

DR. ALLAN D. WOODBURY, P.ENG.

3918 Gallagher's Circle, Kelowna, B.C. V1W3Z9

(H): (778) 484-3300 (C): (204) 223-0707

E-mail: woodbur@cc.umanitoba.ca

Web pages: <http://home.cc.umanitoba.ca/~woodbur/>

QUALIFICATIONS

- Senior Groundwater Hydrologist and Professional Engineer
- Internationally recognized research
- Specialist consulting experience
- High-level technical reviews

CURRENT EMPLOYER/ POSITION

- Visiting Professor, University British Columbia, Okanagan
- Senior Scholar, University of Manitoba, Winnipeg, MB

ACADEMIC EDUCATION

- B.Sc. (UBC 1973) Geophysics
- Continuing education:
 - Structural Engineering (1977)
 - Technical report writing, UBC (1978)
 - Professional Management (1978)
 - Rock Mechanics, Penn State (1978)
 - Groundwater Engineering, UBC (1979)
- M.Sc. (UBC 1983) Geological Sciences: Hydrogeology/ Geothermics
- Ph.D. (UBC 1987) Geological Sciences: Hydrogeology/Inverse theory

HONOURS & AWARDS

- NSERC postgraduate scholarships
- University of Manitoba Rh Award (Applied Sciences), 1994
- Canadian Association of University Teachers: Dedicated Service Award, 2005

PROFESSIONAL AFFILIATIONS

- Registered Professional Engineer, Province of British Columbia (2014)
- Registered Professional Engineer, Province of Manitoba (1989 – 2013)
- Member, American Geophysical Union

EMPLOYMENT HIGHLIGHTS

University/ Organization	Rank or Title	Dates
University of B.C. Okanagan	Visiting Professor	2014-
University of Manitoba	Senior Scholar	2014-
University of Manitoba	Professor	1998-2014
University of Manitoba	Associate Professor	1989 - 1998
McGill University	Assistant Professor	1987 - 1989
B. C. Hydro	Field Supervisor	1981-1982
Dames & Moore	Geotechnical Eng.	1980
B. C. Hydro	Geological Engineer	1974 - 1980
Indian Affairs- Northern Dev.	Surveyor	1969 - 1974

TEACHING EXPERIENCE

- Experience in conventional lecturing, short courses, multi-media education and problem-based learning
- Finite element analysis, industrial statistics, fluid mechanics, physical and chemical hydrogeology, water resources engineering
- First year engineering geology at McGill University
- Graduate courses in geotechnical engineering, numerical modeling, heat and contaminant transport, advanced groundwater hydrology

ADMINISTRATIVE SERVICE

- Member of the Executive, University of Manitoba Faculty Association (UMFA) 1997-2008 (governance of the Association, budgets, staff).
- Member Board of Representatives, UMFA, 2010-2013 (larger, final board responsible for the Association).
- Collective Agreement UMFA Bargaining Team, 2001, 2004, 2007 (high level negotiations over master agreements with the University, job action strategy).
- Chair of UMFA Staff Benefits (review and recommend positions for negotiations)
- Core member, Faculty of Engineering tenure and promotions committee (responsible for Faculty wide reviews, 1996-2013)
- Graduate Chair, Faculty of Engineering, 1996-1999
- Special Assistant to the Dean of Engineering, 1996-1999
- Academic search committees
- External examiner for Ph.D. theses
- External reviewer for tenure and promotions
- Adjunct Professor in Geological Sciences
- Search committees in Agricultural and Civil Engineering, and Geological Sciences

SELECTED CONSULTING EXPERIENCE

- Consultant to Wardrop Engineering, Inc. on large Bunker Oil spill at The Pas, Manitoba and groundwater at the Red River Floodway.

- Advisor to Manitoba Hydro on the Birthday-Gull site and Conapawa Geothermics.
- Consultant to ID Engineering, Inc. on aquifer capacity and groundwater contamination in E. St. Paul and Springfield Municipalities.
- Consultant to Northman Engineering on aquifer capacity investigations in a northern First Nations community.
- Computer modeling of the Assiniboine Delta Aquifer for Manitoba Water Resources.
- Public service work in regards to environmental hearings related to siting of a waste stabilization pond at Oak Point, MB.
- Peer review consultant to AECL at Pinawa, MB with regard to several tracer tests conducted in fractured rock.
- Specialist consultant to UMA Environmental, Winnipeg. Appeared as an expert witness at the Clean Environment Commission hearings with respect to siting of a municipal landfill in Rosser, MB.
- Consultant to UMA Environmental, Calgary. Review and design of soil and groundwater remediation of a contaminated site in Banff, Alberta.
- Analysis of the transport and fate of DDT contaminated groundwater at Rainy Hollow, B.C. for UMA Engineering.
- Groundwater resource development, Portage La Prairie, Manitoba
- Specialist consultant to the Center for Nuclear Waste Regulatory Analysis, San Antonio
- Specialist consultant to Saskatchewan Water.
- Consultant to Wardrop Engineering on the Red River Floodway expansion.
- Consultant to the MacKenzie Valley Land and Water Board (through Arktis Solutions, Inc.) for reviews of the Cantung Mine and other sites, NWT.
- Saskatchewan Environment. Specialist advisor for the environmental impact of a uranium tailings management facility at McClean Lake, potash mine reviews, oil sands development and groundwater supplies.

MAIN COLLABORATIONS

- Dr. T. J. Ulrych (UBC.): Joint research in Maximum Entropy methods.
- Dr. Harmut Hollander: (U. Manitoba): Improvements in recharge estimation
- Dr. Kenneth Snelgrove, (Memorial University), climate change and hydrology.
- Dr. E. A. Sudicky (U. of Waterloo): Research in stochastic methods and uncertainty.
- Prof. Yoram Rubin (UC Berkeley): Research into inversion of reactive and non-reactive tracer data.
- Drs. David Farrell, Ron Green, Scott Painter and Alex Sun (Southwest Research Institute, San Antonio, Texas): Joint thermal and groundwater inversion, and karst hydrology modeling.
- Dr. Grant Ferguson, Geothermics and sustainable energy.
- Drs. Adam Wei, Jeff Curtis (UBCO) for integrated watershed management; various projects in the Kelowna area.

- Dr. Keni Zhang, (Tongji University), Shanghai, geothermal.

CONTRIBUTIONS TO TRAINING

- Kibreab Assefa, *Impact of upscaled data on recharge for climate change studies, Water Resources Management. PhD Thesis 2014*
- Alireza Hejazi, *Coupling Nitrogen Transport and Transformation Model with Land Surface Scheme SABAE-HW and its Application on the Canadian Prairies, PhD Thesis, 2012.*
- Maeir Olfman, *Characterization of the Ground Thermal Response to Heating by a Deep Vertical Borehole Heat Exchanger, MSc Thesis, 2012.*
- Grant Ferguson, *Groundwater and Heat Flow in Southeastern Manitoba: Implications to Water Supply and Thermal Energy, PhD Thesis, 2004* (present position; Associate Professor, Civil Engineering, University Saskatchewan)
- Paula Kennedy, *Groundwater Flow and Transport Model of the Red River/Interlake Area in Southern Manitoba, PhD Thesis, 2002.* (Formerly Carlton University)
- Keni Zhang, *The Modal Reduction Method for Simulation of Groundwater Flow and Multi-species Transport in Fractured Porous Media, PhD Thesis, 2000.* (current position Chief Scientist Beijing Normal University)
- Vera Langer, *Investigation of Tricholoethene Transport in Fractured Porous Media with Emphasis on Sorption onto Stylolites and Matrix Diffusion, PhD Thesis, 1999.*
- David Farrell, *An Assessment of the Role of Transient Flow on the Dispersion of Non-reactive Solutes in Porous Media: A numerical Study, PhD Thesis, 1997* (Current position, Director Caribbean Meteorological Institute, U. West Indies)
- Henian Li, *Development and Application of the Unsymmetric Lanczos reduction Method, PhD Thesis, 1996* (current position, Sun-Life Boston)
- David Farrell, *An Analysis of the Influence of Water Level Fluctuation on the Dispersion Process at the Borden Aquifer, MSc Thesis, 1992.*
- Yefang Jiang, *A Bayesian Approach to the Groundwater Inverse Problem for Steady State Flow and Heat Transport, MSc Thesis 2002.*
- Other Students (full or partial) at BSc, M.Eng levels: Alex Mann, Rebecca McMillan, Lee Peters, Remi Allard, Jeff Bell, Nick Hudyma, German Ciro, Steven Fletcher
- Postdoctoral Fellows: Lei Wen, McGill; Youssef Loukili, U. Manitoba; Hanou Zong

OTHER SELECTED SCHOLARLY CONTRIBUTIONS

- Visiting Professor, University of British Columbia (Okanagan), 2005, 2009, 2014.
- Visiting Professor, University of the West Indies, Cave Hill Campus, Barbados, 2005
- Invited speaker at special session on innovation in Hydrogeology, GSA annual meeting, October 2005.

- Keynote speaker at a special symposium in Barbados, 2003 and a short course in 2005.
- September 2000, field trip leader for the Society of Petroleum Geologists, Hydrogeology division to the Revelstoke Dam and Downie Slide.
- Guest speaker at University of Arizona, 1999 and Southwest Research Institute, Texas, 1999.
- Invited Speaker, Geological Society America, 2004.
- Invited speaker at a Geotechnical short course at the University of Manitoba, 1999.
- Invited speaker at the NGWA conference in Las Vegas in Dec.1998 and also at the HKK conference in Waterloo in 1999.
- Invited speaker at the AGU conference in 1994, invited and keynote address in 1999.
- Invited to speak at the First International Conference Chlorinated and Recalcitrant Compounds, in May, 1998
- Invited speaker at the 1990 Gordon Conference on Porous Media.
- CSCE National task force on “*Management of Waste Contamination in Groundwater*” (1987-1988).
- Invited speaker at the UBC Department of Geophysics, UC Berkeley Department of Civil Engineering and Lockheed Missiles and Space Research in Palo Alto, Ca.
- Reviewed manuscripts for *Water Resources Research*, *Geophysical Journal*, *Society of Petroleum Engineers*, *Canadian Journal of Earth Sciences*, *American Geophysical Union* and *Advances in Water Resources*, *Computers and Geosciences*, *Journal of Hydrology*.
- Formerly Associate Editor, *Journal of Contaminant Hydrology*.

SIGNIFICANT RESEARCH CONTRIBUTIONS: 2004-2014

a) Work in the area of groundwater and heat transport.

During the last 10 year period, Grant Ferguson and I have investigated the anomalous thermal regime beneath Winnipeg, Canada. This “heat island” effect makes it difficult to resolve information on past climates and in some areas the temperature increases will also have an impact of geothermal energy resources. A recent, comprehensive study, has shown that most open-loop geothermal developments in the Winnipeg area will inevitably experience temperature increases due to heat transport occurring between the injection and withdrawal wells in an individual system. This work is of particular interest to the Winnipeg’s Waverly West development. Work in temperature surveys and methods to determine past climatic changes from boreholes was the subject of published works with Ferguson and also Dr. Jim Hendry, at the University of Saskatchewan.

- Work with Grant Ferguson has been well received not only internationally but by Manitoba Hydro, and the local engineering community; citations in journals.

- The American Geophysical Union, selected our 2004 paper as one of their featured articles.
- Prominent mention of Ferguson and Woodbury's works in Banks' (2009) textbook on Geothermics and by British Geothermal expert, Paul Younger.

b) Improvements in Atmosphere/Land Surface Interactions.

One of my long-term goals is to develop an efficient hydrological and numerical coupling of the land surface with groundwater flow, and also with the atmosphere through accurate descriptions of the lower boundary conditions. We succeeded in benchmarking our improved version of the Canadian Land Surface Scheme SABAE-HW, and inter-comparisons to other models such as HYDRUS-1D and HELP3 ensure the applicability and viability of our code. Eventually, I would like to move ahead with numerical programming towards the ultimate coupling of our groundwater code with the Canadian GCM, in order to allow for more accurate exchanges of water and energy fluxes between the atmosphere and the earth surface. The overall objective is to assist other research efforts in trying to understand, assess and quantify the evolution of drought. Also, the future inclusion of human practices in each of the model components (agriculture, pumping, wastes, and so on) will allow us to study the influences on climate variability and change. As a result of interactions and synergies created within the above network, other publications have been targeted to understand the evolution of climate in the north of Canada.

- Ph.D. student Alireza Hejazi won of an outstanding poster presentation award at the (2011) annual Canadian Water Network conference as a result of his contributions to the SABAE code noted above.

c) Information-based Inversion and Stochastic Hydrology.

I am probably best known for my work with the late Tad Ulrych (UBC) in probabilistic methods (Bayesian, Maximum Entropy, Minimum Relative Entropy, MRE). One of my most recent efforts (2011) was a theoretical piece comparing Bayes to MRE as a tribute to Dr. Kapur. Note that there is a large degree of uncertainty in the measured values of fundamental flow and transport parameters and the development of methods assigning probability distributions to these parameters is extremely useful, and crucial. Leading researchers in the field routinely refer to my work. Since mathematical inversion is the cornerstone-problem in geophysics, the impact of these works has been high. For example, with my research team, I have successfully used these information-based techniques to effectively image the Edwards Aquifer in Texas. The developed transmissivity field was adopted by the USGS in their most recent model of the aquifer. This is a strategically important aquifer in South Central Texas that is the sole source of water supply for San Antonio.

- I was invited to write a chapter in an AGU monograph series on data integration. This chapter focused on combining thermal and hydrologic methods in groundwater (see Woodbury, 2007) .

- Contributions to the development of MRE and Bayes have been prominently featured in textbooks by Rubin (2003), and Ulrych and Sacchi (2005).
- An earlier paper with Ulrych and Sacchi in 2001 on Bayes has been widely referred to and cited in the geophysical literature.
- Woodbury and Sudicky (1991) is considered a benchmark paper in Groundwater Hydrology, and has become highly cited (over 170 times to date).

LIST OF CONTRIBUTIONS TO ENGINEERING AND SCIENCE

Books/ Monographs

Woodbury, A.D., Combining Thermal and Hydraulic Data for Hydrologic Estimation, Chapter 13, in "Data Integration in Subsurface Hydrology" (D. Hyndman editor), American Geophysical Union Monograph Series, 253 p., ISBN:978-0-87590-437-5, 2007.

Woodbury, A.D., Snelgrove, K., Wen, L., Lin, C., Hejazi, A., and Y. Loukili, Drought predication and vulnerability of aquifers under climate change, In: The 1999-2005 Canadian Prairies Drought: Science, Impacts, and Lessons, Stewart, R. and R. Lawford Editors, Canadian Foundation For Climate and Atmospheric Sciences, 114 p., ISBN 978-9868749-0-1, 2011. DRI

Woodbury, A.D. and W.S. Dunbar (editors), Applications of Krylov Subspace Methods in Geophysics and Hydrology, *unpublished e-version available upon request*. See <http://home.cc.umanitoba.ca/~woodbur/publication.html>

Articles Submitted or In Press

Wang, Z., Assefa, K.A., Woodbury, A.D., Holländer, H.M. (in revision): Improved groundwater recharge estimation from portable, low-cost weather stations, *Groundwater*. 2014

Assefa, K.A., Woodbury, A.D., Holländer, H.M. (in preparation): Impact of soil data parameterization, scaling and conditioning on recharge for climate change studies, *Vadose Zone Journal*. 2014

Hejazi, A., Woodbury, A.D., Loukili, Y. and O.O. Akinremi, (submitted) Coupling a Nitrogen Transport and Transformation Model with the Land Surface Scheme SABAE-HW and Application to the Canadian Prairies, submitted to *Vadose Zone Journal*, 2014

Journal Publications

Assefa, K. A. and A.D. Woodbury, Model evaluation using field data for transient spatially varied groundwater recharge modeling, *Water Resources Research*, 49(8),4593-4606, DOI: 10.1002/wrcr.20332, 2013

Olfman, M., Woodbury, A.D. and J. Bartley, Effects of depth and material property variations on the ground temperature response to heating by a deep vertical ground heat exchanger in purely conductive media, *Geothermics*, 51,9-30, 2014.

Woodbury, A.D., Comment on: Entropy theory for derivation of infiltration equations by V.P. Singh, (2010), *Water Resources Research*, 48, W08802, doi:10.1029/2012WR012322, 2012.

Woodbury, A.D., Minimum relative entropy, Bayes and Kapur, *Geop. J. Int.*, doi: 10.1111/j.1365-246X.2011.04932.x, 2011

Jiang, Y. and A.D. Woodbury, Full-Bayesian, simple zoned inversion and transmissivity assessment of the Edwards Aquifer, Texas, USA, *Managing Groundwater and the Environment, Proc. ModelCARE 2009*, Wuhan, China, IAHS Publ. 341, 2011.

Ulrych, T.J. and A.D. Woodbury, An Occam's razor view of the lead-lag dispute in global warming, *The Leading Edge*; August 2009; v. 28; no. 8; p. 914-917; DOI: 10.1190/1.3192838

Woodbury, A.D., H. Bhuyian, and J. Hanisak, Observations of northern latitude ground-surface and surface-air temperatures, *Geophys. Res. Lett.*, 36, 7, doi:10.1029/2009GL037400, 2009

Loukili, Y., Woodbury, and K. Snelgrove, SABAE-HW – An enhancement of the water balance prediction in the Canadian Land Surface Scheme, *Vadose Zone J.*, 7, 865-877, 2008.

Ferguson, G.A.G. and A.D. Woodbury, The urban heat island in the subsurface, *Geop Res. Lett.*, 34, L23713, doi:10.1029/2007GL032324, 2007

Hendry, M.J. and A.D. Woodbury, Clay aquitards as archives of Holocene paleoclimate: ^{18}O and Thermal Profiling, *Ground Water*, 45(6), 683-691, 2007.

Painter, S., Woodbury A.D., and Y. Jiang, Transmissivity Estimation for Highly Heterogeneous Aquifers: Comparison of Three Methods Applied to the Edwards Aquifer, *Hydrogeology Journal*, 15(2), 315-331, 2007.

Ferguson G., H. Beltrami, A.D. Woodbury, Perturbation of ground surface temperature reconstructions by groundwater flow, *Geophys. Res. Lett.*, 33, L13708, doi:10.1029/2006GL026634, 2006.

Woodbury, A.D. and G.A.G. Ferguson, Ground surface paleotemperature reconstruction by information measures and empirical Bayes, *Geop Res. Let.* Vol 33, DOI:10.1029/2005GL025243, 2006

Jiang, Y. and A.D. Woodbury, A full-Bayesian approach to the inverse problem for steady state groundwater flow and heat transport, *J. Geop. Inter.*, 167(3), 1501-1512, 2006.

Ferguson, G.A.G. and A.D. Woodbury, Observed thermal pollution and post-development simulations of low-temperature geothermal systems in Winnipeg, Canada, *Hydrogeology Journal*, 14(7), 1206-1215, 2006.

Kennedy, P.A. and A.D. Woodbury, Sustainability of the bedrock aquifer systems in south-central Manitoba: Implications for large-scale modeling, *Canadian Water Resources Journal*, 30(4), 281-296, 2005.

Ferguson, G.A.G. and A. D. Woodbury, The effects of climate variability on estimates of recharge from temperature profiles, *Ground Water*, 43(6), 837-842, 2005.

Ferguson, G.A.G. and A. D. Woodbury, Thermal sustainability of groundwater-source cooling in Winnipeg, Manitoba, *Canadian Geotechnical Journal*, 42, 1-12, 2005.

Jiang, Y., Woodbury, A.D. and S. Painter, A full-Bayesian inversion of the Edwards Aquifer, *Ground Water*, 42(5), 724-733, 2004.

Woodbury, A.D., A FORTRAN program to produce minimum relative entropy distributions, *Computers in Geosciences*, 30, 131-138, 2004.

Ferguson, G.A.G., and Woodbury, A.D., Subsurface Heat Flow in an Urban Environment, *Journal of Geophysical Research - Solid Earth*, 109(B02402), 2004.

Ferguson, G.A.G., Woodbury, A.D. and Matile, G.L.D., Estimating Deep Recharge Rates Beneath an Interlobate Moraine using Temperature Logs, *Ground Water*, 41(5), 640-646, 2003.

Ulrych, T. J. and A. D. Woodbury, Extension of minimum relative entropy for noisy data, *Journal of Contaminant Hydrology*, 67(1-4), 13-25, 2003.

Zhang, K., and A. D. Woodbury, A Krylov finite element approach for multi-species contaminant transport in discretely fractured porous media, *Advances Water in Water Resources*, 25 (705-721), 2002.

Kennedy, P. L. and A.D. Woodbury, Geostatistics and Bayesian updating for transmissivity estimation in a multiaquifer system in Manitoba, Canada, *Groundwater*, 40(3), 273-283, 2002.

Ulrych, T.J., Sacchi, M. and A.D. Woodbury, A Bayes tour of inversion: A tutorial, *Geophysics*, 66(1), 55-69, 2001.

Woodbury, A.D. and K. Zhang, Application of the Lanczos reduction method for the long term simulation of groundwater flow in discretely fractured media, in press, *Adv. Water Res.*, 2001.

Zhang, K. and A. D. Woodbury, The Arnoldi reduction technique for efficient direct solution of radionuclide decay chain transport in dual-porosity media, *J. Cont. Hydrol.*, 44, 387-416, 2000

Woodbury, A.D., Y. Rubin, A full-Bayesian approach to parameter inference from tracer travel-time moments, *Water Resources Research*, 36(1), 159-171, 2000.

Ulrych, T.J., Velis, D.R., and A.D. Woodbury, L-moments and C-moments, *Stoch. Envir. Res & Risk Assess.*, 14(1), 50-68, 2000.

Woodbury, A.D., and T.J. Ulrych, A full-Bayesian approach to the groundwater inverse problem for steady state flow, *Water Resources Research*, 36(8), 2081-2093, 2000.

Zhang, K. and A. D. Woodbury, The Arnoldi reduction technique for efficient direct solution of radionuclide decay chain transport in dual-porosity media, *J. Cont. Hydrol.*, 44, 387-416, 2000.

Zhang, K., A. D. Woodbury, and W. S. Dunbar, Application of the Lanczos algorithm to the simulation of groundwater flow in dual-porosity media, *Adv. Water Res.*, 23, 579-598, 2000.

Kennedy, P.L., Woodbury, A.D. and K. Wang, Minimum relative entropy: theory and application to surface temperature reconstruction from borehole temperature measurements, *Geop. Res. Letters*, 27(19), 3081-3085, 2000.

Langer, V., Novakowski, K, and, A.D. Woodbury, Trichloroethene sorption onto stylolites, *Journal of Contaminant Hydrology*, 40, 1-23, 1999.

Li, H., Woodbury, A.D., and P. Aitchison, Application of the unsymmetric Lanczos reduction method to the radionuclide decay chain transport in porous media, *Num. Meth. Appl. Mech. Eng.*, 44, 355-372, 1999.

Li, H., P. Aitchison, and A.D. Woodbury, Methods for overcoming breakdown problems in the unsymmetric Lanczos reduction method applied to contaminant transport problems, *Num. Meth. Appl. Mech. Eng.*, 42, 389-408, 1998.

Li, H., Woodbury, A.D., and P. Aitchison, Eigenvalue translation method for stabilizing an unsymmetric Lanczos reduction process, *Num. Meth. Appl. Mech. Eng.*, 43(2), 221-240, 1998.

Woodbury, A.D., Sudicky, E.A., Ulrych, T.J. and R. Ludwig, Three-dimensional plume source reconstruction using minimum relative entropy inversion, *J. Cont. Hydrol.*, 32, 131-158, 1998.

Woodbury, A.D. and T.J. Ulrych, Minimum relative entropy and probabilistic inversion in groundwater hydrology, *Stochastic Hydrology and Hydraulics*, 12, 317-358, 1998.

Woodbury, A. D., and T. J. Ulrych, Reply to: "Comment on: Minimum relative entropy inversion: Theory and application to recovering the release history of a groundwater contaminant by Kabala and Skaggs", *Water Resources Research*, 34(8), 2081-2084, 1998.

Woodbury, A.D., Review of "Introduction to Geostatistics: Applications to Hydrogeology, by Peter Kitanidis, Cambridge University Press, 1997", *Journal of Hydrology*, 208, 280-282, 1998.

Farrell, D.A., Woodbury, A.D., and E.A. Sudicky, Numerical modeling of the advection dispersion equation: A comparison of the Laplace Transform Galerkin and Arnoldi methods, *Advances in Water Resources*, 21,217-235, 1997.

Woodbury, A. D., A probabilistic fracture transport model: Application to siting a municipal landfill on a fractured clay deposit, *Can. Geot. J.*, 34, 784-798, 1997.

Woodbury, A.D., and T.J. Ulrych , Minimum relative entropy inversion: Theory and application to the source release history of a groundwater contaminant, *Water Resources Research*, 32(9), 2671-2681, 1996.

Woodbury, A.D., F.W. Render and T.J. Ulrych, Practical probabilistic groundwater modeling, *Groundwater*, 33(4), 532-538, 1995.

Farrell, D., Woodbury, A.D., Sudicky, E.A. and M. Rivett, Stochastic and deterministic analysis of dispersion in unsteady flow at the Borden Tracer-Test site, Ontario, Canada, *Contaminant Hydrology*, 15, 159-185, 1994.

Farrell, D., Woodbury, A.D., and E.A. Sudicky, The 1978 Borden tracer experiment: Analysis of spatial moments, *Water Resources Research*, 30(11), 3213-3223, 1994.

Dunbar, W.S., Woodbury, A.D. and B. Nour-Omid, Comment on: On time integration of groundwater flow equations by spectral methods, by: G. Gambolati, *Water Resources Research*, 30(7), 2347-2352, 1994.

Woodbury, A.D. and T. J. Ulrych, Minimum relative entropy: Forward probabilistic modeling, *Water Resources Research*, 29(8), 2847-2860, 1993.

Woodbury, A.D., and E.A. Sudicky, Inversion of the Borden tracer experiment data: Investigation of stochastic moment models, *Water Resources Research*, 28(9), 2387-2398, 1992.

Woodbury, A.D., Dunbar, W.S., and B. Nour-Omid , Correction to "Application of the Arnoldi algorithm to the solution of the advection-dispersion equation", *Water Resources Research*, 28(5), 1501, 1992.

Nour-Omid, B., Dunbar, W.S. and A.D. Woodbury, Application of Lanczos and Arnoldi techniques to the solution of the convection-diffusion equation, *Comp. Meth. Appl. Mech. Eng.*, Vol. 88, 75-95, 1991.

Woodbury, A. D. and E. D. Sudicky, The geostatistical characteristics of the Borden Aquifer, *Water Resources Research*, 27(4), 533-546, 1991.

Woodbury, A. D., Narod, B., Chandra, B., and B. Bennist, Temperature measurements in geotechnical studies using low-noise high-resolution digital techniques, *Canadian Geotechnical Journal*, 28(5), 639-649, 1991.

Dunbar, W.S. and A.D. Woodbury, Application of the Arnoldi Algorithm to mass transport in geologic media, *Transport And Mass Exchange Processes In Sand And Gravel Aquifers: Field and Modeling Studies*, G. Moltyaner, Editor, Proc. Int. Conference and Workshop, Ottawa, Canada, 505-515, 1990.

Woodbury, A.D., Dunbar, W.S., and B. Nour-Omid , Application of the Arnoldi algorithm to the solution of the advection-dispersion equation, *Water Resources Research*, Vol. 26(10), 2579-2590, 1990.

Smith, L., C.B. Forster, and A.D. Woodbury, Numerical simulation techniques for modeling advectively disturbed thermal problems, *Hydrogeologic Regimes and Their Subsurface Thermal Effects*, Editors A. E. Beck, G. Garven and L. Stegena, AGU Monograph Series, Vol 47/IUGG 7, p 1-6, 1989.

Woodbury, A.D., Bayesian updating revisited, *Mathematical Geology*, Vol 21(3), 285-308, 1989.

Dunbar, W.S. and A.D. Woodbury, Application of the Lanczos algorithm to the solution of the groundwater flow equation, *Water Resources Research*, Vol 25(3), 551-558, 1989.

Woodbury, A.D., and J.L. Smith, Simultaneous inversion of temperature and hydraulic head data, 2. Application with thermal data, *Water Resources Research*, Vol 24(3), 356-372, 1988.

Woodbury, A.D., J. L. Smith, and W.S. Dunbar, Simultaneous inversion of temperature and hydraulic head data, 1. Theory and application using hydraulic head data, *Water Resources Research*, Vol 23(8), 1586-1606, 1987.

Woodbury, A.D., and J.L. Smith, On the thermal effects of three dimensional groundwater flow, *Journal of Geophysical Research*, Vol 90(B1), 759-767, 1985.

Woodbury, A.D., and J.L. Smith, Application of finite element techniques to heat flow investigations within sedimentary basins, *Proc. 5th, Int. Conf. Finite Elements in Water Resources*, Editors J.P. Laible, C.A. Brebbia, W. Gray, G. Pinder, Springer-Verlag, 701-713, 1984.

Kennedy, L.A., and A.D. Woodbury, The Hat Creek Coal Deposit: A geophysical case history, *Geoexploration*, 21, 19-48, 1983.

Selected Conference Proceedings and Presentations

Holländer, H.M., Assefa, K.A., Wang, Z., and Woodbury, A.D: Groundwater recharge modelling using low-cost measurement technique. Conference DGG-Section Hydrogeology, Bayreuth, Germany, 28.-31.05.2014.

Assefa, K.A., Woodbury, A.D., and Holländer, H.M: Impact of soil data parameterization on recharge for climate change studies. EGU General Assembly 2014, Vienna, Austria, 27.04.-02.05.2014, *Geophysical Research Abstracts*, 16:14988.

Assefa, K.A., Holländer, H.M., and Woodbury, A. (2013): Impacts of Single and Dual Porosity on Groundwater Recharge Modelling Under Changing Climate. 2013 Joint Scientific Congress "Bridging Environmental Science, Policy and Resource Management", Saskatoon, Saskatchewan, Canada, 26.05.-30.05.2013.

Assefa, K.A., Holländer, H.M., Wie, A.X., and Woodbury, A. (2013): Water resources sustainability under changing climate and land use conditions in Northern Okanagan. 2013 Joint Scientific Congress "Bridging Environmental Science, Policy and Resource Management", Saskatoon, Saskatchewan, Canada, 26.05.-30.05.2013.

Wang, Z., Assefa, K.A., Woodbury, A.D., and Holländer, H.M. (2013): Recharge Estimation as a Base for Nutrient Transport Problems in Southern Abbotsford, Canada. IAH 2013, Perth, Australia, 15.-20.09.2013.)

Hejazi, A. and A.D. Woodbury, Modeling Energy and Water budgets in the soil-vegetation-atmosphere system using land surface scheme SABAE-HW, GeoHydro 2011, IAH conference, 2011. CWN, DRI

Assefa, K.A. and A.D. Woodbury, Groundwater Recharge Modeling for transient groundwater models, and Water Resource Sustainability under the impacts of Climate Change and Increasing Water Demand: MIKESHE, presentation workshop UBCO - Dec 2011.

Assefa, K.A. and A.D. Woodbury, Groundwater Recharge Modeling: Linkage to Deep Aquifers and Implications for Stream Transport and Nutrient Impacts in Receiving Waters, presentation to CWN workshop, Waterloo University- May 2011.CWN

Hejazi, A. and A.D. Woodbury, Modeling Snow Depth, Soil Temperature, Soil Moisture and Nitrate Transport in a Soil Groundwater-Atmosphere System Using the Land Surface Scheme SABAE-HW, Canadian Water Network annual conference, February 2011

Olfman, M. and A.D. Woodbury, Analytic solution for modeling of the ground heat exchanger and groundwater system, AGU Fall meeting, 2009.

Jiang, Y., and A.D. Woodbury, Bayesian, Pest Inversion and transmissivity assessment of the Edwards Aquifer, Texas, USA, ModelCARE 2009, The 7th International Conference on Calibration and Reliability in Groundwater Modeling Wuhan, China September 20-23, 2009

Woodbury, A.D., and K. Snelgrove, Drought prediction and vulnerability of aquifers under climate change, Drought Research Initiative Workshop, Calgary, January 2008.

Allan D. Woodbury, AKM Hassan Bhuiyan, John Hanesiak and Grant Ferguson, Observations of Northern Latitude Ground-Surface and Surface-Air Temperatures, EGU annual conference, Vienna Austria, April 2008.

Allan D. Woodbury, AKM Hassan Bhuiyan, John Hanesiak, Observations of Northern Latitude Ground-Surface and Surface-Air Temperatures 42nd annual CMOS Conference, Kelowna, BC, May 25 – 29, 2008

Loukili, Y. and A.D. Woodbury, SABAE-HW3D: a Meteor-Hydrological Model Coupling the Land Surface to Groundwater Flow, 88(52), Fall Meet. Suppl., Abstract H33C-1449.

Ferguson, G.A. and Woodbury, A.D. 2007. Thermal Use of Groundwater and Source Water Protection. 35th IAH Congress, Lisbon, Portugal, Sept 2007.

Loukili, Y., Woodbury, A.D. and K.R. Snelgrove, AccuCLASS - an Enhancement of the Canadian Land Surface Scheme for Climate Assessment Over the Prairies, Eos Trans. AGU, 87(52), Fall Meet. Suppl., 2006.

Woodbury, A.D., Hendry J., and G.A.G. Ferguson, Ground surface paleotemperature reconstruction by empirical Bayes: Application to thick clayey aquitards, Geological Society America, 2005 Salt Lake City Annual Meeting (October 16–19, 2005)

Ferguson, G.A.G, Woodbury, A.D. and H. Beltrami, When is groundwater flow and important consideration in ground surface temperature reconstruction? American Geophysical Union, Fall Meeting, 2005.

Woodbury, A.D., Snelgrove, K.R., Loukili, Y., and S. Yirdaw-Zeleke, Climate change assessment over the Assiniboine Delta Aquifer, Geological Society America, 2005 Salt Lake City Annual Meeting (October 16–19, 2005, Invited)

Ferguson, Grant A.G. and A.D. Woodbury, Factors Affecting the Sustainability of Groundwater-Source Cooling, 2004 Fall Meeting, AGU, 2004.

Woodbury, A.D., Workshop on Sustainable Water Resources, Barbados, May 2003 (invited).

Zhang, K. and A.D. Woodbury, Arnoldi reduction method for simulation of multi-species contaminant transport in discretely fractured media, Geologic Society America Annual Meeting, November, 2003 (invited).

Woodbury, A.D., Full-Bayesian inversion of the Edwards Aquifer, Texas Geologic Society America Annual Meeting, November, 2003.

Ferguson, Grant A.G. and Woodbury, Allan D., Advective Heat Flow Beneath Winnipeg, Manitoba, 4th Annual Joint CGS-IAH Conference. Winnipeg, Manitoba, Sept. 29-Oct. 1, 2003.

Rubin, Y., Chen, J., Hubbard, S., Kowalsky, M.B. and A.D. Woodbury, A structured approach to Bayesian data fusion, 2002 Fall Meeting AGU, 2002.

Painter, S L, Jiang, Y. and A.D. Woodbury, Estimating transmissivity in the Edwards Aquifer using upscaling, geostatistics, and Bayesian updating, 2002 Fall Meeting AGU, 2002.

Ferguson, G.A. and Woodbury, A.D., Groundwater and Heat Flow in an Interlobate Moraine in Southeastern Manitoba, Institute on Lake Superior Geology 2002 Annual Meeting, May 12-16, Kenora, Ontario, p. 15., 2002.

Ferguson, G.A. and Woodbury, A.D., Heat Flow, Climate Change and Advective Heat Transfer Beneath Winnipeg, Canada Eos Trans. AGU, 83(47), Fall Meet. Suppl., Abstract G51A-0953, 2002.

Ferguson, G.A. and Woodbury, A.D., Geothermal Investigations in Southeastern Manitoba and Their Application to Hydrogeology, Presented at The Southeastern Manitoba Hydrogeology Workshop, Nov. 28, 2002.

Zhang, K., and A. D. Woodbury, Application of the Lanczos reduction method for the long term simulation of groundwater flow in discretely-fractured porous media, Proc. XIII International Conference on Computational Methods in Water Resources, Calgary, AB, 2000.

Kennedy, P.A. and Woodbury, A.D., Application of Minimum Relative Entropy to recover past climate changes from borehole temperature measurements, EOS Trans. AGU 80(46), F83, 1999.

Woodbury, A.D. and T.J. Ulrych, A full-Bayesian approach to the groundwater inverse problem for steady state flow, EOS Trans. AGU 80(46), F319, 1999.

Woodbury, A.D., Simultaneous inversion of thermal and hydrologic data: Where do we go from here, EOS Trans. AGU 80(46), F337, 1999 (invited)

Woodbury, A.D., Minimum relative entropy and probabilistic inversion, Proc. HKK Conference, Waterloo, Ontario, 1999 (invited).

Woodbury, A.D., A Full-Bayesian Approach to Parameter Inference from Tracer Travel-Time Moments, National Water Well Association, Las Vegas, Dec., 1998 (invited).

Woodbury, A.D., and H. Li, The Arnoldi-finite element method for solving transport of reacting solutes in porous media, First Int. Conference Chlorinated and Recalcitrant Compounds, Monterey, California, May 1998 (invited).

Zhang, K., Woodbury, A.D., and W.S. Dunbar, Lanczos algorithm for the simulation of groundwater flow in fractured porous media using the dual-porosity approach, Intern. Symposium for Dynamics of Fluids in Fractured Rocks, Berkeley, California, 1998.

Yeung, D. and A. D. Woodbury, A geostatistical analysis of the Assiniboine Delta Aquifer, EOS Transactions, American Geophysical Union, 1994 Fall Meeting, Vol 75, No. 44, Nov., 1994 (invited).

Woodbury, A. D., Ulrych, T.J. and E.A. Sudicky, Minimum relative entropy inversion: Theory and application to recovering the release history of a groundwater contaminant, EOS Transactions, American Geophysical Union, 1994 Fall Meeting, Vol 75, No. 44, Nov., 1994.

Farrell, D.A., Woodbury, A. D., and E.A. Sudicky, Numerical modeling of the advection dispersion equation: Laplace Transform Galerkin and Arnoldi methods, EOS Transactions, American Geophysical Union, 1993 Fall Meeting, Vol 74, No. 44, Oct., 1993.

Dunbar, W.S. and A. D. Woodbury, Mass transport subdomain algorithms, Conference On Porous Media and the Environment, May 1993, University of Manitoba.

Farrell, D.A., Woodbury, A. D., and E.A. Sudicky, Numerical modeling of the advection dispersion equation: Laplace Transform Galerkin and Arnoldi methods, EOS Transactions, American Geophysical Union, 1993 Fall Meeting, Vol 74, No. 44, Oct., 1993.

Woodbury, A. D., and T. J. Ulrych, Minimum relative entropy: Forward probabilistic modeling, American Geophysical Union, San Francisco. December, 1992.

Farrell, D., Woodbury, A. D., Sudicky, E.A. and M. Rivett, Geostatistical analysis of the fluctuating water levels at the Borden Aquifer, American Geophysical Union, San Francisco, December, 1991.

Woodbury, A. D., Reduced Basis Methods in Groundwater Analysis, Gordon Research Conference on Flow in Porous Media, New Hampshire, August, 1990 (invited).

Dunbar, W.S. and A. D. Woodbury, Application of the Arnoldi Algorithm to mass transport in porous media, Proc. of Transport and Mass Exchange Processes in Sand and Gravel Aquifers: Field and Modeling Studies, AECL, Ottawa, October, 1990.

Woodbury, A.D., Dunbar, W.S., and B. Nour-Omid, Linear and Non-linear solutions to the advection dispersion equation by the Arnoldi Method, American Geophysical Union, San Francisco, December, 1989.

Woodbury, A.D., Dunbar, W.S., and B. Nour-Omid , Application of the Arnoldi algorithm to the solution of the advection dispersion equation, American Geophysical Union, San Francisco, December, 1988.

Dunbar, W.S. and A.D. Woodbury, Application of spectral decomposition techniques in the solution of the groundwater flow equation, American Geophysical Union, San Francisco, December, 1987.

Woodbury, A.D., Bayesian updating revisited, American Geophysical Union, San Francisco, December, 1987.

Smith, L., C.B. Forster, and A.D. Woodbury, Numerical simulation techniques for modeling advectively disturbed thermal problems, 19th. Conference of: International Union of Geodesy and Geophysics, Vancouver, Canada, August, 1987.

Dunbar, W.S. and A.D. Woodbury, Semi-analytic solution to the heat convection equation, 5th. International Conference on Numerical Methods in Thermal Problems, Montreal, July, 1987.

Woodbury, A.D, Inverse theory and model identifiability: An overview, Canadian Engineering Centennial Convention, Montreal, May, 1987.

Woodbury, A.D. and J.L. Smith, Simultaneous inversion of hydrogeologic and thermal data, American Geophysical Union, San Francisco, December, 1986.

Woodbury, A.D., and J.L. Smith, Application of finite element techniques to heat flow investigations within sedimentary basins, Proc. 5th, Int. Conf. Finite Elements in Water Resources, Editors J.P. Laible, C.A. Brebbia, W. Gray, G. Pinder, Springer-Verlag, p. 701-713, 1984.

Woodbury, A.D., and J.L. Smith, Computer simulation of thermal-fluid interactions in three dimensional sedimentary basins, 19th Annual Western Inter-University Geological Conference, Vancouver, January, 1983.

Woodbury, A.D. and J.L. Smith, Thermal effects of three dimensional groundwater flow, Geological Association of Canada, Victoria, May, 1983.

Woodbury, A.D. and J.L. Smith, Thermal effects of three dimensional groundwater flow, American Geophysical Union, San Francisco, December, 1983.

Woodbury, A.D., and L.A. Kennedy, Engineering geophysics of the Hat Creek Coalfield, Geological Society of America, Toronto, October, 1978.

Theses Supervised

Assefa, K.A., Impact of soil data parameterization, scaling and conditioning on recharge for climate change studies, *PhD Thesis* 2013

Alireza Hejazi, Coupling Nitrogen Transport and Transformation Model with Land Surface Scheme SABAE-HW and its Application on the Canadian Prairies, PhD Thesis, 2012.

Maier Olfman, Characterization of the Ground Thermal Response to Heating by a Deep Vertical Borehole Heat Exchanger, MSc Thesis, 2012.

Ferguson, G.A.G. Groundwater and Heat Flow in Southeastern Manitoba: Implications For Water Supply and Thermal Energy, Ph.D. Thesis, University of Manitoba, 2004.

Kennedy, P.A. Groundwater Flow and Transport Model of the Red River/Interlake Area in Southern Manitoba, Ph.D. Thesis, University of Manitoba, 2003.

Jiang, Yefang, A Bayesian approach to the groundwater inverse problem for steady state flow and heat transport, M.Sc. Thesis, University of Manitoba, 107pp., 2002.

McMillan, R., Investigation of Seepage from Earthen Animal Manure Storages. BSc Thesis, University of Manitoba, 2000.

Zhang, K., The Modal Reduction Method For Simulation Of Groundwater Flow and Multi-species Contaminant Transport In Fractured Porous Media, PhD Thesis, University of Manitoba, 2000 (Now postdoctoral fellow at Lawrence Berkeley labs).

Langer, V., Investigation of Trichloroethene Transport in Fractured Porous Media with Emphasis on Sorption onto Styrolites and Matrix Diffusion, PhD Thesis, University of Manitoba, 1999 (Now a postdoctoral fellow at University of Switzerland).

Bell, J., Three-dimensional Hydrostratigraphic Modeling of Manitoba for the Purpose of Large Scale Groundwater Modeling BSc Thesis, University of Manitoba, 1999 (Now at Friesen Drillers, Steinbach, MB).

Farrell, D., An Assessment Of The Role Of Transient Flow On The Dispersion Of Non-reactive Solutes In Porous Media: A Numerical Study, PhD Thesis, University of Manitoba, 1997 (Now at University of the West Indies, Barbados).

Li, H., Unsymmetric Lanczos reduction method for the numerical solution to contaminant transport in porous media, PhD Thesis University of Manitoba, September, 1996 (now at Sun-Life, Boston).

Allard, R., A groundwater modeling application for a groundwater flow problem for a shallow unconfined aquifer in Borno State, Nigeria, M.Eng. Thesis, 1994 (Now at Piteau & Associates, Kelowna, B.C.).

Mann, A., The spatial and statistical hydraulic conductivity distributions of the Assiniboine Delta Aquifer, BSc Thesis, 1994 (Now at Golder Associates, Winnipeg).

Hudyma, N., A simple mathematical model for predicting ground temperatures, BSc Thesis, 1992, (now Associate Professor, U. North Florida).

Selected Technical Reports

Song, H. and Woodbury, A.D., Simulation of chlorinated solvent transport and remediation performance assessment at the Rockwood propellant plant, Manitoba, Department of Civil and Geological Engineering, October, 1998.

Rainy Hollow Contaminant Transport Modeling, 1997, report to UMA Engineering Ltd.

Hydrogeologic review: Proposed tailings disposal system, McClean Lake Project, Cogema Resources Inc. Phase I, Phase II", 1997, report to Saskatchewan Environment.

Hydrogeological Review: Proposed Integrated Waste Management Facility In The Rural Municipality of Rosser, Report to UMA Engineering, November, 1995.

Groundwater Contamination And Qualitative Risk Assessment: Brewster Garage Banff, Alberta, report to UMA Engineering Ltd., July, 1996.

Rural Municipality of East St. Paul, Groundwater Study of the Spring Hill Discharge Zone, by A. D. Woodbury, 1995;

Groundwater Study of the Moosenose Ridge Aquifer, Manitoba, report to ID Engineering Canada Inc., by A. D. Woodbury, 1994;

Rural Municipality of East St. Paul – Groundwater Study, Parts 1 and 2 by A.D. Woodbury, 1992.

CURRICULUM VITAE



Jamie VanGulck, Ph.D., P.Eng.

Principal, Chief Technical Officer

Ph: 867 446 4129; Fax: 1 866 475 1147

E-mail: vangulck@arktissolutions.com

EDUCATION

- Ph.D., Geotechnical and Geoenvironmental Engineering, Department of Civil Engineering, Queen's University
- B.E.Sc., Civil and Environmental Engineering University of Western Ontario

EMPLOYMENT HISTORY

- ARKTIS Solutions Inc., Chief Technical Officer
- ARKTIS Piusitippaa Inc., Chief Technical Officer
- VGQ Consulting Inc., Director
- University of Manitoba, Department of Civil Engineering, Adjunct Professor
- University of Manitoba, Department of Civil Engineering, Assistant Professor
- Geotechnical Research Centre, University of Western Ontario, Research Contractor

PROFESSIONAL SOCIETIES

- Association of Professional Engineers, Geologist & Geophysicists of NWT & Nunavut
- Association of Professional Engineers of Yukon

SUMMARY OF EXPERIENCE

Prior to being a co-founder for Arktis Solutions Inc., Jamie worked as an Assistant Professor in the Department of Civil Engineering at the University of Manitoba. Jamie left academia to become a private consultant to link business and research opportunity to the science and engineering sectors and resulted in the development of VGQ Consulting Inc.

Jamie is the Chief Technical Officer with Arktis Solutions Inc. and lead engineer within the organization. Jamie's roles include contributing to the strategic, business and financial operations of the organizations, as well as, lead technical resource and project management.

Jamie has more fifteen years of experience in the following areas: geotechnical, environmental, and geoenvironmental engineering; mining; hydrogeology; northern infrastructure development; policy and regulatory review and development; and research and development. He has authored and co-authored numerous technical papers in various refereed journals and conferences. Additionally, he has contributed to the development of regulations and guidance documents for Government and Aboriginal organizations in the sectors of mining and municipal infrastructure.

Jamie specializes in cross-disciplinary design and analysis which has led to fluid collaborations with multi-disciplinary and multi-sector teams. He has acted as an expert technical reviewer of: northern mining and site remediation projects; contaminated site clean up projects; and municipal infrastructure design and construction projects. Additionally, Jamie has been: a lead designer and project manager for municipal infrastructure projects; and, instructor for drinking water treatment, waste water treatment and solid waste management courses for community operators.

PROJECTS BY SECTOR

MINING

- **Aboriginal Affairs and Northern Development Canada (NT)** – Expert technical reviewer of the Tyhee Gold Project environmental impact assessment. Review focused on geotechnical and hydrogeological aspects of the project, as well as, water quality and quantity of surface water and groundwater from the mine site and tailings containment facility.
- **Government of the Northwest Territories (NT)** – Expert technical reviewer of Avalon Rare Metals Inc.'s Nechalacho Rare Earth Metals Project Type A Water Licence application. Review focused on tailings management, tailings pond design, geochemistry, closure and reclamation and financial security.
- **Government of the Northwest Territories (NT)** – Expert technical reviewer of North American Tungsten Corporation's Cantung Mine Type A Water Licence amendment application. Review focused on tailings management, tailings pond design and geochemistry.
- **Qikiqtani Inuit Association (NU)** – Project lead in the development of the 2013 and 2014 financial security assessment for the Baffinland Iron Mines Corporation Mary River project on behalf of the land owner. Expert technical lead in regulatory and lease negotiations and workshops pertaining to financial security.
- **Qikiqtani Inuit Association (NU)** – Technical resource and lead in the completion of an annual environmental audit of the Baffinland Iron Mines Corporation Mary River project in 2009 to 2014. Development of a site inspection protocol to evaluate site conditions in relation to environmental and lease requirements.
- **Qikiqtani Inuit Association (NU)** – Environmental impact assessment and regulatory expert technical reviewer for the Baffinland Iron Mines Corporation proposed iron mine from 2011 to 2013. Project manager of the Environmental Assessment team in the topics of socio-economics, terrestrial, marine, aquatic resources, engineering and regulatory.
- **Qikiqtani Inuit Association (NU)** – Expert technical reviewer of the abandonment and restoration plan and security estimate for Baffinland Iron Mines Corporation Mary River Bulk Sampling Program. Development of the 2010 financial security estimate for the landowner.
- **Qikiqtani Inuit Association (NU)** – Expert technical and regulatory review of the Baffinland Iron Mines Corporation Type A and Type B water licence applications from 2008 to 2014.
- **Parks Canada Agency (NT)** – Expert technical reviewer of the Canadian Zinc Corporation, Prairie Creek environmental impact assessment. Review focused on winter road construction and geotechnical stability, spill contingency and risk, geochemistry of tailings predictions, and mine water management and treatment. Assisted in the development of information requests on behalf of Parks Canada Agency for submission to Mackenzie Valley Environmental Impact Review Board.
- **DeBeers Canada (NT)** – Engineering lead in the development of a closure and reclamation plan in 2011 and update in 2013 for the Snap Lake mine in Northwest Territories. Expert witness at the water licence public hearing. Organized and facilitated community engagement workshop regarding mine closure planning.
- **DeBeers Canada (NT)** – Engineering lead in the development of mine closure financial liability estimate for the Snap Lake mine in the Northwest Territories in 2011 and updated in 2013. Expert witness at the water licence public hearing.
- **DeBeers Canada (NT)** – Research and development engineering lead associated with closure and reclamation of the Snap Lake mine in Northwest Territories from 2010 to 2014. Focus of R&D is



associated with cover performance for the waste rock/tailings pile, progressive reclamation of impacted land, revegetation and contaminated site investigations and reclamation action plans.

- **DeBeers Canada (NT)** – Project manager for the 2013 implementation assessment of the four separate impact benefit agreements in place between De Beers and the local First Nations for the Snap Lake mine.
- **DeBeers Canada (NT)** – Project manager and technical resource to complete a dam feasibility study, and the engineering design and construction tender documents for two water retention dams at the Snap Lake mine.
- **DeBeers Canada (NT)** – Project manager and technical lead for the preliminary design of a quarry and water retention sump, as well as, a water balance and chemical load balance model for the sump at the Snap Lake mine.
- **DeBeers Canada (NT)** – Project manager for the development of emergency preparedness and emergency response plans for two dams at the Snap Lake mine.
- **DeBeers Canada (NT)** – Closure and reclamation workshop facilitator at the Gahcho Kue mine.
- **Huckleberry Mines Ltd (BC)** – Project manager in the evaluation of mine water quality and sources of nutrients in mine water.
- **Yellowknives Dene First Nation (NT)** – Expert technical reviewer in the evaluation of the Giant mine’s environmental impact assessment. Technical review focused on water quality, waste management, and site closure conditions.
- **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Great Slave Lake Mines, NWT Remedial Action Plan.
- **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Tundra Mine, NWT Remedial Action Plan.
- **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Hidden Lake Mine, NWT Remedial Action Plan.
- **Tlcho Government (NT)** – Technical resource development consultant and contributed to the regulatory and technical review of Proponent information in their advancement towards entering into an environmental assessment.
- **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer for the Phase II Remedial Action Plan for the Tundra Mine Site that included reclamation and closure of: tailing containment area for ARD/ML tailings and waste rock, site water management and treatment, petroleum hydrocarbon contaminated soil and rock. Lead engineer in technical/regulator meetings with proponent and participant in the public hearing. Assisted in the development of the water licence.
- **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer for the Miramar Northern Mining Ltd. Con Mine closure plans for backfill and cover of the tailings containment ponds and hazardous waste areas.
- **Mackenzie Valley Land and Water Board (NT)** – Project manager for a team of scientist and engineers in the water licence review of the North American Tungsten Corporation mine in the NWT. Technical lead in the review of surface infrastructure, hydrologic, hydrogeologic, geochemistry, abandonment and reclamation, and security components. Lead engineer in technical/regulator meetings with proponent and participant in the public hearing. Assisted in the development of the water licence.



- **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer of the following De Beer’s Snap Lake mine engineering documents pertaining to the waste rock, ore storage and tailings management.
- **Lutsel K’e Dene First Nation (NT)** – Expert technical reviewer for following BHP Billiton Diamonds Inc. – EKATI diamond mine engineering documents pertaining to adaptive management, closure and reclamation, financial security, waste rock and tailings management.
- **Lutsel K’e Dene First Nation (NT)** – Expert technical reviewer for the following Diavik Diamond Mine Inc. – management documents pertaining to hazardous materials and spill contingency.
- **Lutsel K’e Dene First Nation (NT)** – Participated in Deze Energy Corporation Taltson Hydroelectric Expansion Project, Environmental Impact Assessment technical sessions organized by the Mackenzie Valley Environmental Impact Review Board.
- **Mackenzie Valley Environmental Impact Review Board (NT)** - Project manager for the socio-economic review of the proposed Gahcho Kué diamond mine in the NWT.
- **Saskatchewan Environment Resource Management (SK)** – Expert technical reviewer of groundwater and brine migration model predictions below the Cory, Mosaic, Mosaic K1, Mosaic K2, and Patience Lake, Saskatchewan potash mines during operation and post-closure.
- **Nunavut Water Board (NU)** – Expert technical reviewer and licence compliance assessor for the Miramar Hope Bay Limited Windy Lake and Boston Exploration Camps, specifically, the water monitoring program, QA/QC plan, annual reporting, and abandonment and restoration plan.
- **Nunavut Water Board (NU)** – Technical reviewer of the following Tahara Diamond Corporation- Jericho Diamond Mine application documents for water licence consideration.
- **Nunavut Water Board (NU)** - Technical reviewer of the following Miramar Hope Bay Limited- Doris North Gold Mine application documents for water licence consideration.
- **UMA Engineering Ltd. (MB)** - Chemical treatment of mine water effluent at the closed Fox Lake, Manitoba.
- **INCO LTD. (MB)** - Contributed to the characterization and trial revegetation of mine tailings at INCO Ltd., Thompson, Manitoba.
- **INCO LTD., Manitoba Sustainable Development Innovation Fund, and University of Manitoba (MB)** - Field and laboratory measurement of unconsolidated and cemented (hard-pan) tailings hydraulic properties and implications on metal leachate and acid mine drainage.
- **Manitoba Mines Branch, Manitoba Sustainable Development Innovation Fund, and University of Manitoba (MB)** - Assessment of attenuation and potential mobility of arsenic at the abandoned New Britannia Mine, Manitoba.
- **Federal University of Rio Grande do Sul, Brazil and University of Manitoba (MB and Brazil)** – Project manager and engineering advisor in the assessment of contaminant transport properties through compacted soil liners subjected to acid mine drainage percolation.
- **Federal University of Rio Grande do Sul, Brazil and University of Manitoba (MB and Brazil)** - Project manager and engineering advisor in the measurement of geotechnical strength characteristics of residual soils, with and without cement additives, subjected to acid mine drainage percolation.

OIL AND GAS

- **Government of the Northwest Territories (NT)** – Expert technical reviewer of Imperial Oil Limited’s Norman Wells Production Facility security estimate. Expert advisor regarding financial security and closure and reclamation of the facility.



- **Aboriginal Affairs and Northern Development Canada (NT)** – Review and update of the existing RECLAIM model used in the NWT for estimating reclamation liabilities at oil & gas sites through to oil & gas production sites.
- **Inuvialuit Water Board (NT)** – Expert technical and regulatory assessment of Imperial Oil Limited’s Type B water licence application pertaining to the reclamation of Bar-C in the Inuvialuit Settlement Region.
- **Inuvialuit Water Board (NT)** – Expert technical and regulatory assessment of Shell Canada’s Closure and Reclamation Plan for the Camp Farewell site.
- **Government of Northwest Territories – Environment and Natural Resources (NT)** – Expert technical reviewer of Oil & Gas Drilling Waste Disposal Practices for the Proposed Type A Water Licence in the Cameron Hills, NWT Region. Expert technical witness during the water licence public hearing.
- **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer for Paramount Resources Ltd. water licence and land use permit application materials to support their Cameron Hills extension project.
- **Department of Indian Affairs and Northern Development (NT)** – Technical and regulatory reviewer for the Paramount Resources Ltd. Cameron Hills Type ‘B’ Water Licence Application that included aspect to evaluate impacts on surface water quality and quantity.
- **Northwest Territories Water Board (NT)** - Preliminary technical review of Shell Canada Ltd. Camp Farewell, NT Environmental Site Assessment.
- **Northwest Territories Water Board (NT)** - Preliminary technical review of MGM Energy Corporation 2D, 3D, and seismic drilling operations and review of draft water licence conditions.

REGULATORY

- **Northwest Territories Water Board (NT)** – Expert technical reviewer for the Inuvik to Tuktoyuktuk all-weather highway project. Acted as regulatory officer throughout the licensing process, and prime expert witness during the water licence public hearing. Post hearing activities involved review of the Type A water licence submittals.
- **Wek’eezhii Land and Water Board (NT)** – Project manager in the jurisdictional review of land and water use permits in Saskatchewan, Yukon, Alberta, Alaska, British Columbia, and Ontario. Focus of review was focused on the following resource sector activities: waste disposal sumps, diamond drilling on land and ice, camp waste management, on-land seismic activities, and winter road activities on land and ice.
- **Qikiqtani Inuit Association (NU)** – Contributed to the development of a lands resource security policy in conjunction with this landowner.
- **Plan Review Process & Guideline Working Group – Mackenzie Valley Land and Water Boards (NT)** – Lead engineer and technical resource consultant in the completion of a guideline for waste management practices that proponents seeking a water licence can use to ensure that their plans and designs capture elements necessary to understand waste management and the expectations that the Water Boards within the Mackenzie Valley. The guideline is applicable to the mining, oil and gas, exploration, industrial, and municipal sectors, and includes all sources of waste ranging from tailings, construction & demolition waste, hazardous waste, contaminated soil, and municipal refuse.
- **Environment Canada (YK, NT, NU)** – Project manager and lead engineer to evaluate the legal obligations (e.g., permitting, compliance promotion, and enforcement) and authorities of governments and Boards within the Canadian North responsible for environmental legislation and protection. Also, evaluated the potential implementation issues for the new CEPA Storage Tank regulation in the North and the proposed federal Clean Air Regulatory Agenda for the Northern Oil and Gas Sector.



- **South Australia Environmental Protection Authority (Australia)** - Contributed to the development of the landfill standards, specifically, barrier system design and contaminant transport, test methods for organic matter and calcium content for leachate collection drainage materials, leachate collection system design and service life predictions, and expert review of draft standards.
- **Nunavut Water Board (NU)** – Lead engineer responsible for the development of draft guidance document for northern waste and water containment facilities, specifically, landfills, landfarms, lagoons, and water retention structures. Document provides proponents involved in these facilities of the hydrology, hydrogeologic, geotechnical, design, operation, monitoring, and maintenance issues that may be considered and detailed in an application for the purposes of obtaining a water licence.
- **Nunavut Water Board (NU)** - Contributed to the development of application guidelines for Miramar Hope Bay Ltd.- Doris North Gold Mine and Cumberland Resources Ltd.- Meadowbank Gold Mine.
- **Nunavut Water Board (NU)** - Technical review and licence compliance assessment for monitoring program, QA/QC plan, annual reporting, and abandonment and restoration plan for the following Distant Early Warning (DEW) line sites: DYE-M- Cape Dyer; CAM-2- Gladman Point; FOX-2- Longstaff Bluff; FOX-5- Qikiqtarjuaq; BAF-5- Resolution Island; and, CAM-1- Jenny Lind Island.
- **Ontario Ministry of Environment (ON)** - Contributed to the review of state-of-the-art of landfill design, specifically pertaining to leachate characteristics for municipal solid waste landfills, leachate collection system design, and geosynthetic use in leachate collection system and cover applications.

MUNICIPAL INFRASTRUCTURE

- **Environment Canada (YK, NT, NU)** – Expert technical reviewer of draft guidance document “Solid Waste Facilities in Northern Climate”.
- **Environment Canada (YK, NT, NU)** – Expert technical support for the development of the document “Modern Municipal Solid Waste Facilities in Northern Climate”. Performed consultation activities between Environment Canada and various Territorial Government departments.
- **Environment Canada (YK, NT, NU)** – Project lead in the development of a foundation report for a technical document on municipal solid waste landfills in northern conditions: engineering design, costing, construction, and operation.
- **Environment Canada (YK, NT, NU)** – Project lead in the review of the state of waste management practices for community solid waste within the three territories. The focus of the study was on regulatory requirements, territory wide solid waste profiles and challenges, as well as, community scale operations and challenges.
- **Government of Nunavut (NU)** – Project manager and technical lead in the completion of best management practices for landfills in Nunavut. Analysis includes strategic planning, options analysis, and cost-benefit analysis.
- **Government of Nunavut, Hamlet of Sanikiluaq (NU)** – Technical resource in the design, construction, and costing of the community’s wastewater lagoon expansion cell. Evaluation of the existing lagoon and wetland treatment capabilities and design of modifications to the current system to achieved effluent water quality criteria.
- **Government of Nunavut, Hamlet of Igloolik (NU)** – Technical resource in the design and construction of a new drinking water containment structure and associated infrastructure / piping for water treatment/delivery.
- **Government of Nunavut, Hamlet of Resolute Bay (NU)** – Project lead and engineer in the development of a new solid waste facility and decommission of the existing solid waste site (municipal landfill, recycling area, and bulky metals site) in Resolute Bay, Nunavut. Core activities included: siting and design of a new solid waste disposal facility; waste audit and development of waste management plan for the new disposal facility; construction costing; closure and reclamation

plan; and, provision of tendering services upon acceptance of design including tender documents, construction specifications and QA/QC plan, drawings, and contract administration during construction.

- **Government of Nunavut, Hamlet of Grise Fiord (NU)** – Technical resource in the development of a new solid waste facility and decommission of the existing solid waste site (municipal landfill, recycling area, and bulky metals site) in Grise Fiord, Nunavut. Core activities included: siting and design of a new solid waste disposal facility; construction costing; closure and reclamation plan; and, provision of tendering services upon acceptance of design including tender documents, construction specifications and QA/QC plan, drawings, and contract administration during construction.
- **Government of Nunavut, Hamlet of Pangnirtung (NU)** – Lead environmental and geotechnical designer and engineer in the optimization of the hamlet’s water supply facility and completion of a Comprehensive Performance Evaluation report. Activities include: assessment and repair of water retention structure and associated infrastructure; geotechnical and geothermal modelling of the water reservoir slopes; and, design of an improved water supply facility to meet current and future community needs.
- **Mackenzie Valley Land and Water Board (NT)** – Project manager for a technical team to technically review the City of Yellowknife’s water licence application and supporting documents. Topics covered included review of the proponent’s landfilling and wastewater treatment practices and future expansion plans. Participant in technical /regulatory meetings with the proponent. Assisted in the development of the water licence.
- **Mackenzie Valley Land and Water Board (NT)** – Technical reviewer of the Town of Hay River’s water licence application and supporting documents. Topics covered included review of the proponent’s landfilling and wastewater treatment practices and future expansion plans. Participant in technical /regulatory meetings with the proponent. Assisted in the development of the water licence.
- **Department of Indian Affairs and Northern Development (NT)** – Lead geotechnical engineer in the completion of a desktop study for a leased land in Ft. Simpson, NT that is proposed for two storage facilities.
- **Department of Indian Affairs and Northern Development (NT)** – Project manager and geotechnical engineer in the completion of a geotechnical field investigation for a leased land in Ft. Simpson, NT that is proposed for two storage facilities.
- **Wekweeti Community Government – Tlicho (NT)** – Project manager for a community energy audit.
- **Gameti Community Government – Tlicho (NT)** – Project manager for a community energy audit.
- **Infrastructure Canada- Knowledge-building, Outreach, and Awareness Program (Canada)** - Assessment of national incidence of water well infrastructure deterioration in Canada, life-cycle cost analysis of groundwater extraction wells with consideration given to operations and maintenance, and characterization of water quality, hydrogeology, and well design and operation impacts on water well deterioration.
- **Grundfos Management A/S (Denmark)** – Grundfos is the world leader in the manufacturing of pumps. Acted as an expert participant in a workshop in Denmark to review mechanisms and process leading to biological, chemical, and physical clogging mechanisms and process for groundwater wells and pumps.
- **Agriculture and Agri-Foods Canada Water Supply and Expansion Program and City of North Battleford (SK)** – Project lead and engineer to complete a groundwater capture zone study. The capture zone objectives were to: establish the causes of well and water quality deterioration and formulate methods of predicting long term well performance and service life.
- **Nunavut Water Board (NU)** – Expert technical reviewer of the geotechnical, construction specifications, containment function, and water quality impact, for the following:
 - Hamlet of Qikiqtarjuaq- lagoon, landfill, landfarm hazardous waste storage area, and water reservoir

- Hamlet of Kugluktuk- lagoon, landfill, and landfarm
- Hamlet of Kugaaruk- lagoon
- Hamlet of Taloyoak- landfarm
- **Deline Land Corporation (NT)** - Lead geotechnical engineer in the investigation of the Grey Goose Lodge foundation evaluation and repair.
- **UMA Engineering Ltd. (MB)** – Field engineer to completed aquifer pump tests at Keewatin and PTH 59 North locations.
- **City of Winnipeg, Manitoba Waste Reduction and Pollution Prevention (MB)** – Project manager and engineering advisor for the field measurement of refuse hydraulic properties and efficiency of leachate extraction wells to reduce leachate levels in municipal solid waste landfills.
- **City of Winnipeg, Manitoba Waste Reduction and Pollution Prevention (MB)** – Engineering advisor for the bench top assessment of submerged membrane bioreactor to aerobically treat landfill leachate.

ENVIRONMENTAL ASSESSMENTS AND SITE REMEDIATION

- **Wekweeti Community Government – Tlicho (NT)** – Environmental engineer responsible to complete a fuel spill investigation that occurred adjacent to a community building in Wekweeti, NT. In addition to an assessment of the physical site characteristics, soil samples were collected and analyzed for total petroleum hydrocarbon levels. General recommendations for site restoration were provided.
- **Smiths Landing First Nation (AB)** – Lead engineer to compete a Phase 1 Environmental Site Assessment of a transfer land from the Crown to the Band through the provisions set in the Treaty Lands Entitlement framework.
- **Smith Landing First Nation (AB)** – Expert review the findings of Hay Camp, Wood Buffalo Park Phase 1, 2, and 3 Environmental Site Assessment, and remediation action plan, to understand environmental and human health risk for the First Nation. Participant in technical meetings with consultant and government organizations regarding clean up strategies and proposed remedial action.
- **Smith Landing First Nation (AB)** – Expert technical and regulatory support pertaining to risk management and remedial actions associated with uranium and radiation contamination on Reserve lands. Participant in technical discussions on behalf of First Nation with various government organizations with regards action plans.
- **Government of Northwest Territories – Transportation: Policy, Planning, and Environment (NT)** – Phase 1 Environmental Site Assessment of leased land within the First Simpson, NT airport.

AGRICULTURAL

- **Prairie Farm Rehabilitation Association- Agriculture and Agri-Foods Canada (Canada)** - Clogging of agricultural tile drains, impacts on performance, and field crop revenue loss.
- **Prairie Farm Rehabilitation Association- Agriculture and Agri-Foods Canada (Canada)** - Review of impressed current systems to mitigate biofouling clogging effects in groundwater extraction wells.
- **Manitoba Conservation and University of Manitoba (MB)** - Measurement of contaminant and nutrient migration below earthen manure storage lagoons in southern Manitoba. Evaluation of contaminant transport parameters for inorganic and nutrient constituents in various aquitards below manure lagoons.

EDUCATION AND TRAINING

- **Saskatchewan Ministry of Environment (SK)** – Developed and delivered a workshop to the Ministry of Environment on the topics of: groundwater flow and contaminant transport, site remediation, and porous media flow and transport modelling.
- **Tlicho Government (NT)** – Developed and delivered a workshop to the Tlicho Assembly on the proposed NICO mine development.
- **Nunavut Arctic College (NU)** - Developed and instructed a five day course for municipal operators and foremen in the areas of drinking water treatment, wastewater treatment, and solid waste management. The course was held in Rankin Inlet, NU in January, 2014.
- **Nunavut Municipal Training Organization (NU)** – Developed and instructed a translation workshop to assist translators in communicating scientific and construction terms, common in municipal infrastructure activities, from English to Inuktitut.
- **Nunavut Municipal Training Organization (NU)** – Developed and instructed a five day course for municipal operators and foremen in the areas of drinking water treatment, wastewater treatment, and solid waste management. The course was held in Iqaluit, NU and Rankin Inlet, NU in May, 2009, and in Iqaluit, NU in October, 2009.
- **Building Environmental Aboriginal Human Resources –BEAHR (Canada)** – Developed student manual, instructor manual, and instructor presentation materials for a solid waste coordinator course. Curriculum materials are to be licenced by BEAHR to instructors to train Aboriginals in topics relevant to operate and manage a solid waste facility.
- **Environmental Monitoring Advisory Board – EMAB (NT)** – Developed and facilitated a mining closure and reclamation workshop in Yellowknife, NT. EMAB is a consensus board of ensuring the protection of Lac De Gras environment where the Diavik Diamond Mines is located. Workshop participants included members of Aboriginal communities and regulators who ensure compliance with licences and leases, and Diavik personnel.
- **Government of Northwest Territories – Municipal and Community Affairs** – Managed, developed, and instructed an eight day Introduction to Environmental Management course in Inuvik, NT in 2008 and 2011. Course topics included: general environmental awareness; roles and responsibilities of regulators and legislation that helps protect the environment; Mackenzie Valley Resource Management Act and associated Boards; Inuvialuit Land Administration; challenges of waste disposal and community infrastructure such as sanitary landfills and wastewater lagoons; contaminants in the North and their effects; site inspection; remediation technologies; and understanding of Government of Northwest Territories and Indian and Northern Affairs Canada programs.
- **Government of Northwest Territories – Municipal and Community Affairs (NT)** – Managed, developed, and instructed a five day Class 1 Drinking Water Treatment Plant Operator course in Inuvik, NT in 2008. Hay River, NT in 2010, and Inuvik, NT in 2011.
- **Government of Northwest Territories – Municipal and Community Affairs (NT)** – Managed, developed, and instructed a five day Class 2 Drinking Water Treatment Plant Operator course in Norman Wells, NT in 2010 and Fort Smith, NT in 2010.
- **University of Manitoba – Department of Civil Engineering (MB)** – Managed, trained, and operated an independently funded research program to support the completion of 2 Ph.D, 6 M.Sc., and 2 B.Sc. student theses.

- **University of Manitoba – Department of Civil Engineering (MB)** – Developed curriculum and instructed the following undergraduate and graduate student courses:
 - Groundwater hydrology
 - Hazardous waste management
 - Fluid mechanics
 - Groundwater contamination
 - Solid waste engineering
 - Physical and chemical hydrogeology
 - Geoenvironmental engineering

RESEARCH AND DEVELOPMENT

- Long term geochemical characterization of mine effluent waters.
- Evaluation of biological, chemical, and physical clogging mechanisms, and rates of clogging, in drainage stone used in landfill leachate collection systems and leachate transmission pipes used in landfills and bioreactors.
- Geochemical and hydrologic interactions in mine tailings exposed to atmospheric conditions.
- Validation of finite element model that links biogeochemical reactions to groundwater flow and solute transport to predict clogging in granular media permeated with leachate.
- Development of design tables for the design and operation of liquid injection systems in bioreactor landfills.
- Prediction of the interactions of pipe hydraulics and unsaturated/saturated refuse hydraulic properties on liquid injection system design and operation.
- Review of geotechnical strength parameters and saturated/unsaturated hydraulic properties of municipal solid waste.

PUBLICATIONS

BOOK CHAPTERS

1. VanGulck, J. and Rowe, R.K. 2010. Landfilling: Geotechnology. Chapter 10, Solid Waste Technology and Management, eds. Christensen, Wiley-Blackwell.
2. Clark, R., Koda, E., Lipinski, M., Wolski, W., Rowe, R.K., and VanGulck, J. 2005. Environmental Geotechnics- Chapter 1: Design Basics and Performance Criteria. Report for International Technical Committee No. 5 (ITC5) on Environmental Geotechnics of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE).

ARTICLES IN REFEREED PUBLICATIONS

3. Lozeczniak, S., Oleszkiewicz, J., Clark, S., Sparling, R., and VanGulck, J. 2012. Effects of Turbulence and Temperature on Leachate Chemistry. *Journal of Environmental Engineering*, **138**(5): 562-569.
4. Lozeczniak, S., Sparling, R., Clark, S.P., VanGulck, J.F., and Oleszkiewicz, J.A. 2012. Acetate and propionate impact on the methanogenesis of landfill leachate and the reduction of clogging components. *Bioresource Technology*, **104**: 37-43.
5. Sherriff, B.L., Etcheverry, D.J., Sidenko, N.V., and VanGulck, J. 2011. Spatial and temporal evolution of Cu-Zn tailings during dewatering. *Applied Geochemistry*, **26**(11): 1832-1842.
6. Simpson, S., Sherriff, B.L., VanGulck, J., Khozhina, E., Londry, K., and Sidenko, N. 2011. Source, attenuation and potential mobility of arsenic at New Britannia Mine, Snow Lake, Manitoba. *Applied Geochemistry*, **26**(11): 1843-1854.

7. Lozecznik, S., Sparling, R., Oleszkiewicz, J.A., Clark, S., and VanGulck, J.F. 2010. Leachate treatment before injection into a bioreactor landfill: clogging potential reduction and benefits of using methanogenesis. *Waste Management*, **30**(11): 2030-2036.
8. Lozecznik, S. and VanGulck, J.F. 2009. Full-scale laboratory study into clogging of pipes permeated with landfill leachate. *ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management*, **13**(4): 261-269.
9. VanGulck, J., Lozecznik, S., and Murdock, J. 2009. Hydraulic design tables for horizontal liquid injection systems in bioreactor landfills. *ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management (special edition)*, **13**(3): 147-155.
10. Sherriff, B.L., Ferguson, I., Gupton, M.W., VanGulck, J.F., Sidenko, N., Priscu, C. 2009. A Geophysical and geotechnical study to determine the hydrological regime of the Central Manitoba gold mine tailings deposit. *Canadian Geotechnical Journal*, **46**: 1-12.
11. Knop, A., VanGulck, J., Heineck, K.S., and Consoli, N. 2008. Transport of contaminants through a compacted soil liner subjected to acid mine drainage (AMD) percolation. *Journal of Hazardous Materials*, **155**(1): 269-276.
12. VanGulck, J.F. and Rowe, R.K. 2008. Parameter estimation for modeling clogging of granular medium permeated with leachate. *Canadian Geotechnical Journal*, **45**(6): 812-823.
13. Sadri, S., Cicek, N., and VanGulck, J. 2008. Aerobic treatment of landfill leachate using a submerged membrane bioreactor – prospects for on-site use. *Environmental Technology*, **29**: 889-907.
14. Sherriff, B., Salzsauler, K.A., Simpson, S., Sidenko, N.V., and VanGulck, J. 2008. Arsenic mobility from arsenopyrite-rich gold mine waste in Snow Lake, Manitoba, Canada. *Chinese Journal of Geochemistry*, **25**(1): 29-30.
15. Cooke, A.J., Rowe, R.K., VanGulck, J.F. and Rittmann, B.E. 2005. Application of the BioClog model for landfill leachate clogging of gravel-packed columns, *Canadian Geotechnical Journal*, **42**: 1600-1614.
16. VanGulck, J.F., Rowe, R.K. 2004. Influence of landfill leachate suspended solids on clog (biorock) formation. *Waste Management*, **24**: 723-738.
17. VanGulck, J.F. and Rowe, R.K. 2004. Evolution of clog formation with time in columns permeated with synthetic landfill leachate. *Journal of Contaminant Hydrology*, **75**: 115-139.
18. VanGulck, J.F., Rowe, R.K., Rittmann, B.E., and Cooke, A.J. 2003. Biogeochemical calcium precipitation in landfill leachate collection systems. *Biodegradation*, **14**: 331-346.
19. Rowe, R.K., VanGulck, J.F. and Millward, S.C. 2002. Biologically induced clogging of a granular medium permeated with synthetic leachate. *Canadian Journal of Environmental Engineering and Science*, **1**(2): 135-156.
20. Cooke, A.J., Rowe, R.K., Rittmann, B.E., VanGulck, J.F. and Millward, S.C. 2001. Biofilm growth and mineral precipitation in synthetic leachate columns. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*, **127**(10): 949-856.

CONTRIBUTIONS TO INDUSTRIAL RESEARCH AND DEVELOPMENT

21. VanGulck, J.F. and Dwyer, R. 2012. Solid waste survey in the territories. *Journal of the Northern Territories Water and Waste Association*.
22. Sherriff, B., Hozhina, E., Sidenko, N., and VanGulck, J.F. 2006. The characterization and trial revegetation of mine tailings at Inco Ltd., Thompson, Manitoba. Report submitted to Inco Ltd. 107 pages.
23. VanGulck, J.F. 2005. Landfill barrier system contaminant fate and transport modeling. Report submitted to South Australia Environmental Protection Authority. 27 pages.
24. VanGulck, J.F. 2005. Review of test methods for organic mater and calcium carbonate content in soil. Report submitted to South Australia Environmental Protection Authority. 11 pages.



25. VanGulck, J.F. 2005. Sensitivity analysis of leachate collection system design and service life. Report submitted to South Australia Environmental Protection Authority. 16 pages.
26. VanGulck, J.F. 2005. Implications of leachate collection system clogging to the South Australia draft landfill standards. Report submitted to South Australia Environmental Protection Authority. 18 pages.
27. VanGulck, J.F. 2005. Review of impressed current systems to mitigate the clogging effects of biofouling in water wells. Report submitted to Agriculture and Agri-Food Canada-PFRA. 28 pages.
28. VanGulck, J.F. and Novy, L. 2005. Clogging of agricultural tile drains due to iron ochre. Report submitted to Agriculture and Agri-Food Canada-PRFA. 68 pages.
29. Hettiaratchi, J.P.A., Perera, M.D.N., Richards, N., and VanGulck, J.F. 2004. Methane emissions from landfills: opportunities and challenges. CSCE Magazine, Summer 21.3.
30. Rowe, R.K., Southen, J., VanGulck, J.F., Moore, I.D., Sangam, H.P. and Krol, M. 2001. Review of the state-of-the-art of landfill design. Report submitted to Ontario Ministry of the Environment, Waste Management Policy Branch. 533 pages.

NOËL L. JOURNEAUX, ENG., M.S.C.E., F ASCE

Working in the geotechnical and mining fields for more than forty (40) years, Mr. N. Journeaux, M.S.C.E., P. Eng., has acquired extensive experience in major civil engineering structures such as foundations for high-rise office towers, tailing and water dams, pit slopes, bridges and highways, railways, harbours, excavations, tunnels and underground transportation systems and permafrost. This experience was acquired throughout Canada, but also in Africa, India and the Caribbean area in mining, energy, transportation, construction and environmental sectors. During his career, Mr. Journeaux acquired considerable experience in business management, first being director of the geotechnical and quality control departments at Warnock Hersey Professional Services Ltd. between 1966 and 1978, then became the president of Lupien, Rosenberg, Journeaux et Assoc. between 1979 and 1986, and vice-president of Hoggan Engineering and Testing Ltd. of Edmonton, Alberta between 1983 and 1987. He was president of Journeaux, Bédard & Assoc. Inc. from 1986 and 2006. In 1993, he formed LAB JOURNEAUX BÉDARD INC., which incorporated all the testing facilities of Warnock Hersey Professional Services Ltd.

Experience

MINING PROJECTS:

QUEBEC CARTIER MINES

- Prepared a mine closure plan detailing specific measures to maintain unobstructed flow of all precipitation around the mine and through the tailing disposal area.
- Prepared operational and maintenance manuals for the tailing dams and spillways, and emergency procedures manual for incidents with different levels of risk.
- Consultation on the design, construction supervision of tailings storage area involving a 5 km tailing dam and a 3 km long 35 m high process water retention dam for storage of 20,000,000 cubic metres of tailings and 5,000,000 cubic metres of ice, which accumulate over winter when temperatures drop to -30° C.
- Development of low cost tailings distribution box for separation of coarse tailings for use in construction of dikes with minimum equipment and personnel.
- Design of deep wells for drainage of production benches in the pit.
- Design of permanent pit slope cut in silty till overburden subject to water pressures.
- Stability analysis for 700-foot high till dumps.
- Stability studies on rock cuts and bridge sites along canyon section of the railway line to Port-Cartier, Quebec.
- Design of pumping system for pit dewatering.
- Installation of hydraulic piezometer at Mont Wright pit behind 250-metre high hanging wall for stability analysis; successfully installing in three boreholes, groups of piezometers at 90, 180, 270 and 360 meter depth.

Profile

EDUCATION

Queens University – B.A.Sc.
 Engineering Geology (1960) - Majoring in ground water and hydrology;
 Purdue University – M.S.C.E. Civil Engineering (1962) – Majoring in Soil Mechanics and Foundation Engineering with minors in air-photo interpretation and engineering geology;
 University of Missouri – 1986 – Intensive course on grouting and ground stabilisation related to hydrological conditions;
 U.S. Department of Transportation, Federal Highway Administration – 1993 – Stream stability and scour at bridge piers and approach fills.

EXPERIENCE

- 1993
 Lab Journeaux, Bédard Inc.
 President
- 1982
 Kilbarco Construction Ltd
 Tunnels, grouting, concrete repairs
 President and owner
- 1986 – 2006
 Journeaux, Bédard & Assoc. Inc.
 Priincipal shareholder and President
- 1979 – 1986
 Lupien, Rosenberg, Journeaux et Associés
 President and Senior partner
- 1983 – 1986
 Hoggan Engineering and Testing Ltd.
 Edmonton, Alberta
 Vice –President
- 1966 – 1979
 Warnock Hersey International Ltd.
 General Manager of Montreal geotechnical department and quality control laboratory, employing up to 30 technical people
- 1964 – 1966
 Geocon Ltd.
 Des\nior geotechnical engineer
- 1962 – 1964
 Terratech Ltée
 Geotechnical engineer

QUEBEC MINISTRY OF ENVIRONMENT

- Investigation and design of two storage cells involving impervious containment dikes and HPDE membrane covers for acid generating (sulphide) tailings at abandoned WEEDON MINES in Quebec Eastern Townships. Responsible for preparation of plans and specifications and construction supervision (project called on unrestricted open bid in Quebec and awarded on technical merits).

KUDRUMUCH IRON ORE MINES, MANGALOR, INDIA

- Design of tailing dams and spillways in order to store 8 million cubic meters of rejects per year in a mountainous region with more than 10 meters of precipitation during the monsoon season. Special surface drainage system had to be designed for down stream slope of dam to prevent washouts and erosion during monsoon season. Participated on design of pervious debris arresting dams creating sedimentation basins to recover iron ore washed down from high and steep mine roads subject to flash flooding during monsoon.

NOREBEC-MANITOU MINES

- Design of impervious tailing dikes for recycled acid generating tailings in Val d'Or.

BALMORAL MINES

- Evaluation of stability problems for raising of dikes for acid generating tailings in Val d'Or.

IRON ORE COMPANY OF CANADA

- Planning volume calculations for 80 years storage of tailings in Wabush Lake by discharging from high mountain on west shore line at a rate of 30,000,000 cubic metres per year.
- Design and construction supervision of Luce Creek diversion involving 600-metre long dam, 2 km channel and buried culvert and stilling basin, all on tailings.
- Risk analysis and closure plan for 1 mile square tailings containment pond in Sept-Iles. Instrumentation of the Sept-Iles concentrator's waste basins.
- Consultation on the stabilisation of ship loader foundation on loose to very loose sand by grouting techniques in Sept-Iles. Investigate instrument and design of recovery system by depression of water table with deep wells for a major diesel fuel leak (ongoing recovery of 200 gal./day over 10 years). Yearly spring inspection of culverts in swift and high run off gullies, icing zones, tunnels, rock cuts in Moise River Canyon and areas of ice scour at bridge piers and river bends affecting railway embankments. Prioritise sites for yearly maintenance budget.
- Geotechnical investigation for new pellet plant modernisation.

WABUSH MINES

- Development of plan to store 43 years of tailings to meet future MMLER requirements.
- Design of 6 km of interceptor ditches, dikes and control structure for diverting natural run-off around tailings storage site.

Profile

PROFESSIONAL MEMBERSHIPS

Order of Engineers of Quebec;
 Corporation of professional Engineers, Geologists and geophysicists of Alberta;

Association of professional Engineers and Geoscientists of the province of Newfoundland and Labrador;

Fellow of the American Society of Civil Engineers (ASCE);

International Society of Soil Mechanics and Foundation Engineers;

International Association of Engineering geologists;

Participant, Association Minière du Canada.

TECHNICAL PUBLICATIONS

"Friction and End Bearing Test on Bedrock for High Capacity Rock Socket Design"

"Design, Construction and Performance of a Slurry Trench Wall Next to a Settlement Sensitive Building Foundation"
 29th Canadian Geotechnical Conference, Vancouver, British Columbia.

"Slurry Trench Wall Supported in Glacial Till"
 Submitted to the Canadian Geotechnical Journal.

"Settlement Limitations for Cylindrical Steel Storage Tanks"
 32th Canadian Geotechnical Conference, Montreal, Quebec.

"Experiences of concrete on permafrost in the Nunavik"
 Annual seminar 1998 of the American Concrete Institute – Progress of the concrete technology, Sherbrooke, Quebec

"Rapid evaluation and stabilisation of railway embankment failures"
 53rd Canadian Geotechnical Conference, Montreal, Québec.

LAKE ASPBESTOS OF QUEBEC MINES

- Consultation on the pit wall stability, design of a waste water dam, and roof stabilisation of a 1 km long rock tunnel in severely sheared and brecciated, soft serpentine formations.
- Slope stability analysis of 200-foot and 770-foot high waste dumps, Black Lake.
- Design and construction supervision of stabilisation measures for dewatering sump, Asbestos, Quebec.

INCO

- Geotechnical studies for the design of a process water dam, retaining dikes and buildings for sensitive clay deposits in Abitibi for the CASA BERARDI project.

SIGMA (DOVE MINES)

- Consultation on the design of an access road across very soft lacustrine silts and clays in Lac Demontigny, Val d'Or.

SOQUEM

- Geotechnical studies and consultation for excavation slopes for the gold mine in the very loose silt deposits in Val d'Or.

NORANDA MINES

- Consultation on building foundations and excavation slopes for the open pit in Noranda.

GASPE MINES

- Vibration analysis of grinding mill foundations, Murdochville, Quebec.
- Geotechnical investigation for major expansion involving crusher, concentrator and smelter buildings, rock cut, etc.

PROJECTS IN ARCTIC REGIONS:

KUUJJUAQ

- Geotechnical investigation and design of a breakwater shelter for pleasure boats.
- Geotechnical investigation and consulting for the supply of potable water for the village including water intake dike structure, pump house on permafrost protected by thermosyphons, 5 km of water line and distribution building. Search for borrow pits.
- Geotechnical investigation and quality control of foundations for the new Transport Canada garage at the Kuujuaq airport, design of thermosyphon system to prevent thawing of permafrost.
- Quality control of construction of offices for the Kativik Regional Administration.
- Geotechnical investigation for the new municipal garage and design of a thermosyphon system to stabilise the permafrost.
- Geotechnical investigation and control of construction materials for the new RRSS building.
- Quality control of crushed aggregates for new airstrip.
- Geotechnical investigation for the new Makivik building.
- Geotechnical investigation and control of construction materials for the new bar.

- Geotechnical investigation for new private residences with basements.
- Geotechnical investigation for the new day care.
- Geotechnical investigation to determine the causes behind the sinking of the Air Inuit building slab and design of thermosyphons to stabilise the permafrost and prevent further thawing.

KANGIQSUALUJJUAQ (George River)

- Geotechnical studies for runway and buildings for Transport Canada, search for borrow materials and quarries to supply the aggregates to be used for the construction of the runway and the concrete.
- Geotechnical investigation for lake intake structure, pumping station, 4 km of aqueduct, storage reservoirs and water treatment building.
- Geotechnical investigation and quality control of concrete for the new municipal garage (1997). Design of thermosyphon system to avoid thawing of permafrost.
- Geotechnical investigation and stability analysis for the construction of the proposed harbour facilities and rip-rap dikes on deep deposits of marine clay in an area of 30-foot tides. Search for rip-rap and quarry run rock for construction of the dikes.
- Geotechnical investigation of three (3) proposed sites for reconstruction of school damaged by recent avalanche. Selection of foundation system and quality control during construction.
- Geotechnical investigation for the new day care centre and the new community centre.

TASIUJAJQ

- Geotechnical investigation for potable water supply for including water intake in Leak River and 3 km of pipeline to storage tank and distribution building, all carried on frozen marine clays rich in ice lenses and layers.
- geotechnical investigation for the new school and new garage including investigation of settlement problem in floor slab of the old garage and thermosyphons design to stabilise thaw.
- Geotechnical investigation for runway and buildings for Transport Canada as well as 5 km of road with culverts and bridge; search for borrow materials and quarries to produce the aggregate for the lower and upper foundations of the runway.

AUPALUK

- Geotechnical investigation for potable water supply for including water intake in Leak River and 3 km of pipeline to storage tank and distribution building, all carried on frozen marine clays rich in ice lenses and layers.
- Geotechnical investigation for water intake, 5 km of aqueduct as well as studies for the construction of storage reservoirs in rock or in the permafrost.
- Geotechnical investigation for the new municipal garage.
- Geotechnical investigation and design of airport for Transport Canada including runway, aprons and buildings. Search for aggregate and quarries.

KANGIRSUK

- Geotechnical investigation and design of foundations for the Transport Canada communications towers.
- Geotechnical investigation for the supply of potable water including water intake structure, pumping station, 5 km of pipeline across severely frost heaved, vertically dipping slate bedrock formations, water reservoir, and distribution building.
- Investigations for new residences with basements.

QUAQTAQ

- Geotechnical investigation of the new municipal building and residences with basements.
- Geotechnical investigation and quality control of construction materials for the potable water system including intake structure, pumping station, 6 km of pipeline, storage reservoir and the distribution building. Search for construction materials.
- Geotechnical investigation and stability analysis for the construction of the proposed harbour facilities and dikes in an area of 25-foot tides. Search for rip-rap and quarry run rock for construction of the dikes.

KANGISUJUAQ

- Supervision of local personnel for the construction of roads including the installation of culverts.
- Geotechnical investigations and consulting for new residences on permafrost.

SALLUIT

- Geotechnical investigation for new municipal garage and new sewage treatment facilities, including outfall line.
- Investigation to determine the cause of pile settlement under biodisk building; recommendations to prevent the thawing of saline marine clays with thermosyphons.
- Geotechnical investigation to determine the reasons for the slab settlement of the Community Centre; design and thermosyphons to stabilise and refreeze thawed soils
- Supervision of local personnel for the construction of roads including the installation of culverts.

IVUJIVIK

- Geotechnical investigation of three (3) potential sites for potable water supply sources for the village involving intake structure, pumping station, pipelines up to 10 km long, water storage reservoirs and treatment building.

AKULIVIK

- Geotechnical investigation for the new school.

PURVIGNITUK

- Geotechnical investigation for the supply of potable water including water intake structure, pipeline and distribution building.
- Geotechnical investigations for the new municipal garage (1997), municipal office, technical school and new hotel.

- Geotechnical investigation and stability analysis for the construction of the proposed harbour facilities and rock dikes to be built on soft marine clays. Search for rip-rap and quarry run rock for construction of the dikes.

INUKJUAQ

- Geotechnical studies and design of communications tower foundations for Transport Canada.
- Geotechnical investigation for training school for the Kativik School Board.
- Geotechnical investigation for the extension to the arena.
- Geotechnical investigation for the new day care.
- Geotechnical investigation and quality control of construction materials for the new dispensary and the technical school.

UMIUJAQ

- Chosen by Transport Canada for the geotechnical investigations for the runway and buildings as well as the analysis of all aggregates that were used during construction of the runway and apron and the fabrication of the concrete for the project.
- Consultation on design of water reservoir in large rock excavation.
- Geotechnical investigation for residential building to be constructed with basement.

DECEPTION BAY

- Geotechnical studies for the mining development of Asbestos Corp., including seaport, storage building, fuel tanks, access roads, including river crossings.

FROBISHER BAY

- Geotechnical studies and recommendations for Hudson Bay store and R.C.M.P. hangar foundations.

CLYDE RIVER

- Geotechnical studies for school and load testing program to evaluate adhesion values for piles installed in permafrost.

PANGNIRTUNG

- Geotechnical investigation and recommendations for construction in permafrost of a potable water storage basin and retaining dikes subject to thawing of permafrost.

CAPE DORSET

- Geotechnical investigation and recommendations for construction of dikes in permafrost for a potable water storage basin and retaining dikes.

IGLOOLIK

- Geotechnical investigation and recommendations for the foundation of the new medical research centre.

HALL BEACH

- Rock core analysis for construction in rock of a potable water storage basin.

KING POINT, YUKON

- Geotechnical studies for rip-rap quarry, choice of road corridors and river crossings for 10 miles of roads to the seaport, the airstrip, site buildings and Beaufort sea wharf for quarry development for rip-rap production for oil production islands, all on permafrost.

NORTHWEST TERRITORIES

- Geotechnical studies for different municipal buildings in Rankin Inlet, Chesterville Inlet, Snow Drift, Gjoa Haven, Spence Bay, Pelley Bay, Yellowknife, Hay River, Inuvik, Holman Island, Artic Bay and Sanikiujuaq in Hudson Bay.

RAILWAY PROJECTS:

CANADIEN NATIONAL

- Coring of concrete and limestone blocks on seventeen (17) piers of the Victoria Bridge across the St. Lawrence River.
- Geotechnical investigation and installation of inclinometers and piezometers for the stability analysis of the railway bridge abutment in Coteau Station, L'Épiphanie, Joliette and St-Hyacinthe, Quebec.
- Geotechnical investigation, caisson design, analysis of results and preparation of the report for the construction of a viaduct below Peel and de la Commune Streets, Montreal.
- Design of asphalt paving and subdrainage system for the large container terminal at Taschereau and Turcot Yards
- Geotechnical investigation for new station at Ile-Perrot, Quebec.
- Geotechnical investigation, supervision of work and installation of piezometers for the pedestrian tunnels at MacMasterville and Ile Perrot Stations.
- Geotechnical investigation of the causes of the serious stream erosion leading to the collapse of the main line Montreal-Toronto railway tracks and major derailment in Coteau-du-Lac.
- Stability analysis for Coaticook landslide due to flash flood and improper surface drainage system.
- Investigation of CN derailments at Shawinigan and Latuque due to flash flooding due to rapid runoff from the high side hill rock slopes, insufficient culvert capacity leading to overtopping of rails and resulting washouts followed by instability due to rapid draw down conditions.
- Geotechnical investigation and drainage evaluation for the new siding at Coteau Station considering problems of track foundation on saturated clays.
- Soil investigation and soil characterization for new bridges at Sub. Montreal Mile 2.86 and at Rivière des Prairies Yard.
- Culvert installation under the CN main line in Dundas, Ontario.
- Reconstruction of 8-foot diameter drainage tunnel under main line in Moncton, New Brunswick.
- Geotechnical investigation and design of ground water control using sub-drains and a control pumping pit under Montreal-Toronto main line in Ville St-Pierre, Quebec.
- Legal expertise on the construction claim related to collapse of large diameter tunnels in 60-foot high loose sand fills in northern Alberta.

- Detailed soil investigation for new CNR container port in Turcot Yard to be constructed on deep peat deposits.
- Investigation on pavement design and drainage system for new CN Cargoflo depot, Taschereau Yard, Montreal.

CHEMIN DE FER BAIE DES CHALEURS

- Review of drainage and washout following a severe rainstorm, stabilisation and correction of deficiencies on the Cimbec Cement property and landslide.
- Track reconstruction after rock slide on high vertical undercut cliffs along the Baie des Chaleurs.
- Investigation of formation of large voids developing beneath tracks.

CHEMIN DE FER MATAPEDIA ET DU GOLFE

- Track inspection and review of major culvert installation under high fills to evaluate risks of washouts over 50 miles of track.

QNS & L RAILWAY

- Inspection of bridge piers and abutments for ten (10) major bridges between Sept-Iles, Wabush Labrador and Schefferville.
- Inspection of culverts (1,600) along 250 miles of track, mostly along the Moisie River valley where severe surface runoff occurs in melt season.

PULP AND PAPER PROJECTS:

C.I.P., ABITIBI-PRICE, STONE CONSOLIDATED, CONSOLIDATED BATHURST, BOWATERS, DONOHUE PAPER MILLS

- Paper mill foundations on rock, till and clay, at Pontiac, Matane, Grand-Mère, Amos, Chandler, New Richmond, Bathurst, Dalhousie, Minas Basin, Quebec, Grand Falls, Newfoundland.

GOVERNMENTAL PROJECTS:

CITY OF MONTREAL

- Engineer responsible for drilling and sampling of fill areas, site characterisation program and installation of monitoring wells.
- Engineer co-ordinating soil sampling for numerous oil company service stations in the Montreal area, installation of monitoring wells.

TRANSPORT CANADA

- Complete investigation of site for Mirabel Airport including search for concrete aggregates.
- Engineer responsible for geotechnical studies for the landing strips in Umiujaq, Tasiujaq, Aupaluk and George River, New Quebec.

NWT GOVERNMENT

- Engineer responsible for many geotechnical studies in NORTHWEST TERRITORIES including Inuvik, Hay River, Hollman Island, Yellowknife, Snow Drift, Spence Bay, Pelley Bay, Rankin, Belcher Islands and Baffin Island.

PUBLIC WORKS D'ALBERTA

- Geotechnical investigation for a new penitentiary in Grande Cache, Alberta.

ADMINISTRATION RÉGIONALE KATIVIK

- Investigated more than 25 km of pipeline routes and maintenance roads for above ground or shallow depth water distribution systems to avoid severe spring run-off and washouts for the villages of Kuujuaq, George River, Tasiujaq, Aupaluk, Quaataq, Kangirsuk, Kangirsukjuaq, Salluit, Ivujivik, Povungnituk and Inukjuak.
- Legal expertise on construction claims on arctic projects.
- Design of pavements and drainage systems for four (4) villages in Arctic Canada underlain by frozen saline silty clays.

JUSTICE CANADA

- Legal expertise for the dredging claims for the ports of Cacouna, Les Méchins and Ste-Flavie.

PARKS CANADA

- Geotechnical investigation for reconstruction of Ottawa locks 1, 2 and 3 involving deep braced excavations and cofferdams.

SEBJ

- Engineer responsible of on site detailed geotechnical investigations for the LG-1 and LG-4 dams on La Grande River for Hydro-Quebec.
- Engineer responsible of soil studies, culverts and bridge sites along 200 miles of access roads between LG-2 and LG-4. Co-ordination of terrain mapping. Photo interpretation for borrow pits.

PUBLIC WORKS CANADA

- Docking facilities in Quebec and Newfoundland.

TRANSPORT QUEBEC

- Foundation investigation for 13 miles of AutoRoute including bridges, overpasses, embankment, pavement sections, etc.

INDUSTRIAL PROJECTS:

UNION CARBIDE

- Design of storage pads and surface water recovery system for contaminated soils for the Montreal East plant.

PPG STANCHEM

- Design of lagoons to store mercury contaminated sludges for plan in Beauharnois, Quebec. Analyse and monitor surface run-off from plant site and investigate extent of airborne pollutants in surrounding 5-mile radius.

ERCO

- Geotechnical investigation and design of a clayey soil impervious cover for plant waste basins containing toxic wastes.
- Evaluation of dredging difficulties over 3 km channel to dock in the Magdalen Islands.

SOCIÉTÉ MONTUPET

- Soil investigation and footing design on a lot in Rivière Beaudette on deep deposits of loose to very loose silt.

KIEWIT & SONS, OMAHA, NESBRASKA

- Engineer responsible for the geotechnical studies of roads, airport and harbour installations as well as the evaluation of the quality of quarry materials and rip-rap for the construction of islands in the Beaufort Sea.

BEAVER LILLEY INC.

- Consultation on the caving and stability problems of tunnels for M.U.C. projects. Draining analysis for dewatering of access shafts (5) in downtown Montreal.
- Instrumentation of Eastmain, LG-3, LG-4, and Caniapisciau dams and dikes, James Bay.

CANADAIR

- Geotechnical investigation and construction, supervision of new Canadair assembly plant, Dorval, Airport.

CERES

- Investigation of crane rails for container unloaded at the Port of Montreal.

IMPERIAL OIL

- Design and construction supervision for releveling two 200-foot diameter oil tanks, Beauport, Quebec.

BOT CONSTRUCTION

- Evaluation of construction claims for dewatering problems on LG-3 North Dikes.

STELCO

- Geotechnical investigation for foundation design for steel mill complex on 100-foot deep deposits of firm clay in Contrecoeur, Quebec.

HALIFAX BRIDGE - DARTMOUTH

- Foundation piers and anchors for Dartmouth-Halifax suspension bridge studies.

HYDRO-QUEBEC

- Transmission line tower foundation studies for 735 kV line between Montreal and Quebec City.
- Air photo interpretation used for road location, search for borrow materials, concrete aggregate, etc.
- Location of 735 kV transmission line between Quebec and Montreal from aerial photographs, design of towers foundation.

ASBESTOS CORPORATION

- Foundation investigation for port in Ungava, Quebec including foundation on permafrost for townsite, millsite, bridges, roads and port facilities.

OTHERS

- Chemical stabilisation of a sewer tunnel through saturated silts and sands under AutoRoute 20, Levis, Quebec.
- Consultation and instrumentation of a 15-foot thick rock bolted roof over a 100-foot wide opening in limestone for Montreal Metro Station.
- Foundation investigation for several high structures and design of high capacity caissons socketed into bedrock.
- Highway embankments, slope stability and design of an 80-foot high compacted clay dam in Jamaica.
- Design of mill buildings to be carried on 60-foot deep waste rock dumps.

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Neil van der Gugten, M.A.Sc., P.Eng.

Hydrologist / Hydrotechnical Engineer

Professional summary

Mr. van der Gugten has over 45 years experience on hydrotechnical and water resources projects in western and northern Canada and abroad ranging from feasibility assessments and preliminary engineering to final design and construction supervision. His project experience includes dams, hydroelectric developments, hydraulic structures, river engineering, channel stabilization, sedimentation and erosion, river crossings for pipelines and bridges, baseline hydrology, mine water management, watershed assessments, flood protection, agricultural drainage, irrigation, water supply systems, stormwater management, and water resources environmental issues. His international experience includes projects in Egypt, Nepal, Vietnam, Suriname, Brazil, and the Philippines. He has a master's degree specializing in hydraulic design and hydrology.

Professional qualifications/registration(s)

Professional Engineer: Alberta, since 1989; British Columbia, since 1970;
Northwest Territories, since 1998, Nunavut, since 1998.

Education

Master of Applied Science, Hydraulics and Hydrology, University of British Columbia, Vancouver, British Columbia, 1972

Bachelor of Applied Science, Civil Engineering, University of British Columbia, Vancouver, British Columbia, 1967

Short courses

Decommissioning of Dams, 2001

Reservoir Management, 2001

River Ice Engineering, 2001

Shore Erosion, 2000

Stormwater Management, 1994

Environmental Auditing for Managers, 1993

Erosion and Sediment Control, 1992

International Land Drainage, 1985

Memberships/Affiliations

Association of Professional Engineers, Geologists and Geophysicists of Alberta

Association of Professional Engineers and Geoscientists of British Columbia

Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories and Nunavut, Licensee

Canadian Dam Association

Language(s)

English, Dutch, French (reading), German (reading).

Employment history

Amec Foster Wheeler Environment & Infrastructure, Hydrotechnical Engineer / Project Manager, Calgary / Edmonton, Alberta, 1997 to present

Cochrane Engineering Inc., Hydrotechnical Engineer / Project Manager, Edmonton, Alberta, 1996 to 1997

Stanley Associates Engineering Ltd., Hydrotechnical Engineer / Project Manager, Edmonton, Alberta, 1994 to 1996

SNC-Lavalin Inc., Hydrotechnical Engineer / Project Manager, Edmonton, Alberta and Saskatoon, Saskatchewan, 1985 to 1994

Delcan, Chilliwack, Hydrotechnical Engineer / Project Manager, British Columbia, 1976 to 1985

Crippen Engineering, Hydrotechnical Engineer, North Vancouver, British Columbia, 1975 to 1976

B.C. Hydro, Hydrotechnical Engineer Vancouver, British Columbia, 1970 to 1975

Canada Energy, Mines and Resources, Junior Engineer, Vancouver, British Columbia, 1969 to 1970

Summary of core skills

Hydrology, Watershed and Mine Water Balance Studies

Project Manager and/or Project Engineer for hydrologic studies, flow monitoring, snow surveys, water balance studies, water management planning and water balance studies for mining, resource development, industrial power, transportation, and municipal clients. Northern hydrology mining project experience includes Diavik, Hackett, Gahcho Kue, Izok, Hope Bay Doris North, Colomac, Meadowbank, and Meliadine.

Mine and Storm Water Management

Responsible for hydrologic and hydraulic analyses and designs of mine water management and stormwater systems including ditches, culverts, storage ponds, pump stations, and inlet and outlet control structures as well as specialized works such as decant structures, and rock and gabion chutes and drop structures.

Dams, Reservoirs and Hydroelectric Developments

Project Manager and/or Project Engineer for hydroelectric, multi-purpose and river diversion projects involving dams, reservoirs and hydraulic structures, on rivers in British Columbia (Peace, McGregor, Columbia), Saskatchewan (Churchill), Northwest Territories (Snare), Labrador (Churchill), and overseas (Philippines, Nepal, Suriname); and for dam safety reviews, dam breach inundation studies and dam freeboard assessments in Alberta, BC, Ontario and Nunavut.

River Engineering

Responsible for investigating and design of numerous river engineering projects including pipeline crossings, bridge crossings, intakes, river surveys, regime studies, channel improvements, diversions, and erosion and sedimentation studies on the North and South Saskatchewan, Athabasca, Peace, Mackenzie, Beaver, Churchill, Snare, Hay, Coppermine, Yukon, Attawapiskat, Columbia, and Fraser rivers, and many other rivers and streams throughout western and northern Canada.

Flood Risk Studies and Flood Control

Responsible for flood risk mapping and flood zone delineation studies, feasibility and benefit-cost studies for flood control and flood damage mitigation measures, and design of flood control works including dyking, channel improvements, internal drainage facilities, pumping stations and flood boxes.

Erosion and Sediment Control

Responsible for evaluation of erosion and sediment issues and development of erosion control measures for surface runoff, drainage channels, river banks and lake shores. Projects include a study of lateral erosion on the Hay River, design of bank protection and stabilization works on the South Saskatchewan, Coquihalla, Bow and Elbow Rivers, and sediment pond design for Smoky River Coal.

Agricultural Drainage and Irrigation

Responsible for study, design and construction supervision of agricultural drainage and irrigation improvement works in B.C., Alberta, Saskatchewan and overseas, involving subsurface drainage, open drains, culverts, pump stations, flood boxes and irrigation structures.

Municipal and Environmental

Responsible for stormwater and sanitary sewer system studies and designs, surface and subsurface water management systems, site servicing, and miscellaneous special projects.

Representative projects

Hydrology, Watershed and Mine Water Balance Studies (Northern Projects in Bold)

Diavik Diamond Mine Processed Kimberlite Facility Closure Water Balance, Diavik Diamond Mines Inc, Northwest Territories (2012-2013).

Development of climate and hydrologic parameters and water balance analysis of closure options for the process kimberlite (tailings) containment facility.

Hackett River Project, Sabina Silver, Nunavut (2007 to 2008).

Lead Hydrologist responsible for review of hydrologic and meteorologic data and selection of water balance parameters for mine feasibility engineering studies.

Gahcho Kué Diamond Project, De Beers, Northwest Territories (2003 to 2007).

Lead Hydrologist to evaluate existing hydrologic data, identify data gaps, design and implement a hydrologic

data collection program, and prepare a baseline data report. Responsibilities included input to the EIA, providing support for water balance and mine water management studies, and design of water management structures.

Izok Mine Water Balance Parameters, MMG Resources, Nunavut (2010).

Review and analysis of regional hydro-climatic data and selection of appropriate water balance parameter values for application to mine water management.

Victor Diamond Mine Hydrometric Program, De Beers, Attawapiskat, Ontario (2000 to 2003 and 2008 to 2009).

Project Manager for a hydrometric monitoring program and evaluation of baseline conditions for climate and surface water hydrology for a diamond mine project. Subsequently provided comprehensive review of current hydrometric program, prepared recommendations for upgrading to Water Survey of Canada standards and meeting Ontario Environment regulatory requirements.

Meadowbank Gold Project, Cumberland Resources, near Baker Lake, Nunavut (1998 to 2005).

Assessment of hydrologic and meteorologic monitoring needs and implementation of a monitoring program for a proposed gold mine near Baker Lake. Follow-up work included preparation of a baseline data report and preliminary descriptions of potential project effects and possible mitigative measures.

Doris North Gold Project, Miramar, Nunavut (2002 to 2003).

Specialist input on review and evaluation of hydrologic data, preparation of baseline hydrologic data report and surface water aspects of the EIS for Miramar Hope Bay's Doris North Gold Project in Nunavut.

Colomac Mine Tailings Water Management, Northwest Territories (2001).

Specialist to evaluate and quantify runoff volumes to the tailings impoundment and recommend pumping facilities to prevent discharges of contaminated tailings water to the environment.

Colomac Mine Abandonment Plan EIA, Public Works, Northwest Territories (2001).

Specialist input to EIA on hydrology and surface water environmental impact and mitigation issues of the Colomac Mine Abandonment and Reclamation Plan.

Deep Water Lake Hydrology, Ferguson Simek Clark, Fort McPherson, Northwest Territories (2000).

Project Manager to develop hydrology of a lake proposed as potable water supply source for the community of Fort McPherson, NWT. The work included confirmation of the adequacy of the lake to supply the projected water demand, through development of a detailed water balance model using long-term climate data inputs, and evaluation of the impact of withdrawals on lake level variations.

Meliadine West Gold Project Hydrology and Water Balance Study, WMC Int., Rankin Inlet, Nunavut (1997 to 2000).

Project Manager of a 4-year program of hydrometric monitoring, snow surveys, climate data analysis, and development of a water balance for a proposed gold mine in the Meliadine River Basin near Rankin Inlet.

Nipissar Lake Watershed Study, Rankin Inlet, Nunavut (1987).

Compiled and analyzed snowfall and rainfall data, applied correction factors, estimated lake evaporation and basin evapotranspiration, developed a water balance model and forecasted the long-term adequacy of Nipissar Lake as a water supply for Rankin Inlet.

Rio Paracatu Mineracao Gold Mine Expansion Project, Kinross Gold Corp., Minas Gerais, Brazil (2007 to 2010).

Lead Hydrologist responsible for review and analysis of hydrologic and meteorologic data, development of mine water balance parameters including mean and extreme values of rainfall, evaporation and runoff.

Water Supply Project, Alberta Environment / Special Areas, Alberta (2003 to 2004).

Lead Hydrologist for development of design flows and inflow hydrographs for design of water management structures for a multi-project scheme to distribute water through the Sounding Creek and Berry Creek watersheds in the dry Special Areas of Southern Alberta.

Brenda Mine, Noranda Inc., British Columbia (1998).

Hydrologic modelling of mine area and adjacent stream basins to assess impacts of mine surface water and seepage water quantity and quality on receiving waters, and develop a runoff management system to meet regulatory requirements.

Oilfield Injection Water Supply Study, Norcen, Alberta (1998).

Study to identify and evaluate amount and reliability of surface water supplies in the Eyehill Creek Basin for injection purposes for Norcen Oilfield near Bodo.

Assiniboine River Basin, Design of Planning Study, Sask Water, Saskatchewan (1987).

Compiled available data and developed planning objectives and terms of reference for basin planning study.

Hope River Watershed Study, District of Chilliwack, British Columbia (1985).

Reconnaissance study of the Hope River to identify major erosion, sedimentation, flooding and channel capacity problems, and outline alternative remedial programs.

Coquihalla Highway, BC Highways, British Columbia (1985).

Hydrologic analyses of regional flow data to determine design discharges and runoff regime at creek crossings for 65 km of new highway and identify impacts of highway crossings on wetlands.

Mine and Storm Water Management

Alaska Highway Culvert Replacement, BC Transportation, Taylor, British Columbia (2012-2013).

Project Engineer for design of 157 m long 2000 mm culvert with gabion stilling basin on the north valley slope of the Peace River near Taylor BC.

Alaska Highway South Peace Hill Drainage Improvements, BC Transportation, Taylor, British Columbia (2011-2013).

Project Engineer for investigation and design of drainage improvements to improve stability of a large slide area on the south valley slope of the Peace River at Taylor.

Horizon Oil Sands Mine, Tailings Dewatering System, Canadian Natural Resources Ltd., Alberta (2009 to 2010).

Development of design rainfall and snowmelt runoff events and preliminary design of surface water management system for large-scale oil sands tailings (MFT) dewatering scheme consisting of 30 cells of 30 ha each. System components include cell decant structures, emergency spillways, lateral and collector pipe systems, and outfall structures.

Dyke 10 South Pump Station Design Revisions, Suncor, Alberta (2010).

Review and revise existing design of a pump station and storage pond to manage oil sands tailings pond dyke surface runoff and seepage flows.

SWSS East Perimeter Road Culvert Replacement, Syncrude, Alberta (2010).

Investigation and analysis of sedimentation and icing problems, and design of a 1500 mm culvert.

Kinnard Storm Trunk Drop Manhole, City of Edmonton, Alberta (2009 to 2010).

Analysis of hydraulics and design of energy dissipation chamber for a 12 m hydraulic drop in a 23 m deep manhole.

Dyke 11 South and North Pump Stations, Suncor, Alberta (2007 to 2009).

Responsible for design of several stormwater pump stations including storage ponds, inlet and outlet control structures, pump wells, and discharge lines, to manage oil sands tailings pond dyke surface runoff and seepage flows.

Coke Storage Facility Stormwater Pumping Systems, Suncor, Alberta (2007).

Responsible for design of oil sands area seepage and stormwater pumping system including sub-surface sump and storage capacity, inclined shaft submersible pumps, and discharge lines.

Alaska Highway Re-alignment, BC Transportation, Taylor, British Columbia (2003 to 2005).

Project Engineer for design of 1 km long riprap and gabion lined channel over a steep fill area, for BC Ministry of Highways. The design involved a vertical drop of 90 m including an extended reach with a gradient of 20%.

Highway Drainage and Erosion Control Structures Rehabilitation, Alberta Transportation, Peace River Region, Alberta (2001 to 2003).

Project Engineer for investigation and assessment of various highway drainage and erosion control structures including culverts, down-drains, riprap linings and gabion drop structures. Work covered a number of sites in

the Peace River Region where slopes are typically very sensitive to erosion and instability problems, and included design of rehabilitation works, replacement structures and new structures.

Fernie Estates Surface Water Management Plan, Fernie Preserve Properties, Fernie, British Columbia (1998 to 1999).

Reconnaissance and evaluation of existing drainage conditions, assessment of development impacts on drainage and runoff, and development of a storm and surface water management plan for an 80 ha hillside rural residential development in Fernie.

Panian Mine Water Management, Semirara Coal, Philippines (1998).

Development of a surface water management plan for a new coal mine including hydrologic analysis, design sizing of ditches, sumps, pump stations, piping and discharge works, and assessment of power requirements.

Edmonton Springs Development Water Supply Study, Edmonton, Alberta (1995).

Evaluation of available water supplies, consumptive uses and water diversion requirements for a proposed golf course development. The work included preparation of a report and coordination with regulatory agencies to support proponent's application for a water license.

City of Edmonton Kennedale Storm Trunk and Basin Study Phase III, City of Edmonton, Alberta (1995).

Conduct benefit / cost analyses of flood relief options, assist with development of real-time control logic for SWMF facilities and prepare report for comprehensive stormwater management study of the 7500 ha Kennedale Basin.

McKenzie Interchange Surface Water Management Plan, Alberta Transportation, Red Deer, Alberta (1994).

Analysis of rainfall runoff and storage effects using OTTHYMO, design of surface drainage facilities including detention pond, and replacement of wetland habitat for Highway 2 Interchange at Red Deer.

Ash Landfill Water Management, Paiton Power Plant, Indonesia (1992).

Design of surface water management facilities including perimeter and on-site ditching, sediment ponds, pumps and pipelines for the ash landfill of a large coal-fired power plant.

Hydrocarbons Project, Dow Chemical, Fort Saskatchewan, Alberta (1990).

Surface hydrology and groundwater analyses and design of a permanent groundwater control system consisting of deep-buried horizontal perforated tubing, pump-out sumps, collector headers, storage pond, pumping station, discharge line and outfall to North Saskatchewan River.

West Interceptor Ditch (Toe Berm Project), Syncrude Canada Ltd., Alberta (1991).

Design of over 20 large gabion flow and erosion control structures including grade controls with drops of up to 15 m, flow control weirs and culvert drop inlets, as part of relocation of a major surface runoff interceptor channel around Syncrude's North Tailings Pond.

Trans Mountain Pipeline Expansion, British Columbia.

Served as a Specialist to carry out hydrologic analyses and design of rehabilitation of surface drainage control works at the Burnaby Mountain Storage Tank Farm. The work included stream diversions, erosion control measures, culvert and storm drain replacements, and recommendations for control of suspended sediment during construction to satisfy downstream fisheries and environmental concerns.

Horne Creek Storm Drain Outfall, City of Mission, British Columbia.

Project Manager responsible for design and construction supervision of a 1500 mm diameter storm drain, outfall and outlet channel to a tidal reach of a fish-bearing stream. Design considerations included sedimentation and debris handling at the inlet, prevention of back-flooding due to high tides at the outfall and fisheries and environmental restrictions.

Dams, Reservoirs and Hydroelectric Developments

Deadfish Dam, Dam Breach Inundation Study, Alberta Environment and Sustainable Resource Development, Alberta (2013-2014).

Project Manager - A dam breach inundation study was conducted for the Deadfish Dam constructed in 1950 and rehabilitated in 2004. The project Inflow Design Flood (IDF) was completely updated using special hydrologic analysis methods applicable to the semi-arid Special Areas in which the Deadfish Dam is located.

The overtopping failure scenario required computation of discharge rating curves for the duckbill service spillway and the two-stage fuse-plug auxiliary spillway.

Milk River Ridge Reservoir Dam Safety Review, Alberta Environment and Sustainable Resource Development, Alberta (2013-2014)

Hydrotechnical Lead - responsible for the hydrotechnical aspects of dam safety review for the Milk River Ridge Reservoir involving two dams, two outlet structures and three dykes.

Copper Mountain Mine Tailings Management Facility, Dam Breach Inundation Study, Copper Mountain Mine Ltd., British Columbia, (2013).

Project Manager - Analyses of downstream consequences of earthquake-induced failures of twin tailings dams near Princeton BC. Analyses included evaluation of tailings runout, formation of a secondary dam by the runout mass, consequent river valley blockage, and subsequent overtopping failure of the secondary dam, as well as flood routing of water releases.

McLean Creek Dam, Dam Classification and Hydrotechnical Analysis, Suncor, Alberta, (2011-2013).

Lead Hydrotechnical Engineer for development of dam classification based on Canadian Dam Association 2007 Guidelines, hydrologic analysis and derivation of the Inflow Design Flood, analysis of overtopping scenarios, and design of an overflow weir to improve flood management.

Red Lake Gold Mines Tailings Pond Freeboard Analysis, Goldcorp, Ontario, (2013).

Analysis of wind and wave conditions and determination of freeboard requirements to satisfy Canadian Dam Association 2007 Guidelines.

Ambatovy Project, Phase 2 Tailings Management Facility, Sherritt, Madagascar (2012).

Hydrotechnical review of flood management and spillway design for a large mine tailings pond.

Tailings Pond 8B Freeboard Analyses and Mitigation Study, Suncor, Alberta 2012).

Evaluation of Inflow Design Flood, wind and wave analysis, and determination of freeboard requirements to satisfy dam safety guidelines for Suncor's Tailings Pond 8B, plus a study of mitigation alternatives. The latter involved analysis of overtopping discharge rates for various dyke geometries and design wave criteria, and maximum allowable overtopping rates.

Chain Lakes Dams Rehabilitation, Alberta Transportation, near Nanton, Alberta (2010).

Lead Hydrotechnical Engineer for hydrologic analysis and development of the Inflow Design Flood for design of new flood handling facilities.

Blood Indian Creek Dam, Special Areas Board, near Brooks, Alberta (2010).

Lead Hydrotechnical Engineer for hydrologic analysis and development of the Inflow Design Flood for design of new flood handling facilities.

San Roque Multi-purpose Project, Japan Bank for International Cooperation, Luzon, Philippines (1999 to 2012).

Hydrotechnical and river engineering expert on an interdisciplinary team evaluating compliance with environmental and associated hydrotechnical requirements and guidelines for the construction and operation of a 200 m high dam on the Agno River in Luzon, on behalf of the project lenders. The dam provides 345 MW of hydro generation, regulation for irrigation and flood control, and water quality improvements. Technical aspects included dam safety, dam breach and inundation studies, an emergency preparedness plan, reservoir rim stability, flood forecasting and warning system, river regime and morphology, watershed erosion, reservoir sedimentation and sediment management, and downstream effects of regulation.

Dam Safety Reviews, Deadfish Dam and Loyalist Dam, Alberta Environment, Alberta (2009).

Lead Hydrotechnical Engineer for design flood assessment, flood handling facilities and hydrotechnical aspects of dam safety reviews.

Major Oil Sands Project, Confidential Client, Northern Alberta (2009).

Technical review and guidance to dam breach modellers on selection of breach parameters, 2D flow, and receiving stream flood characteristics.

Rio Paracatu Mineracao Gold Mine Expansion Project, Kinross Gold Corp., Minas Gerais, Brazil (2007 to 2010).

Lead Hydrologist responsible for development of mine watershed hydrology including water balance parameter

values, estimation of extreme / PMP rainfall events, PMF development and flood routing, selection of flood storage and spillway capacity for two tailings ponds, and diversion requirements during tailings dam construction.

Tailings Pond 1, Pond 2/3, and Pond 5 Freeboard Analyses, Suncor, Alberta (2006 to 2009).

Responsible for evaluation of Inflow Design Flood, wind and wave analysis, and determination of freeboard requirements to satisfy dam safety guidelines for several large oilsands tailings ponds.

Lower Churchill Hydroelectric Generation Project, Newfoundland and Labrador Hydro, Labrador (2006 to 2009).

Lead River Engineer for investigation and assessment of the effects of developing two hydro dams on the sediment regime and morphology of the Churchill River.

Dickson Dam Assessment of Alternatives to Manage the Inflow Design Flood, Alberta Transportation, Alberta (2004 to 2009).

Conducted assessment of previous PMF studies and flood analyses and recommended the final inflow design flood to be used for design.

Aurora North Tailings Dam Emergency Preparedness Plan, Syncrude, Alberta (2000, 2008).

Provided critical review and input on the EPP for a 50 m high tailings dam, including review of the dam breach modelling and inundation mapping, for both the original 2000 work and the 2008 update.

Travers Reservoir Structures Rehabilitation, Alberta Transportation, Alberta (2002 to 2003).

Lead Hydrotechnical Engineer for start-up phase of project for analysis and design of rehabilitation measures for hydraulic structures and auxiliary spillway system to manage the PMF.

Similco Mine Tailings Dam Review, Similco Mines, Princeton, British Columbia (2001 to 2002).

Hydrologic analysis of regional snow course, precipitation, and runoff data to estimate the PMF for a 100 m high tailings dam and make recommendations for spillway requirements and dam safety aspects.

Gardiner Dam Re-evaluation of Probable Maximum Flood, Water Resource Consultants / Sask Water, Saskatchewan (2001 to 2002).

Hydrologic analyses and SSARR model development and calibration of the South Saskatchewan River Basin at Lake Diefenbaker were carried out as part of a re-evaluation of the PMF for the Gardiner Dam. PMP and snowmelt inputs (provided by others) were modelled to produce sub-basin runoff hydrographs which were then combined and routed through the stream network using the SSARR model.

Tapanahoni River Diversion Project, Kvaerner Alcoa Alliance, Suriname (2000 to 2001).

Project Manager for a feasibility study to divert 270 m³/s from the Tapanahoni River to the adjacent Suriname River Basin to increase power generation at an existing hydro plant, in support of a proposed aluminium smelter for the Suriname Aluminium Company, a subsidiary of Alcoa. The project involved a multi-disciplinary team conducting hydrologic studies, reservoir and hydro plant simulations, conceptual design of diversion dams, spillways, control structures and canals and assessment of environmental and socio-economic impacts.

Little Bow River Dam Emergency Preparedness Plan, Alberta Transportation, Alberta (1999).

Provided critical review and input for EPP for Little Bow River Dam, including inundation mapping.

Swan Hills Reservoir Dam Safety Upgrade, Anderson Exploration, Alberta (1998).

Project Manager for analysis, design and construction of dam safety upgrade for a 20 m high embankment dam. The work included evaluation of dam classification and design criteria, dam breach and inundation study, and design of a new enlarged spillway.

Esterhazy Dam Probable Maximum Flood Estimate, IMC Canada, Saskatchewan (1992).

Analysis of storm rainfall and streamflow hydrographs and use of regional PMF studies to estimate the probable maximum flood on Cutarm Creek at Esterhazy Dam.

Snare Cascades Hydroelectric Project, Northwest Territories (1990).

Design of spillway and diversion channel for EPC tender for construction of hydro plant on the Snare River.

Karnali (Chisapani) Multi-purpose Project, Ministry of Water Resources, Nepal (1989).

Served as Specialist for coordination and supervision of a program to collect and analyze suspended sediment and hydrometric data on the Karnali River and estimate reservoir sedimentation for a proposed hydroelectric and irrigation water supply dam at Chisapani, Nepal. Responsibilities included technical review of methods,

procedures and equipment, recommendations for improvements to the program and expansion of the data collection network in the basin, and training of staff in the field.

Lake Diefenbaker Reservoir Water Use Study, Sask Water, Saskatchewan (1988).

Development of a water balance for Lake Diefenbaker and assessment of impacts of increased withdrawals on flows and levels and on existing water users, including hydro generation at downstream plants.

Island Falls Hydroelectric Re-development Project, SaskPower, Churchill River, Saskatchewan (1985 to 1986).

Hydrologic studies, river surveys, design of spillway and river channel improvements, ice studies, and power and energy studies for re-development of the Island Falls Hydro Plant for SaskPower.

Mica Dam Project, BC Hydro, British Columbia (1974).

Review and analysis of results of hydraulic model studies on scour and sedimentation associated with spillway and low level outlets operation; recommendations for direction of the model studies.

W.A.C. Bennett Dam – Peace River Downstream Studies, BC Hydro, British Columbia and Alberta (1970 to 1974).

Studies and field programs to assess the effects of flow regulation on the hydraulics, flooding potential, scour, sedimentation, ice effects and environmental aspects of the Peace River downstream to the Peace-Athabasca Delta.

McGregor River Diversion, BC Hydro, British Columbia (1972 to 1973).

Planning and execution of a field program to collect baseline data on river characteristics including cross-sections, profiles, bed and bank materials, and sediment loads, followed by a study to evaluate hydrologic, environmental and river regime impacts of river diversion to augment power generation at the W.A.C. Bennett Dam.

Site One Hydroelectric Development, BC Hydro, Peace Canyon, British Columbia (1972).

Hydraulic design of spillway, power intakes, trash racks and power conduits for the Site One Development on Peace River.

Gold River Hydro Development, BC Hydro, British Columbia (1971).

Hydrologic study of the watershed to determine long-term flows available for power generation at alternative sites.

Moran Dam Site, BC Hydro, British Columbia (1970).

Reservoir sedimentation study including review and analysis of flow and sediment data, for proposed Fraser River dam site.

Jordan River Hydroelectric Re-development, BC Hydro, British Columbia (1970).

Hydrologic analysis to develop an extended record of monthly flows, determine reservoir storage requirements, and develop operating rules for a 3-reservoir system for power generation purposes.

River Engineering

Riviere des Rochers Little Rapids Weir Boat Passage Alternatives, Alberta Environment and Sustainable Resources, Peace-Athabasca Delta, Alberta (2011-2013).

Project Manager and Lead Hydrotechnical Engineer for both Phase 1 and Phase 2 of a study to identify, design and evaluate alternatives to an existing tramway-based boat passage facility in the Peace-Athabasca Delta. Alternatives included a new navigable channel, a navigation lock, and an improved tramway system. The studies included establishing navigability criteria, analysis of channel hydraulic behaviour, evaluation of dredging quantities and spoil disposal strategies, and development, calibration and verification of a hydrologic model to assess the effects of proposed works on water levels of Lake Athabasca and the Peace-Athabasca Delta.

Redwater River Tributary Diversion, Redwater Water Disposal Co., Alberta (2009).

Hydrologic analysis to assess flood regime and predict spring runoff; and, design of temporary diversion works to by-pass contaminated site clean-up zone.

Victor Kimberlite Project, De Beers, Attawapiskat, Ontario (2005).

Lead River Engineer for site selection and conceptual design of a raw water intake on the Attawapiskat River. Responsibilities included specifying river bathymetric and hydrometric surveys, development of design water

levels, evaluation of river bed and bank stability, and managing sub-consultant's evaluation of ice conditions.
Mackenzie and Peel River Ferry Crossing Effects, Gov't of NWT, Department of Transportation, Northwest Territories(2001).

River engineering evaluation of effects of ferry operations and ferry landing construction and maintenance on river hydraulics, near-shore turbulence and the sedimentation regime.

Muskeg River Bridge, Shell Canada Ltd., Alberta (1999).

Hydrotechnical analysis and design of a bridge crossing for Shell Canada's Muskeg River Oil Sands Project.

Athabasca Pipeline Project, Wild Rose Pipeline Inc., Northeastern Alberta (1998).

Field reconnaissance, hydrology and river engineering for hydrotechnical design of 28 major river crossings and numerous minor crossings for 550 km pipeline in north-eastern Alberta.

Williams Creek Permanent Stream Channel Design, KOKEN General Contractors, near Barkerville, British Columbia (1998).

Design of a permanent stream channel for Williams Creek through an area severely disturbed by Placer Gold mining activities near Barkerville, British Columbia.

Strachan North Pipeline Project, Gulf Canada, Alberta (1997 to 1998).

Hydrotechnical analysis and design of all watercourse crossings for a 75 km pipeline in west central Alberta.

Kugluktuk Water Intake Modifications, Ferguson Simek Clark, Kugluktuk, Nunavut (1997).

Carry out river engineering, modelling and analysis to provide hydrotechnical design parameters (water levels, velocities, ice conditions, sedimentation) and recommendations for modifications to the Kugluktuk potable water intake in the Coppermine River.

Hangingstone River Pipeline Crossing Stabilization, Suncor Energy Inc., Alberta (1997).

Field reconnaissance and river engineering analysis of stabilization alternatives to protect an existing pipeline crossing threatened by exposure due to a meander loop cutoff.

North Saskatchewan River Near-Field Mixing, City of Edmonton, Alberta (1996 to 1997).

Evaluated jet trajectories and near-field mixing characteristic of the City of Edmonton's major storm and combined sewer outfalls into the North Saskatchewan River, and provided related input parameters for WASP water quality modelling of the river.

St. John Creek Pipeline Crossings, Anderson Exploration, Fort St. John, British Columbia (1996).

Design of large gabion grade control / drop structure to control erosion and protect existing pipeline crossings of St. John Creek. The work included evaluation of fish passage requirements and design of a vertical slot fish ladder acceptable to B.C. Environment.

Marsh Head Creek Bridge, ANC Timber Ltd. / Berland Resources, Alberta (1996).

Design of remedial works including channel restoration, gabion and riprap bank protection and debris control for a bridge.

Kennedy Creek Bridge, Alberta Transportation, Thorhild, Alberta (1996).

Preliminary design (hydrology, hydraulics, assessment of alternatives), detailed design and construction supervision of structural plate arch beam (ABC) culvert replacement for Highway 18 crossing of Kennedy Creek.

Blue Grave Creek Crossing Improvements, BC Environment, British Columbia (1996).

Hydrologic and hydraulic analysis of 3 forestry road crossings of Blue Grave Creek and development of alternative designs for replacement crossings to improve fish passage.

Coppermine River Water Intake Siting Study, Ferguson Simek Clark, Kugluktuk, Nunavut (1995).

Study of hydrology, hydraulics, river regime and salinity intrusion in the estuary of the Coppermine River to identify feasible locations for potable water intake.

Yukon River, Canyon City Wharf, SLG Stanley Consultants, Whitehorse, Yukon (1995).

Specialist to evaluate river flow and water level regime, flow velocities and ice conditions and develop design parameters for wharf reconstruction.

Gas Utilization Pipeline Project, Vietgas, Vung Tau, Vietnam (1992 to 1993).

Field reconnaissance, hydrology, and preliminary design of 45 pipeline river crossings up to 800 m wide

including tidal estuary channels, for the Dragon-White Tiger-Thu Duc gas pipeline.

Stream Crossing Studies, CP Rail, Saskatchewan (1986).

Prepared preliminary designs for 6 bridge and culvert stream crossings requiring replacement. Work included field reconnaissance, site surveys, hydrologic analyses, flood routing, determination of design flows and water levels, selection of replacement structures, erosion control and embankment stabilization.

Camp-Hope Channel Improvement Project, Chilliwack, British Columbia (1984).

Project Manager for design and supervision of construction of controlled water intake structure and inlet channel system to take off water from the Fraser River to augment flows for improved water quality and fisheries habitat.

Salmon River Culvert Failure, Willis Cunliffe Tait, Langley, British Columbia (1979).

Analysis and report on the failure of a large structural plate culvert during a major flood event on the Salmon River. The work included field investigations, detailed meteorologic and hydrologic analyses, assessment of design criteria and determination of failure mechanism.

Anderson Creek Culvert, District of Langley, Langley, British Columbia (1977).

Served as Project Manager for design and supervision of construction for rehabilitation and extension of a double 3 x 2 m concrete box culvert including baffles and weirs for fish passage, gabion revetments and retaining walls.

River Regime Surveys, Environment Canada, British Columbia (1970).

Conducted water level and stream flow measurements, sediment sampling, and river surveys on the Fraser and Kootenay Rivers; critical review of hydrometric data for B.C. stream gauging stations, and inspections and surveys of Fraser River dykes.

Chilliwack Creek Salmon Rearing Channel, Chilliwack, British Columbia.

Project Manager for determining groundwater supply and design of a 2 km long salmon rearing channel.

Flood Risk Studies and Flood Control

Orphan Dykes Emergency Response Planning, Ministry of Water, Land & Air, British Columbia (2001 to 2002).
Provided critical review and input for reports addressing emergency response planning issues for dykes and associated structures at 40 locations in B.C.

Doig River Flood and Erosion Risk Study, Stanley Consulting Group, near Fort St. John, British Columbia (1998).

Assessment of flood risk and susceptibility to erosion of proposed infrastructure facilities for the Doig River Indian Band near Fort St. John, British Columbia.

Medicine Hat Flood Damage Mitigation Study, City of Medicine Hat, Alberta (1997 to 1998).

Assessment of flood damages, development of mitigation alternatives, benefit-cost analyses and preparation of a report to recommend implementation of flood damage mitigation measures for the City of Medicine Hat. Recommended measures included structural measures, non-structural measures, and development of a detailed emergency response plan.

Vermilion River Flood Risk Mapping, Alberta Environment, Vegreville, Alberta (1994).

Conducted HEC-2 analyses and prepared flood risk maps for the Vermilion River through Vegreville.

Chilliwack Dykes Section B Outside Alignment, BC Environment, British Columbia (1981).

Study Director for a feasibility study to determine benefits and costs of relocating a 6.5 km section of main river dyke to protect an additional 700 ha of agricultural land in the Fraser River Delta floodplain. The study included hydrologic analyses, conceptual designs for a 10 m³/s pump station, a 35 m³/s floodbox and dyke cross-sections, surveys, land use studies, flood damage assessment and cost-benefit analysis.

Chilliwack Wing Dykes Feasibility Study, District of Chilliwack, British Columbia (1978).

Evaluation of dyking alternatives to protect areas of Chilliwack, British Columbia between Minto Landing and Shefford Slough. The work included hydraulic analysis of Fraser River flood profiles, backwater effects, erosion and flooding potential, and development of alternative protection options.

Fraser River Flood Control Program, Surrey, British Columbia (1975).

Design of open drains, culverts, hydraulic structures, pumping stations and flood boxes to provide internal drainage for Fraser River floodplain areas protected by dykes.

Fraser Mills and Cape Horn Flood Control, Coquitlam, British Columbia.

Feasibility study and preliminary design of flood control works and surface drainage system for a 1000 ha industrial site on the Fraser River floodplain.

Internal Flood Control, Coquitlam, British Columbia.

Design of open drains and culverts, and preliminary design of 16 m³/s pumping station to provide internal drainage of a dyked floodplain area.

Scott Creek Flood Control, British Columbia.

Design of channel improvements and flood control measures in a fish-spawning creek for mixed-residential / agricultural watershed.

Lamont Creek Flood Risk Mapping, Alberta Environment, Lamont, Alberta.

Conduct HEC-2 analysis and prepare flood risk mapping.

Erosion and Sediment Control

Hay River Erosion Study, Dene Band, Hay River, Northwest Territories (1998 to 2003).

Project Manager for assessment of river bank erosion along the Dene Indian Reserve in the Hay River delta. The project included GIS analysis of river channel movement based on air photo data, hydraulic modelling of river flows, and monitoring of erosion processes and erosion rates.

Discovery Mine Borrow Pit Reclamation Plan, Public Works and Government Services Canada, Northwest Territories (2002).

Project Manager for development of a reclamation plan to control erosion and contamination of pit water by eroded sediments and downstream discharge of the contaminated water. Proposed reclamation measures included a wood chip insulating cover to control permafrost degradation, riprap erosion protection of drainage inlets and the pit shoreline, and re-vegetation. Short-term measures included flocculation with alum, pH adjustment using lime, and pumping of the pit water.

East Trout Lake Shoreline Erosion, Cabin Owners, Saskatchewan (2001 to 2002).

Assessment of a shoreline erosion problem along a lake-front cottage development, evaluation of alternative shore protection works, and conceptual design of a shore revetment to control erosion.

Lesser Slave River Stability, AMEC Infrastructure, Alberta (2001).

Evaluation of lateral stability of Lesser Slave River adjacent to the Old Smith Highway (Highway 2A) and preparation of recommendations for setbacks for highway re-alignment.

South Saskatchewan River Bank Stabilization, City of Medicine Hat, Alberta (1998 to 1999).

Hydrotechnical analysis and design of bank stabilization works to provide erosion protection for City of Medicine Hat park and pathway facilities.

Bow and Elbow Rivers Bank Stabilization, Calgary Parks & Recreation, Calgary, Alberta (1997 to 1998).

River engineering, hydrotechnical analysis and design of bank stabilization works to control river bank erosion and to protect and enhance the City's river bank pathway system. Services included fish habitat assessments and the design of habitat compensation.

Sediment Pond Expansion, Smoky River Coal Ltd., Grande Cache, Alberta (1997).

Hydrologic and hydraulic analysis and civil design of expansion of an existing sediment pond. The design included reconstruction of the dam and spillway and a new inlet flow monitoring weir.

Coquihalla River Bank Protection Improvements, District of Hope, British Columbia (1997).

Design of remedial works to upgrade a section of river bank in the District of Hope. Existing riprap bank protection had been failing and improvements to the filter bedding and the riprap gradation were made.

Clear Lake Beach Study, Parks Canada, Wasagaming, Manitoba.

Specialist for determining causes of loss of beach sand and deterioration in water quality at a Parks Canada recreational area. The work included field investigations, sediment and water sampling and analyses, wind and wave analyses and recommendations of remedial measures to permit natural beach replenishment and

improved water quality.

Sheep River Bank Stabilization, Pembina Resources, Okotoks, Alberta.

River engineering, hydrotechnical analysis, fisheries evaluations and design concepts for bank stabilization works to control bank erosion and protect the Town of Okotoks' infrastructure facilities.

Horne Creek Watershed Erosion Control, City of Mission, British Columbia.

Study Director for a study and field investigation to assess severity of present and future erosion, determine stable regime channel parameters, and recommend remedial work program for Horne Creek watershed.

Agricultural Drainage and Irrigation

Peace River Basin Drainage Studies, Alberta Environment, Alberta (1989).

Drainage study to evaluate the severity, extent and causes of flooding problems in 3 agricultural areas in the Peace River Basin, and development of alternative solutions.

Integrated Soil and Water Improvement Project, CIDA, Egypt (1987 to 1988).

Chief Drainage Engineer for project mobilization and design start-up phase. Responsible for management and execution of all drainage improvement work for 30 000 ha of agricultural land suffering from water logging and salinization in the Nile Delta.

Quill Lakes Drainage Investigations, Saskatchewan Water Corporation, Saskatchewan (1986).

Investigation of drainage problems and development of remedial works for individual farms in the poorly drained Quill Lakes area.

McFarlane Creek Drainage and Flood Control Project, Saskatchewan Water Corporation, Saskatchewan (1985).

Feasibility study and preliminary design of drainage improvements to control flooding for 5000 ha of agricultural land.

Vant Creek Drainage Project, Saskatchewan Water Corporation, Saskatchewan (1985).

Feasibility study, engineering design and preparation of construction drawings and specifications for drainage improvements to 1300 ha of agricultural land.

Russell Creek Irrigation, Saskatchewan Water Corporation, Saskatchewan (1986).

Assessment of existing water delivery system and preliminary design and cost estimates of alternative systems to minimize water losses and improve irrigation efficiencies.

East Chilliwack Agricultural Drainage, BC Agriculture, British Columbia (1979 to 1983).

Feasibility study, design and construction supervision of drainage works and irrigation improvements for 4000 ha of farmland.

Somenos – Richards Creek Drainage Project, BC Agriculture, Duncan, British Columbia (1981).

Hydrologic analysis and hydraulic design of drainage improvements to facilitate timely removal of runoff and control of water tables for improved agricultural production.

Yarrow Drainage Study, District of Chilliwack, British Columbia.

Feasibility study and preliminary design of drainage improvements to a system of natural streams, open drains and culverts to prevent flooding of a mixed agricultural and residential area.

Municipal and Environmental

North Saskatchewan River Water Quality Sampling, City of Edmonton, Alberta (1996).

Coordination of a sampling program to measure and assess water quality variations in the North Saskatchewan River through Edmonton as affected by storm sewer, combined sewer and treatment plant discharges during dry and wet weather, as part of the City of Edmonton's 1996 Environmental Monitoring Program.

Edmonton Interconnections Strategy Mill Creek Areas Evaluation, City of Edmonton, Alberta (1995).

Coordination of the program to analyze sewer interconnection hydraulics, develop remedial alternatives and implementation plans, assessment of benefits and costs, and preparation of reports.

Hydrocarbons Project, Dow Chemical, Fort Saskatchewan, Alberta.

Specialist for the analysis of sanitary sewage system requirements, development of design parameters, design of new gravity lines, pumping stations and force mains and design of flow control and flow measurement improvements to existing system.

Civic Services Center Off-site Services, Chilliwack, British Columbia.

Project Manager for the design, contract documents and construction supervision of access road, curb and gutter, water, sewer and storm drainage services to Chilliwack's Civic Services Center.

Deacon Estates Industrial Subdivision, Matsqui, British Columbia.

Served as Project Manager for surveys, design, approvals, tender documents and construction supervision of an industrial subdivision including complete servicing.

Inches Creek Salmon Hatchery, Department of Fisheries and Oceans, Mission, British Columbia.

Project Manager for the design, preparation of contract documents and tendering for a groundwater supply system consisting of 12 Hp and 25 Hp pumps with complete metering, control and alarm systems, including automatic switching to standby diesel generator. Complete electrical, mechanical and HVAC design of the hatchery building was included.

Publications and presentations

"Environmental Monitoring for the San Roque Multi-Purpose Project Philippines." van der Gugten, Neil and Rozon, Gordon. Proceedings of 2002 Annual Conference, Canadian Dam Association, Victoria, British Columbia, 2002.

"Re-Evaluation of Gardiner Dam PMF." Pentland, Ray, Hogg, W. D., Taylor, George H., Orton, Mark and van der Gugten, Neil. Proceedings of 2002 Annual Conference, Canadian Dam Association, Victoria, British Columbia, 2002.

"Embankment Hydrology – Storage Water Controls in Slope Stability in Surface Mining." Beckstead, Gary; Slater, John; van der Gugten, Neil; and Slawinski, Andrzej. Society for Mining, Metallurgy and Exploration, Hustrulid, McCarter and VanZyl eds., Littleton, Colorado, US, 2000.

"Drainage and Erosion Control in the Athabasca Oil Sands." van der Gugten, C.A., Lokhorst, B. and Peirone, B. International Erosion Control Association Conference, Regina, SK, 1992.

"Hydrology for Storm Water Management, Storm Water Management Seminar." van der Gugten, C.A. New Westminster, 1982.

"Discussion of Scour Around Bridge Piers at High Flow Velocities." van der Gugten, C.A. By S.C. Jain and E.E. Fisher, J., Hydraulics Division, American Society of Civil Engineers, 108, pp. 292 to 298, 1982.

"Discussion of Designing Spillway Crests for High Head Operation." van der Gugten, C.A. By J.J. Cassidy, J. Hydraulics Division, American Society of Civil Engineers, 96, pp. 1778 to 1779, 1970.

ZAJDLIK & ASSOCIATES INC.

BARRY ZAJDLIK, PRINCIPAL

PROFESSIONAL EXPERIENCE

1991–present Zajdlík & Associates Inc. Rockwood, Ont.

Principal

- Project management, contract acquisition.
- Environmetrician, report writing.

1992–present Pollutech EnviroQuatics Pt. Edward, Ont.

Research Associate

- Statistical consultation on experimental design, analysis and interpretation.
- Project manager.

1989–1990 Department of Population Medicine Guelph, Ont.

Statistician

- Guidance in statistical design, analysis and interpretation to faculty and staff in biomedical statistics.
- Responsible for providing SAS seminars, computer support, (servicing, installation and purchasing), and custom Fortran and SAS programming.

1990-current Professional Activities

External Program/Project Manager

- Managed international CIDA program, manage projects for other consulting firms.

Lecturer

- An invited lecturer at various universities, governmental agencies, and professional societies with topics falling under the general umbrella of statistics and environmental science.

Panel Member

- An invited panel member at the federal (since 1993) and provincial (since 2000) governmental levels, on issues related to the application of statistics and environmental science.

Peer Reviewer

- Review papers published in the primary literature, book chapters and governmental documents, in the areas of environmental toxicology and statistics.

Legal

- Acted as expert witness, and provide reviews for legal proceedings.

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PROJECT EXPERIENCE: SELECTED RESEARCH

- **Statistical Assumptions for Defensible Estimation of Toxicity Test Endpoints.** Weighting (Poisson and inverse variance), transform both sides, and combinations thereof, were assessed for their ability to remedy heteroskedasticity and non-normality in the context of nonlinear regression. The effect of these remedies on bias and confidence interval coverage for ICp estimates was assessed. Environment Canada, Methods Development and Application Unit. 2015.
- **Assess Protectiveness of Safety Factors.** The level of protection afforded by safety factors was shown to vary by sample size, degree of variation and underlying statistical distribution. The level of protection varies wildly and has implications for environmental management. Mining Association of British Columbia. 2014-2015.
- **Investigate Standardization Methods to Derive Zn CCME Water Quality Guideline.** There is a desire to modify Zn water quality guidelines on the basis of known toxicity modifying factors. This project explored statistical adjustments of Zn toxicity in order to estimate site-specific Zn water quality guidelines. National Guidelines and Standards Office. 2013.
- **Develop a Tier II Site-Specific Remedial Objectives Paradigm.** Soil quality guidelines for PHCs in Canada are primarily driven by the soil contact pathway. Although there is a provision to modify Tier II SSROs there is no method to do so. This project investigates a new paradigm for doing so. PERD, CAPP, Stantec 2012 Research Fund. 2013.
- **Estimate Background Concentrations of Soil Analytes in Ontario.** Background concentrations underpin many of the regulations associated with soil use in Ontario. This project seeks to improve the current background estimation paradigm. 2007-ongoing.
- **Develop Soil Sampling Protocols for Cryosols.** Cryosols cover a vast area of Canada and to date no systematic soil sampling protocol has been developed. Such a protocol is necessary to assess potential development effects in the Canadian North. INAC: 2009.
- **Applying SSD Concepts to Bimodal Distributions.** This project involved extending the current CCME paradigm for generating water quality guidelines to substances that exhibit target-specific effects and non-target effects. Environment Canada: 2007.
- **Investigate Spatio-Temporal Variability in Arctic Lakes.** Oil and gas exploration and development along the Mackenzie Valley corridor may lead to requirements for monitoring of lake water quality. The drivers of tundra lake water quality are not currently understood and are under investigation. Indian and Northern Affairs Canada: 2006-2008.

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PROJECT EXPERIENCE: SELECTED RESEARCH

- **Incorporate Toxicity Modifying Factors in the SSD Approach to Estimating Canadian Water Quality Guidelines.** The current water quality guidelines in Canada are generic and suffer from several shortcomings. New methods have been developed for use in Canada that obviate these shortcomings (work conducted by Zajdlik & Associates, Inc.). These new methods are still generic though. This project provides recommendations on how to make the new Canadian approach to generating water quality guidelines site-specific at least with respect to the principal toxicity modifying factors. CCME: February-April 2006.
- **Toxicity Modifying Factors in Ammonia Toxicity to *D. magna*.** This project involves optimizing an experimental design to assess the simultaneous effects of pH and acclimation temperature on ammonia toxicity for *Daphnia magna*. The results will be used to improve the applicability of Canadian Water Quality Guidelines for ammonia. Ontario Ministry of Environment: 2006.
- **Identify Statistical Models to Describe Species Sensitivity Distributions.** This project involved assessing the statistical and ecotoxicological and regulatory literature to determine what statistical models have been used globally to describe species sensitivity distributions. Then, 7 species sensitivity distributions were examined to generate a suite of statistical models that could potentially describe all species sensitivity distributions for derivation of water quality guidelines within Canada. Ontario Ministry of Environment / CCME: March-October, 2005.

PROJECT EXPERIENCE: SELECTED EXPERIMENTAL DESIGN

- **Soil Sampling Protocols for Toxicity Testing.** Provide guidance and direct input to newly developed protocol. Environment Canada: 2009-2010.
- **Review of BHP Billiton Ekati Diamond Mine aquatic effects monitoring program.** Indian and Northern Affairs Canada: 2007
- **Design of environmental monitoring program to assess potential human and ecological effects of the Munitions Environmental Test Centre activities within the St. Lawrence River and interpretation of results.** Department of National Defense: 2004-2007
- **Design of experiments to compare the hepatocyte toxicity test with the Environment Canada regulatory rainbow trout toxicity test.** Ontario Ministry of Environment: 2003
- **Redesign and interpretation of ongoing monitoring program to assess the potential cumulative ecological effects of uranium mines in northern Saskatchewan.** Saskatchewan Environment: 2002 - 2004
- **Design of fish consumption survey to determine age-specific consumption rates in a First-Nations community.** GlobalTox Environmental Inc. 2004.
- **Review of sampling plans to identify unexploded ordnance, Port Albert.**
- **Design of experiment to evaluate the relative sensitivity of trout hepatocyte and gill cell lines and the 96-hour acute lethality rainbow trout test, to spiked industrial effluents to evaluate utility as an Environment Canada test method.**
- **Design of experiments to assess the efficacy of Hg separators for dental amalgams**

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PROJECT EXPERIENCE: SELECTED EXPERIMENTAL DESIGN

- and creation of a federal guidance document for technology verification. Ontario Centre for Environmental Technology Advancement: 2002
- Design of experiments to determine the efficacy of As mitigation technologies in Bangladesh. Over 1, 000, 000 wells are contaminated with As. The WHO and Government of Bangladesh are using Canadian expertise in verifying environmental technologies to design a series of field and laboratory verification experiments that will be implemented by the British Geological survey. Ontario Centre for Environmental Technology Advancement: 2001-2002
- Design of *in situ* bivalve bioaccumulation study to assess potential movement of PCB congeners from an industrial site. Confidential.
- Design of adaptive soil sampling plans designed to reduce sampling costs and quantify the risk of undetected hot spots. The contaminants of concern were PAHs that had been stockpiled in a mixture containing highly and slightly contaminated soils. Confidential.
- Design of experiments to estimate relative sensitivity of a sublethal, flagellate bioassay to mining effluents. This research contract was awarded through CANMET.
- Design of numerous benthic community surveys to delineate spatial and temporal changes in areas, potentially impacted by heavy metals, PAHs, chlorinated organic compounds and insecticides.

PROJECT EXPERIENCE: SELECTED ANALYSIS AND INTERPRETATION

- Modelling effects of contaminant releases from dikes. Department of Fisheries and Oceans. 2012.
- Modelling Crop Yields and Prediction of Effect Concentrations. Stantec Consulting. 2012.
- Modelling Temporal Trends in Slave River Water Quality Analytes. Aboriginal Affairs and Northern Development Canada: 2010-2011.
- Analysis and Interpretation of Soil Toxicity Data. Stantec Consulting. 2011.
- Historical Review of Sarnia Lambton Environmental Associations Sediment Quality Surveys. Pollutech EnviroQuatics. 2011.
- Geostatistical analyses of eutrophication indicators. Department of Indian and Northern Affairs Canada. 2009.
- Geostatistical analyses of sediment quality indices. Department of National Defense. 2007.
- Estimate thresholds for remediation using 26 types of soil toxicity tests conducted on 49 soil samples. Stantec Consulting Ltd. 2007.
- Assessed effects of mine tailings on plant growth in both field and laboratory experiments and assessed congruence between same. Ontario Ministry of Environment. 2004.
- Determined probabilistic intervention criteria for soil B(a)P in the Ivy Avenue area of Toronto, based upon a human health risk-based intervention criterion. Ontario Ministry of Environment. 2004.

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PROJECT EXPERIENCE: SELECTED ANALYSIS AND INTERPRETATION

- Predicted financial liabilities to the DFO due to ownership of contaminated sites across Canada. Department of Fisheries and Oceans 2002-2005.
- Nonlinear calibrations to determine probable time to failure for groundwater As mitigation devices. Ontario Centre for Environmental Technology Advancement: 2005.
- Interpreted multivariate data to independently confirm conclusions regarding potential human health effects of the Sydney tar ponds. Nova Scotia Department of Health: 2003.
- Managed a risk assessment of the capability of marshland to retard movement of radionuclides. Pollutech EnviroQuatics: 2002.
- Validation of toxicity test endpoint calculations conducted under GLP.
- Determined probabilistic intervention criteria for soil Ni in the Rodney St. Area of Port Colborne, based upon a human health risk-based intervention criterion. Ontario Ministry of Environment: 2002.
- Determined exposure of Walpole Island First Nation residents to contaminants in fish. GlobalTox: 2003.
- Estimation of endpoints from problematic data generated by OECD method 201.
- An evaluation of methods used to interpret the *Vibrio fischeri* solid-phase luminescence test. Environment Canada, Waste at Sea is considering using the *Vibrio fischeri* test in determining the suitability of dredged materials for disposal at sea. Environment Canada: 2000.
- Developed the statistical component of the Canadian Environmental Technology Verification program. ETV Canada: 2000.
- Analysis and interpretation of TEQ emission rates used to determine the impact of wood stove combustion on dioxins and furan loadings. Environment Canada, Environmental Technology Centre: 2000.
- Analysis and interpretation of data generated by Cycle II EEM pulp and paper compliance monitoring programs (2 locations).
- Design and interpretation of a contaminated harbour assessment on the St. Lawrence River, using a sediment quality triad approach. Pollutech EnviroQuatics: 2000.
- Monte Carlo analysis of soil contaminant, volume estimates in an environment subject to tidal influences. Imperial Oil: 1999.
- Managed an ecological risk assessment to investigate the risks of remediation of contaminated sediments in the St. Clair River. Sarnia Lambton Environmental Association: 1999-2001.
- Determining the relationship between sediment, and porewater metal levels of lead in various forms to *Amphiporeia virginiana* following a spill of materials. Pollutech EnviroQuatics: 1999.
- A commentary on the statistical implications of compliance biological test design and interpretation.
- Estimation of limits of quantification used in setting criteria for the virtual elimination of PCBs and PCDDs in Canada. Environment Canada (Analysis and Methods Division).
- Interpretive guidance for bioassays using pollution gradient studies. The performance

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PROJECT EXPERIENCE: SELECTED ANALYSIS AND INTERPRETATION

of sediment bioassays along a gradient of PAH and PCB contamination was examined. Concomitant sediment chemistry and benthic macroinvertebrate abundance data was used to link toxicity test responses with environmental measurements and effects using the sediment quality triad paradigm. Recommendations for the assessment of dredged materials in Canada prior to ocean disposal were given. Environment Canada, Ocean Disposal: 1999-2000.

- Analysis of round-robin data used to explore new methods for hydrocarbon analyses. BC MELP.
- Estimation of spatial extent of toxicant contamination in marine sediments following a spill event.
- Assessment of the correlation between metal contaminants in soil and crop yields and growth.
- Analysis of experiments to refine the standard operating procedure for an experimental biological test used to assess water quality of mining effluents. CANMET Research Grant.
- Analysis of air quality discontinuities resulting from process control changes in a chemical manufacturing plant.
- Consultation on sampling design for routine monitoring of dredged material disposal sites. Environment Canada.
- Predicting process control parameters in pilot effluent remediation studies to ensure effluent compliance.
- Estimation of "Safe Levels" of food additives using structural class to conform to a defined risk. "Safe levels," were estimated using the 5th percentile of NOECs, and by an empirical bootstrapping method developed by Zajdlik & Associates. The effects of using various types on endpoints (mortality, blood, liver, gonadal, kidney, etc.), and stratifying factors such as sex, species tested, and structural class.
- Triad analysis of industrial, municipal and agricultural inputs to a fluvial system. This multi-year study compared sediment chemistry, sediment toxicity tests and benthic macroinvertebrate community structure using the sediment quality triad paradigm. Sarnia Lambton Environmental Association
- Consultation on survey design for estimating daily nutrient intakes in Canada.
- Incidence of mammary gland tumours in ACK treated rats. The dose-response between level of ACK and incidence of tumours in rat was estimated, stratifying by tumour type.
- Determining the probability of detecting occasionally non-compliant industrial effluent under various sampling regimes.
- Interpretative Guidance for Bioassays using Pollution Gradient Studies. The performance of sediment bioassays along a gradient of metal contamination was examined. Concomitant sediment chemistry and benthic macroinvertebrate abundance data was used to link toxicity test responses with environmental measurements and effects using the sediment quality triad paradigm. Environment Canada (Waste at Sea).
- Geostatistical analysis of background levels of sediment associated metals. This contract explored the utility of existing background metals data sets in estimating background levels of metals in potential disposal sites. Environment Canada (Waste at Sea).

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PROJECT EXPERIENCE: SELECTED ANALYSIS AND INTERPRETATION

- Conducted a statistical comparison of various micro and kit toxicity tests to the standard rainbow trout and *Daphnia magna* for the Canadian mining industry on behalf of Natural Resources Canada (CANMET). Tests were compared in part, on the basis of sensitivity to an effluent and the specificity of a response to toxicant levels within an effluent.
- Participated in the development and validation of a rapid aggregation toxicity test for mining effluents. This is a sublethal, micro-scale flagellate bioassay that may be used to explore a hitherto, unexamined trophic level. Conducted through a research grant from CANMET.
- Analysis of sediment quality triad data. Over 20 distinct projects.
- Analysis of toxicity test responses and water chemistry variables to identify potential sources of toxicity. This type of analysis is routinely done. In one instance, an analysis of egg toxicity in a flow through situation resulted in a reassessment of culpability.
- Analysis of multiple aquatic toxicity test types to determine most sensitive test.
- Analysis of pharmacokinetic data using compartment models.
- Analysis of non-quantal toxicity test data using threshold models.
- Statistical modelling of the distribution of the combustion by-products of transformer fires containing PCB's. This predictive atmospheric disturbance model is used to determine evacuation areas downwind of PCB fires. Ontario Hydro.

PROJECT EXPERIENCE: CUSTOM PROGRAMMING

- Custom software for international technology verification. Ontario Centre for Environmental Technology Advancement: 2003
- Custom Excel macros to address statistical requirements of Environment Canada toxicity test methods. Private Sector Laboratories: 2002 – ongoing.
- Creation of statistical worksheets for the Canadian Environmental Technology Verification program. Ontario Centre for Environmental Technology Advancement: 2001
- Writing software capable of predicting the dispersion of combustion by-products of PCB transformer fires. Ontario Hydro
- Writing custom software to analyze captured video images consisting of arising from gel electrophoresis studies. University of Guelph

PROJECT EXPERIENCE: SOFTWARE VALIDATION

- Validation of selected CETIS toxicity test analyses. Environment Canada, Methods Development and Application Unit. 2015.
- Validation of algorithmic stability and implementation of statistical theory underlying the analysis of quantal response data using the “Stephan” program circulated by Environment Canada. ESG International.

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PROJECT EXPERIENCE: PROJECT MANAGEMENT

- Managed projects within Zajdlik & Associates Inc. since company inception.
- Managed CIDA funded program in Bangladesh, April 2003.
- Provide external project management on an as-needed basis to Pollutech EnviroQuatics.

PROJECT EXPERIENCE: SELECTED LEGAL/ PEER REVIEW/GUIDANCE DOCUMENTS

- Expert Witness and Hearings
 - Fortune Minerals Water License Hearing, Behchoko, 2014.
 - Prairie Creek EA Hearing, Fort Simpson, 2013.
 - BHP Billiton AEMP Hearing, Yellowknife, 2009, Behchoko, 2013.
 - Diavik Diamond Mine AEMP Hearing, Rae Edzo, 2007.
 - Diavik Diamond Mine Technical Hearings, Yellowknife, 2005.
 - Crown vs. Hay Bay Genetics, Napanee, 2001
 - Crown vs. Provincial Papers, Thunder Bay, 2000
- Selected Guidance Documents
 - Contributor to: Environment Canada, 2012. Guidance Document on the Sampling and Preparation of Contaminated Soil for Use in Biological Testing. Science and Technology Branch, Ottawa, February 2012.
 - Contributor to: Biological Test Method: Fertilization Assay Using Echinoids. EPS1/RM/27, Environment Canada. 2011.
 - Terriplan Consultants, C. Burn and B. Zajdlik. 2010. A Shared Path to Understanding the Land, NWT CIMP Guidelines and Principles for Monitoring Discussion Paper, March 31. Submitted to: M. Lange, Environment & Conservation, INAC, Yellowknife.
 - Contributor to: Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the Northwest Territories. Indian and Northern Affairs, Canada: 2008-2009.
 - Contributor to: CCME. 2007. A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life – Draft. July, 2007.
 - Contributor to: Statistical Methods for Environmental Toxicity Tests. EPS 1/RM/46. Environment Canada. 2005.
 - Author of: Guidance on Evaluating Environmental Monitoring Programs for Diamond Mines in the Canadian Arctic. Environment Canada. 2004.
- Selected Peer Reviews:
 - Fortune-NICO Environmental Assessment and Water License Submissions- Aboriginal Affairs and Northern Development. 2012; 2014, respectively.
 - Canadian Zinc Environmental Assessment and Water License Submissions- Aboriginal Affairs and Northern Development. 2011; 2013, respectively.
 - Aquatic Effects Monitoring Program Baseline – Diavik Diamond Mine.

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PROJECT EXPERIENCE: SELECTED LEGAL/ PEER REVIEW/GUIDANCE DOCUMENTS

- Department of Indian Affairs and Northern Development. 2006.
- Aquatic Effects Monitoring Program – Ekati Diamond Mine. Department of Indian Affairs and Northern Development, Independent Environmental Monitoring Agency, Environment Canada. 2004.
- Cumulative Effects Monitoring Program - Review of ongoing monitoring program to assess the potential cumulative ecological effects of uranium mines in northern Saskatchewan. Saskatchewan Environment. 2002 – 2004.
- Urinary As Study for the Greater Sudbury Area. Ontario Ministry of Environment. 2004.
- Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Environment Canada. 2004.
- Human Health Risk Assessment. Designated expert reviewer for Ontario Ministry of Environment. 2003.
- Ecological Risk Assessment Designated expert reviewer for Ontario Ministry of Environment. 2003.
- CCME. 1996. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. 2003.
- Statistical Guidance for Environment Canada Test Methods, Environment Canada, 2001- 2003.
- Part A: MOE Report Soil Investigation and Human Health Assessment for the Rodney Street Community: Port Colborne, Ontario Ministry of Environment, 2001.
- Background Environmental Concentrations for the Sydney Tar Ponds, Nova Scotia Department of Health, 2001.
- EPA. 1999. Emission test evaluation of a crematory at Woodlawn Cemetery in the Bronx, N.Y. Volume I of III. Office of Air Quality, Planning and Standards. EPA-454/R-99-049. For, Ontario Ministry of Environment, 2001.

OPINION PAPERS

- Potential Statistical Models for Describing Species Sensitivity Distributions. Canadian Council of Ministers of the Environment. 2006.
- New Statistical Paradigms for Two-sample Toxicity Tests. U.S. EPA. 2005.
- Guidance on Evaluating Environmental Monitoring Programs for Diamond Mines in the Canadian Arctic. Environment Canada, 2005.
- Statistical Inference and the Species Sensitivity Distribution Approach to Deriving Water Quality Guidelines, Ontario Ministry of Environment, Canadian Council of Ministers of the Environment. 2004-2005.

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SHORT COURSES

- I'm Gonna Make You Love Me: Discover That You Love Stats and Stats Loves You Back.
 - Topics:
 1. Analysis of Field Toxicity Test Data when a Reference Site is Unavailable Slides
 2. Power Analysis – Theoretical Underpinnings
 3. Why Statistical Assumptions Matter
 - Aquatic Toxicity Workshop, Ottawa, 2015. 30 participants.
- Statistics for Environmental Scientists
 - SETAC Laurentian, - 30 participants, 1 day. July 2014, Guelph.
 - Environment Canada, Edmonton – 25 participants, 1.5 days, March 2012/13, Yellowknife – 20 participants, 3 days, January 2006.
 - Department of Indian Affairs and Northern Development - approximately 10 participants, 3 days, March 2005
 - Bruce Nuclear – approximately 15 participants, 2 days, February 2005.
 - Ontario Ministry of Environment, - over 70 participants, 5 days, February 2004.
- Graphical Presentation of Statistical Data, Ontario Ministry of Agriculture and Foods, approximately 30 participants, 1 hour, September 2013.
- Principal Components Analysis, Agriculture and Agrifoods Canada - approximately 15 participants, 3 days, March 2013.
- Working with Large Datasets, Department of Fisheries and Oceans, Yellowknife - approximately 10 participants, 3 days, January 2008.
- Introduction to the ANOVA Table, Annual Aquatic Toxicity Workshop, Waterloo, 7 participants, October 2005.
- Applied Environmental Statistics, Nonlinear Regression as Applied to Environment Canada Test Methods for Measuring Survival and Growth in Soil Using Terrestrial Plants. Environment Canada, Method Development and Technology Section, Charlottetown approximately 10 participants, October 2004.
- What to Look for and How to Interpret a Benthic Invertebrate Report: From Bugs to Statistics. Zaranko and Zajdlik, Annual Aquatic Toxicity Workshop, Ottawa, approximately 10 participants, October 2003.
- An Introduction to Statistical Methods for Chronic Biological Testing, Annual Aquatic Toxicity Workshop, Québec, approximately 7 participants, October 1998.
- Statistical Issues in Toxicology, Annual Aquatic Toxicity Workshop, Calgary, Alberta, approximately 20 participants, October 1996.
- Statistical Methods and Software for Toxicological Data Analysis", Society of Environmental Toxicologists and Chemists, Annual Meeting, Denver, Colorado, 50 participants, November 1994.

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PROFESSIONAL AFFILIATIONS AND COMMITTEES

- Member of SSWQO Derivation Committee: Aboriginal Affairs and Northern Development, 2012.
- Member of Scientific Advisory Committee: "Development of an Environment Canada Test Method for Measuring Survival and Growth in Soil Using Terrestrial Plants. Environment Canada, Method Development and Technology Section, 2001-2003.
- Member of the Cumulative Effects Monitoring, working group for northern Saskatchewan. Saskatchewan Environment. (2001-2004)
- Member of the "Advisory Committee on Statistics and Programs for Biological Tests" sponsored by the Technology Development Branch of Environment Canada. 1993-present.
- Panel Member, "The Statistics Workshop for Toxicological Testing", 1999 and 2001. Invitational Meeting under auspices of Environment Canada, Method Development and Application Section. Vancouver, British Columbia.
- Statistical Workshop Chairperson, 1995 Annual Aquatic Toxicity Workshop, St. Andrews, New Brunswick. This workshop addressed the topic of "Statistical Issues in Toxicity Testing."
- Member of the 1995, SETAC U.K. discussion group entitled "Ecotoxicological Statistics: Asking the right questions," Egham, Surrey, U.K.
- Chairperson, 1994 Aquatic Toxicity Workshops session entitled "Toxicological Statistics," Sarnia, Ontario.

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PUBLICATIONS

- Greenberg, M., I. Schoeters, R. Wentsel, D. Charters, I. Mitchell, I. and B. Zajdlik. 2014. Regulatory Considerations for the Potential Development and Application of Metal Cleanup Values. *Int. Env. Ass. Man.* In Press
- Renoux, A.Y., B. Zajdlik, G.L. Stephenson, and L.J. Moulins. 2013. Risk-Based management of site soils contaminated with a mixture of hazardous substances: methodological approach and case study. *Hum. Ecol. Risk. Asses.* 19:1127–1146.
- Cott, P.A., B.A. Zajdlik, K. J. Bourassa, M. Lange, and A. M. Gordon. 2010. Effects of forest fire on young of-the-year Northern Pike, *Esox lucius* in the Northwest Territories. *Canadian Field-Naturalist* 124(2): 104–112.
- Zajdlik, B.A., D.G. Dixon and G. Stephenson. 2009. Estimating Water Quality Guidelines for Environmental Contaminants Using Multi-Modal Species Sensitivity Distributions: A Case Study with Atrazine. *Human. Ecol. Risk Assess.* 15(3):554 – 564.
- Kokelj S.V., B. Zajdlik and M.S. Thompson. 2009. The impacts of thawing permafrost on the chemistry of lakes across the subarctic boreal-tundra transition, Mackenzie Delta region, Canada. *Permafrost and Periglacial Processes*. *Permafrost and Periglacial Process.* 20:1-15.
- Zajdlik, B.A. 2008. Scoping of Approaches Used to Deal with Bimodal Distributions of Pesticides in Aquatic Ecosystems. National Agri-Environmental Standards Initiative Technical Series Report No. 4-43. 90 p.
- Macdonald, D. and B. Zajdlik. 2008. Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories. Prepared for Indian and Northern Affairs Canada, Northwest Territories.
- ESG International and B. Zajdlik & Associates. 2002. Guidance Document for Acute Lethality Testing of Metal Mining Effluents. Prepared for Ontario Ministry of the Environment, Toronto, ON.
- Zajdlik, B., G. Gilron, P. Riebel and G. Atkinson. 2001. The \$500,000.00 fish. *SETAC Globe*, 2(1):28-30.
- Jonczyk, E., G. Gilron and B. Zajdlik. Sea urchin fertilization assay: An evaluation of assumptions related to sample salinity adjustment and use of natural and synthetic marine waters for testing. *Env. Tox. Chem.* 20(4): 804-809.
- Zajdlik, B.A., K. G. Doe and L. M. Porebski. 2000. Report on biological toxicity tests using biological gradients: Sydney Harbour. *EPS/3/AT/2*.
- Zajdlik, B. and P. Riebel. 2000. The cost-benefit of EEM study design. *Pulp & Paper Canada*. 101(5): 46-48.

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PUBLICATIONS

- Porebski, L. M., K. G. Doe, B. A. Zajdlik, D. Lee, P. Pocklington, and J. Osborne. 1999. Evaluating the techniques for a tiered testing approach to dredged sediment assessment - a study over a metal concentration gradient. *Env. Tox. Chem.* 18:2600-2610.
- Porebski, L., K. Doe, B. Zajdlik, D. Lee, P. Pocklington, G. Atkinson and J. Osborne. 1998. Interpretive guidance for bioassays using pollution gradient studies - Belledune, New Brunswick. WM-20.
- Gilron, G., D. Lynn and B. A. Zajdlik. 1998. Further development and validation of a sublethal protozoan bioassay for mining effluents. Prepared for Public Works and Government Services on behalf of the National Biotechnology Strategy Program "Biotechnology for the mining environment".
- Moran, T. S., and B. A. Zajdlik. 1995. Comparison of results from alternate toxicity tests with the acute Rainbow Trout bioassay for select mine effluents. *Proc. Aquatics Effects Technology Evaluation First Annual Review*, Nov. 1, 1995. Ottawa, Ontario.
- Zajdlik, B. A. 1990. Analysis of irregularly spaced time series. MSc. Thesis University of Guelph.
- Smith, I. R. and B. A. Zajdlik. 1989. Spontaneous regression of epidermal papillomas in white suckers, *Catostomus commersonii* from Lake Ontario. *J. Fish Diseases*.

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PAPERS PRESENTED

- Zajdlik, B.A. Considerations when estimating ambient water quality concentrations in the Canadian North. Aquatic Toxicity Workshop, Ottawa, 2015.
- Zajdlik, B.A. and G.L. Stephenson. 2013. Alternative Tier II SSROs that Acknowledge Non-Contaminant Effects. PTAC's Soil and Groundwater Forum, Calgary, 2013.
- Zajdlik, B.A., J. Velicogna, N. Feisthauer and R. Scroggins. 2010. Statistical Sampling Designs for the Biological Assessment of Contaminated Soils. Aquatic Toxicity Workshop, Toronto, Oct. 2010.
- Zajdlik, B.A., A. Renoux, G. L. Stephenson and L. J. Moulins. 2010. Methodological Framework for Establishing Toxicity-based Site-specific Remedial Objectives For Contaminated Soils. Aquatic Toxicity Workshop, Toronto, Oct. 2010.
- Poirier, D. and B. Zajdlik. 2008. The Effects of low temperatures and low pH on the toxicity of ammonia to *Daphnia magna*. Aquatic Toxicity Workshop, Saskatoon, Oct. 2008.
- Zajdlik, B.A. and D.D. MacDonald. Key Aquatic Effects Monitoring Program Concepts. Aquatic Effects Monitoring Program Guidelines Workshop. Oct. 21-22, 2008.
- Zajdlik, B.A. 2008. Integrating Traditional Knowledge into the Testable Hypothesis. Science in the Changing North. Yellowknife.
- Zajdlik, B.A., D.G. Dixon and G. Stephenson. 2007. Estimating Water Quality Guidelines For Atrazine and Diquat Using Multi-Modal Species Sensitivity Distributions. Society of Environmental Toxicology and Chemistry, Milwaukee.
- Zajdlik, B.A., I.J. Young, J. Rebiniczak, S. Barrett, B. Brady, P-Y Robidoux, G. Sunahara and H. Fanous. 2007. Integrating Sediment Quality Metrics to Prioritize UXO Clearance in an Aquatic Ecosystem. Society of Environmental Toxicology and Chemistry, Milwaukee.
- Zajdlik, B.A. 2007. Choosing Environmental Quality Guidelines for the North. Science in the Changing North. Yellowknife.
- Zajdlik, B.A., S. Kokelj and M. Thompson. 2007. Regional Variability in Water Quality of Tundra Lakes in the Mackenzie Delta. Environmental Studies across the Treeline. Yellowknife.
- Scroggins, R., L. Taylor, Leana Van der Vliet and B. Zajdlik. 2007 Statistical Software Development Project. Aquatic Toxicity Workshop, Halifax, Nova Scotia.

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- Zajdlik, B.A. 2006. Key Elements of Aquatic Effects Monitoring Program in the North. Invitational: A workshop on "Guidelines for Aquatic Monitoring and Assessment of Development Projects in the NWT", sponsored by Indian and Northern Affairs Canada and Environment Canada, Yellowknife, April 11th-12th.
- Zajdlik, B. A. 2006. Aquatic thresholds – conceptual and developmental challenges. Invitational: A workshop on "Thresholds: From Theory to Practice", co-sponsored by Indian and Northern Affairs Canada and Environment Canada, Yellowknife, March 13th-14th.
- Zajdlik, B., G. Gilron, P. Riebel and G. Atkinson. 2000. The \$500,000.00 fish. 27th Annual Aquatic Toxicity Workshop, St. John's, Newfoundland.
- Zajdlik, B. A. L. M. Porebski, K. G. Doe and J. M. Osborne. 1999. Making inferences from a suite of biological tests. 26th Annual Aquatic Toxicity Workshop, Edmonton
- Porebski, B. A. Zajdlik, K. G. Doe and J. M. Osborne. 1999. Taking it to the creek - using an organic pollution gradient to evaluate techniques for dredged sediment assessment. 26th Annual Aquatic Toxicity Workshop, Edmonton.
- Zajdlik, B. A. and P. Riebel. 1999. The cost-benefit of EEM study design. 85th Annual Meeting of the Pulp and Paper Technical Association, Montréal.
- Jonczyk, E. G. Gilron and B. Zajdlik. 1998. Comparison of sea urchin fertilization test results using natural and synthetic marine water. 25th Annual Aquatic Toxicity Workshop, Québec City.
- Zajdlik, B. A., T. S. Moran and S. Munro. 1997. Assessing spatial extent of impacted areas in the St. Clair River using the sediment quality triad. 24th Annual Aquatic Toxicity Workshop, Niagara Falls.
- Zajdlik, B. A. 1997. Defining the word "replicate" in the context of sampling benthic macroinvertebrate communities. 24th Annual Aquatic Toxicity Workshop, Niagara Falls.
- Jonczyk, E. G. Gilron and B. Zajdlik. 1997. Sample salinity adjustment for culturing and testing sea urchins. 24th Annual Aquatic Toxicity Workshop, Niagara Falls.
- Gilron, G. L., D. H. Lynn, B. Zajdlik, J. Schroeder and C. Krawczyk. 1997. Development of a sublethal behavioural bioassay for mining effluents using the heterotrophic flagellate, *Polytomella a*. 24th Annual Aquatic Toxicity Workshop, Niagara Falls.
- Zajdlik, B. A. Statistics: Why Bother? A Presentation to SETAC Laurentian Members, 1996. Guelph, Ontario.
- Zajdlik, B. A. An introduction to threshold modelling of non-quantal bioassay data. 1995 Annual Aquatic Toxicity Workshop, St. Andrews, New Brunswick.

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- Zajdlik, B. A. A review of the ICp method. 1995 Annual Aquatic Toxicity Workshop, St. Andrews, New Brunswick.
- Zajdlik, B. A., and D. G. Dixon. 1994. Statistical considerations in the design and analysis of experiments using a first-order single compartment model. 15th Annual Meeting of the Society of Environmental Toxicologists and Chemists.
- Zajdlik, B. A., T. S. Moran and S. Munro. 1994. Survival analysis of Rainbow trout *Oncorhynchus mykiss* egg hatchability data and environmental decision-making. 21st Annual Aquatic Toxicity Workshop, Sarnia.
- Dutton, M. D., B. A. Zajdlik, D. G. Dixon and J. F. Klaverkamp. 1994. Reassessing interactions between bioenergetics and cadmium bioaccumulation in Rainbow trout. 21st Annual Aquatic Toxicity Workshop, Sarnia.
- Zajdlik, B. A. 1993. Statistical Software and the Analysis of Toxicological Data. 20th Annual Aquatic Toxicity Workshop, Quebec City.
- Smith, I. R., B. A. Zajdlik, H. W. Ferguson and M. A. Hayes. 1987. Alterations in serum chemistry in rainbow trout *Salmo gairdneri* with liver degeneration after partial hepatectomy or treatment with carbon tetrachloride or alpha-naphthylisothiocyanate. 14th Annual Aquatic Toxicity Workshop, Toronto

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EDUCATION

- | | | |
|-----------|--|----------------|
| 1991–1995 | University of Waterloo | Waterloo, Ont. |
| | <ul style="list-style-type: none">■ Ph.D., Statistical Derivation of Environmental Quality Guidelines”■ Resumed, Spring 2006. | |
| 1987–1990 | University of Guelph | Guelph, Ont. |
| | <ul style="list-style-type: none">■ MSc., Applied Statistics, Project Title “Analysis of Irregularly Spaced Time Series” | |
| 1982–1987 | University of Guelph | Guelph, Ont. |
| | <ul style="list-style-type: none">■ BSc., Major: Aquatic Biology, Minor: Statistics | |

SCHOLARSHIPS AND AWARDS

- 2006 Ontario Ministry of Environment Strategic Partnership Grant
- 1994 University of Waterloo Graduate Scholarship
- 1992-1993 National Sciences and Engineering Research Scholarship
- 1991-1992 National Sciences and Engineering Research Scholarship
- 1989-1990 Ontario Graduate Scholarship
- 1988 University of Guelph Graduate Scholarship
- 1987 University of Guelph Graduate Scholarship

