelectric power stations that will potentially be redeveloped as museums or for other public use. The primary contaminants of concern were metals, petroleum, and polycyclic aromatic hydrocarbons in soils. Risks were assessed for future residential users as well as maintenance and construction workers. (2005 – 2007).

**Site-Specific Human Health and Ecological Risk Assessment Former Landfill**  
Ottawa, ON

Principal Human Health Risk Assessor responsible for conducting a site-specific human health and ecological risk assessment of a former landfill and salt storage site that is being redeveloped for residential and parkland use. The primary contaminants of concern were metals and polycyclic aromatic hydrocarbons in soil. Site-specific metal bioaccessibility in soil was used in the exposure calculations. Risks were assessed for future residential users as well as maintenance and construction workers. (2005 – 2007).

**Human Health Risk Assessment and Soil Vapour Intrusion Modelling, Brochet School**  
Brochet, Manitoba

Principal Human Health Risk Assessor and project manager responsible for conducting a soil vapour investigation at Brochet School, in northern Manitoba, to evaluate whether Health Canada guidance's default assumptions provided reasonable risk estimates in subarctic and arctic climates. A historic fuel spill had occurred beneath the school. The purpose of the investigation was two-fold and included an improved knowledge of subsurface chemical fate and transport in northern climates (including biodegradation processes) as well as an assessment of the impact of petroleum hydrocarbons under the school and any potential risks that might still exist for students and teachers. (2009).



**Human Health Risk Assessment, Former Whitehorse Tank Farm**  
Whitehorse, Yukon

Principal Human Health Risk Assessor and project manager responsible for the development of site-specific soil standards for industrial land use at the former Yukon Pipelines Limited Upper Tank Farm, Whitehorse, Yukon. Vapour intrusion modelling was used to derive the site-specific standards. Confirmatory soil samples, which were collected at the time of remedial excavation works conducted in 2001, were screened using the site-specific standards for industrial use. These site-specific soil standards for industrial use were developed in response to conditions imposed by the National Energy Board (NEB) their review of an Abandonment Order and subsequently accepted by the NEB. (2009).

**Finalization of Clean-up Criteria**  
Port Hope, ON

Scientist responsible for the critical assessment of exposure models used in Ontario and other jurisdictions to derive risk-based cleanup criteria and assessment of the suitability for use in this community which had historically been impacted by uranium processing. A site-specific multimedia approach was recommended for several contaminants of concern. (2001).

**Ontario Ministry of the Environment Course on the Contaminated Sites Guidelines**  
Ontario

Key Speaker at the Ontario Ministry of the Environment's course on Contaminated Sites Guidelines for environmental consultants and municipal planners held in several locations throughout Ontario. Discussed how to conduct the human health component of a site-specific risk assessment, including best practices and technical review considerations. (2001).

**Screening Human Health and Ecological Risk Assessment**  
Fort McMurray, AB

Principal Risk Assessor responsible for screening level human health and ecological risk assessment of a historic Oil Sands Extraction site from the 1950s. The primary contaminants of concern included petroleum hydrocarbons, PAHs and novel alkylated PAHs. The risk assessment exposure pathways included direct soil contact and vapour intrusion into indoor and outdoor air for human receptors as well as terrestrial and aquatic components for ecological receptors which included wildlife food chain modelling. The results will be used to prioritize further risk assessment or risk management measures for the various areas of concern at the Site. The risk assessment approach included modifying guidelines as per the Alberta Environment Tier II approach. (2010).

**Preliminary Quantitative Risk Assessment CFB Shilo**  
Manitoba

Senior risk assessor and project manager responsible for conducting a preliminary quantitative human health and ecological risk assessments of a former shooting and rifle ranges at Canadian Forces Base (CFB) Shilo located in Shilo, Manitoba for Defence Construction Canada. The risk assessments were conducted to determine risks to ecological receptors as well as human residential, recreational users and construction workers resulting from elevated concentrations of metals and polycyclic aromatic hydrocarbons in soil and groundwater. Ecological risk evaluation (ERE) and Federal Contaminated Sites Action Plan (FCSAP) scoring worksheets were also completed. The report was used to obtain funding under FCSAP for further work. (2008 – 2009).



**Preliminary  
Quantitative Risk  
Assessment FOX-3  
DEW Line Site**  
Nunavut

Senior human health risk assessor and project manager responsible for conducting a preliminary quantitative human health risk assessment of a former FOX-3 distant early warning (DEW) line site located in Dewar Lakes, Nunavut for Defence Construction Canada. The risk assessment was conducted to determine risks to recreational users and construction workers resulting from elevated concentrations of metals and polycyclic aromatic hydrocarbons in soil and surface water. Ecological risk evaluation (ERE) and Federal Contaminated Sites Action Plan (FCSAP) scoring worksheets were also completed. The report was used to obtain funding under FCSAP for further work. (2007).

**Screening-Level Risk  
Assessment,  
Commercial Office  
Tower**  
Vancouver, BC

Human health risk assessor responsible for conducting a human health risk assessment of a commercial office tower constructed on the site of a former drycleaner operation. The risk assessment was conducted to determine potential risks to building users and off-site receptors resulting from elevated concentrations of tetrachloroethene present in site groundwater. (2002 – 2003).

**Screening-Level Risk  
Assessment, Active  
Drydock**  
Vancouver, BC

Senior risk assessor responsible for conducting a human health risk assessment of an active drydock and associated property for purposes of a land transaction. The risk assessment was conducted to determine potential health risks to drydock and construction workers as well as site trespassers to elevated concentrations of petroleum hydrocarbons and metals in site soils and groundwater. (2005 – 2008).

**Preliminary  
Quantitative Risk  
Assessment**  
Bedford, NS

Senior Human Health Risk Assessor responsible for conducting a preliminary quantitative human health risk assessment of a former landfill at a former dredgeate disposal facility at the Canadian Forces facility. The risk assessment was conducted to determine risks to commercial and construction workers resulting from elevated concentrations of metals and polycyclic aromatic hydrocarbons in soil and sediment. The report was used to obtain funding under the Federal Contaminated Sites Action Plan for further work. (2005 – 2006).

**Screening-Level Risk  
Assessment,  
Application of Coal Tar  
Enamel to Large-  
Diameter Pipes**  
Vancouver, BC

Senior Risk Assessor responsible for conducting a human health risk assessment related to inhalation of PAHs, particulates, and VOCs as the result of application of coal tar enamel to large-diameter water pipes that are being placed through a series of residential neighbourhoods. The risk assessment was conducted to determine potential health risks to construction workers and nearby residents. (2008).

**Site-Specific Risk  
Assessment of a  
Former Iron Pigments  
Manufacturing Facility**  
Etobicoke, ON

Senior toxicologist responsible for conducting a site-specific risk assessment to determine the potential for adverse health impact to site users exposed to elevated metals concentrations in soil. A site-specific soil remedial criterion was developed for iron. The project also involved significant interaction with legal counsel for the former facility. (2001).

**Screening-Level Risk  
Assessment, Public  
Storage Facility**  
Vancouver, BC

Human health risk assessor responsible for conducting a human health risk assessment of a public storage facility constructed on a former commercial/industrial site. The risk assessment was conducted to determine potential risks to building users and off-site receptors resulting from elevated concentrations of concentrations of petroleum hydrocarbons in groundwater and lead in soil. (2004 – 2006).



**Screening-Level Risk Assessment of a Manufacturing Facility**  
Confidential

Human Health Risk Assessor responsible for conducting a human health risk assessment of a manufacturing facility that was potentially impacted by a historic spill of chlorinated solvents. The risk assessment was conducted to determine potential risks to building users and construction workers associated with inhalation of indoor and outdoor air as the result of the subsurface vapour intrusion resulting from elevated concentrations of chlorinated solvents in site soils and groundwater. (2006 – 2009).

**Screening-Level Risk Assessment, Church and Underground Parking Garage**  
Vancouver, BC

Human health risk assessor responsible for conducting a human health risk assessment of a church and underground parking garage in adjacent commercial building impacted by a historic fuel oil spill. The risk assessment was conducted to determine potential risks to building users and off-site receptors resulting from elevated concentrations of petroleum hydrocarbons and polycyclic aromatic hydrocarbons present in site soil. (2004 – 2006).

**Screening-Level Risk Assessment Former Corrections Camp**  
Alouette Lake, BC

Senior risk assessor responsible for conducting a human health risk assessment of a former corrections camp on the shore of Alouette Lake which had been the site of fuel storage leak. The future site use is a proposed recreational camp for children. The risk assessment was conducted to determine potential risks to building users resulting from elevated concentrations of residual petroleum hydrocarbons present below several residential buildings on-site. (2004-2006).

**Screening-Level Risk Assessment Public Works Yard**  
Nelson, BC

Senior risk assessor responsible for conducting a human health risk assessment of a public works yard. The risk assessment was conducted to determine potential risks to building users and off-site receptors resulting from elevated concentrations of concentrations of petroleum hydrocarbons in groundwater and lead in soil. This risk assessment was submitted to BC MOE. (2005).

**PROJECT EXPERIENCE – HUMAN HEALTH TOXICOLOGY**

**Technical Advisor, Human Health Risk Assessment**  
Wawa, ON

Senior Regulatory Toxicologist representing the Ontario Ministry of the Environment on the Wawa Technical Steering Committee. Responsibilities included providing expert advice, guiding and critically reviewing the human health risk assessments, human health toxicological data, and biological monitoring studies of a population living adjacent to soil containing elevated levels of arsenic. Regular meetings with the local medical officer of health, industrial stakeholders, local government, and their technical consultants were also required. (1999 – 2001).

**Technical Advisor, Community-Based Risk Assessment**  
Pt. Colborne, ON

Senior Regulatory Toxicologist representing the Ontario Ministry of the Environment in the multistakeholder development of a community-based risk assessment approach for use in Pt. Colborne. Pt. Colborne has elevated metals concentrations in the soils in the area resulting from historical metal refining activities. Responsibilities included providing expert human health toxicological advice, critically reviewing the proposed community-based approach including the framework for the human health and ecological risk assessments, potential risk management measures, and implementation of these risk management measures. Risk communication at public forums and frequent interaction with the local medical officer of health, industrial stakeholders, local government, and their technical consultants was required. (1999 – 2001).



**Provision of Expert Toxicological Advice to Ontario Medical Officers of Health**  
Ontario

Senior Regulatory Toxicologist responsible for providing expert toxicological advice to Ontario Medical Officers of Health on an “as-needed” basis. Various projects included the initiation of two blood lead screening programs for children and pregnant women exposed to lead (1) in mine tailings used for garden landscaping and paving, (2) from aerial deposition in gardens in a smelting town; and assessment of off-site odour/health issues related to remediation activities, and (3) odour and potential health issues associated with unknown noxious substances in soil. (1999 – 2001).

**Development of a Provincial Uranium Air Standard**  
Ontario

Co-author of the provincial uranium air standard for the Ontario Ministry of the Environment based on the chemical toxicity specific to exposures by human and ecological receptors in a community adjacent to a uranium refinery. The uranium air standard was set to ensure that unacceptable levels of uranium did not accumulate in soil as the result of aerial deposition and utilized a multimedia approach. The development of the standard included a critical review of uranium human health toxicological data to determine an appropriate toxicity reference value. The development of the uranium standard involved extensive communication and consultation with the local medical officer of health, industrial stakeholders, local government, and public interest groups. (1999 – 2001).

**Development of a Provincial Acetonitrile Air Standard**  
Ontario

Senior Toxicologist responsible for developing a provincial acetonitrile air standard for the Ontario Ministry of the Environment, based on protection of human health and the environment. The development of the standard included critically assessing the current literature related to the human health toxicology of acetonitrile.

**Market Analysis – Sepsis and Septic Shock**  
Boston, MA

Scientist responsible for a market analysis of the disease state, sepsis and septic shock for use by pharmaceutical and biotechnology companies. The market analysis included (1) a summary of most recent understanding of cause and mode of action of disease state, (2) summary of current treatment regimens (pharmaceutical and clinical) and efficacy of these treatments, (3) summary of new pharmaceuticals in the pipeline for the treatment of sepsis, including mode of action and expected efficacy, (4) analysis of sales of major pharmaceutical products used for treatment in various markets (Europe, Asia, and North America), and (5) interviews with leading medical experts specializing in the treatment of sepsis to determine what tools would be most useful to them in the treatment of disease. (1999).



## PROJECT EXPERIENCE – GUIDANCE DOCUMENTS, CLASSIFICATION SYSTEMS AND CHEMICAL ASSESSMENTS

**Update of Environmental, Health and Safety Guidelines for Base Metals Smelting and Refining**  
Washington, DC

Project Manager involved in updating the International Finance Corporations (IFC) Environmental Health and Safety Standards (EHS) for Base Metals Smelting and Refining (e.g., aluminum, copper, lead, nickel, and zinc). The EHS guidelines are used internationally by project managers and financiers to minimize and/or control EHS impacts during construction, operation, and decommissioning of base metals smelters and refineries. The role involved project management, liaising with IFC, providing direction to and coordinating inputs from several industry experts, data analysis, and writing the guidance document. (2006 – 2007).

**Update of the National Contaminated Sites (NCS) Classification System**  
Ottawa, ON

Project Manager and Principle Scientist involved in updating the existing NCS classification system which is used to rank federal sites. The NCS is used to determine priority of federal sites for further investigation and standardize prioritization for funding. The system is based on (1) the assessment of environmental fate and transport of chemicals, (2) hazard ranking of the chemicals, and (3) assessment of site characteristics that would increase risk of chemical to the environment or human health. Primary changes to the NCS included the reduction of ambiguity to assist in the standardization of responses, improved clarity, and incorporation of additional technical scoring such as northern specific issues. The updated NCS has recently undergone trial testing using several case studies with a variety of datasets before use for prioritization of federal sites nationally. (2004 – 2007).

**Management of Coarse Particulate Matter in Canada**

Project Manager and senior risk assessor responsible for risk management assessment for coarse particulate matter (PM<sub>2.5-10</sub>) in Canada completed for Health Canada. The project included the (1) review and compilation of information related to primary emission sources of coarse particulate matter in Canada focussing on industrial/urban and rural environments; (2) identification and compilation of risk management measures for coarse particulate matter from or proposed in other regulatory jurisdictions including interviews of regulators and other experts specializing in risk management of coarse PM; (3) identification of the major sources of coarse particulate matter in Canada and possible risk management measures that would address these major sources; and (4) prioritization of the risk management measures by identifying positive and negative effects associated with these measures. (2010).



**Soil Vapour Intrusion Model and Updated Soil Vapour Characterization Guidance – British Columbia**

Project Manager for the development of a soil vapour intrusion model which provides chemical-specific attenuation factors and also updated guidance on soil vapour intrusion for the Science Advisory Board for Contaminated Sites in BC. Work is in progress with respect to the development of a chemical-specific vapour intrusion model which will include of the adaptation of an existing spreadsheet model, which implements partitioning calculations from soil and groundwater to soil vapour and models vapour intrusion according to the Johnson and Ettinger algorithm. The Johnson and Ettinger defaults are adapted from those adopted by Health Canada for their vapour intrusion guidance and incorporated in the BC MOE Technical Guidance for attenuation factors. In addition to the model development, the project includes the update of a 2006 soil vapour characterization guidance document previously prepared by Golder for the SAB and the incorporation of field research on soil properties and moisture content in vapour attenuation modelling. (2009 – ongoing).

**PSL II – Evaluation of the Environmental Toxicology of Inorganic Chloramines**  
Vancouver, BC

Scientist responsible for evaluating the environmental toxicology of the drinking water disinfectant, chloramine, in accordance with the Environment Canada Priority Substances II List protocol. Technical tasks included collecting chloramine-related toxicological data, evaluating the data and data quality, determining that a new analytical method would need to be developed for the assessment, and selecting appropriate assessment endpoints for additional toxicity testing. A meta-analysis was conducted with the resulting toxicological data. Another key area of the project involved setting up a Environmental Resource Group consisting of chloramine experts from various academic, industrial, and government sources to provide ongoing feedback on the technical decisions made during the evaluation. Formal oral presentations were made to the Environmental Resource Group in Ottawa and Vancouver. (1995 – 1997).

**Environmental Toxicity of Avermectins**  
Vancouver, BC

Scientist responsible for evaluating the environmental toxicology of the avermectins (a pesticide) for Environment Canada. Technical tasks included a conducting a literature survey of avermectin environmental toxicological data, evaluating the data and data quality, determining the key toxicological effects of avermectins, and the concentrations in the environment at which one would expect to find environmental effects on non-target species. (1996).

**Environment Canada Polycyclic Aromatic Hydrocarbon Risk Management Workshop**  
Vancouver, BC

Scientist responsible for organizing a workshop to discuss risk management options for a community and surrounding environment in northern British Columbia impacted by industrial emissions of polycyclic aromatic hydrocarbons. Other responsibilities included facilitating summary discussions and documenting workshop proceedings. Workshop participants included industrial stakeholders and their technical consultants, government scientists and officials, and native elders from the impacted community.



**A Survey of Particulate Emission Control Devices Used with Wood-Fuelled Power Boilers in North America**  
Vancouver, BC

Scientist responsible for conducting a survey of particulate emission control devices used on wood-fuelled power boilers in North America. Dioxins and furans can be formed by the incomplete combustion of wood products and the objective of the survey was to determine (1) the type of particulate emission control device used most frequently with wood-fuelled power boilers and (2) the resulting dioxin/furan emissions associated with each control technology. The results were used to determine what type of control technology would be most effective in reducing environmental emissions of dioxins and furans from wood-fuelled power boilers at sawmills and pulpmills in BC. (1996).

**Assessment of Environmental Impacts of Pesticide Applications**  
Vancouver, BC

Scientist responsible for determining potential environmental effects associated with proposed pesticide applications. Pesticide permit applications were reviewed to determine compliance with federal environmental regulations, specifically protection of fish and migratory birds, and input was provided to a federal-provincial committee as to whether the application should be granted. Audits of pesticide applications were also conducted. In addition to the review of pesticide applications, activities also included response to public concerns related to pesticides and education related to pesticide use in urban and residential environments. (1994 – 1996).

**Environment Canada Polycyclic Aromatic**  
Vancouver, BC

Scientist responsible for organizing a workshop to discuss risk management options for a community and surrounding environment in Northern British Columbia impacted by industrial emissions of polycyclic aromatic hydrocarbons. Other responsibilities included facilitating summary discussions and documenting workshop proceedings. Workshop participants included industrial stakeholders and their technical consultants, government scientists and officials, and native elders from the impacted community. (1995).

**PROJECT EXPERIENCE – THIRD-PARTY PEER REVIEW**

**Peer Review of Human Health Risk Assessment for a Natural Gas Pipeline**  
BC

Senior Toxicologist responsible for the peer review of a human health risk assessment conducted to support an environmental impact assessment for a natural gas pipeline in BC and Alberta. Acted as an expert witness on behalf of a First Nations group and provided advice at a National Energy Board Hearing. The primary contaminant of concern was hydrogen sulphide which had the potential to impact health of trappers and residents living in the vicinity of the pipeline in the case of a pipeline rupture. The peer review was conducted in accordance with the protocol provided by the Alberta Energy Board. (2008).

**Review of Site-Specific Risk Assessments**  
Ontario

Senior Regulatory Toxicologist responsible for reviewing site-specific risk assessments and remediation criteria to ensure compliance with the Guideline for Use at Contaminated Sites for the Ontario Ministry of the Environment. Excellent knowledge of Ontario Contaminated Sites Guidelines and the Ministry's site-specific risk assessment approval process. (1999 – 2001).



**Peer Review of a Toxicity Reference Value for Salt**  
BC

Senior Toxicologist responsible for the peer review of a toxicity reference value derivation for salt and provided advice to the British Columbia Science Advisory Board. The toxicity reference value had been derived for Health Canada and would potentially be used to derive soil and groundwater standards for use at Contaminated Sites in British Columbia. The review included assessing the technical validity of the approach utilized and examining the selection of the key toxicological studies as well as providing a comparison/contrast with the proposed method of addressing salt by the BC MOE and practical considerations with regards to implementation of standards derived using the proposed toxicity reference value. (2008).

**Peer Review of BC Human Health Soil Quality Matrix Guidelines**  
BC

Senior Toxicologist responsible for the peer review of a proposed update to the BC Contaminated Sites Task Group (CSST) for the derivation of human health soil quality matrix standards for contaminated sites. The peer review was conducted on behalf of the BC Science Advisory Board. The peer review included a technical assessment of the approach and exposure parameters utilized. (2008).

**Peer Review of Vapour Risk Assessment**  
BC

Senior Toxicologist responsible for a third-party peer review of human health and ecological risk assessment on behalf of a property developer in order to assist them with providing advice as to whether the site is suitable for a residential development. Several data gaps were identified in the site characterization were identified and recommendations included some additional site investigation work and updating the risk assessment with the measurement of soil vapours after pursuing additional source removal. (2008).

**Peer Review of Four Site-Specific Risk Assessments for Off-Site Impacts**  
Ontario

Senior Toxicologist responsible for the peer review of four site-specific risk assessments that had been conducted to determine the potential human and ecological risks originating from an industrial facility. Soil and groundwater remedial criteria were also reviewed. The primary contaminants of concern were elevated levels of chlorinated solvents such (such as trichloroethene, vinyl chloride and cis-1,2-dichloroethene) which have migrated in groundwater to a residential neighbourhood. The peer review was conducted in accordance with the protocol outline in the "Guidance on Site-Specific Risk Assessment for Use at Contaminated Sites in Ontario". (2001).

**PROJECT EXPERIENCE – ECOLOGICAL RISK ASSESSMENT**

**Terrestrial and Groundwater Ecological Risk Assessments – South East False Creek**  
Vancouver, BC

Project manager for terrestrial and groundwater ecological risk assessments of a former industrial site scheduled for redevelopment for the 2010 Winter Olympic Athletes Village and later for use as a mixed residential and urban park property. Contaminants of potential concern included elevated concentrations of metals and PAHs in soil and groundwater. Responsibilities included providing direction and design of assessments, overseeing data analysis and food chain modelling and overall responsibility for report writing.



**Ecological Risk Assessment of a Former Sawmill site**  
Vancouver, BC

Project manager for terrestrial and aquatic groundwater ecological risk assessments of metals and chlorophenols at a former sawmill site adjacent to the Fraser River. Responsibilities included providing direction and design of assessments, overseeing data analysis and food chain modelling and overall responsibility for report writing.

**Ecological Risk Assessment for Pt. Atkinson Lightstation and Lighthouse Park**  
West Vancouver, BC

Project manager for terrestrial and aquatic ecological risk assessments of elevated metals in soils adjacent to lightstation and in several areas of the park. Responsibilities included providing direction and design of assessments and problem formulation workshop, overseeing data analysis and food chain modelling and overall responsibility for report writing.

**Ecological Risk Assessment Tofino Airport**  
Tofino, BC

Project manager and senior risk assessor for terrestrial and aquatic ecological risk assessment for three former landfill sites associated with the Tofino airport. Contaminants of concern included elevated metals and petroleum hydrocarbons in site soils, groundwater, surface water and sediments. The problem formulation was presented to stakeholders for input and will be used to obtain funding under the Federal Contaminated Sites Action Plan for further work. Responsibilities included providing direction and design of assessments, overseeing data analysis, toxicity testing and food chain modelling and overall responsibility for report writing.

**Ecological Risk Assessment First Nations Reserves**  
BC

Project manager and senior risk assessor for terrestrial and aquatic ecological risk assessment for two First Nations reserves in remote locations on the West Coast of BC. Contaminants of concern included elevated metals, petroleum hydrocarbons and phenols in site soils, groundwater, surface water and sediments. The risk assessment will be used to obtain funding under the Federal Contaminated Sites Action Plan for further work. Responsibilities included providing direction and design of assessments, overseeing data analysis, toxicity testing and food chain modelling and overall responsibility for report writing.

**Ecological Risk Assessment Grain Terminal**  
Vancouver, BC

Project manager and senior risk assessor for aquatic ecological risk assessment for a grain terminal adjacent to an aquatic environment. Contaminants of concern included elevated metals, petroleum hydrocarbons and tannins/lignins associated with woodwaste in soils and groundwater. Responsibilities included providing direction and design of assessments, overseeing data analysis, toxicity testing and overall responsibility for report writing.



## TRAINING

**Mid-America Toxicology Course**

*Kansas City, Missouri, May 2007*

**Probabilistic Risk Assessment**

*Harvard School of Public Health, Cambridge, Massachusetts, 2000*

**Expert Witness Training**

*Ontario Ministry of the Environment, Toronto, Ontario, 2000*

**Fourth International Conference on Arsenic Exposure and Health Effects**

*The Society of Environmental Geochemistry & Health, San Diego, California, 2000*

**Crystal Ball – Probabilistic Risk Assessment Software Training**

*Toronto, Ontario, 1999*

**Human Health and Ecological Risk Assessment**

*SENES Consultants and Oak Ridge National Laboratories, Vancouver, British Columbia, 1994*

## PROFESSIONAL AFFILIATIONS

American Chemical Society

Society for Risk Analysis

Society for Environmental Toxicology and Chemistry

## PUBLICATIONS

### Other

“New Environmental Health and Safety Guidelines for Smelting and Refining”. Audrey Wagenaar and Rick Hilton. *Environmental Mining Journal*. October 2008.

“Novel Mono-and bis-Metallated Complexes of Dialkyldiaziridines; X-ray Diffraction Structures of Three Platinum Complexes”. Adeyemi Adedapo, Anthony G. Avent, Duncan Carmichael, Penny A. Chaloner, Peter B. Hitchcock and Audrey Wagenaar. *J. Chem. Soc., Chem. Commun.*, 1993, 186 – 187.

“Novel Diaziridine Complexes of Platinum and Palladium”. P. Chaloner, A. Adepo, P. Hitchcock, and A. Wagenaar, *Abstracts of the Papers of the American Chemical Society*, April 1992.



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## Wayne Corso, P.E. – Vice President of Engineering, 26 + Years Industry Experience

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Throughout Wayne's 26 years of experience in the mining industry, he has planned, coordinated, and directed resources and activities for a wide variety of projects. He has successfully demonstrated the ability to apply skills in both technical and managerial roles. Wayne's most significant attributes include being an excellent coordinator, with extraordinary analytical and communication skills, versatility, practicality, ethics and professionalism.

### Major Responsibilities

- Project management
- Engineering and supervisor roles
- Site operations
- Test mine supervisor
- Site engineer/camp manager
- Feasibility and scoping studies

### Relevant Industrial Experience

#### JDS Energy & Mining, Kelowna, BC

2007 - Present

#### VP Engineering

2007 - 2011

Applied previous technical, operational, and management skills to drive the evaluation and development of various properties through management of the JDS technical group.

#### Farallon, G-9, Mexico

- Underground zinc start-up

#### Norsemont, Constancia, Peru

- Copper feasibility study

#### Debeers/Mountain Province, Gahcho Kue

- Feasibility study for arctic diamonds

#### Capstone, Kutcho Project, BC

- Base metals prefeasibility study
- **Other Evaluation Projects**, Carmen Copper-Philippines, Karma Gold-Burkina Faso, Pebble Project-Alaska, El Creston-Mexico, Niblack-Alaska, Kivalliq-Nunavut, Lik project-Alaska.

#### Equipment Watch

#### Research Manager

2000 - 2007

Industry expert who managed expansion of technical group during growth through acquisition.

#### RMC Pacific

#### Assistant Plant Manager

1998 – 2000

Assistant plant manager at a local gravel pit. Responsible for site operations, and capital project expansions.



Wayne Corso

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## **BHP Billiton**

### **Senior Engineer**

**1990 - 1998**

Quickly moved from a technical position, (evaluating projects and providing mine engineering support) to field positions in project development.

#### Hartley Platinum, Zimbabwe

- Test mine supervisor

#### Ekati Diamonds, NWT Canada

- Site engineer/Camp manager

#### Muskeg River mine, Ft McMurray AB

- Senior mine engineer

## **Homestake Mining Co.**

### **Shift Supervisor/Mining Engineer**

**1984 - 1990**

Obtained operations foundation at the Homestake Mine in Lead, SD via a two year management training program followed by 4 years of at-the-face engineering and supervisory roles.

## **Education and Courses**

B.Sc., Engineering - Colorado School of Mines

**1984**



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## **Daniel Johnson, P.E., VP Projects, 30+ Years Industry Experience**

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Dan has over 30 years of experience as a civil engineer and professional mining engineer. His expertise ranges from mine design, construction, and operations to finance and corporate management. Dan has designed, constructed and operated mines across the globe. His experience also includes running public companies. He is an accomplished leader in the mining industry, being able to prove time and again that he is able to deliver results throughout his progressive career from construction engineer, project engineer, operations superintendent, mine manager, project development manager, general manager, and company CEO and President.

### **Major Responsibilities**

- Manage feasibility projects
- Provide marketing and business management
- Develop and organize policies, procedures, and systems for safety
- Cost engineering
- Budget preparation

### **Relevant Industrial Experience**

#### **JDS Energy & Mining Inc., Kelowna, BC**

**2007- Current**

##### ***Project Development, Design Build and Management***

- Provide project development, design, permit, construction, operation and maintenance, consulting and construction management services to various worldwide energy and mineral companies in early stage execution through to production
- Provide marketing and business management
- Manage project evaluation and feasibility studies

##### **JDS Projects - acted as lead manager:**

- Yellowhead Mining – Harper Creek Project, BC
- The Pebble Partnership (Anglo American – Northern Dynasty) – Pebble Project, Alaska
- Mountain Province/DeBeers – Gahcho Kue Project, NWT
- MMG Minerals – High Lake, Izok Lake
- Harry Winston – confidential property evaluation
- Morley Group – Waterhen and Longnose properties, Minnesota
- Norsemont – Constancia Copper Project, Peru
- Anvil Mining – Technical Due Diligence, Congo

#### **Tahera Diamond Corp., Toronto/Nunavut**

**2004 – 2007**

##### ***Executive Vice President, Operations***

Accountable for leading the safe design, construction and operation of the Jericho Diamond Mine in Nunavut.

- Managed Feasibility Study for project



Daniel Johnson

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- Assisted in company financing efforts and obtained vendor financing for project
- Selection and commercial negotiation of engineering, supply, construction contractors
- Developing organization policies, procedures and system for safety, financial, HR, IR, Community relations and process control
- Recruited, hired, directed operations management and operating team members
- Project was constructed in 11 months after receiving permit and on budget.
- Construction completed without lost time injury

**Diamond Fields International, Vancouver, BC**

**1997 - 2001**

***President and CEO***

Accountable for general management of Diamond Exploration Company

- Raised capital to fund company operations
- Registered company as public corporation on Toronto Stock Exchange
- Negotiated operations contracts

**BHP-Billiton, Vancouver/Yellowknife, NWT**

**1994 - 1997**

***Manager, Mine Development***

Overall responsibility for the permitting, design, construction and operational set up of the \$700million Ekati Diamond Mine in Canada`s Arctic.

- Managed all aspects of mine development
- Lead representative for on panel to obtain mine permits
- Established and executed construction strategy
- Recruiting, hiring, & placing key managers and site operations contractors
- Project built safely, on time and under budget

**BHP Billiton, Syama Gold Mine, Mali West Africa**

**1989 - 1994**

***Mine Manager***

Accountable for the safe operation of the Syama Gold Mine in remote section of Mali

- Exceeded production targets
- Developed and trained local work force
- Increased reserves to extend oxide mine life by two years

**BHP Billiton, Queensland, Australia**

**1987-1989**

***Mine Engineer/Production Superintendent***

Accountable for the Safe Mine Planning and Production supervision of open cast coal mines

- Mine planning for Riverside Coal mine
- Integration of Riverside and Goonyella mines
- Coal Mining Superintendent – Goonyella Mine
- Coal Mining Superintendent – Norwich Park Mine



Daniel Johnson

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**BHP Billiton US and International**

**1981 - 1997**

***Project Engineering and Construction Manager***

Accountable Project Engineering and Construction Management services for multitude of development projects for BHP including:

- Design and Construction Management for DTA 25Mtpy coal export terminal; Virginia, USA
- Escondida Copper Mine Project Feasibility Study - Chile
- La Plata Coal Mine – Project Management – New Mexico
- Technical Services for Company's Operations

**Tidewater Construction, Virginia/Alabama**

**1977 - 1979**

***Construction Engineer***

Accountable for the field management, contract management and quality control for large industrial and marine construction projects

- Managed dredging subcontracts
- Planning and QA/QC
- Site Safety Officer

**Education and Certificates**

- B. Sc. Civil Engineering - Virginia Tech, Blacksburg, Virginia
- MBA - Amos Tuck School of Business, Dartmouth College, Hanover NH
- Virginia and NWT/Nunavut - Registered Professional Engineer (P.E.)

**Director & Memberships**

Past Director – Wolfden Resources

Past Director – Diamond Fields International

Director – Sigma Alpha Properties LLC

Director/President – The Morley Group

# RESUME **Bill T. Horne**



**Bill T. Horne, P.Eng.**  
Principal Consultant

## ■ 25 YEARS OF CONSULTING EXPERIENCE

Mr. Horne is a Senior Geotechnical Engineer/Principal Consultant with EBA, a Tetra Tech Company, in the Edmonton office. He has over 25 years of experience in geotechnical and permafrost engineering for mines, oil and gas facilities, and municipal projects in Northwest Territories, Yukon, Alaska, Alberta, Russia, and the Beaufort Sea. Areas of expertise include industrial plant site development, heavy equipment foundations, water and tailings dam designs, tailings deposition management, geothermal and deformation modelling, and project management. He has been responsible for directing geotechnical site investigation activities, designs, and construction quality control programs. Mr. Horne has also carried out investigations at numerous contaminated sites and abandoned mine sites.

## RELEVANT EXPERIENCE

Projects that highlight Mr. Horne's experience include the following:

- Gahcho Kue Diamond Mine, De Beers Canada, JDS Energy and Mining Inc. - Project Manager for components of a feasibility study. Responsible for waste and water management plan, tailings management, waste rock dumps, and geotechnical design of plant site and civil infrastructure components. The project included a water management scheme to drain the lakes for three open pits under a lake. A total of 15 dykes were designed to control the water. The project focus was to develop a cost and environmentally effective feasibility and closure plan.
- Jericho Mine, Nunavut, Tahera Diamond Corporation - Principal Engineer for the design and construction of the tailings facility. Dams and dykes were designed to retain fine processed kimberlite tailings. Both frozen core and geomembrane dams were constructed. A tailings management operation guideline document was prepared. A water balance for the tailings facility was developed, along with guidelines for process water discharge. Provided input to the closure plan.
- EKATI Diamond Mine Processed Kimberlite Facility, NT, BHP Billiton Diamonds Inc. - Senior Project Engineer for the processed kimberlite disposal plan, and dam design and construction. Frozen core dams are used for perimeter containment structures to increase the capacity of the basin. Intermediate filtration dykes are used within the tailings facility. Tender drawings and specifications were prepared. The construction included blasted rock key trenches, frozen placed fill, filters, and rockfill.
- Kubaka Water Dam and Tailings Dam, Magadan Russia, Kinross - Project Engineer for the design and construction of a tailings facility for the Kubaka Gold Mine, Magadan, Russia. A thickened tailings deposition scheme was developed. A water retention dam was constructed downstream of the tailings area. Construction drawings and specifications and the closure plan were developed.
- Polaris Mine, NT, Cominco - Project Engineer for the design of the first frozen core dam in Canada. The dam was for the tailings facility. The thermal behaviour was modelled to evaluate the thermal regime during construction and over the long term. Recommendations for the shore protection and construction materials were provided. A reclamation and abandonment plan was developed.
- Bullmoose Area Mines closure and abandonment and reclamation plan. Project Principal for the cleanup of seven (7) historic mine sites in the Yellowknife NWT area. An enhanced Phase III was done to develop a remedial action plan. The project involved tailings ponds, demolition, waste rock piles, contaminated sediments and soils and hazardous materials.

## EDUCATION

B.Sc., Civil Engineering, University of Calgary, Calgary, AB

M.Sc., Geotechnical Engineering, University of Alberta, Edmonton, AB

## SUMMARY OF EXPERIENCE

Geotechnical and Permafrost Engineering, foundation analysis and design, earth dam designs, numerical modelling, and construction drawings and specifications for variety of mining and energy projects and contaminated sites

Geotechnical site investigation, foundation and earth embankment designs

## AFFILIATIONS

Member, Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA)

Licensee, Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories and Nunavut (NAPEGG)

Member, Canadian Geotechnical Society (CGS)

Member, Geotechnical Society of Edmonton (GSE)