



Note to File

EA1314-02

De Beers Canada Inc, Snap Lake Diamond Mine Amendment Project

Re: Independent Consultant– March 28, 2014

The Review Board and the Mackenzie Valley Land and Water Board have retained an independent consulting firm, EcoMetrix Inc.

Background

The purpose of this note to file is to inform parties that the Review Board and MVLWB have retained an independent consulting firm to review all of the technical materials submitted by De Beers Canada Inc. (DBCI) as part of its amendment application submitted in December 2013. The independent consulting firm is Ecometrix Incorporated.

The responsibilities of EcoMetrix are outlined in the attached document, Independent Consultant – EcoMetrix, along with the CVs of the consultants.

Correspondence related to this assessment should be directed to:

Simon Toogood, EAO

Phone: (867) 766-7053

Fax: (867) 766-7074

Email: Stoogood@reviewboard.ca

Sincerely,

Simon Toogood

EAO

Mackenzie Valley Review Board



March 28, 2014

Re: Independent Review of the Amendment Application Submitted December 2013 by De Beers Canada Inc (DBCI) for the Snap Lake Mine

The purpose of this letter is to inform parties and interveners that the Review Board and MVLWB have contracted an independent consulting firm to review all of the technical materials submitted by De Beers Canada Inc. (DBCI) as part of its amendment application submitted in December 2013. The independent consulting firm is Ecometrix Incorporated:

- 6800 Campobella Road
- Mississauga, Ontario, Canada. L5N 2L8
- Tel: (905) 794-2325
- Fax: (905) 794-2338

Scope of Work for Ecometrix Inc.

In summary, Ecometrix Inc. will review the relevant materials and provide a report that will be publically available on May 8, 2014. Parties may, if they wish, follow up on and use the information in the Ecometrix Report in their technical reports (due May 21, 2014). Representatives of Ecometrix will attend the technical sessions in order to ask any outstanding questions they have as a result of their review. As well, an Ecometrix representative will attend both the MVEIRB and MVLWB public hearings in order to answer questions from all parties on their May 8, 2014 report.

Documents for Review

The MVEIRB and MVLWB have requested that Ecometrix Inc. review the following documents:

1. *TDS Response Plan (DBCI, Dec. 2013)*. Development of TDS benchmark in attachment 2, development of a fluoride benchmark in attachment 1, and rationale for a chloride SSWQO in section 3.1.2.
2. *Nitrogen Response Plan (DBCI, Dec. 2013)*. Development of a nitrate benchmark in attachment 1, rationale for an ammonia SSWQO in section 3.1.2.
3. *Strontium Response Plan (DBCI, Dec. 2013)*. Rationale for a strontium SSWQO in section 4.
4. *Evaluation of EQC Report (DBCI, Dec. 2013)*. Rationale for SSWQOs for several metals with hardness-dependent WQOs in Appendix 1.
5. *Groundwater Flow Model Update (Itasca Denver, Aug. 2013)*. Predictions of the quality of water coming from the underground mine.
6. *Mine Site Water Quality Update (DBCI, Dec. 2013)*. Prediction of the quality of site discharge from now to end of mine life.

7. *Snap Lake Hydrodynamic and Water Quality Model Report (DBCI, Dec. 2013)*. Prediction of long-term water quality in Snap Lake using information from the groundwater and site water reports.
8. *2012 Plume Characterization Study (Golder Associates, Jan. 2013)*. Monitoring of receiving water quality in 2012 to characterize the plume following installation of a new outfall diffuser in 2011.

Questions to be Answered

The Review Board and MVLWB have requested that EcoMetrix Inc. investigate the following questions, but not limited to:

- a. *Are the proposed water quality objectives (WQOs), in your professional opinion, appropriate for the aquatic receiving environment?*
- b. *Based on the review of the various water quality models, are any of the contaminants of concern likely to exceed water quality objectives (WQOs) in the aquatic receiving environment?*
- c. *For those contaminants that are expected to exceed WQOs, what, in your professional opinion, are the potential effects to aquatic life in Snap Lake and the downstream receiving environment?*
- d. *Based on the review of the Response Plans, are there, in your professional opinion, feasible mitigation measures that can be implemented at the Snap Lake mine site that will either ensure that contaminants do not exceed WQOs, or will minimize effects to the aquatic receiving environment?*
- e. *Is the proposed method of calculating EQC appropriate, in your professional opinion, to meet the dual objective of minimizing waste discharge and protecting downstream water uses?*

In addressing each of the questions the Review Board and MVLWB have requested that a rationale for any of the opinions or conclusions expressed be provided, as well as a request to provide any other relevant information that EcoMetrix determines is warranted.

If you have any questions about this process please contact,

MVEIRB

- Simon Toogood, Environmental Assessment Officer
- (867) 766-7053
- stoogood@reviewboard.ca

MVLWB

- Rebecca Chouinard, Regulatory Manager
- (867) 766-7459
- rchouinard@mvlwb.com

DONALD R. HART, Ph.D.

PRINCIPAL, SENIOR ECOTOXICOLOGIST

Don joined Beak International in 1983, and worked for BEAK until its acquisition by Stantec Consulting in 2002. He left Stantec in 2004 to form EcoMetrix Incorporated. In over 25 years of environmental consulting, as a technical leader and project manager, he has specialized in assessment of ecological risks and impacts related to chemical and radiological contaminants in aquatic and terrestrial environments. This has included design of environmental monitoring programs to support such assessments. Selected project experience includes:

- estimation of ecological and human health risks from organic and inorganic contaminants at industrial sites, brownfields, landfills, mine sites and waste repositories;
- review of brownfields risk assessments for regulatory agencies;
- development of environmental effects monitoring programs and technical guidance manuals for EEM in pulp and paper, mining and energy sectors;
- acute and chronic toxicity testing, including sediment quality triad studies, effluent studies, and genotoxicity test development;
- development of effects-based sediment quality guidelines for heavy metals, organochlorine pesticides, PCBs and PAHs in Ontario sediments (MOE); and for zinc in sediments (CCME);
- review of watershed monitoring programs for local conservation authorities and for federal/provincial/territorial agencies;
- development of effluent quality criteria for mine sites to ensure that water quality conditions in receiving waters are protective of aquatic resources and water uses;
- calculation of radionuclide release limits for nuclear generating stations, uranium mines and other facilities, to ensure protection of human health and environment;
- development of CSA standards for calculation of risk-based release limits and for environmental monitoring and for environmental risk assessment at nuclear facilities;
- development of quality assurance guidelines for biological monitoring of aquatic environments.

EDUCATION

- Post-doctoral Fellowship, Genetic Toxicology, University of Ottawa, 1981-83
- Post-doctoral Fellowship, Radioecology, Whiteshell Nuclear Research Est., 1980-81
- Ph.D. Environmental Biology, Tulane University
- M.Sc., B.Sc., Zoology, University of Manitoba

- Human Health Risk Assessment – Training, Toronto – Health Canada – 2010

PROFESSIONAL AFFILIATIONS

- Society of Environmental Toxicology and Chemistry
- Canadian Standards Association

SELECTED PROJECT EXPERIENCE

Atomic Energy of Canada Ltd. (2002-2013)

- **Baseline Monitoring and Risk Assessment – Port Hope.** Pre-cleanup environmental monitoring and ecological risk assessment to establish risk levels in and around the remediation sites and long-term waste management facilities, as part of the Port Hope Area Initiative. This work and subsequent aquatic effects assessments support the EA for this federal initiative. Don attended various public and stakeholder meetings to present the baseline work and effects assessments.
- **Site-Specific Criteria Development – Port Hope.** Site-specific criteria were developed for key radionuclides and metals, to be used in remediation of low-level radioactive waste and industrial waste sites in the Port Hope area. The work involved soil toxicity testing, as well as calculation of risk-based criteria protective of human health and environment.
- **Limits for Discharge from Port Granby WMF.** Discharge criteria were developed based on expected flow from the treatment plant, in order to meet site-specific criteria for water quality in the nearshore zone of Lake Ontario.
- **Environmental Risk Assessment – Chalk River Labs.** Assessment of human health risks near CRL and ecological risks in the aquatic and terrestrial receiving environments in and around CRL. This work involved synthesis of chemical and biological monitoring data, plume modelling, and estimation of chemical/ radiation exposure and risk to humans and natural biota.
- **Monitoring and Risk Assessment for Sculthorpe Marsh.** This SSRA was completed as an EA follow-up requirement, including HHRA and ERA at this contaminated site. It involved extensive water, sediment and biota monitoring, and sediment toxicity testing in the marsh. Based on this work, a remediation strategy was developed.

Atomic Energy Control Board / Canadian Nuclear Safety Commission (1997-2009)

- **Sediment toxicity tests with uranium.** Tests were performed using spiked sediments and amphipods of different ages, in order to define dose response relationships for possible future use in environmental assessments at uranium mine sites.
- **Development of population models for estimation of contaminant effects on population success.** Fish and amphipod population models were developed to permit estimation of contaminant exposure in a spatially heterogeneous environment and resulting effects on population success as influenced by toxicity stress. Toxicity parameters focused on arsenic, nickel and uranium as contaminants, since these are released from licensed uranium mines.
- **Review of the environmental fate of tritium in the atmosphere.** The review addressed tritium fate and transport in the atmosphere, and partitioning to soil water and ground water. Model-predicted and observed concentrations were compared around selected facilities.

Canadian Council of Ministers of the Environment (2009-2010)

Methods for development of sediment quality guidelines using spiked sediment toxicity test data were reviewed, and suitable methods were testing using SSTT data for zinc. Methods using species sensitivity distributions were recommended. Freshwater and marine guidelines for zinc were derived.

CANMET (1997-98)

Study design, statistical analysis and interpretation of AETE pilot studies on environmental effects monitoring (EEM) for the mining sector. Various monitoring tools were evaluated as to their utility in detecting mine effects and exposure-effect relationships.

Canadian Standards Association/ CANDU Owners Group (2005-2012)

Development of CSA standards for calculation of risk-based release limits (N288.1), for environmental monitoring to support dose and risk assessment (N288.4, N288.5), and for environmental (human and ecological) risk assessment at nuclear facilities (N288.6).

Cigar Lake Mining Corporation (1994, 2004)

Preparation of an environmental impact statement for a proposed new uranium mine and mill in northern Saskatchewan, including predictive modelling of ecological and human health risks from chemical releases and physical habitat alterations. An update study was completed ten years later.

City of Port Colborne (2001-2004)

- **Sports Complex HHRA.** A human health risk assessment was performed for a future sports complex in Port Colborne, where contaminants related to historical nickel refining operations were found in soil. Site-specific soil criteria were developed.
- **Review of CBRA.** A community-based risk assessment was reviewed on behalf of the City. As part of the BEAK/Stantec review team, Don participated in meetings with the Technical Review Committee and attended a number of public meetings.

Credit Valley Conservation (2009-2010)

A comprehensive review of the CVC's water, sediment and benthos monitoring program on the Credit River was completed, considering the objectives of the program to track temporal and spatial trends and to understand the condition of the watershed. The existing program data were statistically analyzed to characterize spatial patterns and trends in water and sediment quality and benthic ecology, and to relate these to watershed features, including hydrology, degree of urbanization, known point and non-point sources, and nutrient loadings. A summary report was prepared. Based on this interpretive effort, areas for program improvement were identified.

Deline Uranium Team (2004)

Review of a dose reconstruction study which addressed the radiation dose and risk incurred by Deline workers who carried uranium ore and yellowcake while working at the Port Radium mine.

EnCana West Ltd. (2007-2009)

Studies at the Gordon Lake mine site included estimation of contaminant loadings to receiving water, monitoring of downstream surface water, sediments and biota, and evaluation of current and potential future effects on the downstream environment, to support closure and reclamation planning. The aquatic studies included sample collection from various media (water, sediments, benthic invertebrates, aquatic plants and fish), assessment of aquatic communities, surveys of aquatic habitat and lake bathymetry, and analysis of contaminant levels in all media. A human health and ecological risk assessment was conducted based on the results of the aquatic study. Risks to recreational site users and ecological receptors were determined.

Environment Canada (1985-2006)

- **Review of EIS for closure of uranium mines.** On behalf of Environment Canada, the EIS for Serpent River mines was reviewed, and a parallel assessment was performed of expected future contaminant levels in the watershed downstream of the mine sites.

- **Literature review to evaluate ICRP conclusion that radiological protection of man adequately protects biota.** Study reviewed the literature on the effects of radiation on the natural environment, particularly at the cellular and population/community levels, in order to examine the evidence supporting or refuting the ICRP conclusion that radiological protection for man will adequately protect other biota.
- **Radiological risk assessment of uranium mining, milling and tailings management in northern Saskatchewan.** Atmospheric and aquatic releases were evaluated and terrestrial and aquatic pathway models constructed and used to assess radiological impacts on natural populations of caribou, moose, aquatic plants, algae, zooplankton, invertebrates, fish eggs and adult fish, in addition to human populations. This study was published by Environment Canada.
- **Surveys of radionuclide contamination and associated ecological risks in Port Hope and Serpent River Harbours in Ontario.** Study included surveys of radionuclide and heavy metal contamination in sediment and biota in waters affected by uranium refining and mining activities to evaluate the degree of contamination as well as to assess bioaccumulation and impacts on benthic communities and fish.
- **Gathering of Toxicity and Environmental Fate Information for Use in Development of E2 Plans.** A number of data compilation projects were completed for Environment Canada, including studies of 3,3-dichlorobenzidine, nonyl phenol and its ethoxylates, and sulphur and sulphuric acid.
- **Priority substance assessment of ecological risks from routine releases of copper and zinc refinery effluents to aquatic environments in Canada.** Three sites were evaluated and risk results were incorporated into two Environment Canada PSL reports.

First Capital Holding Corporation (2007-2009)

Human health and ecological risk assessment for a brownfield property contaminated by volatile organic compounds. The risk assessment was accepted by the MOE and supported a Record of Site Condition for the property.

Goldcorp Canada Ltd. (2010-2013)

Studies at the Delnorte mine site focused on development of surface water and sediment objectives for cleanup of a former gold mining property on the Upper South Porcupine River. The studies included sampling and analysis of metal levels in surface waters and sediments, benthic community characterization, sediment toxicity testing, and development of water and sediment cleanup objectives for arsenic. These objectives were based on limitation of ecological risk and assurance of acceptable human risk. A cleanup strategy was developed based on achieving the site-specific water and sediment quality objectives.

Indian and Northern Affairs Canada (2006-2007)

Preliminary quantitative risk assessment (PQRA) for the Sawmill Bay Site SM 204 N.W.T. The PQRA addressed human and ecological risk from metals, petroleum hydrocarbons and radionuclides.

Infrastructure Ontario (2013)

Review of a PSF and MGRA submission prepared for Underpass Park in the West Don Lands. Preparation of a streamlined risk assessment for an Oakville, ON property, in collaboration with Conestoga-Rovers & Associates.

Laird Developments Inc. (2006-2007)

Site-specific risk assessment (HHRA, ERA) for a Toronto property. The risk assessment was accepted by the MOE and supported a Record of Site Condition for the property.

Mackenzie Valley Land and Water Board (2011)

Water Quality Objectives and Effluent Quality Criteria for Snap Lake – Water quality objectives for Snap Lake were developed, considering the local ecology, and consistent with the Water and Effluent Management Policy. Based on review of water quality modelling and monitoring for the lake, expected future loadings to the lake from the Snap Lake Diamond Mine, and the known lake hydrology, a simple mass and water balance model was developed and utilized to estimate effluent quality criteria that, if met, would allow water quality objectives to be met in the lake by the end of operations. The work was presented at water licence hearings.

Natural Resources Canada (2002)

Review of the ecological toxicity, environmental fate and effluent treatment options for selected metals in metal mine effluents. Typical levels and likelihood of related impacts on fish and benthic invertebrate communities were addressed.

Noranda Inc. (2003)

Worker health risk assessments were prepared for a concentrate handling facility in New Brunswick, and for an adjacent industrial property potentially influenced by airborne metal contaminants from the facility. This work was conducted in accordance with NB and CCME guidelines.

Ontario Ministry of the Environment (1985-2013)

- **Survey of radionuclides in Quirke Lake and Elliot Lake uranium mining areas of Ontario, and associated ecological risks to aquatic biota.** Detailed characterization of the sediments of Quirke Lake for use as a baseline to assess potential risks related to proposed deep water uranium tailings disposal. The work included characterization of the existing benthic invertebrate communities, characterization of the chemical and radiological contamination of sediments, and physical/chemical factors controlling the benthic communities.
- **Derivation of sediment quality guidelines for heavy metals, pesticides and PCBs in Ontario, based on ecological risk assessment.** Study derived and compared sediment quality guidelines by a variety of approaches, including equilibrium partitioning, screening level concentration, apparent effects threshold and spike bioassay approaches. The resulting chemical concentration limits were designed to explicitly limit the risk of defined ecological effects. This work provided the basis for new provincial sediment quality management guidelines.
- **Provision of Expert Advice Related to Risk Assessment.** Several studies were completed, including an evaluation of soil-plant bioaccumulation factors, a jurisdictional review of environmental standards used in risk assessment, and a jurisdictional review of approaches to multiple sites.
- **Review of Site-Specific Risk Assessments.** As part of the SSRA review process, Don reviewed the ERA components of numerous risk assessments on behalf of the MOE. In the most recent VOR contract Don also served as alternate review team co-ordinator. Comments provided were incorporated into MOE reviews.

Ontario Power Generation (2000-2013)

- **Ecological Effects Review – Bruce NGS.** Review and assessment of ecological effects in the aquatic and terrestrial receiving environments of the Bruce Nuclear Generating Station. This work involved synthesis of biological monitoring data, as well as modelling of chemical and radiochemical exposure and estimation of risk to natural biota.
- **Development of DRL Guidance.** A manual on calculation of Derived Release Limits for radionuclides in liquid and airborne effluents was prepared. The procedure is used to define risk-based limits that are protective of public health in the vicinity of nuclear generating stations.
- **Review of Public Dose Calculations.** Third party review of OPG calculations of radiation dose to members of the public based on modelling and monitoring of radionuclides in the environment around the Pickering and Darlington nuclear generating stations.
- **Collective Dose Calculations.** Collective dose was estimated in person-Sv/a for the populations surrounding the Pickering and Darlington nuclear generation stations.
- **Environmental Risk Assessment – Pickering NGS.** Synthesis of earlier ERA and HHRA studies, new exposure and risk calculations, and studies of thermal effects and entrainment/impingement, to produce a site-specific risk assessment for the Site, in accordance with CSA N288.6-12 guidance.

Public Works (2000)

Site-specific risk assessment of a Coast Guard lighthouse station on Lake Huron, including assessment of ecological and human health risks related to site contamination by metals (lead from paint chips and zinc from galvanized steel) and petroleum hydrocarbons from former fuel storage. A risk-based site management strategy was developed, consistent with MOE and CCME guidelines.

Prime Inc. (2003-2004)

Following a pesticide spill at a road crossing of Fifteenmile Creek, a tributary of the Columbia River in Oregon, risk-based cleanup targets were developed based on human health and ecological protection. On completion of cleanup, an HHRA and an ERA were prepared to verify the adequacy of the cleanup effort. These risk assessments were reviewed and approved by the Oregon State Department of Environmental Quality.

Rio Algom Limited (1999-2010)

Development of an environmental effects monitoring program for the mine waste management areas in the Serpent River watershed. Monitoring of biological recovery, and of contaminant levels in soils, plants, sediments, invertebrates, water and fish. Calculation of dose and risk to biota and people.

Standard Radio Inc. (2004)

Site-specific risk assessment for a radio-transmitter site in North Bay, Ontario, addressing human health and ecological risks. The risk assessment was accepted by the MOE and supported a Record of Site Condition for the property.

Rochester Gas and Electric (2001-2002)

Sediment quality triad evaluation of a site on Lake Ontario with PAH and metal contamination of sediments. The program included chemical and biological sampling and toxicity testing.

Wek'eezhii Land and Water Board (2007-2013)

Review of aquatic effects monitoring programs, site-specific water quality objectives, and adaptive response frameworks related to water licenses for the Ekati Mine and the Diavik Mine, NWT. The work has included critical review of statistical analyses of ecological datasets, and of ecological findings, with consideration of northern hydrology, and loadings of major ions and nutrients. Technical comments provided to the Board have assisted in decision-making around water monitoring programs and related water quality issues. Don has attended licence hearings and participated in technical meetings with licensees.

SELECTED PUBLICATIONS AND REPORTS

- Hart, D.R. 1979. Niche relationships of *Thamnophis radix haydeni* and *Thamnophis sirtalis parietalis* in the Interlake District of Manitoba. *Tulane Studies in Zoology and Botany* 21:125-140.
- Hart, D.R. 1980. A selected bibliography of radiation effects on whole organisms, populations and ecosystems. Atomic Energy of Canada Limited. Report. AECL-6798.
- Hart, D.R. 1981. Selection and adaptation in irradiated plant and animal populations: a review. Atomic Energy of Canada Limited. Report. AECL-6808.
- Hart, D.R. 1982. Delayed metamorphosis and recurrence of bacterial infection in irradiated *Rana clamitans* tadpoles. Atomic Energy of Canada. Report. AECL-6824.
- Hart, D.R. 1982. Growth of Painted Turtles, *Chrysemys picta*, in Manitoba and Louisiana. *Canadian Field-Naturalist* 96:127-310.
- Hart, D.R. 1983. Dietary and habitat shift with size of Red-eared Turtles (*Pseudemys scripta*) in a southern Louisiana population. *Herpetologica* 39:285-290.
- Hart, D.R. 1984. Assessment of mutagenic effects in amphibian embryos. In "QSAR in Environmental Toxicology". K.L.E. Kaiser (ed.), D. Reidel Publishing, Dordrecht, Holland.
- Hart, D.R. and J.B. Armstrong. 1984. Assessment of mutagenic damage by monofunctional alkylating agents and gamma radiation in haploid and diploid frogs, *Xenopus laevis*. *Environmental Mutagenesis* 6:719-735.
- Hart, D.R., J. Fitchko, D.L. Lush, C.R. Phillips and F.C. Lendrum. 1985. Procedures for evaluation of data in environmental databases, with particular reference to uranium tailings. Report to National Uranium Tailings Program, CANMET, Energy, Mines and Resources Canada.
- Hart, D.R., P.M. McKee, A.J. Burt and M. Goffin. 1986. A benthic community and sediment quality assessment of Port Hope Harbour, Lake Ontario. *Journal of Great Lakes Research* 12: 206-220
- McKee, P.M., W.J. Snodgrass, D.R. Hart, W. Keller and J.H. McAndrews. 1987. Sedimentation rates and sediment core profiles of U-238 and Th-232 decay chain radionuclides in a lake affected by uranium mining and milling. *Can. Journal of Fisheries and Aquatic Sciences* 44: 390-398.

- Warwick, W.F., J. Fitchko, P.M. McKee, D.R. Hart and A.J. Burt. 1987. The incidence of deformities in *Chironomus spp.* from Port Hope Harbour, Lake Ontario. *J. Great Lakes Res.* 13: 88-92.
- Hart, D.R. 1987. Survey of data on the radionuclide content of fish in Canada. AECB Research Report INFO-0231-2. Atomic Energy Control Board, Ottawa.
- Hart, D.R. and R. Alvo. 1988. Impact of acid precipitation on amphibian breeding in Georgian Bay Islands National Park. Report to Environment Canada Parks.
- Hart, D.R., J. Fitchko and P.M. McKee. 1988. Development of sediment quality guidelines. Phase II - Guideline development. Report to the Ontario Ministry of the Environment.
- Fitchko, J. and D.R. Hart. 1989. Chemical pollution of the Great Lakes and its impact on fisheries and associated biota. Report to Department of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Environment Canada.
- Hart, D.R. 1990. QA guidelines for biology in aquatic environmental protection. Report to Environment Canada. National Water Research Institute, Special Publ.
- Burt, A.J., P.M. McKee, D.R. Hart and P. Kauss. 1991. Effects of pollution on benthic invertebrate communities of the St. Marys River. In: M. Munawar and T. Edsall (Eds.). *Environmental Assessment and Habitat Evaluation of the Upper Great Lakes Connecting Channels.* Hydrobiologia. Special Publ.
- Hart, D.R. and D. Andrews. 1991. The In-Place Pollutants Program, Volume VI, Contaminant Movement from Sediments to Biota. Ontario Ministry of the Environment, Toronto.
- McKee, P.M. and D.R. Hart. 1991. Environmental evaluation of a landfill berm distress at the Abitibi Price Thunder Bay Mill. Report to Weiler, Maloney, Nelson, Thunder Bay.
- Hart, D.R. and M.A. Rosen. 1994. Environmental and Health Benefits of Utility-based Cogeneration in Ontario, Canada. *Environment and Energy* 5: 363-378.
- Hart, D.R. and D.W. Major. 1994. Development of Draft Criteria for Use in Risk Assessment of Microorganisms for Finding of CEPA Toxic. Report to Environment Canada.
- Hart, D.R. and M.A. Rosen. 1996. Environmental and Health Benefits of District Cooling Using Utility-Based Cogeneration Ontario, Canada. *Energy* 21: 1135-1146.
- Hart, D.R. and F. Garisto. 1997. An Ecological Assessment Model for Prediction of Population Level Impacts at AECB Licensed Facilities. Report to Atomic Energy Control Board of Canada.
- Hart, D.R. and P. McKee. 1997. Recommendations for Updating of "Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities". Report to Atomic Energy Control Board of Canada.
- Garisto, F. and D.R. Hart. 1998. Pathways Analysis for the Bruce Nuclear Generating Station. Report to Ontario Hydro.

- Garisto, N. and D.R. Hart. 2001. Radiation Risk Assessment. Chapter 25. In: A Practical Guide to Understanding, Managing and Reviewing Environmental Risk Assessment Reports. Benjamin, S.L. and D.A. Belluck, eds. Lewis Publishers.
- Hart, D.R. 1999. PSL2 Assessment of Copper and Zinc Refinery Effluents. Report to Environment Canada.
- Hart, D.R. and T. Thompson. 2000. Risk Assessment of Mississagi Strait Light Station. Report to Public Works and Government Services.
- Hart, D.R., M. Rinker and M. Dutton. 2002. Literature Review of Environmental Toxicity of Mercury, Cadmium, Selenium and Antimony in Metal Mining Effluents. Report to the TIME Network.
- Hart, D.R. 2004. Ecological Risk Assessment for Fifteenmile Creek. Report to Prime Inc., for submission to Oregon Department of Environmental Quality.
- Hart, D.R. 2004. Human Health Risk Assessment for Fifteenmile Creek. Report to Prime Inc., for submission to Oregon Department of Environmental Quality.
- Hart, D.R., P.M. McKee and C. Wren. 2005. Ecological Effects Review (Risk Assessment) of Chalk River Laboratories. Report to Atomic Energy of Canada Limited, for submission to the Canadian Nuclear Safety Commission.
- Hart, D.R. 2008. Guidance for Calculation of Derived Release Limits in Airborne and Liquid Effluents. Report to the Candu Owner's Group.
- Hart, D.R., T. Yankovich and R. Haley, 2009. Investigation of the Environmental Fate of Tritium in the Atmosphere. Report to the Canadian Nuclear Safety Commission. Published as INFO-0792.
- Hart, D.R. and K. Ji, 2010. Methods Development for the Derivation of a Sediment Quality Guideline for Zinc based on Spiked Sediment Toxicity Data. Report to the Canadian Council of Ministers of the Environment.
- Racher, K., N. Hutchinson, D. Hart, B. Fraser, B. Clark, R. Fequet, P. Ewaschuk and M. Cliff-Phillips. 2011. Linking Environmental Assessment to Environmental Regulation through Adaptive Management. *Integr Environ Assess Manag* 7: 301-302.

CONFERENCE PRESENTATIONS

- Schuldt, A., D. Hart and R. Scroggins. 1984. A Comprehensive Bioassay Assessment of Steel Plant Process Water. Joint AISI/EPA Symposium, Cleveland.
- Hart, D.R. 1985. Assessment of mutagenicity using haploid and diploid amphibian embryos (abstract). Proc. 10th Annual Aquatic Toxicity Workshop, Halifax.
- Hart, D.R., J. Fitchko, M. Brinkman and P. McKee. 1986. A biological indicator system to identify genotoxicity of in-place pollutants. Proc. Technology Transfer Conference, Toronto. Part D, Analytical Methods. pp. 167-188.

- Dinnen, R.D., S.M. Tomlinson, D. Hart, C. Chopra and J.A. Heddle. 1987. Application of a micronucleus assay to the peripheral blood of the rainbow trout, *Salmo gairdneri*. Can. Tech. Rep. Fish. Aquat. Sci. Proc. 14th Annual Aquatic Toxicity Workshop, Toronto.
- Hart, D.R., J. Fitchko and D. Persaud. 1988. Development of sediment quality criteria: a critical review of approaches. Proc. 31st Annual Conference on Great Lakes Research, Hamilton.
- Hart, D.R., J. Fitchko and D. Persaud. 1989. Comparison of methods for deriving sediment quality guidelines for the Great Lakes. Proc. 32nd Annual Conference on Great Lakes Research, Madison.
- Heddle, J.A. and D.R. Hart. 1990. Use of mutagenicity assays for detection of mutagens in drinking Water. Proc. 4th National Conference on Drinking Water, Toronto.
- Hart, D.R. and J.A. Heddle. 1990. Micronucleus assays in peripheral blood of rainbow trout: timing of response and chemical mutagen sensitivity. Proc. 17th Annual Aquatic Toxicity Workshop, Vancouver.
- Hart, D.R., D. Andrews and J.L. Robertson. 1991. Standardization and accreditation needs in chemical and biological testing. Proc. 74th Canadian Chemical Conference, Hamilton.
- Hart, D.R. 1992. Quality Assurance Planning in Great Lakes Ecological Studies. Proc. 5th Ecological Quality Assurance Workshop, Toronto.
- Lush, D.L., D.R. Hart and D.W. Acton. 1993. Ecological risk assessment of proposed deep geological disposal of high-level nuclear waste in Canada. Proc. 4th Annual International High-level Radioactive Waste Management Conference, Las Vegas.
- Hart, D.R., N. Garisto and P. McKee. 1995. Assessment of human and ecological risks from uranium and gold mining activities. Second SETAC World Congress, Vancouver.
- Hart, D.R. and M. Rosen. 1997. Environmental and health benefits of utility-based cogeneration to supply district heating and cooling systems. Proceedings of the Canadian Society of Mechanical Engineering, Annual Conference, Toronto.
- Saghir, S.A. and D.R. Hart. 1998. Evaluation of toxicological uncertainty in risk assessment of four important PCB congeners. Society of Toxicology, Annual Meeting, Seattle.
- Hart, D.R., D.L. Lush and N.P. Morris. 2000. Integrated Risk Assessment using a Screening-Level Computer Model. 21st Annual Conference of the Canadian Nuclear Society, Toronto.
- Hart, D., P. McKee and N. Morris. 2002. Ecological Risk Assessment, Environmental Effects Monitoring and Radionuclides. Seminar on Canadian Perspectives on Protection of the Environment from the Effects of Ionizing Radiation, Ottawa, December 2002.
- Hart, D.R. and H. Kleb. 2005. Ecological Risk Assessments for the Baseline Conditions for the Port Hope and Port Granby Projects. *In*: Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities. Canadian Nuclear Society, Ottawa.

Hart, D.R. and A.J. Burt. 2006. Allometric Relationships in the Transfer of ²³⁸U-Series Radionuclides from Food to Wildlife Tissues. SETAC North America 27th Annual Meeting, Montreal.

Hart, D., R.V. Nicholson and M. Venhuis. 2011. Investigation of Tritium in Groundwater around a Light Manufacturing Facility. In: Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities. Canadian Nuclear Society, Toronto.

Hart, D., N. Garisto, R. Parker, R. Kovaks and B. Thompson. 2012. Draft CSA Standard on Environmental Risk assessments at Class 1 Nuclear Facilities and Uranium mines and Mills. 33rd Annual Conference of the Canadian Nuclear Society, Saskatoon.

IAN J. COLLINS, M.Eng., P.Eng., QP_{RA}

PROFESSIONAL PROFILE

Mr. Collins is a Professional Engineer with twelve years of experience, including ten years of experience in human health and ecological risk assessments. Ian has been involved in the conduct of numerous of federal and provincial human health and ecological risk assessments using CCME and similar methodologies. He has developed site specific models using Microsoft Excel-based tools including extensive use of macros and Visual Basic for Applications (VBA) as well as other tools and programming languages for the development of geochemical source terms and water quality predictions for a variety of mining and nuclear industry sites. He has also developed site-specific estimates of risk and remediation objectives. Ian has managed several Preliminary Quantitative Risk Assessments (PQRAs), due diligence-level risk assessments, risk assessments in the format required by the Ontario Brownfields Regulation, and a large-scale environmental risk assessment for a mine site in Saskatchewan. Ian was the principal author for the baseline water quality assessment report under the Environmental Assessment for the Marathon PGM-Cu project.

EDUCATION

- M.Eng., Chemical Engineering, University of Toronto, Graduated June 2006
- B.A.Sc., Engineering Science (Environmental Option), University of Toronto, Graduated June 2002

TRAINING

- Soil Vapour Seminar, Maxxam Analytics Inc., Delta Meadowvale, May 13, 2013
- "Health in Numbers: Quantitative Methods in Clinical and Public Health Research," graduate-level course offered by the Harvard School of Public Health through edX.org, October 2012 to January 2013
- "Computing for Data Analysis," four-week course offered by the Johns Hopkins School of Public Health through coursera.org, October 2012
- MEDIC First Aid, including CPR and Automated External Defibrillator training, February 2012
- "Introduction to Environmental Forensics," four-month course offered by the Association for Environmental and Health Sciences Foundation, September to December 2011
- "Advanced Principles of Toxicology," graduate-level course offered by the University of Guelph, May 2011
- Joint Health and Safety Committee Part 1 Certification Training, OSSA, April 2011
- Information Session on Soil Vapour Intrusion Assessment Guidance, Ontario Ministry of the Environment, January 2011

PROFESSIONAL AFFILIATIONS

- Professional Engineer, Association of Professional Engineers of Ontario (PEO) and Association of Professional Engineers and Geoscientists of Saskatchewan (APEGGS)
- Member of Society for Risk Analysis (SRA)
- Member of Association for Environmental Health and Sciences (AEHS)
- Member of International Society of Environmental Forensics (ISEF)

EMPLOYMENT HISTORY

2009 to present	EcoMetrix Incorporated, Mississauga, Ontario Environmental Engineer (July 2009 to present)
2004 to 2009	Stantec, formerly Jacques Whitford Limited, Markham, Ontario Environmental Risk Assessor (May 2004 to July 2009) Team Leader, Risk Assessment and Management Services (April 2008 to December 2008) Junior Project Manager (November 2008 to July 2009)
2000 to 2001	Inco Limited (now Vale), Mississauga, Ontario Hydrometallurgy Research Assistant (May 2000 to August 2001)

SELECTED PROJECT EXPERIENCE

Review and Development of Water Quality Models and Guidelines

Investigation of Potential Releases from Nuclear Generating Stations: Ontario Power Generation (2013)

- Reviewed estimates of potential releases of water containing radionuclides and non-radionuclides from a nuclear generating station in Ontario and prepared a peer review report for the client;
- Developed similar estimates of releases for two nuclear generating stations under five different scenarios;
- Conducted a literature search for relevant surface water quality guidelines for radionuclides, non-radionuclides, and temperature, and evaluated the suitability of each;
- Selected appropriate benchmarks, and estimated receiving water quality and human and ecological risks under each scenario due to these potential releases; and
- Wrote report and prepared disposition of client comments.

Review of Documents Supporting Water License Renewal for Ekati Mine, Northwest Territories: Wek'èezhii Land and Water Board (2012)

- Reviewed report on water quality model for the Koala watershed; and
- Prepared review report sections dealing with the water quality model, including descriptions and evaluations of model inputs, outputs, and methodology, key assumptions and uncertainties in the model, and a comparison of model results to monitoring data.

Development of Effluent Quality Criteria (EQCs) for Snap Lake Diamond Mine, Northwest Territories: Mackenzie Valley Land and Water Board (2011 to 2012)

- Developed and implemented a transient mass balance model in Microsoft Excel to represent Snap Lake during the operating period of the mine;
- Contributed to the development of EQCs for the mine site using the model; and
- Assisted with preparation of the final memorandum to the Land and Water Board summarizing the modeling efforts and results.

Validation of a Short Duration Shoreline Release Aquatic Dispersion Model: Ontario Power Generation (2010 to 2011)

- Reviewed existing model of a historical tritium release from a nuclear generating station in Ontario and prepared a peer review report for the client;
- Used the same approach to model historical tritium releases from other nuclear generating facilities, and prepared a report outlining methods, assumptions, water quality results, and conclusions.

Environmental Assessments

Baseline Water Quality Assessment for Marathon PGM-Cu Project: Stillwater Canada Inc. (2010 to 2012)

- Compiled all available water quality data, set up Microsoft Access database to manage the data, performed data analysis, and served as Principal Author of the report.

Geochemical Fate and Transport Modeling

Mass Balance Model for a Tailings Impoundment: Cameco Corporation (2009 to 2013)

- Designed and implemented a multi-compartment transient fate and transport mass balance model in Microsoft Excel for post-closure studies of a mill tailings impoundment in Saskatchewan.

Parameters of interest included both radiological and non-radiological species. In addition, assisted with report preparation for the study.

Mass Balance Models for a Tailings Impoundment: Mines Aurizon Ltée, now HECLA (2009 to 2010)

- Designed and implemented a multi-compartment transient fate and transport mass balance model in Microsoft Excel for post-closure studies of a mill tailings impoundment in Québec. Parameter of interest was arsenic. Prepared a water quality report based on this study.

Mass Balance Model for Tailings Deposition Feasibility Study: Vale Canada Limited (2011 to 2012)

- Adapted an existing proprietary computer fate and transport model for investigating possible effects of various tailings deposition strategies at a mineral processing site in Canada on nickel loadings from the tailings management facility. Prepared several reports and presentations for this study.

Estimate of Tailings Management Facility Lime Demand: Xstrata, now Glencore (2010 to 2011)

- Adapted an existing annual lime demand model built in Microsoft Excel for a tailings management facility to a new situation in order to develop updated lime demand estimates for that facility. Prepared the final report for this study.

Water Balance Model for Proposed Mine Shaft Feasibility Study: Vale Canada Limited (2010 to 2011)

- Adapted an existing proprietary computer fate and transport model for investigating possible effects of construction of a new mine shaft at a mineral processing site in Canada on nickel loadings from the tailings management facility. Prepared the final report for this study.

Project Management

Environmental Risk Assessment: Cameco Corporation (February 2012 to January 2014)

- Managed tasks, schedules, and budget for a multidisciplinary team of seven junior and intermediate staff and five senior discipline leads conducting Phase 1 of an environmental risk assessment for a mining operation in Saskatchewan with a budget of \$265,000.
- Managed tasks, schedules, and budget for a multidisciplinary team of nine junior and intermediate staff and two senior discipline leads conducting Phase 2 of the above environmental risk assessment with a budget of \$158,000.

**Brownfield Risk Assessments under Contract to Conestoga Rovers Associates (CRA):
Infrastructure Ontario (January 2012 to present)**

- Assisted Project Principal with management of tasks, schedules, and budgets for both due diligence-level and full Ontario Regulation 153/04-level risk assessments for brownfield properties managed by Infrastructure Ontario;
- Served as liaison with prime contractor (CRA) to facilitate the preparation of deliverables; and
- Prepared due diligence level risk assessment reports and assisted with preparation of Ontario Regulation 153/04-level risk assessments.

**Preliminary Quantitative Risk Assessment (PQRA) and Ecological Risk Evaluation (ERE),
Neskantaga First Nation (FN), under Contract to True Grit Consulting Limited (TGCL):
Aboriginal Affairs and Northern Development Canada (AANDC), formerly Indian and Northern
Affairs Canada (INAC) (2011 to 2013)**

PQRA and ERE, Webequie FN, under Contract to TGCL: AANDC, formerly INAC (2011 to 2013)

PQRA and ERE, Bearskin Lake FN, under Contract to TGCL: AANDC, formerly INAC (2011 to 2013)

Petroleum hydrocarbon contamination, as well as other related impacts had been observed in both of these First Nations Communities. Primary Contaminants of Concern (CoCs) were BTEX, petroleum

hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and metals. Health risks to local residents and workers were evaluated in order to prioritize and conduct remediation work in these communities.

- Supervised the preparation of these documents, and conducted a first-pass review of the final product.

Risk Assessments for Contaminated Sites

Risk Assessment on Confidential Property in Vaughan, Ontario: Confidential Client (2010 to present)

- Prepared screening-level risk assessment for property to identify potential environmental risk issues and develop a scope of work for supplemental investigations;
- Prepared risk management plan for property as part of risk assessment report for submission to Ministry of the Environment under Ontario Regulation 153/04;
- Served as project manager since departure of previous project manager in June 2013.

Port Colborne Community-Based Risk Assessment: Vale, formerly Inco Limited (2005 to 2012)

- Assisted with calculating estimates of human health exposures and risks to residents of Port Colborne, Ontario, due to arsenic, cobalt, copper, and nickel in local soil, and with human health risk assessment report preparation, as well as with presentations to the public and Ministry of the Environment staff when requested; and
- In 2012, updated the Microsoft Excel spreadsheet used for derivation of community-specific soil remediation goals and estimation of human health risks using advanced functions and tools in Excel.

PQRA and ERE, Wawakapewin FN, under Contract to TGCL: AANDC, formerly INAC (2011)

PQRA and ERE, Keewaywin FN, under Contract to Anebeaaki Environmental Inc., now TGCL: AANDC, formerly INAC (2009 to 2011)

Petroleum hydrocarbon contamination, as well as other related impacts had been observed in both of these First Nations Communities. Primary CoCs were BTEX, petroleum hydrocarbons, PAHs, and metals. Health risks to local residents and workers were evaluated in order to prioritize and conduct remediation work in these communities.

- Performed all calculations, including the application of Health Canada PQRA Guidance Part IV Spreadsheet to the estimation of human health risks;
- Researched and filled out Ecological Risk Evaluation spreadsheets developed by Environment Canada; and
- Developed and wrote complete document to fulfill the guidance set out in Health Canada's PQRA Guidance Parts I, II, and III.

Risk Assessment on 629 and 633 Eastern Avenue, Toronto, Ontario: Eastern Avenue Developments (2004 to 2009)

Contamination on these commercial/industrial Sites consisted of Dense Non-Aqueous Phase Layer (DNAPL) in addition to soil and groundwater impacts. Primary Contaminants of Concern (CoCs) included chlorinated aliphatic compounds (trichloroethylene, dichloroethylenes, and vinyl chloride), BTEX and petroleum hydrocarbons, and inorganic parameters.

- Performed all calculations, including the application of the US EPA Vapour Intrusion model, as well as the Atlantic PIRI RBCA model, to the estimation of human health risks;
- Developed and wrote complete document, including development of a Risk Management Plan, which addressed exposure to DNAPL as well as soil and groundwater;
- Compiled toxicological profiles for all CoCs considered in the project;
- Submitted Risk Assessment to MOE under O.Reg.153/04 in support of a Record of Site Condition; and

- Prepared a comparison of the issued Certificate of Property Use with original Risk Management Plan for internal purposes.

Risk Assessment on 9 Yonge Street, Huntsville, Ontario: Shell Canada (2008)

The Site in question was previously owned by a petroleum distributor, and redevelopment into parkland was being considered. Primary CoCs were BTEX and petroleum hydrocarbons, as well as inorganic parameters. Part of the Site bordered a body of water, and was considered sensitive under the definition in the Regulation.

- Performed all calculations, including the application of the US EPA Vapour Intrusion model to the estimation of human health risks;
- Developed and wrote complete document, including the Risk Management Plan; and
- Although the document was written in the spirit of O.Reg. 153/04, it was completed for the client's internal purposes, and was not submitted under the Regulation.

Risk Assessment on 121 Industry Street, Toronto, Ontario: Toronto Transit Commission (2006 to 2007)

This Site was vacant at the time of the project, but the client was considering its development into a commercial/industrial facility. Primary CoCs included chlorinated aliphatic compounds (tetrachloroethylene, trichloroethylene, dichloroethylenes, and vinyl chloride), BTEX and petroleum hydrocarbons, and inorganic parameters in soil and groundwater.

- Performed all calculations, including the application of the US EPA Vapour Intrusion model to the estimation of human health risks;
- Worked with staff biologists to evaluate ecological risks to plants and small mammals and birds on-site;
- Developed and wrote complete document, including the Risk Management Plan;
- Compiled toxicological profiles for all CoCs considered in the project; and
- Although the document was written in the spirit of O.Reg. 153/04, it was completed for the client's internal purposes, and was not submitted under the Regulation.

Screening-Level Risk Assessment, Michipicoten Light Station, Ontario: Public Works and Government Services Canada (2006)

- Compiled data, performed calculations for, and wrote Screening-Level Ecological Risk Assessment for this federally-owned Site.

Other Risk Assessment Projects

Assisted with preparation of various Human Health and Ecological Risk Assessments, including:

- Human Health Risk Assessments concerning radiological and chemical parameters for 26 homes located in an area with naturally occurring radioactive materials;
- Biosolids Pellet Review Study, Human Health and Ecological Risk Assessment, Toronto, Ontario (prepared for Toronto Public Health);
- An Imminent Hazard Evaluation for a contaminated site in Massachusetts;
- A Human Health Risk Assessment concerning herbicide (2,4-D and 2,4,5-T) and dioxin and furan exposures to workers at an industrial facility in Edmonton, Alberta;
- Several Human Health and Ecological Risk Assessments with risk management submitted to the Ontario Ministry of the Environment under Ontario Regulation 153/04; and
- Screening-Level Risk Assessments for various clients.

Programming with Visual Basic (VB) and Visual Basic for Applications (VBA)

Data Analysis Automation Tool Programming: Confidential Client (2009 to present)

- Designed and implemented specialized tools in Visual Basic for Applications (VBA) under Microsoft Excel to perform statistical analyses on large quantities of data output by other modeling tools, and then to automatically generate charts summarizing these data, and automatically tabulate the statistical analysis results, with the effect of increasing efficiency and decreasing processing time for these repetitive tasks.

Database Administration and Programming: Cameco Corporation (2009 to present)

- Designed, developed, tested, and maintained a comprehensive database of environmental monitoring data for several mine sites operated by the client;
- Designed, developed, and tested Visual Basic code within the database to automate input file pre-processing. This code was later ported into Microsoft Visual C# in a stand-alone application.

Database Administration and Programming: Techstream Inc. (Summer 1999, Summer 2002)

- Designed, developed, and tested manufacturing plant time-clock software application in Microsoft Visual Basic and Microsoft Access, along with associated supervisory and administration software. Administrators were given access to an extensive collection of custom-designed reports and queries to allow accurate reporting and manipulation of data. Time-clock application was successfully tested and used in the plant, and the administrative modules were used by payroll staff in their day-to-day activities.

Metallurgical Process Modeling: Vale, formerly Inco Limited (Winter 2001 to Summer 2001)

- Designed, implemented, and validated mass and heat balance models of metallurgical processes using METSIM for Windows and APL. Developed and tested user interfaces for these models in MS-Excel and Visual Basic, involving COM and DCOM architectures.

MICHAEL A. VENHUIS, M.Sc., P.Geo. (ON, SK, BC)
ASSOCIATE, ENVIRONMENTAL GEOSCIENTIST

Mr. Venhuis is a specialist in environmental geochemistry with over 13 years of experience in research and environmental consulting, primarily in the mining sector. Michael has been involved in a variety of mining, hydrogeologic, site assessment and remediation projects for clients throughout Canada. Mike's role on these projects has included project management, geochemical modeling, field investigations and laboratory studies, analysis and assessment of data and conducting sensitivity and probabilistic analyses on the release of contaminants using computer modelling. He has completed geochemical assessments of gold, nickel, uranium, zinc and phosphate mine operations and exploration activities, and has completed numerous geochemical evaluations for mine site Closure Plans, Environmental Assessments and Feasibility studies.

Michael has completed investigations at numerous mine rock and tailings facilities including developing and implementing contaminant hydrogeologic investigations, geochemical evaluations of mine wastes and affected soils to assess management and remediation options at mine properties. These investigations included assessment of surface and groundwater quality, groundwater-surface water interaction, acid generation rates and effects on groundwater and surface water, mitigation measures and rehabilitation strategies. He is currently involved in various investigations for base metal and uranium mining facilities that include completion of a series of laboratory tests on uranium wastes, the quantification of source terms from various waste forms, determination of transport and mobility of contaminants through various environmental pathways and development of environmental risk assessments. Michael is also currently part of a team completing reviews for mine site expansions and permit applications for the Yukon Environmental and Socio-economic Assessment Board.

Mike has participated in the hydrogeological aspects related to mine expansions and permitting including evaluation of effects to downstream water quality. Waste rock and tailings assessments have been completed for numerous projects, involving both proposed and existing operations, focusing on prediction of surface water quality associated with drainage from waste, and on implementation of waste management and mitigation strategies.

In addition to these recent and ongoing mine site projects, Michael has also been project manager for geochemical aspects related to Phase III Environmental Site Assessments involving the remediation of abandoned mine sites in Northwest Territories for Indian and Northern Affairs Canada. He has also designed and implemented several urban and rural landfill monitoring projects in Eastern Ontario. These have included various groundwater resource management projects in Eastern Ontario.

Michael's experience and technical skills provide him with a strong foundation to contribute valuable expertise to projects requiring chemical and hydrogeological evaluations. Michael's interest and experience in geochemical and environmental research and applications also provides valuable skills in the evaluation and interpretation in the field of geochemistry.

EDUCATION

M.Sc., Earth Sciences - Geochemistry, University of Waterloo 2000
B.Sc., Environmental Chemistry, University of Waterloo 1998

PROFESSIONAL AFFILIATIONS

Member, Association of Professional Geoscientists of Ontario
Member, Association of Professional Engineers and Geoscientists of Saskatchewan
Member, Association of Professional Engineers and Geoscientists of British Columbia

EMPLOYMENT HISTORY

Sept. 2004 – Present Environmental Geoscientist - EcoMetrix Incorporated
Oct. 2002 - Sept. 2004 Environmental Geoscientist - Stantec Consulting Ltd. (acquired BEAK
2002)
Sept. 2002 - Oct. 2002 Environmental Geoscientist - BEAK International Inc.
Feb. 2001- Sept. 2002 Environmental Scientist/Project Manager - Golder Associates Ltd.
Sept. 1997 – Feb. 2001 Research Scientist – University of Waterloo
Jan. 1997 – Aug. 1997 Research Scientist – Environment Canada (Canada Centre for
Inland Waters)

PROJECT EXPERIENCE

Hydrogeological (2001-Present)

Michael is currently part of the Technical Sub-committee drafting a new guidance document for groundwater monitoring for Class I Nuclear facilities and Uranium Mines for the Canadian Standard Association (N288.7). Michael was the project manager and lead investigator for the updates to the groundwater monitoring programs for Ontario Power Generation's Darlington and Pickering Nuclear Power Stations. Groundwater studies have also included radionuclide contamination (Tritium) in clays and fractured rock at tritium light manufacturing facilities in Canada. Michael has completed hydrogeological assessments in support of Permits to Take Water. As part of the primary project team, Michael also had an integral role in the development of a wellhead protection strategies for 3 systems of water supply wells in Ottawa, Ontario. The completion of a 24 hour pumping test on the wells without service interruption was an obstacle which was required and completed under Michael's supervision. He has served as Project Manager on several urban and rural landfill monitoring projects in Eastern Ontario. Project tasks included development and implementation of groundwater and surface water monitoring programs, landfill expansion permitting and landfill closure planning. Michael's experience also includes the supervisory role in a municipal water sampling program, which consisted of the sampling, analysis and interpretation of over 250 residential water supplies in Cumberland, Ontario.

Mining (2002-Present)

Michael has been involved with the hydrogeological evaluations related to mining expansions for various mining clients. Michael has provided review of proposed mine developments and expansions in Yukon for YESAB. As part of a study team for many mine site evaluations, Michael has completed geochemical modeling of the mobility and distribution of contaminants surrounding current and former mine sites across Canada. Michael has completed investigations at numerous

tailings facilities to assess surface and subsurface water quality, acid generation rates and rehabilitation strategies. His experience includes investigations at base metals mines, gold and uranium operations including Kidd (zinc-copper), Strathcona (nickel-copper-cobalt), and Williams Operating (gold), Casa Berardi (gold), Selbaie (copper-zinc), Marathon PGM (copper-PGM). Tailings assessments focused on cost effective innovative approaches to control costs and maximize information collection.

Waste rock assessments have been completed for numerous projects, both at proposed and existing operations including several uranium mines in the Athabasca basin of Saskatchewan, closed copper mines in BC and an iron project in Nunavut. The characterization studies focused on prediction of water quality associated with drainage from waste with emphasis on implementation of waste management strategies to prevent water quality impacts.

Environmental Assessments (2001-Present)

Michael was the Project Manager and Lead Assessor for the remediation of two former copper transfer facilities in BC. As part of the remediation, Preliminary and Detailed Site investigations were completed, Remediation Plans prepared and submitted for Ministry Approval. Both sites have been remediated and requests for Certificate of Compliance are anticipated for the sites in the near future.

As part of collaborative projects under a standing offer contract, Michael acted as the Senior Field Assessor and Geochemistry Lead in numerous Phase III Environmental Assessments for abandoned mine sites in Northwest Territories. The projects included tailings and waste rock characterization, chemical assessment of contamination at the site and recommendations for further remediation work. In addition, Michael played a key role in a Phase III Environmental Assessments for a former uranium ore transfer location in Northwest Territories. The project included a radiological and chemical assessment of contamination at the site, and recommendations for further remediation work.

Michael supervised numerous Phase I and II Environmental Assessments in Ontario and Quebec, including commercial, residential and industrial sites. On many occasions, these projects were advanced to Phase III assessments, where Michael implemented clean-up and remediation programs. Michael was a key contact with Hydro One Services Inc. in the completion of Environmental Assessments and remediation of hydro sites in Eastern Ontario.

Research and Technology (1997-Present)

One of Michael's interests is in the research and application of new technologies and methods in the evaluation and prevention of environmental contamination. Michael currently operates a Geochemistry laboratory where leaching experiments of various materials, particularly waste materials from the mining industry are completed with focus on acid rock drainage and metal leaching. The results of the experiments are used to guide operation, reclamation and closure activities for the mining industry.

Michael has completed many other research projects including the design and testing of a new technology to carbonate cement-based waste forms. The research focused on the use of carbonated cement based waste forms for disposal of low-level radioactive wastes generated from the power industry. In addition, Michael has worked with Environment Canada in the evaluation of commercially available polyalkastylene absorbent beads for the in-situ remediation of PCE in groundwater. Through batch tests and column experiments, it was found that although suitable for surface water remediation, the beads were inappropriate for sub-surface remediation.

PUBLICATIONS/PRESENTATIONS

- Collins I., R.V. Nicholson, M. Venhuis, L. Anctil. 2012. The Use of Field Investigations for the Development of a Water Quality Model for Gold Tailings in Northern Quebec. 9th International Conference on Acid Rock Drainage. Ottawa, Ontario. 20-26 May.
- Nicholson, R.V., I. Ludgate, E. Clyde and M. Venhuis. 2012. The Successful Reclamation of Acid Generating Tailings in the Elliot Lake Uranium District of Canada: A Good-News Case History. 9th International Conference on Acid Rock Drainage. Ottawa, Ontario. 20-26 May.
- Venhuis, M.A., R.V. Nicholson and D. Yaschyshyn. 2011. Water quality expectations for thickened tailings and lessons learned at the Kidd Metsite TMA, Timmins, Ontario. 18th Annual BC Metal Leaching / ARD Workshop, November 30-December 1, 2011, Vancouver.
- Hart, D., R.V. Nicholson, and M. Venhuis. 2011. Investigation of Tritium in Groundwater Around a Tritium Light Manufacturing Facility. Conference on Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities. Toronto, Ontario. 11-14 September.
- Bower, M., M. Venhuis, R. V. Nicholson and R. Schwenger. 2011. Investigating the Effects of Tailings Dusting on the Metal Loadings and Transport to Local Water Bodies at a Lead-Zinc Mine. *In Proceedings Sudbury 2011 Mining and the Environment Conference.* Sudbury, Ontario. 25-30 June.
- Biglari, M., M.A. Venhuis, and R. V. Nicholson. 2007. Geochemical Optimization of Thickened Tailings Deposition to Minimize Water Treatment During Operation at the Kidd Metallurgical site, Timmins, Ontario. *In Proceedings Sudbury 2007 Mining and the Environment Conference.* Sudbury, Ontario. 22-24 October.
- Venhuis, M.A., P. McKee, R.V. Nicholson and B. Huls. 2006. Defining Source Terms for Backfill Components in the Selbaie Mine Pit, 13th Annual BC Metal Leaching / ARD Workshop, November 29-30, 2006, Vancouver.
- Guerin, Frederic, Ronald V Nicholson and Michael A. Venhuis, 2005. Characterization of arsenic, uranium and nickel porewater concentrations: Implications for underwater disposal of fresh and weathered materials from uranium mines in Northern Saskatchewan, Canadian Geotechnical Conference, Saskatoon, SK, September, 2005
- Nicholson, R.V., M.J. Rinker, M.A. Venhuis, G. Williams and B. Swarbrick. 2003. Implications of Non-Acidic Metal Leaching on Mine Rock Management at a Nickel Mine in Permafrost Terrain: Environmental Baseline Investigation. *In Proceedings Sudbury 2003 Mining and the Environment Conference.* Sudbury, Ontario. 25-28 May.
- Rinker, M.J., R.V. Nicholson, M.A. Venhuis and B. Swarbrick. 2003. Implications of Non-Acidic Metal Leaching on Mine Rock Management at a Nickel Mine in Permafrost Terrain: Mine

Rock Evaluation. *In* Proceedings Sudbury 2003 Mining and the Environment Conference. Sudbury, Ontario. 25-28 May.

Nicholson, R.V., M.J. Rinker, G. Acott and M.A. Venhuis. 2003. Integration of Field Data and a Geochemical Transport Model to Assess Mitigation Strategies for an Acid-Generating Mine Rock Pile at a Uranium Mine. *In* Proceedings Sudbury 2003 Mining and the Environment Conference. Sudbury, Ontario. 25-28 May.

Venhuis, M. and Reardon, E.J. "Carbonation of Cement-Based Wasteforms Under Supercritical and High Pressure Subcritical Conditions". *Environmental Technology*, 2003, **24**, 877-887.

Venhuis, M. and Reardon, E.J. "Vacuum Method for Carbonation for Cementitious Wasteforms". *Environ. Sci. Technol.*, 2001, **35**, 4120-4125.

Venhuis, M.A., 2000. Carbonation Reactions of Cemented Waste Forms: Physicochemical Aspects of Hazardous Waste Immobilization. M.Sc. Thesis, University of Waterloo, Waterloo, ON.

Venhuis, M., S. Lesage, K.R. Millar and A.S. Crowe. "Evaluation of Polyalkastylene Absorbent Beads for the Remediation of PCE in Groundwater". *Water Qual. Res. J. Canada*, 1999, **34**, 455-468