



AREAS OF EXPERTISE

- Project Scoping
- Environmental Baseline, Impact Assessment, Reclamation, Closure and ARD Studies for Mining
- Waste Management and Environmental Compliance
- Project Management
- Regulatory and Public/First Nations Liaison
- Hydrogeologic Studies
- Investigation of Contaminated Sites
- Remedial Feasibility Studies
- Contaminant Hydrogeology and Groundwater Resource Studies
- Groundwater and Solute Transport Modelling

REPRESENTATIVE EXPERIENCE

David Harpley is currently VP Environment and Permitting Affairs for Canadian Zinc, and managed the EA and permitting of their Prairie Creek project, NWT. He is an environmental specialist with 39 years' experience. He has undertaken and managed a wide variety of studies, primarily for mining projects involving baseline studies, impact assessments, reclamation and closure plan development, acid rock drainage and permitting. He has also led investigations of contaminated sites, from initial characterization to remedial feasibility. David's main focus has been mining and large industrial projects, and he has undertaken projects in North America, Latin America and Africa, and in connection with gold, base metals, diamonds, coal, power station ash and steelworks. Previous projects David has worked on include Iscor Steelworks, South Africa, Willow Creek EIA, BC, Kudz Ze Kayah EIA, Yukon, Comibol mines environmental assessment and closure, Bolivia, assessment of multiple coal mines, Wyoming USA, Bulyanhulu EIA, Tanzania, Ketz River EIA, Yukon, Sullivan Mine closure, B.C., and Faro Mine closure, Yukon.

Canadian Zinc Corporation, 2004 to present

VP, Environment and Permitting Affairs.

David Harpley Consulting, 2002 to 2004

- Aurora Coal. Project Manager for environmental studies associated with a coal mine development project, B.C.
- bcMetals. Environmental Coordinator for the Red Chris mine development project, B.C.
- Assessment of environmental liabilities at mining sites and multiple petro-chemical and oil and gas sites in Canada and the U.S. on behalf of an insurance company.

URS Norecol, Dames & Moore, Vancouver, B.C., Canada, 1992 to 2002.

- Developed, managed and provided technical guidance on environmental, hydrogeological and engineering projects for industry, developers, government, financial institutions and lawyers.

Mining Projects

- Gibraltar Mine, B.C. Assessment of liabilities.
- North Antelope and Rochelle Coal Mines, Wyoming, USA. Assessment of Environmental Compliance.

EDUCATION

Post-graduate studies (1988), Multi-Phase Flow and Contaminant Transport, Colorado State University, Fort Collins, Colorado.

Graduate diploma in Engineering (1987), University of the Witwatersrand, Johannesburg, South Africa.

M.Sc. (1979), Mining Geology and Mineral Exploration, University of Leicester, Leicester, U.K.

B.Sc. Honours (1978), Geology, University of Leicester, Leicester, U.K.

PROFESSIONAL HISTORY

Steffen, Robertson and Kirsten, Vancouver, B.C., Canada, 1989 to 1992.

Steffen, Robertson and Kirsten, Johannesburg, South Africa, 1982 to 1989.

Dames & Moore, Johannesburg, South Africa, 1981.

Phelps Dodge Mining, South Africa, 1979 to 1980.

- Willow Creek Project, B.C. Development of baseline studies for a proposed coal mine.
- Comibol Mine Audits, Bolivia. Lead investigator for the environmental assessment of nine mines, and development of mitigation and/or closure plans and costs.
- Trail, B.C. Manager of geotechnical and environmental studies to characterize base metal furnace slag and a proposed disposal site.
- Nalunaq Project, Greenland. Baseline study and impact assessment planning.
- Bulyanhulu Project, Tanzania. Manager of environmental baseline and waste management planning studies, and Environmental Impact Statement completion to World Bank standards, for a proposed gold mine.
- San Jose Mine, Bolivia. Task manager for the investigation of remediation options and option selection as part of a closure plan for an inactive underground base metal mine with multiple waste piles producing acid drainage and contaminated mine water.
- Natural Resources Canada; Development of handbook providing guidelines for conducting baseline studies for new mines in Argentina.
- BC Ministry of Mines, Peru. Air and water specialist responsible for providing checklist for inspection of mines in Peru.
- Kudz-Ze-Kayah Project, Yukon. Manager of environmental baseline and waste management planning studies, EIA and permitting for a proposed base and precious metal mine in a sensitive area in terms of aquatic resources and terrestrial wildlife.
- Sullivan Mine, B.C. Manager, technical expert and public meeting representative for groundwater, ARD and reclamation studies (soil covers to limit oxygen diffusion and infiltration) related to a mine that has operated since 1906 and is soon to close.
- Red Dog Mine, Alaska. Manager for development of groundwater, ARD and hydrology study plans, and developer of groundwater plan, related to reclamation planning.
- MEND, Canada; Manager of development of an ARD Technology Handbook.

REGISTRATIONS

Professional Geoscientist, B.C. and previously NWT

CERTIFICATIONS

Occupational Safety and Health Administration (OSHA). Hazardous Wastes Operations and Emergency Response (OSHA 29 CFR 1910) 40-hour course.

CITIZENSHIP

EEC. Canada.

COUNTRIES WORKED IN

Argentina, Bolivia, Canada, England, Ireland, India, Namibia, Peru, South Africa, United States

LANGUAGE PROFICIENCY

English, beginner
Spanish

Steffen, Robertson and Kirsten, Vancouver, B.C., Canada, 1989 to 1992.

Mining Projects

- Surface and underground coal mines, central and eastern India. Evaluation of the impact of mine dewatering on regional groundwater resources.
- Faro Mine, Yukon. Managed development of a decommissioning and closure plan for a series of acid generating tailings impoundments involving surface water, groundwater, site and waste characterization, remedial option development for ARD control, simulation of contaminant generation and migration in surface and groundwater using cover and groundwater models, definitions and conceptual engineering design of remedial options, development of costs, receiving water quality predictions.
- Windy Craggy Project, B.C. Managed studies to characterize hydrogeologic conditions and predict flow rates below a proposed flooded impoundment to store tailings and waste rock (seepage), and into a proposed open-pit (inflows).
- Faro Mine, Yukon. Managed environmental and hydrological studies associated with the operation and closure of a proposed in-pit tailings disposal scheme. Included representation at regulatory/public hearings.
- B.C. AMD Task Force/MEND. Managed this project consisting of a Survey of Acid Generation Potential of Abandoned Mines in B.C.
- Sturgeon Lake, Ontario. Directed hydrogeologic studies, seepage analyses and receiving water quality predictions to support remedial plan development for a disused acid generating tailings impoundment.

Steffen, Robertson and Kirsten, Johannesburg, South Africa, 1982 to 1989.

- Iscor Steelworks, Vanderbijlpark, Gauteng. Investigation of surface water and groundwater quality contamination associated with wastewater ponds at a large steelworks site.
- Waste and site characterization, solute transport modelling and waste disposal scheme planning to minimize water quality impacts associated with three major in-pit disposal projects involving power station ash and coal washing plant fines.

- Numerous projects for Witwatersrand gold and gold/uranium mines and coal mines in the E. Transvaal and Natal involving the characterization of mine wastes and waste disposal sites (mainly tailings), assessment of mine inflows and impact of mine dewatering and regional aquifer depletion, determination of baseline and prevailing surface water and groundwater quality, groundwater modelling and monitoring, seepage analyses, prediction of contamination transport, development and recommendation of remedial measures to protect groundwater and surface water quality. Projects involved procurement, management, technical control and client and regulatory liaison.
- Screening, selection, investigation and planning for development of sanitary landfills with provision for groundwater quality monitoring and protection.
- Numerical modelling of mine dewatering and regional groundwater impacts in major regional water supply aquifers.
- Investigation and prediction using models of contaminant transport of arsenic and organic pollutants from metallurgical process wastes and liquid agricultural wastes respectively, in sensitive aquifers.

Dames & Moore, Johannesburg, South Africa, 1981.

- Hydrogeologic studies associated with seepage characterization and mitigation planning for the Rossing Uranium tailings complex, Namibia.
- Investigation of groundwater resource potential and census of wells in tribal homelands in Gauteng and the Orange Free State.

Phelps Dodge Mining, South Africa, 1979 to 1980.

- Exploration geologist undertaking mapping, soil sampling, core and percussion drill supervision, interpretative cross-section preparation and project management.

Co-author of thirteen articles or papers on mine waste characterization and amangement, groundwater modelling and water quality assessment/prediction.

PUBLICATIONS

CONTACT DETAILS

7495 146 St, surrey BC
V3S 8T9
604 594 3855

Skills	Project Experience
<p>Area of Expertise</p> <ul style="list-style-type: none"> Project coordination Road survey, design, and construction Materials testing Crew management <hr/> <p>Education</p> <ul style="list-style-type: none"> Forestry Diploma, British Columbia Institute of Technology (BCIT), 1987 Member, PMI Institute <hr/> <p>Training</p> <ul style="list-style-type: none"> Level 1 First Aid, St. John Ambulance, 2015 HS2 Alive, 2015 CCIL Certified Concrete Field Testing Technician, 2014 TDG Training Certificate, 2013 WHMIS, 2013 METI Ground Disturbance II, 2012 CN Contractor Orientation, 2012 Softwood Lumber Grading Ticket, 2000 Oil Spill Containment and Recovery Certificate, 1992 BC Interior Scaling License, 1992 BC Waste and Residue Certificate Class 1 Drivers License 	<ul style="list-style-type: none"> Trans Mountain Expansion Project, Kinder Morgan, Central/Southern B.C. Road access review and field investigation supporting the proposed expansion of the existing 1,150 km pipeline from Edmonton to Burnaby, B.C. (2015) Prairie Creek Access Road, Canadian Zinc Corporation, Northwest Territories. Completed transportation study reviewing operational logistics and costs to transport concentrate to markets. Additional permitting support for access road including operational plans and procedure manuals. (2015,) Suralco Mine Access Road, Suriname Government, Suriname. Review and assessment of a proposed 100 km access road connecting a processing facility near Parimariboo south-east to bauxite source. Working in extreme humid and hot environment in the jungle. (2015) Prairie Creek Access Road, Canadian Zinc Corporation, Northwest Territories. Completing a 180 km all-season road access plan for remote mine located in NWT. Responsibilities included desk top review and planning, heli and field evaluation, aggregate supply, crew coordination, and final reporting. (2014, ongoing) Coffee Creek Access Road, Kaminak Gold Corporation, Yukon - Completing a preliminary 70 km all-season road access plan for remote mine located in NWT. Responsibilities included desk top review and planning, heli and field evaluation, aggregate supply, crew coordination, and final reporting. (2014) Prince Rupert Gas Transmission Project, UniversalPegasus/TransCanada, Hudson's Hope to Lelu Island, BC - Engineering Services. Full team participant in the planning, field execution and reporting relating to access roads, bridges, camps, and aggregate supply. Responsibilities included desk top review and planning, road data collection and analysis, camp review, locations, reporting, aggregate supply and reporting. (2013-2015) Blackwater Exploration Project, New Gold, Prince George, BC - Primary Lead completing road access plan for power line transmission construction for a proposed mining operation. Responsibilities include assessing existing and new road access constructability and reporting. (2013) Talsequah Chief Project, Chieftain Metals, Onsite Engineering Ltd., Atlin, BC. The project involved evaluating, locating and surveying a proposed 60km access road. Responsibilities included field reconnaissance, road lay out, data collection, documentation and coordination with team members. (2011)



- **Northwest Transmission Line**, BC Hydro, Onsite Engineering Ltd., Terrace to Bob Quinn, BC - The project involved evaluation, location and survey of the proposed power pole access roads. Responsibilities include the field reconnaissance, location, survey, data collection and documentation. (2011)
- **Five Star Timberworks Ltd.**, Hixon, BC - Owner/ Operator. Provided operational planning, field survey, and design for road infrastructure and forest harvesting operations for clients in Northern BC. Operated a small sawmill operation specializing in custom cutting timbers and the design and construction of post and beam cabins and homes. Responsible for business plans, budgeting, marketing, and long-term business management. (1992–2012)
- **Uniwide Drilling**, Prince George, B.C. Part of the drilling team completing geotechnical drilling on for the Northwest Transmission Line from Terrace to Bob Quinn, BC. A variety of geotechnical and contamination drilling sites across northern B.C. (2012)
- **Pittman Asphalt**, Prince George, BC - Asphalt tester. Testing of asphalt for compaction, oil content and gradient. Operation/maintenance of technical equipment located in lab for testing of asphalt. Travel to worksites to operate mobile lab and perform on-site testing. (2008)

Biography

Ernest Kragt has over 25 years of consulting experience in road operations planning, management, and forest harvesting. He has further working experience in residential construction, sawmill operations and geotechnical drilling. Ernest is a respected crew leader with the ability to evaluate various skill levels and maximize team efficiency. He is a strong communicator who works closely with clients and staff to create a safe and efficient work environment. With extensive experience in forestry consulting and surveying, Ernest brings hands-on experience and knowledge to his work. Using his diverse background, he has effectively delivered on countless public and private sector projects across Northern British Columbia.

Skills	Project Experience
<p>Area of Expertise</p> <ul style="list-style-type: none"> Civil infrastructure project management, design, and construction management Design, inspection, and evaluation of bridge structures Construction supervision <hr/> <p>Education</p> <ul style="list-style-type: none"> Bachelor of Science (B.Sc.), Forest Engineering, University of New Brunswick, 2000 <hr/> <p>Membership and Associations</p> <ul style="list-style-type: none"> Professional Engineer (P.Eng.), Association of Professional Engineers and Geoscientists of AB (APEGA) Professional Engineer (P.Eng.), Association of Professional Engineers and Geoscientist of BC (APEGBC) <hr/> <p>Training</p> <ul style="list-style-type: none"> CSA-S6-06 CHBDC 2010, The Canadian Society For Civil Engineering Project Management, 2009 Project Management, APEGBC, 2008 Foundation Design, EPIC, 2008 Fall Protection Training, 2008 	<ul style="list-style-type: none"> Imperial Oil - Kearl Oilsands Muskeg River Bridge, Thompson Bros, Fort McMurray, AB – Project Sponsor for a temporary bridge design and construction of a 200'long, 20'wide 5 span steel girder bridge. Assisted the Project Manager with the preparation of the quality management plan and the inspection and test plan. Completed all of the on-site quality control and construction surveying for the client throughout construction. (2014) Prince Rupert Gas Transmission Project, BC. Engineering Services for UniversalPegasus/TransCanada. Civil Designer for the proposed 900-kilometre natural gas pipeline. Scope included desktop and field assessment of proposed and existing forestry, highway, rail and marine infrastructure; 3D modelling of pipeline right-of-way, aggregate supply vs. demand models; aerial crossings; input into MOE, MOF and OGC regulatory permits; input into route alignment, logistics and procurement; First Nations engagement to support field assessments; development of construction schedules; and capital cost estimating. (2013-ongoing) Northern Gateway Pipeline Project, BC. Engineering Services for Enbridge/WorleyParsons. Civil Designer for the proposed 1,177km twin pipeline oil and condensate pipeline. Scope included desktop assessment of proposed and existing forestry service roads to access the pipeline right-of-way; field assessment (aerial and on-the-ground) of proposed and existing infrastructure; structural engineering assessment of existing forestry bridges; preparation of road design specifications and criteria; preparation of construction methodology statements; development of construction schedules; capital cost estimating. (2012-2013) HDPE Lined Fresh Water Storage Ponds at 14-01-64-25 W5M, 13-33-64-18 W5M, 01-22-64-23 W5M and 36-062-25 W5M, Athabasca Oil Corporation, Grande Prairie, AB – Project Manager for the development of four 70,000m³ HDPE earthen fresh water storage ponds including the review of geotechnical information, development Civil 3D earth balances modeling based on LiDAR data for the ponds, site grading and site access, technical specifications, and drawings. (2013) Dam Safety Assessment of HDPE Lined Fresh Water Storage Ponds, 36-062-25 W5M, Athabasca Oil Corporation, Grande Prairie, AB - Project Manager of dam safety assessment of the 70,000m³ fresh water storage ponds in 36-062-25 W5M that included structural, hydraulic, dam breach, hydrologic failure modes, quality assurance program and reporting requirements. (2013)



- **Bridge Overload Crossing Supervision**, Keyera – Project Engineer/senior reviewer providing structural field review and crossing supervision for overload vehicle crossing Deep Valley Creek Bridge to ensure all crossing restrictions are met. (2013)
- **Deep Valley Creek Bridge Inspection and Evaluation**, Keyera Corp. –Engineer responsible for inspection, and evaluation of a 70m long multispan bridge and crossing supervision for numerous permitted overload vehicles. (2012/2013/2014)
- **Tony Tower Road - Bridge Installations: Tony Creek Bridge, Waskahigan River Bridge**, Encana, Fox Creek AB – Project Sponsor for the design and installation of two 100 ton 100' double lane concrete deck steel girder bridges along the Tony Tower Road. Challenges included tight design timelines along with simultaneous and multi-staged construction. (2012-2013)
- **Sierra Yoyo Desan Road – Upgrade**, Kledo Construction Ltd, Fort Nelson, BC – Completed traffic management plan, quality control plan and fulfilled the role as quality control manager as per BC Ministry of Transportation requirements for the widening and upgrade project from Km 30.5 to 40. (2011)
- **Clearwater Multi-User Access Road**, Ledcor CMI, Fort McMurray, AB – Project involved the detailed design of the 19 km route to a Alberta Transportation standard.
- **Algar Lake Access Road**, Grizzly Oil Sands, Fort McMurray, AB – Detailed design, Tender Preparation and Tender Administration of a 10 km access route and a 27 metre permanent clear span structure.
- **Sierra Yoyo Desan Road – Bridge Upgrades**, Ledcor CMI, Fort Nelson, BC – Detailed design, design review, and special provisions for 2 – 11.00 metre long permanent two-lane precast concrete bridges to accommodate over-dimensional traffic.
- **Sierra Yoyo Desan Road – Upgrade**, Ledcor CMI, Fort Nelson, BC – Project involved the detailed upgrade design to widen the existing route from Km 9.8 to 30.5 and upgrade with an asphalt running surface. (2009)
- **Fort Fraser Overhead No. 1411**, BC Ministry of Transportation and Infrastructure, Near Fort Fraser, BC – Completed structure inspection, detailed inspection report and capacity evaluation using CHBDC CAN/CSA-S6-06. Following the capacity evaluation, completed internal quality management for the rehabilitation/upgrade design of the new superstructure and substructure elements.
- **Cheslatta River Bridge**, BC Ministry of Forest and Range, Near Fraser Lake, BC – Detailed design, design review, special provisions, and engineered cost estimate of a 60.960 metre long, 2 span steel girder – concrete composite deck, L100 bridge. Additionally the project included the design of the structure approaches and realignment of 900 metres of road.
- **Falling Creek Connector Analysis**, Western Canadian Coal, Near Chetwynd, BC – Analysis of potential routes and truck configurations for movement of coal from Brule Pit to the Falls Mountain Coal processing plant. Project involved detailed design, value engineering, and engineered cost estimates of a 62 kilometer haul route including 10 clear span structures ranging from 12.00 to 30.480 meters. The results and financial analysis for multiple route-truck configurations scenarios were then summarized within a detailed report. (2008)
- **Willow Creek Mine**, Western Canadian Coal, Near Chetwynd, BC – Project management, construction management, and engineering assistance for the capacity upgrade of the existing coal processing facility at Willow Creek Coal Mine. (2008)
- **Turnbull Bridge No. 6662**, BC Ministry of Transportation and Infrastructure, Near Lillooet, BC – Site plan, general arrangement, and detailed design to the 75% design stage for a 52 meter clear span, two lane structure founded on cast in place spread footings. Structure was required to replace an existing Howe Truss structure over the BC Hydro Seton Canal on Texas Creek Road No. 204. (2008)



- **Simon Fraser Bridge**, Prince George, BC - Design and construction engineering for the construction of a new crossing of the Fraser River. Design duties included work bridge design to allow for erection of the final girders using 300 ton capacity cranes, cofferdam design, retaining wall design and framework design. (2008-2009)
- **Fort Nelson Community Trail**, Fort Nelson BC – Project Engineer. Detailed design for the 4.5 km trail plus intersection designs for five public accesses from subdivisions. The final design provided surface model of the area, plan and profile sheets with volumes, culverts, clearing limits, typical sections, horizontal and vertical information, mass haul diagrams indicating mass movements and earthworks, plus cross section sheet with existing and design elevation and cut fill end areas. Reports included culvert and grade staking reports. (2009)
- **Fort Fraser Overhead**, Fort Fraser, BC – Design engineer for the design of an upgrade to an existing overhead bridge on Hwy 97. The upgrade included widening/replacing the deck, replacing the steel superstructure members and upgrading the foundation to accommodate the new superstructure. (2008)
- **EPCOR E.L. Smith Water Intake Project**, Edmonton, AB – Design engineer for the installation of a water intake in the North Saskatchewan River. Design duties included work bridge design, cofferdam design, and construction procedures allowing for a phased installation of the pipe corridor and intake. (2005-2006)
- **Rutherford Bridge**, Ministry of Transportation, Pemberton BC –construction inspector on a design-build project for a new 70m clear span, two-lane bridge. (2004)

Biography

Bradley Major has over 15 years of experience in the consulting industry in Alberta and Northern British Columbia. He has gained significant construction experience on multiple transportation projects in a multitude of roles including survey, engineering design, construction supervision, contract management, construction management, quality control/assurance, traffic management and quality management. Bradley has a Bachelor of Science in Forest Engineering (2000) from the University of New Brunswick and P.Eng. designations from the Association of Professional Engineers and Geoscientists of Alberta and British Columbia.



EXPERIENCE SUMMARY

Mr. Jones is the Vice President, Arctic Development for Tetra Tech’s Arctic Engineering Group. He is responsible for the Arctic engineering groups located in the Edmonton, AB, Whitehorse, YT, and Yellowknife, NT offices. He has over 32 years of experience in permafrost engineering, offshore engineering, geotechnical investigations, and the design and analysis of varied structures in Arctic areas of Canada, Alaska, and Russia. His responsibilities include planning, project management, client liaison, and quality control.

RELEVANT EXPERIENCE

Some relevant project engineering experience on northern transportation projects includes the following:

- Senior consultation for evaluation of embankment configurations over ice-rich terrain along Inuvik-Tuktoyaktuk Highway.
- Project Director for concept level evaluations of an all-season road between Iqaluit and the mine, airstrip and site infrastructure for the proposed Chidliak Diamond Mine located on Baffin Island, NU.
- Project Director for feasibility level evaluations for infrastructure including all-season access roads for the Kiggavik Uranium project and DO27 Diamond project.
- Lead Geotechnical Engineer responsible for developing conceptual designs for roadways, airstrips, and an offshore dock and causeway for the Timan-Pechora oil field development on the northern coast of Russia.
- Working together with other consultants on the project team, developed feasibility level designs for the nearly 150 km long railway for the Mary River iron ore mine located on Baffin Island, NU.
- Senior Project Director responsible for route selection, embankment design, and cost estimation for a prefeasibility level evaluation of a 240 km long railway to transport coal from the proposed Northwest Alaska Coal Project to the Red Dog Port.
- Project Director responsible for route selection and embankment designs for concept level evaluations of railways for mining projects located in permafrost terrain in Northwestern Siberia and Alaska.
- Lead Geotechnical Engineer for an oil and gas condensate field development on the Yamal Peninsula in Western Siberia, Russia. One component of the project included the design and construction supervision of an experimental geotextile reinforced access road constructed in the winter using high moisture content, frozen, very silty fine-grained sand.
- Project Director responsible for design of highway stabilization measures using thermosyphons for a highway in northern Manitoba that was experiencing excessive instability due to thaw of discontinuous permafrost.
- Developed designs for roads and pads for the Vankor oil field in Russia.

EDUCATION

Diploma, Civil Engineering Technology, 1979

B.Eng., Civil Engineering, Lakehead University, Ontario

AREA OF EXPERTISE

Permafrost engineering, design, construction, and project management for foundations, dams, and mining developments in Northern Canada

Site investigation, terrain evaluation, Arctic onshore and offshore engineering for hydrocarbon exploration and development projects

Specialized laboratory testing, geotechnical drill sampling, and subsurface instrumentation

REGISTRATIONS/ AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Licensee, Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG)

Member, Canadian Geotechnical Society (CGS)

Member, Geotechnical Society of Edmonton (GSE)

Past-Chair, Cold Regions Division, Canadian Geotechnical Society (CGS)

OFFICE

Edmonton, AB

YEARS OF EXPERIENCE

32

CONTACT

Kevin.Jones@tetrattech.com

Senior Hydrologist

Education

MBA, University of Alberta,
1986

B.Sc. in Civil Engineering,
with distinction, University
of Alberta, 1978

License/Affiliations

Registered Professional
Engineer, Province of
Alberta

Registered Professional
Engineer, State of
Washington

Member, Canadian Water
Resources Association

Member, Washington State
Water Resources Advisory
Committee

Years Experience

30

Areas of Expertise

Surface water hydrology
analysis and modeling for
water supply and flood
hazard assessments.

Stormwater management
regulations and best
management practices,
Washington and Alberta.

Water rights policy and
administration in Alberta,
Washington, and Hawaii.

Expert witness analysis and
testimony on environmental
impacts of development
projects.

Mr. Rozeboom is an engineering hydrologist with wide experience in the assessment and management of surface water resources. During 30 years of employment in government service and consulting practice he has conducted watershed assessment, water supply, stormwater management, river crossing, and flood protection projects in geographic settings encompassing western and northern Canada, the western United States, Hawaii, and the West Indies.

When employed by the Hawaii Water Commission from 1988 through 1992, Mr. Rozeboom established the institutional framework to implement the 1987 Hawaii Water Code. In Washington State through 2005, he was an active member of the Washington State Department of Ecology Water Resources Advisory Committee, and participated in both the Central Puget Sound Regional Water Resources Initiative and Ecology's Water Use Measurement Technical Advisory Group. He has been retained as a technical expert in several legal proceedings and has testified before land use hearing examiners and the Washington State Pollution Control Hearings Board.

Mr. Rozeboom has a solid record of satisfied clients. His active long term clients include the city of Snoqualmie (since 1994), Yukon Energy Corporation (since 2007) and Canadian Zinc (since 2008). His services for the city of Snoqualmie have continued to the present through transitions which include three political administrations, several turnovers in client senior staff, and his return to Canada in 2005.

Employment History

Northwest Hydraulic Consultants

November 1992 – present. Senior hydrologist and project manager with Northwest Hydraulic Consultants in the firm's Seattle office from 1992 through 2005 and Edmonton office since July 2005.

Hawaii Commission on Water Resource Management

June 1988 - November 1992. Hydrologist with the State of Hawaii Commission on Water Resource Management. Implemented new programs for water rights certification and dispute resolution under the 1987 State Water Code.

Self Employed

September 1986 - May 1988. Performed engineering and management consultant services. Work included two overseas assignments for water supply development projects in St. Lucia and in Montserrat, West Indies.

University of Alberta / Alberta Environment

September 1984 - August 1986. Full-time MBA student and graduate assistant. During summer periods, conducted field research studies for Alberta Environment Hydrology Branch of carriage losses from natural channels.

Northwest Hydraulic Consultants

January 1979 - May 1984. Project engineer with Northwest Hydraulic Consultants, Edmonton office. Managed and conducted projects involving field inspections, river surveys, scale model design and testing, hydrologic and river engineering assessments, and computer model development.

Alberta Environment Water Survey Section

Summers, 1976 – 1977. Water survey technologist with Alberta Environment Water Survey Section. Responsible for streamflow metering, lake water level surveys, equipment servicing, data reduction, and rating curve development.

William A. Rozeboom, MBA, P.E., P.ENG.

Project Experience (starting with most recent as of March 2011)

Water Supply Outlook Forecast Review. Conducted a detailed review of current methods, models, and agency practices for forecasting seasonal flow volumes in the western U.S. and Canada. Findings are being used to update Alberta Environment forecast procedures.

Ivanhoe Tamarack EIA Review. Third party hydrology specialist for Alberta Environment's review of the Environmental Impact Assessment for the Tamarack SAGD project in northern Alberta. (ongoing)

Paintearth Mine Water Management. Performed hydrologic assessments to develop a water management plan for open pit mine expansion and site reclamation activity at the Paintearth Mine which supplies coal for the Battle River generating station in eastern Alberta. (ongoing)

Genessee Mine Extension Environmental Assessment. Assessed surface water hydrologic impacts for the extension of the open pit Genessee Mine which supplies coal for the Genessee generating station in central Alberta. Assisted in developing a water management plan to minimize impacts. (ongoing)

Canadian Zinc Prairie Creek Mine Bank Protection and Outfall. Site inspections 2008 through 2010 of bank protection works for mine flood protection berms and an access road through Nahanni National Park, Northwest Territories. Evaluated alternative wastewater outfall sites and designs, responded to regulator information requests, and collaborated in the design of fish habitat compensation works. (ongoing)

Yukon Southern Lakes Hydrologic Routing Study. Managed the development and validation of a HEC-ResSim routing model of the Yukon River basin upstream from the Yukon Energy Whitehorse Rapids Generating Station, simulating daily flows and water levels in each of the basin's six major lakes. Simulations cover a 50-year period of historical record and address variable outlet conditions, complex interactions between several of the major lakes, and alternative operating strategies. (ongoing)

Snoqualmie Ridge Drainage Reviews and Environmental Monitoring. As the city's on-call drainage engineer for 1994-2005, determined the acceptability of hydrologic analyses, drainage plans, and stormwater facility designs for the 2,000-acre mixed used development at Snoqualmie Ridge Phases 1 and 2. Coordinated sub-consultant reviews of water quality, fisheries, and wetlands issues, and oversaw the interpretation of over 10 years of multidisciplinary post-construction monitoring data. Monitoring and drainage review work continues to the present. (ongoing)

TBG Clay Pit Water Management Plan. Developed a water management plan and conceptual outfall designs for disposal of accumulated water from a clay pit north of Fort McMurray and for subsequent operation phase water management.

Izok Mine Environmental Assessment. Discipline lead to characterize and assess potential surface water hydrology impacts relating to a proposed metal mine beneath Izok Lake in Nunavut, and an access road from the mine site to a northern port facility.

Parsons Creek Resources Environmental Assessment. Discipline lead to characterize and assess potential surface water hydrology impacts from a proposed limestone quarry in the floodplain of the Athabasca River north of Fort McMurray.

Suffield National Wildlife Area Infill Drilling Environmental Assessment. Discipline lead to characterize and assess potential surface water impacts relating to EnCana's proposed natural gas infill development in the Suffield National Wildlife Area in southern Alberta.

South Saskatchewan Water Management Plan Technical Review. Conducted a detailed review, on behalf of Treaty 7 First Nations, of the October 2005 draft Water Management Plan for the South Saskatchewan River Basin. Participated in meetings with First Nations representatives and co-authored a technical review report.

William A. Rozeboom, MBA, P.E., P.ENG.

Vantage Point Stormwater Management Plan. Developed and applied a HSPF hydrologic model to assess impacts of a central Alberta rural residential development on downstream stormwater volumes and peak flows, and devised mitigation strategies.

Whitemud Creek Sensitive Area Assessment. Implemented a hydrologic monitoring and assessment program for a unique lake within the McTaggart Sanctuary nature preserve along Whitemud Creek in the city of Edmonton. Recommended measures to mitigate the hydrologic effects of urban development planned for the area uphill from the lake.

Great Divide SAGD Environmental Assessment. Developed, calibrated, and applied a HSPF model to identify and quantify surface water hydrology impacts related to the Great Divide SAGD oil sands development in northern Alberta.

Shepard Energy Centre Water Withdrawal Impact. Performed an assessment to determine if proposed net flow diversions from the city of Calgary Bonnybrook Wastewater Treatment Plant to the Shepard Energy Centre would be material to the Bow River and other water users.

Athabasca River Outfall Design. Oversaw development of a River-2D hydraulic model of the Athabasca River adjacent to the Beaver River Lodge north of Fort McMurray, and provided recommendations for the location and conceptual design of a new wastewater outfall.

Banff Bow River Outfall Design. Performed site inspections and hydrologic and hydraulic analyses for the Bow River at the Banff wastewater treatment plant. Prepared design details and a preliminary construction plan for an upgraded (replacement) wastewater outfall.

Hilliards Bay Marina Conceptual Design. Conducted a feasibility level design for a proposed marina on Lesser Slave Lake in north central Alberta. A design which included dredging of a channel and an armoured breakwater was developed to provide marina boat passage for the expected range in lake water levels and shoreline positions, and to withstand ice and wave action forces.

Peace River Region Hydraulic Capacity Assessments. Performed hydrologic and hydraulic analyses for Alberta Infrastructure and Transportation to address drainage problems at six problem sites across the region. Problems were the result of varied local conditions including obstructed or un-maintained drainage paths, beaver activity, and structural failures. Developed designs and costs for improvements.

Boyle - Amisk Lake Water Supply Assessment. Developed and calibrated a continuous simulation water balance model of Amisk Lake to determine its reliability as a future source of raw water supply for the Village of Boyle. Assessed impacts of proposed municipal withdrawals on lake levels and on the frequency and duration of zero flows at the lake outlet.

Michel Creek Bank Armour Construction Inspection. Provided construction supervision and prepared as-built reports for riprap bank armoring at two Terasen Gas pipeline crossings of Michel Creek in the Crowsnest Pass area of southern B.C.

Fort St. John - Peace River Outfall. Developed a River 2D hydraulic model of the Peace River to assess river hydraulic conditions in the vicinity of proposed wastewater outfall for the City of Fort St. John. Prepared design drawings for outfall placement.

Westlock/Clyde Regional Water Supply Assessment. Conducted a hydrologic assessment of the suitability of the Pembina River near Westlock as a source of raw water supply for a regional system. The assessment included consideration of instream flow needs and active water licenses for consumptive withdrawals.

Meander River Water Supply Assessment. Conducted a hydrologic assessment of the suitability of the Hay River near Meander River as a source of community raw water supply. The assessment included consideration of instream flow needs and active water licenses for consumptive withdrawals.

Faro Mine Hydrology. Reconciled incomplete available water level and streamflow data collected by others at multiple sites along North Rose Creek in preparation for closure of a mine site near Faro, Yukon. Performed flood routing analyses at a flow-through rock drain embankment along the channel.

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Green River Strategic Assessment. Managed a multi-agency assessment of reservoir regulation, land use, and water extraction impacts on tributary and main-stem streamflow in the Green River watershed in western Washington. Analysis methods developed in this work are being applied to other basins as a means to identify reach-specific areas of water quantity impact and mitigation opportunities.

Shared Strategy Instream Flow Assessment Pilot Project. Co-managed the study design for an instream flow pilot study in the Stillaguamish River basin with county and tribal partners. Study objective was to demonstrate a procedure using HSPF and EDT models to quantify the impacts of urbanization, land cover change, and water use on stream flow, water quality, and salmon populations.

SeaTac Airport 3rd Runway Review. Reviewed technical and regulatory elements of the stormwater management plan and related documents submitted for Section 401 State Water Quality Certification for the SeaTac airport third runway project. Identified significant errors in the hydrologic modeling and analyses. Concerns were corroborated by third-party reviews and led to substantial overhauls of the stormwater plan modeling and facility designs. Provided expert testimony before the State of Washington Pollution Control Hearings Board.

Kent Third Avenue Pump Station Hydraulic Design. Managed the analyses and hydraulic design of two stormwater pump stations to augment existing gravity stormwater systems in the City of Kent. Detailed analyses were performed with a continuous-simulation hourly routing model using HSPF-derived inflows and historic Green River water levels. Evaluated various combinations of pump capacity and operating rules to efficiently achieve a target 25-year level of flood protection.

Snoqualmie Ridge II Master Drainage Plan. Retained by the City of Snoqualmie to provide detailed technical reviews of Master Drainage Plans, Environmental Impact Statements, and engineering plans prepared by Quadrant Corporation for the 730-acre Phase II Snoqualmie Ridge development. The site is the headwater area for several small streams and an extensive network of more than 60 on-site wetlands, all of which are vulnerable to site hydrologic changes. Worked closely with city and staff and environmental consultants to incorporate Low Impact Development techniques and to implement a program for post-construction monitoring.

Stillaguamish Basin Instream Flow Hydrology. Performed a hydrologic evaluation of flows in the Stillaguamish River basin, Water Resource Inventory Area 5. The work was in support of a Washington Department of Ecology proposal to promulgate an instream resources protection rule in the basin. Developed data transposition techniques in which locally available data were paired with representative long-record stations to determine site-specific streamflow statistics. Developed and provided hydrographs showing the 5, 10, 20, 50, 80, and 90 percent daily exceedance values for each of fourteen instream flow study sites.

Cedar River Section 205 Project Interior Drainage Assessment. Performed an interior drainage assessment for the levee/floodwall system constructed as a Section 205 Flood Protection Project along the lower Cedar River in the city of Renton. Identified and mapped areas at risk of interior flooding during high river conditions, based on a review of storm drain drawings and field surveys of critical overflow points.

Valterra View Estates Flow Splitter Design. Designed a flow control structure for a proposed residential development located uphill from Snohomish County Diking District No. 2. The flow control structure limits seasonal flow volumes through the diking district to pre-development levels and bypasses excess volumes to a tightline to the Snohomish River. Used HSPF hydrologic modeling to establish flow duration performance targets and to demonstrate satisfactory seasonal performance.

Mount Vernon Surface Water Management Plan Update. Managed the updating of hydrometeorological data sets for previously-developed HSPF models. Recalibrated an HSPF model of Maddox Creek to new streamflow data collected at the city urban growth boundary, using FEQ hydraulic model results to define flood storage conditions in the lower watershed. Work in progress includes detailed assessments of drainage problem areas in the Freeway Drive basin and lower Maddox Creek basin.

Dungeness River Hatchery Water Supply. Reviewed water rights certificates for the state-run fish hatchery on the Dungeness River to identify constraints which would influence the design or operation of a new intake. Performed a hydrologic assessment of published river flow data and identified flood flow and flow duration characteristics necessary for the hydraulic design of the new intake.

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Green River Water Quality Assessment Storm Delineations. Developed and implemented techniques to identify discrete runoff events from continuous streamflow data in daily and hourly formats. This work was performed in support of a multi-year assessment of water quality and quantity data being collected at 13 sites in the Green-Duwamish Watershed. Developed continuous hydrograph separation techniques which produced reasonable results both for isolated storms and within prolonged complex runoff events.

Mill Creek/Mullen Slough Chronic Flooding. Conducted wet weather ground and aerial surveys to document chronic flooding conditions in the lower Mill Creek (Auburn) and Mullen Slough basins in south King County. Evaluated historical hydrometric data and determined the representativeness of the observed conditions. Identified constricting reaches and point obstructions where targeted drainage improvements would provide relief from chronic flooding.

Snoqualmie River – North Bend Flood Insurance Study. Provided a technical review of Snoqualmie River HEC-RAS models and floodplain mapping developed by the Corps of Engineers for a Flood Insurance of the Snoqualmie River and its major tributaries at North Bend. The work was performed on behalf of the City of Snoqualmie, located immediately downstream and potentially affected by the map revisions. In two major cycles of review, identified technical discrepancies which resulted in unjustified flood level increases and which were successfully resolved through meetings and discussions with the Corps and with FEMA.

Seattle South Park Storm/Tide Design Events. Developed a 48 year continuous simulation sequence of urban runoff and tidally-influenced flooding of the City of Seattle South Park area which drains to the Duwamish River. Performed future-conditions hydrologic runoff computations with HSPF and wrote FORTRAN computer code to perform continuous simulation hydraulic routing of inflow, storage, and tidally-restricted outflow. Identified historic events representing 2-year through 100-year design storm/tide sequences.

Chain Lakes Dam Break Analysis. Constructed and debugged a Version 2 FLDWAV model for dam breach inundation studies of the North Dam of the Chain Lakes Reservoir, located in Southern Alberta about 100 km south of the City of Calgary. Prepared pre-processor input templates to expedite code preparation for this unstable model. Performed model debugging support on an on-call basis for the duration of the study.

South Heart Dam Break Analysis. Developed a beta-version FLDWAV model of the South Heart River below the South Heart Reservoir in north-central Alberta, updating previous DAMBRK and DWOPER models developed for the study reach by Alberta Environment. Performed dam breach and inundation modeling for a series of assumed reservoir return inflows, and assisted in the interpretation results.

Kent Third Avenue Storm System Modeling. Performed hydrologic modeling with HSPF and storm drain network modeling with EPANET of the storm drain improvements proposed for the collection system to a new pump station under design. Confirmed pipe sizes necessary to satisfy drainage requirements.

Snoqualmie River Floodway Certifications. In separate studies, performed hydraulic assessments of water level impacts which would result from proposed developments within the federally-regulated Snoqualmie River floodway through the City of Snoqualmie. Assessments were performed and appropriate mitigation measures were developed for a large multi-field municipal park, a commercial building within the City's Historic District, and various residential lot improvements. Prepared technical documentation in support of the "no-rise" certification required by FEMA and by the City's municipal code.

Mitigation Wetland Design. Performed site inspection and hydrologic modeling services for a mitigation wetland proposed for a gravel mine near Arlington in Snohomish County. Evaluated watershed conditions and basin hydrology for the proposed impact and mitigation sites, and through HSPF modeling identified the wetland depth-duration inundation characteristics which would result under alternative mitigation and basin restoration design alternatives.

Crossings at Pine Lake Drainage Review. Performed a technical review of drainage analyses, stormwater facilities, and wetland and stream impacts from the proposed residential development of a 56-acre site on the Sammamish Plateau. The site has several large wetlands and drains to two streams. Findings were expressed in letter reports and as testimony before the City of Sammamish Hearing Examiner.

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Cowlitz River Flood Analysis. Reviewed the controlled flow releases from the Cowlitz River Mossyrock Dam during flood events in November 1995 for compliance with FERC license requirements. Assessed alternative reservoir operating scenarios to determine the extent to which operating practices contributed to downstream flood damages. Testified at trial in Thurston County Superior Court.

Ledger Lake Wetland Impact Assessment. Performed hydrologic modeling and data analyses to evaluate potential impacts of city of Mount Vernon stormwater discharges to the Ledger Lake wetland complex. Modified a daily water balance simulation model of the area to incorporate a proposed pump station at the lake outlet, and to assess future water level conditions for comparison with existing conditions. Interpreted the model results in the context of regulatory guidelines for allowable wetland water level fluctuations.

Snoqualmie Ridge Post-Construction Monitoring Program. Provided technical review and regulatory oversight for a multi-disciplinary post-construction monitoring program to assess impacts of the 1,300-acre Snoqualmie Ridge Mixed Use Development. The development drains to numerous wetlands and fish bearing streams and is one of the first projects in King County to implement the requirements of the 1998 King County Surface Water Design Manual. The monitoring plan was developed to assess the performance of representative stormwater facilities, to determine if impacts to wetlands and streams were within the tolerances predicted by the project EIS, and to take remedial measures as necessary.

Snoqualmie River HEC RAS Modeling. Managed the updating of an existing HEC RAS hydraulic model of the Snoqualmie River at Snoqualmie to assess impacts of proposed modifications to the dam crest at the Snoqualmie Falls Hydroelectric Project. Work included a field survey, verification of model calibration to observed summer water level data, and hydraulic analyses to identify project water level impacts affecting summer river access and recreational opportunities.

Mill Creek Salem Hydrologic and Hydraulic Modeling. Developed, calibrated, and applied hydrologic and hydraulic models to assess flood control alternatives for Mill Creek at Salem, Oregon. HEC 1 and HEC HMS models were developed of the 104 square mile upper basin, calibrated to the record flood of February 1996, and applied to compute design flow hydrographs for current conditions and future scenarios with regional detention facilities. Developed and calibrated an unsteady flow branched network hydraulic model, UNET, for 15 network reaches describing Mill Creek and its tributaries which flow through the city of Salem. The UNET model was calibrated to high water mark data and very limited hydrograph data from the record flood of February 1996, and updated to incorporate flood reduction works constructed after flood event.

February 1996 Postflood Report. Managed the preparation of a postflood report for the Portland District Corps of Engineers (COE) providing comprehensive qualitative and quantitative documentation of the major storm which struck the Pacific Northwest in February 1996, causing record or near-record flooding in many basins. Archived and summarized more than 1,200 hydrometeorological data sets from USGS, NOAA, COE, and NRCS sites, developed storm isopluvial maps, determined storm intensity and flood discharge return periods, assessed flood control operations at 13 COE flood control reservoirs and 4 Section 7 flood control projects, and described COE flood fight activities.

Thunder Ridge Erosion Control. Provided expert advice, on behalf of a downstream landowner, on the adequacy of site erosion control measures at the 50-acre Thunder Ridge Estates Subdivision development in Snohomish County. Confirmed through a site inspection that the development erosion control did not comply with required Best Management Practices, and prepared documentation which led to a stop work order.

Mount Vernon Riverbend Stormwater Alternative. Determined the hydraulic effects of discharging stormwater from 230 acres of the City of Mount Vernon to low lying fields outside the City limits. The fields are located in a diked meander loop of the Skagit River, and interact with the river by seepage flows and a flap-gated culvert. Developed a daily water balance model of the area and calibrated seepage functions and soil specific yields to reproduce historic conditions. Determined design parameters for alternative pump station and culvert improvements to mitigate impacts of the proposed stormwater discharge.

Clarewood Development Review. Assessed drainage patterns and flood risk for properties downstream of the proposed Clarewood development in Pierce County. Provided expert testimony at a development hearing on the uncertain performance of infiltration facilities to be constructed upslope of an area with past flooding problems and the downstream flood impact risk associated with the development as proposed.

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Lake Chelan Hydroelectric Project PMF Study. Developed and calibrated a HEC-1 model of the Lake Chelan basin to determine PMF rain-on-snow lake inflow and outflow hydrographs for the Lake Chelan Hydroelectric Project. The basin consists mostly of rugged mountain terrain with very steep precipitation and temperature gradients which greatly affecting local snowpack and precipitation amounts. Calibration was made to historic flood events, and PMF simulations evaluating alternative reservoir operational scenarios were made in accordance with National Weather Service and Federal Energy Regulatory Commission guidelines.

North Fork Issaquah Creek Floodplain Mapping. Updated an existing HSPF hydrologic simulation model of the North Fork basin to determine flood quantiles for current land use conditions, and developed a HEC-2 hydraulic model to determine floodplain boundaries for 1.2 miles of channel ending at the confluence with the main stem Issaquah Creek. Flood flows and floodplain boundaries in the lower portion of the study reach were determined to be influenced significantly by inter-basin flood flows originating from the main stem channel and which overtop a ridge between the basins during major floods.

Snoqualmie Ridge Golf Course Drainage Reviews. Provided technical reviews of stormwater management plans and permanent utility plans and specifications for the Snoqualmie Ridge Golf Course on the Lake Alice Plateau above Snoqualmie Falls. Reviews were made for technical accuracy and compliance with City ordinances and MDP and EIS documents. The work required analyses of numerous requests to depart from the approved MDP and standard facility designs for purposes of golf course aesthetics and to construct a large lake combining functions of water quality treatment and storage of recycled water. Results were expressed by detailed review memoranda, meetings with the City and applicant, and participation at meetings of the City Planning Commission.

Wenatchee Alluvial Fan Flood Hazard Review. Reviewed flood hydrology and flood hazard mapping for alluvial fan streams in the City of Wenatchee to address a 20-year old dispute over the extent of 100-year flood hazard. Evaluated methodologies and assumptions used by previous studies, and developed updated flood hydrology estimates analyses based on HEC-1 modeling, regional analysis, and a 90-year archival record of flooding from local newspaper reports. Performed hydraulic analyses with the Federal Emergency Management Agency's FAN alluvial fan model. Study results led to an 80% reduction of the regulatory flood hazard zone, relieving more than 500 property owners from the need to purchase federal flood insurance.

Nevada Flood Insurance Hydrology Studies. Updated hydrology studies and determined design flows for FEMA floodplain mapping of three mountain streams in Washoe County near Reno and the North Las Vegas Wash Flood Control Project near North Las Vegas, Nevada. Design flows for the Washoe County streams were determined from a regional analysis to be governed by a population of relatively rare (about 50-year and higher return periods) cloudburst events accompanied by high sediment and debris loads. Existing HEC-1 models for the North Las Vegas Wash were reviewed and updated to improve estimates of 500-year flows. Methodologies used in the previous analyses had substantially underestimated 500-year flows by overlooking the loss of flow control when the 100-year design capacity of a major flood control facility is exceeded.

Washington Watershed Assessments. Conducted surface water assessments of the Deschutes, Snohomish, and Walla Walla Water Resource Inventory Areas under a statewide program of initial watershed assessments for the Washington State Department of Ecology (DOE). The purpose of this work was to characterize the "health" of the surface water resources in each watershed to facilitate decision-making by DOE on water rights applications. Examined available flow data in relation to established instream flow regulations, and conducted time-series assessments of streamflow and precipitation data to determine whether there were indications of declining minimum or average annual flows unrelated to natural climatic fluctuations.

Faro Mine Dam Break Analysis. Developed and debugged a DAMBRK model to perform dam breach simulations for a water supply reservoir at an abandoned mine in Yukon territory.

Mount Vernon Regional Drainage Analyses. Used HSPF simulation models of current and future land use conditions in the City of Mount Vernon to identify drainage problems along main stem channels throughout the city. Developed designs and costs for proposed alternative solutions including pump stations, regional detention pond facilities, and culvert replacements.

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Snoqualmie Ridge Parkway Plan Reviews. Reviewed Stormwater Management Plans, Erosion and Sediment Control Plans, and construction drawings for stormwater aspects of the 3.2-mile long Snoqualmie Ridge Parkway. Principal stormwater facilities include water quality/detention ponds, biofiltration swales, and a large-diameter high-flow bypass pipeline. The high-flow bypass pipeline is sized to convey excess flow from the Parkway and the adjoining Snoqualmie Ridge and Falls Crossing sites for direct discharge into the Snoqualmie River. Plans and drawings were reviewed for technical accuracy and for compliance with the King County Surface Water Design Manual, City of Snoqualmie ordinances, and project MDP and EIS documents. Coordinated subconsultant reviews of water quality and wetlands issues and facilities.

Mount Pinatubo Regional Hydrologic Analysis. Conducted a regional analysis of rainfall and streamflow data for the Mount Pinatubo region, assessed data reliability, prepared isopluvial maps of 2- through 500-year rainfall amounts for 24-hour through 5-day durations and, through HEC-1 modeling, developed flow duration and flood frequency curves for 39 potential sediment and flood control project sites on major streams affected by the 1991 eruption of Mount Pinatubo. Study results were published in COE Technical Report GL-94-16, Post Eruption Hydrology and Hydraulics of Mount Pinatubo, The Philippines.

Falls Crossing Master Drainage Plan (MDP) Review. Reviewed Draft MDP hydrologic and flood impact analyses submitted to the City of Snoqualmie for approval of a development partially located within the Snoqualmie River floodplain. Coordinated reviews of water quality and wetlands issues by subconsultants.

Cedar Hills Gaging Services and Data Processing. Responsible for operation of a six-station gaging network at the Cedar Hills landfill for a period of one year to identify and eliminate persistent data discrepancy problems. Conducted field tests and theoretical reviews which positively identified two principal problems: control elevations which had been incorrectly reported on "as-built" drawings, and inaccuracies in the technical manual used to derive theoretical rating curves for multiple-orifice outlet structures. Developed revised stage-discharge relationships which eliminated the data discrepancies, and provided training to client staff in data processing and reporting practices.

Snoqualmie Ridge Master Drainage Plan (MDP) Review. Reviewed Draft MDP hydrologic analyses and conceptual facility designs submitted to the City of Snoqualmie for mixed use development approval. Reviewed hydrologic analyses for adequacy of HSPF model calibration and measures proposed to deal with uncertainty in the analyses. Reviewed conceptual facility designs for feasibility and compliance with applicable development standards. Coordinated reviews of water quality and wetlands issues by subconsultants.

Myrtle Creek Flood Study Review. Reviewed flood hydraulics and floodplain mapping studies for the Town of Myrtle Creek located at the confluence of Myrtle Creek and the South Umpqua River. The work was undertaken on behalf of the Federal Emergency Management Agency to resolve a 4-foot discrepancy in the 100-year flood elevation as reported by two other federal agencies. The discrepancy was resolved by identification of an error in one of the earlier analyses.

Snoqualmie Parkway EIS and SMP Reviews. Managed a multidisciplinary review of water quantity, water quality, and wetlands elements of Environmental Impact Statement materials and supporting documents submitted to the City of Snoqualmie for the proposed Snoqualmie Ridge Parkway. Subsequently reviewed the Stormwater Management Plans (SMP) and construction drawings for compliance with applicable standards and representations made in the environmental impact process. The work was undertaken for the City of Snoqualmie under the direction of the Director of Community Development.

Evans Creek HSPF Model Calibration. Calibrated the EPA's Hydrologic Simulation Program - Fortran (HSPF) to streamflow and wetland water level data collected at four sites in the Evans Creek West catchment of the proposed Northridge/Redmond Ridge Urban Planned Development in King County.

Cedar Hills Hydrologic Data Review. Reviewed the accuracy of rain and flow data being collected at the Cedar Hills landfill to determine downstream impacts and for future calibration of a hydrologic model. Identified erroneous records through double-mass analysis, reviewed implications of stage measurement and theoretical rating curve errors, and recommended measures for improving data accuracy.

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Supermall Downstream Impact Assessment. Developed current and future land use HSPF simulation models for the proposed Supermall of the Great Northwest to identify downstream impacts. Linked hourly HSPF simulation results to a finite difference unsteady flow model, FEQ, and assessed water level impacts through a complex system of wetlands, ditches and culverts to the downstream receiving channel.

Hawaii Water Use Inventory. Implemented Hawaii State Water Code legislation requiring registration of all wells and stream diversions statewide, declaration of water use, and monthly reporting of water use. Gave public workshops on water code requirements, developed systems, procedures, and databases to analyze and manage the contents of 7,300 declarations of water use, acted on all declarations, and coordinated field survey activities for verification of water facilities and uses.

Hawaii Database Development. Developed computer databases to track processing of Hawaii well and stream diversion works construction permits, to inventory wells, stream diversions, and water uses statewide, and to target specific groups by geographic area and/or activity for mailings of notices and informational materials.

Hawaii Water Rights and Dispute Resolution. Administered the first contested case hearing before the Hawaii Commission on Water Resource Management, including mediating discussions between opposing expert witnesses, preparing the Findings of Fact, and drafting the Commission's Decision and Order. Prepared the Findings of Fact report which led to the designation of the Island of Molokai as a Water Management Area. Prepared Departmental testimony to the Legislature on proposed amendments to the State Water Code.

Hawaii Satellite-Linked Water Resources Data Collection. Initiated and developed a pilot program for collecting real-time precipitation and other water resources data via satellite from remote areas in Hawaii.

Bank Protection Research. Conducted a comprehensive review of alternative methods of streambank protection, seeking those that would provide cost-effective alternatives to conventional riprap protection for highway bridges in Alberta. Computed present value project life costs of promising alternatives, considering allowable velocities, maintenance costs, local availability of materials, and transportation costs.

Jasper Park Lodge Water System Analysis. Conducted computer analysis of recirculating water system for Jasper Park Lodge; identified causes and recommended solutions to problems of low water pressure and fluctuating water temperatures.

Water Utility Privatization Study. Determined rate structures and impact on consumers which would result from the privatization of water and sewerage facilities for small municipalities.

Montserrat, W.I., Integrated Resource Development Project. Provided specialist water resources input on a five-person multidisciplinary mission in Montserrat, W.I. for the Canadian International Development Agency. Determined design and construction specifics and costs for small dam and irrigation projects to facilitate agricultural self-sufficiency.

St. Lucia W.I. Roseau River Carriage Loss Assessment. Determined water losses which would result from using a natural channel to transmit water from a proposed water storage reservoir to downstream agricultural users.

St. Lucia W.I. Roseau Basin Water Development Program. Provided hydrologic input toward site selection for a water supply reservoir in St. Lucia, W.I. Reviewed reliability of available hydrometric data and extended streamflow records using rainfall records and computer modeling techniques. Estimated low-flow sequences to determine reservoir storage needs, and design floods for spillway sizing. Conducted training with local personnel for computer use and hydrologic techniques.

School Financial Planning Model. Refined a prototype computer model to project finances over a 5-year horizon based on scenarios of economic and demographic growth, required facilities, debt structure, salary rates, and programs of government financing.

City of Yellowknife Municipal Financial Assessment. Assessed the impact of the City's 5-year capital improvements plan on financial stability and tax rates.

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Ross Creek Basin Surface Water Supply. Developed a computer simulation model which accounted for varying precipitation, evaporation, runoff and water consumption within the Ross Creek Basin in southern Alberta. The model was used to develop a 50-year sequence of natural runoff conditions and to assess alternative water supply management proposals.

Peace River Basin Surface Water Supply. Determined surface water supply characteristics from limited streamflow records based on regional correlations and frequency analyses, and computed reliable water supplies for 22 communities in northwest Alberta based on intake characteristics, current and projected water consumption, and existing reservoir facilities.

Pipeline River Crossings. Conducted field surveys and determined hydraulic design parameters of scour, bank erosion and 1.100 year high water levels at 32 river crossings of the Alaska Highway Gas Pipeline and 7 river crossings of the Alberta Deep Basin Pipeline.

Gull Lake Regulation Study. Developed and calibrated a computer simulation model to determine causes of historical declines in lake levels and assessed the effectiveness of alternative lake management scenarios on the basis of historical hydrological conditions.

Carriage Loss Investigations. Designed and coordinated a field research study to monitor carriage losses over 60 km of natural channel in Southern Alberta; analyzed field data to determine the magnitude, uniformity, and causes of losses. Reviewed and evaluated all previous studies conducted to assess carriage losses in natural channels in Alberta and Saskatchewan, and developed techniques to predict carriage losses which affect reservoir release flows into natural channels.

Isle Lake - Lac Ste. Anne Stabilization. Developed and implemented a computer simulation model to examine proposals to stabilize lake water levels.

Alaska Highway Gas Pipeline Route Hydrology. Six-month in-house assignment with the Yukon Pipeline Design Joint Venture design team. Provided hydrotechnical input on small basin hydrology and for development of drainage and erosion control criteria.

Berry Creek Channel Losses. Determined channel losses affecting reservoir release flows over 12 km of natural channel in southern Alberta.

Willow Creek Water Supply. Determined causes of winter water supply shortage at communities drawing water from Willow Creek below Chain Lakes Reservoir in southern Alberta.

Little Bow Basin Water Supply. Assessed basin water supplies as affected by internal runoff and inter-basin water diversions.

Whitford Lake Basin Management. Developed a comprehensive study program to establish an engineering data base and methodologies to evaluate drainage and flood control projects in the Whitford Lake Basin in central Alberta.

Buffalo Bay - Horse Lakes Management Program. Developed a computer simulation model to assess water levels and discharges in the Buffalo Bay - Horse Lakes complex in north-central Alberta under alternative management schemes.

Rat Creek Bridge Crossings. Conducted field surveys, determined hydraulic design parameters, and designed abutment armoring for two single-span bridge crossings in central Alberta.

McLeod River Bank Stabilization. Conducted field surveys and designed rip-rap armoring for bank stabilization at a railway bridge in central Alberta.

Channel Ice Surveys. Conducted winter ice and breakup surveys at 52 river crossings encountered along the British Columbia segment of the proposed Alaska Highway Gas Pipeline.

Red Deer River Floodplain Development. Determined open water and ice jam design flood levels and developed measures for floodplain development in Red Deer, Alberta.

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St. Mary Canal Sedimentation. Conducted field bed load transport studies to assess sources and mechanisms of canal sedimentation in southern Alberta.

Dickson Dam Diversion Tunnel Model Study. Constructed and tested a 1:54 scale physical model of dual 5.5 m diameter diversion tunnels. Assessed and optimized intake and outlet flow patterns, minimized transition losses, and assessed outlet scour. Supervised construction of a 1:70 scale model of the 60 m wide, 190 m long service spillway for the dam project.

Port McNeill Harbour Breakwater Model Study. Constructed and tested a 1:100 scale physical model of the Port McNeill harbour region in British Columbia. Developed a breakwater design to shelter a proposed harbour expansion from ocean waves.

Elbow River Channel Improvement. Conducted field surveys and designed channel improvements to increase Elbow River side-channel flows in the Calgary, Alberta. The work was undertaken to demonstrate city ownership of riparian lands and to discourage encroachment by adjacent private landowners.

Harvey Creek Channelization Model Study. Constructed and tested 1:15 and 1:25 scale physical models of a steep 12 degree channel in British Columbia. Assessed the stability of 1.0 m diameter boulders under flood conditions, and flow patterns through transitions and curves in an engineered reach of channel.

Cooling Pond Circulation Model Studies. Constructed and tested physical scale models of cooling ponds formed in natural topography for three thermal generating stations in central Alberta: the Calgary Power Ltd. Keephills Thermal Plant, the Edmonton Power Genesee Power Project, and the Alberta Power Ltd. Sheerness Generating Station. Assessed alternative dike arrangements to optimize circulation patterns under conditions including thermally stratified flow and adverse wind shear.

Sundance Helper Cooling System Model Study. Developed 1:12 scale model of a 20 m long sump bay with a 2.1 m diameter, 100,000 GPM pump intake. designed baffles to produce smooth intake flows, and determined intake energy losses.

Field Surveys. Conducted hydrometric surveys over two summers of more than 100 rivers and lakes throughout the Province of Alberta. Responsibilities included surveying of seasonal lake level elevations, streamflow gauging by wading and bridge crane methods, sampling of suspended sediment at bridge and cableway sites, hydrographic soundings and mapping of lake bottom contours, field servicing and repair of strip-chart water level recorders, and assisting in the construction and installation of housings and equipment for stream gauge stations.

Publications

"Use of a Scale Model to Improve Pond Circulation," Proceedings of the Specialty Conference on Computer and Physical Modeling in Hydraulic Engineering; Chicago, Illinois; August, 1980.

"Carriage Losses in Natural Channels in Southern Alberta,"with S.J. Figliuzzi. Proceedings of The 1986 Canadian Hydrology Symposium on Drought: The Impending Crisis?; Regina, Saskatchewan, June 1986.

"U.S. Television Programs in the International Market: Unfair Pricing?" with C. Hoskins and R.K. Mirus. Journal of Communication, (Spring 1989) Vol. 39, No. 2, pp. 55-75.

EXPERIENCE SUMMARY

Ms. Langlois is a Biologist with 15 years of consulting experience working primarily across northern Canada. Her principal roles include lead field biologist, principal assessor, project manager, technical advisor, and reviewer. Much of Ms. Langlois' project related experience includes baseline wildlife and water quality studies, wildlife management assessments, impact assessments, and the design and execution of wildlife and water quality monitoring programs for all-season and winter roads, mines, and other large-scale developments.

Ms. Langlois has carried out wildlife surveys for various terrestrial and marine wildlife groups including ungulates, carnivores, sea mammals, birds, amphibians, and fish. For many of her projects, Ms. Langlois works alongside local Aboriginal peoples, providing a respectful and informal venue to share scientific and learn traditional knowledge. She is also a specialist in ultra-trace metal water quality sampling, a procedure that requires precision and strict adherence to quality control protocols.

RELEVANT EXPERIENCE

- Environmental Assessment, Prairie Creek Mine All-season Road, Canadian Zinc Corp., Northwest Territories.** Ms. Langlois prepared the wildlife-related portions of the Developers Assessment Report to upgrade the mine's winter access road to all-season quality, and included an analyses for multiple species/species groups. Considered potential impacts to habitat loss and fragmentation, linear corridor densities in the region, traffic volumes, noise, dust, changes to predator-prey dynamics, energetics and body condition, and harvesting pressure. Project period 2014 to 2015.
- Wildlife Movement Monitoring and Wildlife-Vehicle Collision Mitigation Plans for Highway 63, Alberta Transportation.** Lead biologist responsible for the preparation and implementation of the two plans to predict and verify wildlife crossing locations with fine spatial and temporal accuracy, identify wildlife-vehicle collision prone locations warranting mitigation (using cost-benefit analyses), counsel on site-specific highway mitigation, and plan a monitoring program to assess the effectiveness of mitigation implemented. Project period 2013 to 2016.
- Caribou Protection Plans, Highway 63, Alberta Transportation.** Technical lead responsible for the preparation of a Caribou Protection Plan and its annual amendments for highway twinning construction to proceed through four boreal woodland caribou ranges. These protection plans outline policies and mitigation to avoid and minimize effects on woodland caribou during construction. Ms. Langlois is also responsible for monitoring the effectiveness of mitigations implemented including remote camera trap monitoring of non-project related traffic (e.g., recreational vehicles) into caribou ranges. Project period 2013 and ongoing.
- Baseline Wildlife Surveys, Environmental Assessment, and Effects Monitoring Plan, Nechalacho Rare Earth Elements and Pine Point project sites, Avalon Rare Metals Inc., Northwest Territories.** Project biologist responsible for conducting baseline wildlife and wildlife habitat field studies at both project sites, and was the principal biologist preparing the wildlife portions of the Developers Assessment report that included the two mine facility locations. Following regulatory approvals for the mine developments, Ms. Langlois prepared the draft Wildlife and Wildlife Habitat Effects Monitoring Plan that included strategies and protocols to monitor predicted wildlife effects. Project period 2010 and 2011.
- Baseline Wildlife and Water Quality Studies, Magino Gold Property, Prodigy Gold Inc., northern Ontario.** Lead biologist conducting baseline moose, breeding bird, waterfowl, marsh bird, common nighthawk, and eastern whip-poor-will surveys, as well as comprehensive sediment and water quality (at ultra-trace chemical detections) studies. Later she was

EDUCATION

B.Sc., Specialization in Environmental Biology, University of Alberta, Edmonton, AB

BAEM, Bachelor of Applied Environmental Management, Lakeland College, AB

AREA OF EXPERTISE

Designs wildlife surveys and monitoring programs specific to the species and project site

Prepares environmental impact assessments

Recommends remedial measures for proposed large-scale developments to avoid and or minimize impacts

Works in remote, pristine, and logistically challenging environments

REGISTRATIONS/AFFILIATIONS

Member, Alberta Society of Professional Biologists

Member, Canadian Society of Environmental Biologists

TRAINING/CERTIFICATIONS

Dr. Jim Halfpenny - Winter Wildlife Tracking

Arctic Response - Arctic Winter Survival

PSMJ Resources, Inc. - Project Managers Bootcamp

OFFICE

Yellowknife, Northwest Territories

YEARS OF EXPERIENCE

15

CONTACT

Karla.Langlois@tetrattech.com

responsible for the preparation of the baseline wildlife, water, and sediment quality reports including data analysis and comparison to provincial guidelines. Project period 2011 to 2013.

- **Baseline Wildlife Studies and Environmental Assessment, Yellowknife Gold Project, Tyhee Gold Corp., Northwest Territories.** Project biologist for the baseline wildlife (e.g., barren-ground caribou, moose, breeding bird, waterfowl, nocturnal owl, carnivore and carnivore den) and water quality studies, and prepared responses to the Developers Assessment Report Information Requests. Project period 2005 and 2006, and 2012.
- **Blackmud Creek Wildlife Crossing Review, City of Edmonton, CH2M Hill Canada, Alberta.** Project advisor considering the likelihood of wildlife crossing potentials afforded at downstream locations, which included an evaluation of the proposed road and subdivision expansions, predicted traffic volumes, and the proposed wildlife-pedestrian multi-use crossing structure. Ms. Langlois advised on the likely movements of resident deer through Blackmud Creek and its tributaries, the factors determining the effectiveness of crossing structures to maintain wildlife movements, and site specific crossing structure designs to promote wildlife use. Project period 2011.
- **Mackenzie Valley Highway Route Design and Environmental Assessment, GNWT Department of Transportation, Gwich'in Settlement Area, Northwest Territories.** Unique to this project, Ms. Langlois and project engineers worked together in the field to develop and compromise on a preferred road route that considers engineering as well as local sensitive wildlife areas, wildlife travel corridors, traditional harvesting and conservation zones, and existing/future land disturbances. Ms. Langlois also prepared the Project Description Report which included an assessment of the field data and literature reviews, and determined environmental impacts, cumulative effects, and potential mitigation. Project period 2010.
- **Parson's Road and Interchange Wildlife Assessment, Fort McMurray, Alberta Transportation.** Project biologist to determine and assess sensitive wildlife habitats, particularly for boreal woodland caribou, northern leopard frog, and western toad within the proposed corridors, and was responsible for recommending mitigations during construction. Project period 2009 and 2010.
- **Hangingstone River and Wandering River Bridge Wildlife Crossing Assessments, Highway 63, Alberta Transportation.** Project biologist responsible for evaluating the potential for successful wildlife crossings under the bridges based on species preferences and a consideration of crossing limitations based on the natural sinuosity of the rivers, topographic reliefs, and preliminary engineering design. Using this information, she was responsible for recommending bridge designs to accommodate wildlife passage (i.e., moose, deer, and black bear) at both river crossings. Project period 2010.
- **Environmental Effects Monitoring, Tibbitt to Contwoyto Winter Road, Joint Venture, Northwest Territories.** Project ecologist carrying out an annual monitoring program of the winter road portages and associated camps to determine their ecological effects. Effects were categorized based on an assessment of multiple environmental conditions including waste management, erosion, and sedimentation. Project period 2009 to 2013.
- **Ecological Assessments, NWT Protected Area Strategy, Northwest Territories.** Project biologist responsible for assessing the ecology of six areas proposed for protected area status, and to counsel on the appropriate federal/territorial level of protection. Ms. Langlois determined the ecological representation, suitability of the areas for protection status, and recommend protected area boundaries and designs based on a thorough understanding of key species life history requirements and population dynamics. Project duration 2006 to 2009.
- **Annual Barren-ground Caribou Monitoring, Tibbitt to Contwoyto Winter Road, Joint Venture, Northwest Territories.** For three years, the project biologist carrying out the barren-ground caribou monitoring program, which included monthly aerial surveys of caribou distributions and relative abundances at systematic distances from the road and in relation to traffic volumes. Project period 2006 to 2008.
- **Seasonal Overland Road Baseline Environmental Studies, Joint Venture, Northwest Territories.** Ms. Langlois conducted field based barren-ground caribou, breeding bird, and winter wildlife tracking surveys along the proposed 159 km road route to determine routing options and sensitive habitats, and assisted in the preparation of the Project Description Report. Project period 2007 to 2008.
- **Baseline Wildlife Studies, Pine Point Lead/Zinc Pilot Project, Tamerlane Ventures Inc., Northwest Territories.** Project biologist conducting baseline amphibian, breeding bird, yellow rail, nocturnal owl, and water quality surveys for a proposed lead/zinc mine. Subsequent to the baseline data collection, she analyzed and prepared the field program results and was involved in the preparation of the Developers Assessment Report. Project period 2005 to 2008.

EXPERIENCE SUMMARY

Ms. Amy McLenaghan is a biologist with the Environment Practice in Edmonton, AB. She obtained her Bachelor of Science degree in Environmental and Conservation Sciences at the University of Alberta. Ms. McLenaghan also completed a diploma with honours in Biological Sciences and Renewable Resources, and a diploma in Landscape Architecture Technology from the Northern Alberta Institute of Technology (NAIT).

Ms. McLenaghan has a wide range of experience in wetland monitoring, wetland assessments, environmental assessments, rare plant surveys, ecological land classification (ELC) for pre disturbance assessments, biophysical assessments, natural resource inventories (NRI), environmental screening reports (ESRs), and functional planning studies (FPS). Clients range from industry to all levels of government. Ms. McLenaghan is involved in all aspects of project work including proposals project management, field work, reporting, regulatory applications, peer review, and client and government liaison. Her main focus is rare plant surveys and wetland assessments and monitoring.

RELEVANT EXPERIENCE

Natural Sciences experience includes:

- Project Manager for the Post Construction Environmental Monitoring for the twinning of Highway 63. This is an eight year contract that monitors the progression of borrow pits into wetlands, wildlife movement and animal vehicle collisions, fish habitat compensation, and rare plant transplant success.
- Project Manager for post construction wetland monitoring on Highway 63. Devised sampling methodology to assess vegetation, water quality, hydrological function, wildlife presence, invertebrates, fish, and soil. Created a tool called the "Measures of Progress," which determines an acceptable range for a parameter as it relates back to reference wetlands used in the study as well as indicator/sensitive species or functional groups to determine whether a borrow pit is progressing toward naturalization or requires mitigation.
- Environmental assessments for several highway widening projects. Project tasks included valued ecosystem component (VEC) mapping, rare plant surveys, wetland assessments, wildlife inventory, and species at risk review, providing mitigation measures, and regulatory applications.
- Terrestrial surveys for several proposed transmission line projects in central and northern Alberta. Parameters assessed include: wetlands, rare plants, fish habitat, soil classification, timber salvage volumes, and weeds.
- Wetland assessments and mapping for oil and gas projects land development projects in both the green and white areas of Alberta. Classification of wetlands based on vegetation, soils, topography and ecological health. Completed several wetland compensation projects under Alberta's new *Wetland Policy* with the Alberta Wetland Classification System.
- Rare plant surveys and weed surveys conducted in the Boreal Forest, Grassland, Parkland, Foothills, and Rocky Mountain Natural Regions in Alberta.
- Vegetation effects assessments for several mining projects throughout eastern and northern Canada.
- Detailed site assessments (DSA) for reclamation projects: vegetation identification and soils classification.
- Ecosite Land Classification in the Boreal Forest Natural Region.
- Nest sweeps for migratory birds.
- Fish and fish habitat assessments and fish inventory, including electrofishing and minnow trapping.

EDUCATION

B.Sc., Environmental and Conservation Sciences, University of Alberta

Diploma (Honours), Biological Sciences Renewable Resources, Northern Alberta Institute of Technology

Diploma, Landscape Architecture Technology, Northern Alberta Institute of Technology

AREA OF EXPERTISE

Broad knowledge of, and experience in, biology, ecology, and forestry, with a focus on vegetation and wetlands

REGISTRATIONS/ AFFILIATIONS

Professional Biologist, Alberta Society of Professional Biologists

Member of the Alberta Native Plant Council

Member of the Environment Council within the Transportation Association of Canada

TRAINING/ CERTIFICATIONS

ATV Safety Training

Bear Awareness

Defensive Driving

Electro-fishing crew member

Ground Disturbance Level II

CSTS

Personal Monitor Training

Snowmobile Operator Training

Standard First Aid & Wilderness First Aid

WHMIS, H₂S Alive, TDG

Winter Survival

OFFICE

Edmonton, AB

YEARS OF EXPERIENCE

11

CONTACT

Amy.McLenaghan@tetrattech.com

SUMMARY OF EXPERIENCE

Mr. Wilcockson is an Environmental Specialist with over 10 years experience working as a consultant for a variety of clients including government agencies, pulp and paper, oil and gas, transportation mining operations and international donor agencies. His areas of expertise include aquatic and terrestrial toxicology, environmental monitoring, statistical analyses, ecological and human health risk assessment, food chain modelling and ecological impact assessment. Mr. Wilcockson has managed numerous environmental studies investigating the effects of contaminants on aquatic and terrestrial resources. He has conducted field work and training in several Asian countries, and has developed interactive computer tools for environmental management. Currently, he is the project manager/assistant project manager for environmental monitoring programs for a number of pulp and paper mills and metal mines in British Columbia.

EDUCATION

- 1997 Master of Science – Biological Sciences, Simon Fraser University, Burnaby, British Columbia, Canada
- 1991 Post Baccalaureate Diploma in Environmental Toxicology, Simon Fraser University, Burnaby, British Columbia, Canada
- 1990 Bachelor of Science – Biochemistry, University of British Columbia, Vancouver, British Columbia, Canada

CAREER SUMMARY

- 2006 to Present Environmental Scientist - Hatfield Consultants Ltd., North Vancouver, British Columbia, Canada
- 2004 to 2006 Environmental Scientist – Golder Associates Ltd., North Vancouver, British Columbia, Canada
- 1999 to 2004 Environmental Scientist – EVS Environment Consultants, North Vancouver, British Columbia, Canada
- 1993 to 1999 Research Associate – Simon Fraser University, Burnaby, British Columbia, Canada
- 1997 to 1998 Research Associate – Exxon Biomedical, East Millstone, New Jersey, USA

PROFESSIONAL AFFILIATIONS

- Registered Professional Biologist (R.P.Bio), British Columbia, Canada

LANGUAGES

- English

KEY PROJECT EXPERIENCE***Ecological Effects Monitoring and Statistical Data Analysis***

- **Environmental Assessment, Columbia River, British Columbia Canada** – Project manager for an environmental assessment of the Lower Columbia River. Project included the compilation and analysis of a large analytical data set including concentrations of contaminants in water, sediments and biota. The assessment included a literature review of toxicity information and an assessment of potential effects. Project deliverables included a data synthesis report and a searchable database. Client: Columbia River Integrated Environmental Monitoring Program. **2007 to 2008**
- **Environmental Assessment, Logan Lake, British Columbia Canada** – Project manager for an assessment of potential impacts arising from a large mine. Project is ongoing and includes the collection of water, sediment and biota samples for micro-pollutant analysis. Each year, new data is compiled and analyzed and compared to historical data. Every three years, an assessment of potential effects is conducted and trends in micro-pollutant data are discussed. Client: Highland Valley Copper Mine, Teck Resources Ltd. **2006, Ongoing**
- **Pulp and Paper EEM, Various** – Project manager for an assessment of potential environmental impacts to large rivers arising from two pulp and paper mills. Project is ongoing and includes the collection of water, sediment and biota samples for micro-pollutant analysis. Responsibilities include designing and implementing environmental monitoring studies, providing guidance to mill staff, and liaising with regulatory agencies. **2005, Ongoing**
- **Sediment Quality Assessment, Victoria, British Columbia, Canada** – Principal Investigator for an assessment of sediment quality in Victoria Harbour. Sediment chemistry, toxicity, and benthic community data were reviewed and summarised. Statistical analysis was applied to extract trends in the data set and to uncover factors potentially causing ecological impacts. Client: Transport Canada. **2002 to 2003**
- **Sediment Quality Assessment, Vancouver, British Columbia, Canada** – Analyzed sediment data associated the Iona sewage outfall. Conducted multivariate statistics (principle component analysis and non-metric multi-dimensional scaling) and correlation analysis on sediment chemistry and benthic community data. Client: Greater Vancouver Regional District. **2001 to 2002**
- **Analysis of Micro-pollutants in Sediment, Victoria, British Columbia, Canada** – Conducted statistical analysis on sediment micro-pollutant data downstream of a large sewage outfall. Principal Component Analysis was applied to uncover spatial and temporal trends in data set. Also used non-parametric correlation tests, and non-parametric hypothesis tests. Client: Capital Regional District. **2001 to 2002**

Computer-Based Management Tools

- **Risk Based Management Tool, Department of National Defence** – Principal investigator for designing a risk based environmental management tool for DND's Pacific Operations. Tool was designed to rank the risk of various practice activities based on the type of activity, the severity of potential impacts and the probability of impacts occurring. DND Operations is expected to use the tool to help plan future practice operations. Client: Canadian Department of National Defence, Canada. **2006**

- **Revisions to the CCME National Classification System, Ottawa, Ontario, Canada** – Principal investigator for revising the CCME National Classification System for ranking contaminated sites. Reviewed the existing CCME NCS, made recommendation for improvements and developed a new electronic national classification system. The focus of the revisions was to only make changes that provided significant improvement in terms of greater objectivity and consistency with the current risk assessment approach and framework. Client: Canadian Council of Ministers for the Environment (CCME). **2005**

Environmental Risk Assessment

- **Ecological Risk Assessment, Comox, British Columbia, Canada** – Project Manager for an ecological risk assessment for a former bulk fuel storage facility. This project evaluated the impact of groundwater-borne hydrocarbons on a sensitive salt marsh habitat that supported both small mammal and seabird populations. Client: Shell Canada. **2002**
- **Ecological Risk Assessment, North Vancouver, British Columbia, Canada** – Project Manager for a risk assessment of impacts arising from hydrocarbon-contaminated groundwater entering Burrard Inlet. This project assessed the impact of dissolved polycyclic aromatic hydrocarbons on fish and marine invertebrates. A literature-based effects assessment was conducted to derive site-specific concentration standards. Client: TransLink. **2001**
- **Ecological Risk Assessment, New Westminster, British Columbia, Canada** – Project Manager for a risk assessment of impacts arising from hydrocarbon-contaminated groundwater entering the Fraser River. This project assessed the impacts of petroleum hydrocarbons and polycyclic aromatic hydrocarbons on fish and aquatic invertebrates. An equilibrium partitioning model was applied to estimate hydrocarbon concentrations entering the river. Client: Shell Canada. **2001**
- **Screening-level Risk Assessment, Pilot Bay, British Columbia, Canada** – Principal Investigator for a screening-level risk assessment of impacts arising from smelter waste being used on a dirt road. This project assessed the impacts on terrestrial and aquatic organisms living adjacent to the road. Sampling and analysis was designed to differentiate potential impacts arising from the road and those as a result of historical land use, and measured impacts on a series of potential receptors, including plants, soil invertebrates, small mammals, and birds. Client: British Columbia Ministry of Highways. **2001**
- **Screening-level Risk Assessment, Castlegar, British Columbia, Canada** – Project Manager for a screening-level risk assessment of impacts arising from a train derailment. This project assessed the impact on fish and aquatic invertebrates of potential exposure to iron, extractable hydrocarbons, and sulphate found in surface water and groundwater leachate. Client: Canadian National Railway. **2004**

Mathematical Modelling

- **Metal Speciation/Biotic Ligand Modeling, Hope Bay, Nunavut, Canada** – Used a biotic ligand model to derive a site-specific water quality guideline for copper. The guideline was designed to be protective of aquatic organisms downstream of a proposed tailings pond. Client: Miramar Mining Corporation. **2004**
- **Food Chain Model, PCBs, San Francisco, California, USA** – Constructed a food chain model for PCBs in San Francisco Bay. The model predicted tissue concentration of PCBs in three important sport fish from sediment and water concentrations. The model will be used by regulators to manage PCB loadings to San Francisco Bay. Client: San Francisco Estuary Institute. **2003**

- **Food Chain Model, PCBs and PAHs, New Jersey, USA** – Used mathematical models to describe a short simulated food chain. Used flounders, clams, and contaminated Hudson River sediment. Work performed at Exxon Biomedical, New Jersey. Applied a concentration-based, steady state kinetic model based on the approach used by Robert Thomann, Manhattan College. Client: Exxon. **1998**

International Project Experience

- **Risk Assessment, Indonesia** – Advisor and component manager for an ecological risk assessment assessing potential impacts associated with an industrial outfall to a tropical riverine environment. Primary contaminants of concern were ammonia, hydrocarbons and metals. A literature review of toxicity information was conducted to support the risk assessment. Fieldwork was conducted for TOTAL Indonesia in the Mahakam Estuary, East Kalamantan, Indonesia. **2009 to 2010**
- **Risk Assessment, Philippines** – Project manager for a **World Bank** project to investigate human health and environmental impacts associated with burning waste in the Philippines. The primary contaminants of concern were dioxins/furans. Fieldwork was conducted in Iloilo, Philippines in order to collect air, sediment and tissues of aquatic organisms. Data was be used in a risk assessment to predict potential human health impacts. **2009**
- **International Capacity Building, Malaysia, Cambodia and Laos** – Provided human health risk assessment training to government agencies in Malaysia, Cambodia and Lao as part of a World Bank project on Persistent Organic Pollutants (POPs). Also created web-based tools for prioritizing contaminated sites based on their need for investigation and for estimating human health risk. **2008 to 2009**
- **Human Health Risk Assessment, Vietnam** – Participated in a study of residual Agent Orange contamination associated with the Da Nang Air Base in Da Nang, Vietnam. Conducted field work, analyzed data and used a screening-level risk assessment to characterize potential human health risks. Client: Ford Foundation and Office 33 of the Vietnamese Department of National Defence.

Brent Murphy, M.A., RPA, Senior Project Archaeologist

Brent is a permit holding archaeologist with a Master of Arts degree in anthropology with more than 20 years' experience in the cultural resources management field. He has worked on a wide variety of projects from oil and gas to urban developments, linear projects and mines throughout Alberta, Saskatchewan, Nunavut and the Northwest Territories as well as having international experience in Tanzania, Idaho and Texas and research experience in eastern Canada and southern France. Brent has also acted as discipline lead and senior review of the historic resources and Traditional Land Use components of several Environmental Impact Assessments, Developer's Assessment Reports, Nunavut Impact Review Board, and National Energy Board applications. He is a registered professional archaeologist (RPA) and served two terms as president of the Alberta Association of Consulting Archaeologists.

EDUCATION

M.A. Anthropology, Memorial University of Newfoundland - Saint John's, Newfoundland and Labrador
 B.A. Honours Anthropology, University of New Brunswick - Fredericton, New Brunswick
 B.A. Anthropology, St. Thomas University - Fredericton, New Brunswick

PROFESSIONAL AFFILIATIONS

Registered Professional Archaeologist (RPA)
 Alberta Association of Consulting Archaeologists (past president 2006 and 2008)
 Canadian Archaeological Association
 Alberta Archaeology Society
 Archaeological Institute of America
 Society for American Archaeology

EMPLOYMENT RECORD

2016 - present	Lifeways of Canada Limited, Aboriginal Engagement Specialist and Senior Project Archaeologist
2006 - 2015	Golder Associates Ltd, Associate, Senior Archaeologist and Aboriginal Engagement Specialist
1998 - 2006	Bison Historical Services Ltd., Senior Archaeologist
1996 - 1997	Memorial University of Newfoundland, Research Assistant on various archaeology projects
1996 - 1996	Parks Canada, Contract Archaeologist
1996 - 1996	Independent archaeological contractor, Newfoundland
1995 - 1997	Teaching Assistantships, Memorial University of Newfoundland
1993 - 1995	Archaeological Services New Brunswick, Research Assistant
1995 - 1995	Canadian Museum of History, Research Assistant
1994 - 1994	Jacques Whitford Environment Ltd., Archaeologist
1993 - 1995	University of New Brunswick, Lab Assistant

RELEVANT SELECTED PROJECT EXPERIENCE

Prairie Creek Mine – Northwest Territories

Completed an Archaeological Impact Assessment for the proposed Prairie Creek Mine Access Road Alignment on behalf of Canadian Zinc Corporation near Nahanni Butte in 2012. Prepared an Archaeological Overview Assessment for the proposed All Season Prairie Access Road in 2016.

Fortune Minerals Ltd. – Northwest Territories

Completed a Heritage Resources Impact Assessment for the Fortune Minerals NICO Mine All-Weather Access Road, authored the Physical Heritage Resources section of the Developer's Assessment Report, prepared SIR responses and attended the technical hearings as an expert witness.

Dominion Diamonds Ekati Diamond Mine Expansion – Northwest Territories

Heritage Resources and Traditional Land Use lead for the Developer's Assessment Report/Environmental Impact Statement for the Jay Project. The Jay Project is a proposed expansion to the Ekati Diamond Mine. As lead I was involved in the preparation of the baseline reports and impact assessments, ensuring Traditional Land Use and Traditional Knowledge information was incorporated throughout the application, reviewing final deliverables, attending and presenting heritage results at public and

regulatory meetings in Yellowknife and assisting with follow up correspondence with local communities. Also, held the permit and led the Archaeological Impact Assessment follow up in 2015.

Inuvik to Tuktoyaktuk Highway – Northwest Territories

Completed a Heritage Resources Impact Assessment for the proposed Inuvik to Tuktoyaktuk Highway and two potential realignments in the Inuvialuit Settlement Region. The proposed Highway measures 138 km in length in its current alignment, starting at the end of Navy Road in Inuvik (km 0) and ending in Tuktoyaktuk (km 138). All field work included the participation of local assistants who provided advice on the cultural significance of the landscape traversed during the investigation.

Government of Northwest Territories

Project manager and senior reviewer of a summary report of Transboundary Traditional Knowledge Meetings Summary for Environment and Natural Resources, Government of the Northwest Territories.

Mackenzie Gas Project - Northwest Territories

Crew lead for the heritage resource reconnaissance and impact assessment program in support of the Mackenzie Gas Project. Studies were completed on behalf of Imperial Oil, CONOCO Canada, Shell Canada Limited, ExxonMobil and the Aboriginal Pipeline Group for the Mackenzie Gas Project gas gathering areas north of Inuvik and the pipeline from Inuvik into Northwestern Alberta.

Offshore Exploration – Northwest Territories

Project manager and reviewer for the Traditional Land Use and Traditional Ecological Knowledge Services for ConocoPhillips Amauligak Project. Project included primary Traditional Land Use and Traditional Ecological Knowledge data collection through group mapping workshops with communities in the Inuvialuit Region of the Northwest Territories and strategic advice. Discipline lead for heritage resources for the Imperial Oil Beaufort Sea Project. The Project lies about 120 km offshore of the Northwest Territories in the Beaufort Sea and was a joint venture between Imperial, ExxonMobil Canada and BP. My role was to provide background and strategic advice on heritage resource concerns, both marine and terrestrial.

Enbridge Pipeline Inc. – Alberta, Manitoba and Northwest Territories

Completed Historic Resources Impact Assessments for the Woodland Pipeline Project, Woodland Pipeline Extension Project, Norealis Pipeline Project, Fort Hills Delivery System and Sturgeon Delivery System. Senior reviewer and historic resources discipline lead for the Enbridge Stonefell, Norlite, JACOS, Hangingstone pipeline projects and mitigations associated with the Line 3 Replacement Project. Heritage lead for maintenance work associated with the Enbridge Line 21 (Norman Wells) Pipeline.

Public Works and Government Services Canada – Northwest Territories, Yukon and Nunavut

Completed Archaeological Impact Assessments in support of Environmental Site Assessments for several projects in Nunavut, Northwest Territories and Yukon for Public Works and Government Services (PWGSC) on behalf of Indigenous and Northern Affairs Canada (INAC). Projects include the FOX-D (Kivitoo), FOX-E (Durban Island), CAM-B (Hat Island) and PIN-E (Cape Peel) Intermediate DEW Line sites, Hope Lake mineral exploration camps (Kugluktuk), Padloping Island USAF Weather Station (Padloping Island), Nottingham Weather Island Station (Nottingham Island) and managed the AIAs of the PIN-D (Ross Point), CAM-A (Sturt Point), BAR-B (Stokes Point – Ivvavik National Park), DEW Line sites, former oil and gas exploration and extraction sites on Ile Vanier, Cameron and Bathurst Islands, three abandoned mines on Great Slave Lake (Outpost Island, Blanchet Island, and Copper Pass), former Contwoyto Lake Weather Station and Ennadai Lake Weather Station. Also, provided study summaries for public presentations and attended community meetings in conjunction with the CAM-B project in the communities of Cambridge Bay and Goa Haven with staff of PWGSC and INAC.

Agnico Eagle Meliadine Gold Project - Nunavut

Completed two Archaeological Impact Assessments for the proposed mine, access road, laydown area and additional exploration areas in Rankin Inlet. Senior review for subsequent archaeological surveys associated with the project and Nunavut Impact Review Board application.

Iqaluit Marine Infrastructure Project and Pond Inlet Marine Infrastructure Project - Nunavut

Currently the heritage resources lead for two marine infrastructure projects in Nunavut behalf of the Department of Community and Government Services and the Department of Economic Development and Transportation. Responsible for desktop reviews, field level impact assessment and mitigations and contributing to a Nunavut Impact Review Board screening report.

Small scale oil and gas – Alberta and Saskatchewan

Completed more than 130 permitted Historic Resources Impact Assessments of well sites, access roads, pipelines and gathering systems for a variety of clients including Canadian Natural Resources Limited, Real Resources Inc., Petrobank Energy and Resources Ltd., Regent Resources Ltd., MGV Energy Inc., Penn West Petroleum Ltd., Glencoe Resources Ltd., Gulf Canada Resources Limited, Genesis Exploration Ltd., Husky Energy Inc., and Apache Canada Ltd. among others.

TransCanada Pipelines Limited – Alberta and British Columbia

Aboriginal Engagement Lead and historic resource senior review for the Northern Courier Pipeline Project, the Wolverine River Lateral Loop. (Carmen Creek) Project, Simonette Lateral Loop Project, Towerbirch Expansion Project and South Kirby Extension Project. Completed several Historic Resources Impact Assessments and a multi-year Historic Resources Impact Mitigation on behalf of TransCanada on a variety of projects including NPS 20 Fort Saskatchewan Extension, NPS Western Alberta System Mainline Loop No 2 (Cremona Section and Saratoga Section), Bowmanton East Meter Station, Aurora Sales Meter Station and Cheecham Lateral Loop. Senior review for the historic resources component for the Leming Lake Lateral Loop Project, Saddle Lake Lateral Loop Project, Leismer to Kettle River Crossover Project. Also, worked as an advisor/reviewer for Aboriginal procurement for the geotechnical work associated with the Coastal Gas Link Project.

Total E&P Canada - Alberta

Completed the historical resources component for the TOTAL Upgrader Project EIA application. Work scope included a Historical Resources Impact Assessment followed by staged mitigation, baseline reporting, EIA reporting, preparing SIR responses and hearing support. Senior review for the HRIA and historic resources section of the EIA of the Joslyn Mine Expansion in Northeastern Alberta.

Suncor Energy Inc. - Alberta

Completed the historical resources component for an EA for the Suncor Millennium Mine Dump 9 and the EIA for the Suncor Voyageur South Project. Both projects included field programs, baseline reports and subsequent sections in the EA and EIA applications. Also acted as social component coordinator for both applications.

Shell Energy Canada Sharkbite Mine - Alberta

Project manager, senior reviewer and crew lead for the Shell Energy Canada Muskeg River Mine Expansion Sharkbite Area Project. The 2012 Project included more than 700 metres of excavation at ten sites with a crew of 20 archaeologists and resulted in the recovery of more than 800,000 artifacts.

Kabanga Nickel Company Limited – Tanzania

Manager of the archaeological component of the ESIA for the Kabanga Nickel Company Limited Kabanga Nickel Mine in Tanzania. Responsibilities included developing work plans and procedures, working alongside local sub consultants in the field and managing and technical review of all deliverables to meet both Tanzanian and IMF regulatory standards.

Bureau of Land Management – Idaho, USA

Principle Investigator and project manager for five Class III (intensive) cultural resource inventories on behalf of the Bureau of Land Management, Owyhee, Jarbidge and Shoshone Field Offices. The five projects involved the survey of over 74,000 acres of land in southern Idaho.

Cultural Resource Management Reports

- 2017 Archaeological Impact Assessment Iqaluit Marine Infrastructure Project (NU Permit 2016-038A). Ms on file, Department of Heritage and Culture, Igloolik.
- 2014 Archaeological Impact Assessment for Dominion Diamonds and North Arrow Project Area (NWT Permit 13-015). Ms on file, Prince of Wales Northern Heritage Centre, Yellowknife.
- 2014 Archaeological Impact Assessment of the FOX-D Intermediate DEW Line Site, Kivitoo, Nunavut (NU Permit 2013-31A). Ms on file, Department of Culture, Language, Elders and Youth, Igloolik.
- 2013 Archaeological Impact Assessment for the Prairie Creek Mine Access Road Alignment (NWT Permit 12-016). Ms on file, Prince of Wales Northern Heritage Centre, Yellowknife.
- 2013 Archaeological Impact Assessment for the Nottingham Island Weather Station, Nottingham Island, Nunavut (NU Permit 2012-07A). Ms on file, Department of Culture, Language, Elders and Youth, Igloolik.
- 2012 Heritage Resources Impact Assessment of the proposed Inuvik to Tuktoyaktuk Highway (NWT Permit 11-014). Ms on file, Prince of Wales Northern Heritage Centre, Yellowknife.
- 2012 A Cultural Resources Survey of Three Well Pads, Access Roads and an Electrical Upgrade ROW: Marathon Oil Haynesville Shale Development Plan Shelby County, Texas. Ms. on file at Bureau of Land Management, Tulsa Oklahoma and at the Texas Historical Commission, Austin Texas.

- 2011 Archaeological Impact Assessment for the Comaplex Meliadine Gold West Project, Rankin Inlet, Nunavut (Nunavut Permit 2010-05A). Ms on file, Department of Culture, Language, Elders and Youth, Igloolik.
- 2011 Historical Resources Impact Assessment for Enbridge Pipelines (Woodland) Inc. Woodland Pipeline Expansion Project (ASA Permit 10-278). Ms on file, Archaeological Survey of Alberta, Edmonton.
- 2010 Archaeological Impact Assessment of the Former USAF Padloping Island Weather Station, Padloping Island, Nunavut (NU Permit 2010-016A). Ms on file, Department of Culture, Language, Elders and Youth, Igloolik.
- 2010 Archaeological Impact Assessment of the FOX-E Intermediate DEW Line Site, Durban Island, Nunavut (NU Permit 2010-017A). Ms on file, Department of Culture, Language, Elders and Youth, Igloolik.
- 2010 Archaeological Impact Assessment of the Hope Lake Mining Exploration Camps, Dismal Lakes, Nunavut (NU Permit 2010-019A). Ms on file, Department of Culture, Language, Elders and Youth, Igloolik.
- 2010 Historical Resources Impact Assessment Enbridge Pipelines (Athabasca) Inc. Norealis Pipeline Project: final report (ASA Permit 10-217). Ms on file, Archaeological Survey of Alberta, Edmonton.
- 2010 Historical Resources Impact Assessment Suncor Energy Inc., Fee Lot 6 Gravel Pit Study: final report (ASA Permit 10-170). Ms on file, Archaeological Survey of Alberta, Edmonton.
- 2010 Historical Resources Impact Assessment Enbridge Pipelines (Woodland) Inc. Woodland Pipeline Project (ASA Permit 10-142). Ms on file, Archaeological Survey of Alberta, Edmonton.
- 2010 Historical Resources Impact Mitigation at EgPn-724 For the Dolemo Development Corporation Edworthy Club and Resort, Final Report (ASA Permit 10-019). Ms on file, Archaeological Survey of Alberta, Edmonton.
- 2010 Heritage Resources Impact Assessment Fortune Minerals Limited NICO Cobalt-Gold-Bismuth-Copper Project (NWT Permit 09-003). Ms on file, Prince of Wales Northern Heritage Centre, Yellowknife.
- 2009 Historical Resources Impact Mitigation FkPg 150 TOTAL Upgrader: final report (ASA Permit 09-071). Ms on file, Archaeological Survey of Alberta, Edmonton.
- 2009 Historical Resources Impact Assessment for the Genesee Mine Extension: final report (ASA Permit 09-120). Ms on file, Archaeological Survey of Alberta, Edmonton.
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