



Christopher Bacigalupo, M.Sc., QEP⁰²⁻²³, QP^{RA}

Founder/Principal

Wolf Environmental Science Ltd.



Education:

2006 – M.Sc., Toxicology and Land Resource Sciences, University of Guelph. Guelph, ON.

1995 – B.Sc., Honours Environmental Science, Biology Minor, University of Waterloo. Waterloo, ON.

Professional Experience:

2017 – present:
Founder/Owner, Wolf Environmental Science Ltd.

Oct 2020 – April 2022:
Environmental Science Specialist [temporary contract], Department of Environmental and Occupational Health; Public Health Ontario

1998 – 2017:
Risk Assessor / Senior Risk Assessor/Toxicologist, Intrinsic Corp. (Cantox Environmental Inc.)

1996 – 1998:
Exposure and Risk Assessment Modeler, Cantox Inc.

Affiliations/Designations:

July 2002 – June, 2023:
Qualified Environmental Professional (QEP) — Institute of Professional Environmental Practice

2008 – Present:
Qualified Person for Risk Assessment (QP^{RA}) O. Reg. 153/04

Jan 2023 - Jan 2026: Qualified Person – certifying tier 3 endpoint corrective action. Saskatchewan Environmental Code.

Areas of Expertise:

- HHRA methods and models.
- Air Quality Assessment.
- Standards Development.
- Contaminated Sites.

Career Highlights

- Over 25 years of consulting experience, providing technical/scientific expertise and advice to private and government sector clients in the fields of toxicology and environmental risk assessment, with a specialization in human health-related issues.
- Worked with the Department of Environmental and Occupational Health at Public Health Ontario (PHO) as an Environmental Science Specialist providing scientific and technical support to Public Health Units and Ontario Ministries in the areas of air and water quality, and chemical health hazards.
- Qualified Person for Risk Assessment (QP^{RA}) under Ontario Regulation 153/04 (O. Reg. 153/04). Qualified Person (QP) for certifying Tier 3 endpoint corrective action plan or future risk management under the Saskatchewan Environmental Code.
- Responsible for the development of risk assessment approaches and quantitative models for some of the most comprehensive risk assessments completed in Canada.
- Detailed knowledge of the methods used by regulatory agencies to develop human health-based air quality standards from toxicological data.
- Contributed to the development of regulatory health-based air quality standards on behalf of provincial and federal governments.
- Provision of toxicological advice, scientific reviews, and expert opinions concerning human health issues related to air quality within the context of legal proceedings (e.g., expert reports, affidavit reviews, scientific advice to legal counsel, etc.).
- Responsible for completing, managing, and reviewing human health risk assessments concerning a wide range of issues related to contaminated sites (O. Reg. 153/04 and due diligence), industrial air emissions, and consumer products.
- Experienced in communicating scientific material related to human toxicology and risk assessment to both non-technical and technical audiences.

Representative Examples of Toxicological Assessments and Expert Advice Concerning Air Quality

- Provision of Expert Reports pertaining to the human health risks associated indirect exposures to metals contained within a dust fall event. Senior Toxicologist and Risk Assessor (2023).
- Toxicology advice and provision of an Expert Opinion pertaining to the human health risks associated with chronic inhalation exposure to inorganic arsenic. *Senior Toxicologist (2022)*.
- Toxicological Assessments for Gasoline (CAS# 86290-81-5) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2022)*.
- Technical Review of the Human Health and Ecological Risk Assessment components of a Draft Environmental Impact Statement – Timiskaming Dam-Bridge. Quebec. *Senior Toxicologist (2022)*.
- Toxicological Assessments for 2,4-Dimethyl-1-Pentene (CAS# 2213-32-3) and 5-Methyl-1-Heptene (CAS# 13151-04-7) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2020)*.
- Toxicological Assessments for Naphtha (petroleum), hydrotreated heavy (CAS# 64742-48-9) and Cashew nutshell liquid epoxy (CAS# 115487-50-8) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2020)*.
- Toxicological Assessments for isobutane (CAS# 75-28-5) and Tris(2,4-di-tert-butylphenyl) phosphite (CAS# 315270-04-4) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2019)*.
- A Toxicological Assessment for Isoprene (CAS# 78-79-5) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2019)*.
- An Assessment of the basis Site-Specific Standard for Sulphur Dioxide under Ontario Regulation 419. *Senior Toxicologist and Health Risk Assessor (2019)*.
- A Toxicological Assessment for Furan (CAS# 110-00-9) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2019)*.
- A Toxicological Assessment for Aliphatic Polymer Diamine (CAS# 68911-25-1) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2019)*.
- A Toxicological Assessment for 1,1,2,2,3,3,4-Heptafluorocyclopentane (CAS# 15290-77-4) under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2019)*.
- Provision of an Expert Opinion Report pertaining to the human health risks associated with chronic inhalation exposure to inorganic arsenic. *Senior Toxicologist (2018)*.
- A Toxicological Assessment for Calcined Bauxitic Kaolin under Ontario Regulation 1/17 – Air Emissions EASR Regulation. *Senior Toxicologist (2018)*.
- Completion of two (2) Maximum Concentration Level Assessment (MCLA) Reports (under Ontario Regulation 419) for Solvent and Acid Refined Middle Distillates (Petroleum). *Senior Toxicologist (2018)*.
- Provision of toxicology and risk assessment advice to support the development of a legal defense strategy. Development and selection of appropriate acute and chronic toxicity reference values for specific metal species in air. *Senior Toxicologist and Risk Assessor (2014 – 2017)*.
- Provision of toxicological and risk assessment support and advice concerning the development of provincial SO₂ air quality standards designed to protect human health. *Senior Toxicologist and Risk Assessor (2017)*;

Representative Examples of Toxicological Assessments and Expert Advice Concerning Air Quality (Cont'd)

- Scientific Literature Search and Review — Acute Carbon Monoxide Toxicity. Appropriate Indoor Air Thresholds Pertaining to Carbon Monoxide and the Protection of Public Health. *Senior Toxicologist and Risk Assessor (2016)*;
- Litigation Support — Research and development of expert reports concerning the human health impacts associated with exposures to industrial air emissions in southwestern Ontario. *Senior Risk Assessor and Toxicologist (2011 – 2014)*.
- A Scientific Peer Review of the Proposed Amendments to the Ambient Air Quality Standards for Nickel and Nickel Compounds as outlined by the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs. *Senior Toxicologist (2013)*.
- Toxicology advice and support provided to an Ontario Mining Consortium during the Ontario Air Standards Development Process concerning the development and implementation of health-based air standards for nickel, lead, manganese, and chromium. *Senior Toxicologist (2008 – 2011)*.
- Independent Expert Report and Affidavit — Health Impacts Associated with Predicted Concentrations of Total Reduced Sulphur (TRS) Surrounding a Facility in Hamilton, Ontario. *Senior Risk Assessor and Toxicologist (2010)*.
- Toxicological investigation into the potential cause(s) for burning/tearing eyes among plant workers. Teck Metals Ltd. *Senior Risk Assessor and Toxicologist (2010)*.
- Preliminary Landfill Gas Evaluation — A cursory overview of potential health risks associated with inhalation exposures to predicted concentrations of landfill gas contaminants for the City of Hamilton *Senior Risk Assessor and Toxicologist (2007)*.
- Toxicological reviews for Xstrata Copper and CVRD Inco concerning the toxicological basis for the Ontario Ministry of Environment's Draft Air Standards for Lead and Lead Compounds. Risk Assessor and Toxicologist (2007).
- A Preliminary Assessment of Potential Human Health Risk Associated with an Unintentional Release of Soil Fumigant, Florida, USA. *Risk Assessor (2002)*.

Representative Examples of Contaminated Site Risk Assessment Projects

- Development of a detailed Multimedia Human Health Risk Assessment and Site-Specific Soil Clean-up Criteria for nickel, Ontario (2022).
- Limited Scope Human Health and Ecological Risk Assessment for a commercial property located in Hudson Bay, Saskatchewan. Senior Toxicologist and Risk Assessment Specialist (2022)
- Limited Scope Screening-Level Human Health Risk Assessment for a property located near Cut Knife, Saskatchewan. *Senior Toxicologist and Risk Assessment Specialist (2021)*.
- Detailed Technical Review of a Human Health and Ecological Risk Assessment to Support the Victor Mine Closure Planning. *Senior Toxicologist and Risk Assessment Specialist (2021)*.
- Cursory Review of the Victor Mine Mercury Performance Monitoring 2018 Annual Report. *Senior Toxicologist and Risk Assessment Specialist (2019)*.
- Due Diligence Risk Assessment for a commercial property located with thirty (30) meters of a surface water body. Use of site-specific soil vapour concentrations to characterize health risks associated with vapour intrusion. *Senior Toxicologist (2018)*.

Representative Examples of Contaminated Site Risk Assessment Projects (Cont'd)

- Due Diligence Screening-Level Human Health and Ecological Risk Assessment of a heavy industrial use property located near Sarnia, Ontario. Conducted to fulfill the due diligence requirements of a real estate transaction. *Senior Toxicologist (2018)*.
- The development of a framework for a health-based Community Action Plan (CAP) to address potential metal exposures in Port Colborne, Ontario. *Senior Risk Assessor and Toxicologist (2016 - 2017)*.
- Completion of numerous O. Reg. 153/04 Risk Assessments for properties located in Renfrew, Orillia, and Sault Ste Marie. *Senior Risk Assessor, QP_{RA} (2014 -2017)*.
- Duty of Care Screening-Level Human Health Risk Assessment for Lake Ontario Park, Toronto, Ontario. Martin Goodman Trail Network. *Senior Risk Assessor and Toxicologist (2016)*.
- Due Diligence Risk Assessment for a property located near Hawkesbury, Ontario. Conducted on behalf of EAG Canada. *Senior Risk Assessment Reviewer and Project Manager (2016)*.
- Due Diligence Risk Assessment for two properties located in Hearst and Belleville, Ontario. Conducted on behalf of EAG Canada. *Senior Risk Assessment Reviewer and Project Manager (2015)*.
- Due Diligence Risk Assessment of a former Commercial Property located in Peterborough Ontario. Conducted on behalf of EAG Canada. *Senior Risk Assessor (2014)*.
- Supporting Rationale for the Trail Health and Environment Program – Human Health. A Detailed Review of the Regulatory Status Concerning Lead and the Effectiveness of Lead Intervention Programs & Techniques. *Senior Human Health Risk Assessor (2013)*.
- Nine (9) Human Health and Ecological Preliminary Quantitative Risk Assessments (PQRA) for a large industrial site in Thunder Bay, Ontario. Conducted for Public Works Government Services Canada (PWGSC) and the Fort Williams First Nations (FWFN). *Senior Risk Assessor and Project Manager (2012)*.
- Development of interim guidance for evaluating human health risks associated with direct exposure to contaminated sediments at Federal Contaminated Sites in Canada. Prepared for Health Canada. *Senior Human Health Risk Assessor and Toxicologist (2010)*.
- Contaminated Site Risk Assessment (under O. Reg. 153/04) of 840 Upper James Street, Hamilton Ontario. *Risk Assessor and Project Manager, QP_{RA} (2009)*.
- Contaminated Site Risk Assessment (under O. Reg. 153/04) of 385 Carlingview Drive, Toronto, Ontario. *Risk Assessor and Project Manager, QP_{RA} (2009)*.
- Development of a probabilistic exposure/risk assessment approach and quantitative model used to facilitate the Human Health Risk Assessment of the City of Greater Sudbury and Its Surrounding Area, conducted on behalf of INCO, Falconbridge, the MOE, the City of Sudbury, and the Sudbury District Health Unit. *Lead Human Health Risk Assessor (2003 – 2008)*.
- Human health risk assessments of soil and dust impacted by smelter emissions in La Oroya, Peru. *Lead Human Health Risk Assessor and Toxicologist (2006 – 2007)*.
- Human Health Risk assessment of soil and dust impacted by emissions from mineral concentrate storage and handling facilities at the Port of Callao, Peru. *Lead Human Health Risk Assessor and Toxicologist (2007)*.

Representative Examples of Contaminated Site Risk Assessment Projects (Cont'd.)

- Probabilistic Estimated Daily Intake (EDI) Derivation: An Exploration in Development and Application. Contract for Health Canada. *Human Health Risk Assessor (2006)*.
- Contaminated Site Risk Assessment (under Ontario Regulation 153/04) of the South-West Corner Block Property, Toronto, Ontario. *Risk Assessor, QP_{RA}, (2004/2005)*.
- Contaminated Site Risk Assessment (under Ontario Regulation 153/04) of PCB Impacted Lands to the West of a Compressor Station facility located in the Greater Toronto Area, Ontario (2005).
- Human Health and Ecological Risk Assessment for the Arab Abu Said area south of Cairo, Egypt – assessment of brick factor emissions (heavy oil versus natural gas). *Lead Human Health Risk Assessor (2001 – 2005)*.
- A Detailed Review of the Human Health Exposure Methodologies by Other Jurisdictions and the 1997 Ontario Ministry of the Environment's Guideline for Use at Contaminated Sites in Ontario. Prepared for the Ontario Ministry of the Environment. *Senior Risk Assessor and Toxicologist (2002)*.
- A Detailed Review of the Human Health Exposure Methodologies by other Jurisdictions and the 1997 Ontario Ministry of the Environment's Guideline for Use at Contaminated Sites in Ontario. Prepared for the Ontario Ministry of the Environment. *Risk Assessor (2002)*.
- Development of an Exposure/Risk Model to Generate Updated Generic Health-Based Soil and Groundwater Criteria. Prepared for the Ontario Ministry of the Environment. *Risk Assessor and Modelling Specialist (2003)*.
- Deloro Village Exposure Assessment and Health Risk Characterization for Arsenic and Other Metals. Conducted for the Ontario Ministry of the Environment. *Risk Assessment Modeller (1997 – 1999)*.
- Site Specific Risk Assessment of the Former Gooderham & Worts Limited Property, Toronto, Ontario. *Risk Assessment Modeller (1997 - 1998)*.
- Risk Assessment of Groundwater Contamination at a Colour Toner Facility, Oakville, Ontario. *Risk Assessment Modeller (1996 – 1997)*.
- Site Specific Human Health Risk Assessment – Lower Frederick Street, Sydney Tar Ponds, Nova Scotia. *Risk Assessor/Modeller*.
- Human Health Risk Assessment of the former YPL Whitehorse Upper Tank Farm, Whitehorse, Yukon. *Risk Assessor/Modeller*.
- Detailed Human Health and Ecological Risk Assessment of chemicals detected at abandoned Dew Line Sites in the Eastern Arctic. *Risk Assessor/Modeller*.
- Human Health and Ecological Risk Assessment of three additional sites at the Former U.S. Naval Air Base at Argentia, Newfoundland. *Risk Assessor/Modeller*.
- Preliminary Ecological Risk Assessment concerning specific fungicides at the Banff Springs Golf Course. *Risk Assessor/Modeller*; Human Health Risk Assessment of petroleum contaminated soils at the IOCO Town Site Property, B.C. *Risk Assessor/Modeller*.
- Derivation of Preliminary Risk Management Criteria for metals at a former Gun Range. Burnaby, B.C.

Representative Examples of Human Health Risk Assessment Concerning Air Emissions and Air Quality

- Completion of a Human Health Risk Assessment of Sulphur Dioxide Using Real-Time Air Quality Data and an Evaluation of a Site-Specific Air Standards Under Ontario Regulation 419/05. *Senior Toxicologist* (2018 – 2021).
- Toronto Subway Air Quality Health Impact Assessment and Human Health Risk Assessment. Prepared for Toronto Public Health. *Senior Toxicologist and Human Health Risk Assessor* (2019- 2020).
- Detailed Multi-Media Human Health Risk Assessment of Predicted Air Emissions from a Proposed Plasco Energy Waste Conversion Facility in Ottawa, Ontario. *Senior Risk Assessor* (2013 – 2016).
- Human Health Risk Assessment of Existing Conditions for the Proposed Clean Harbors Lambton Facility Expansion Project. *Senior Human Health Risk Assessor* (2014).
- Preliminary Screening-level Risk Assessment of Glanbrook Landfill Gas Emissions. *Senior Project Manager and Toxicologist* (2008).
- Human Health Risk Assessment and Modeling to support the Human Health Risk Assessment of a proposed large-scale petroleum refinery facility to be located in South-western Ontario. *Senior Human Health Risk Assessor* (2008).
- Toxicological Risk Assessment Pertaining to Potential Occupational and Related Exposures Associated with Historical Herbicide Spraying Operations at CFB Gagetown, completed on behalf of the Government of Canada. *Lead Human Health Risk Assessor* (2007).
- Human Health Risk Assessment of Stack Emissions from the Lafarge Cement Plant Located in Bath, Ontario. *Senior Human Health Risk Assessor* (2007).
- Environmental and Human Health Risk Assessment for the Proposed VBNC Smelter/Refinery and Power Plant Facilities at Argentia, Newfoundland. *Risk Assessment Modeller* (2006 – 2007).
- Peer review of the Durham-York generic risk assessment feasibility study for the proposed energy-from-waste facility under consideration by Durham and York regions. *Senior Risk Assessor* (2007).
- Human Health and Ecological Risk Assessment for the Warwick Landfill Expansion. Including public consultation and risk communication activities. *Human Health Risk Assessor* (2003).
- Human Health and Ecological Risk Assessment for the Richmond Landfill Expansion, Napanee, Ontario. Including public consultation and risk communication activities. *Human Health Risk Assessor* (2003).
- Human Health and Ecological Risk Assessment for the Proposed Bennett Environmental Inc. Thermal Treatment Facility in Kirkland Lake, Ontario. Including public consultation and risk communication activities. *Human Health Risk Assessor and Modeller* (2001 - 2002).
- Human Health Risk Assessment for the proposed expansion of the KMS Peel Inc. Energy from Waste Facility, Brampton Ontario. *Risk Assessor and Modeller* (2002).
- Human Health Risk Assessment of Air Emissions from the Holyrood Thermal Generating Station, Newfoundland and Labrador. *Risk Assessor/Modeller* (1999).
- Predictive modelling of ecological body burdens due to historical releases of Transformer Furnace Emissions from the Bovar Waste Management Treatment Centre, Swan Hills, Alberta. *Modeller* (1997 – 1999).

Select Publications, Posters, and Presentations

- Bacigalupo, C.M.** 2019. A Presentation on risk assessment in the context of contaminated sites and Ontario Regulation 153/04. Presented at a 2-day Environmental Site Assessment (ESA) EPIC Workshop, Mississauga, Ontario. March 2019.
- Bryant, D.W., **Bacigalupo, CM.** And Kelly, P. 2013. *A puzzle of acute temporary eye irritation among plant workers.* Presented at AIHce 2013. Montreal, PQ, May 18-23, 2013.
- Bacigalupo, C.M.,** and Hale, B. *Human Health Risks of Pb and As Exposure via Consumption of Home Garden Vegetables and Incidental Soil and Dust Ingestion: A Probabilistic Screening Tool.* Sci. Total Environ. Volume 423, 15 April 2012, Pages 27-38.
- Ferguson, G., Sigal, E., and **Bacigalupo, C.M..** 2012. Chapters 5, 6 and 7 in *Risk Assessment and Environmental Management: A Case Study in Sudbury, Ontario, Canada.* C. Wren (Ed.). Maralthe Publishing. 450 pp.
- Bacigalupo, C.M.,** and Hale, B. *Soil – Plant Transfer Factors for Garden Produce from Contaminated Soils: Site Specific versus Generic Estimates for As and Pb.* Human and Ecological Risk Assessment 17(2): 394-413. April, 2011.
- Sigal, E.A., Safruk, A.M., and **Bacigalupo, C.M.** *Use of In Vitro Bioaccessibility Analysis, Human Health Risk Assessment, and Urinary Arsenic Measurements to Assess Exposure and Risks of Children in a Northern Canadian Smelter Community.* Poster presentation at SOT Annual Meeting, Washington DC, March 2011.
- Sigal, E., Ferguson, G., and **Bacigalupo, C.** 2009. *Consideration of In Vitro Bioaccessibility of indoor dust when assessing risks in smelter communities.* Presented at SOT, Baltimore, MD, March 2009.
- Sigal, E., Safruk, A., Videla, P.P., **Bacigalupo, C.,** and Hamilton, K.T. 2009. *Comparison of In Vitro Bioaccessibility Results at Smelter-Related Contaminated Sites in North and South America.* Poster presentation at SETAC-South America, Lima, Peru, October 2009.
- Ferguson, G.M., Sigal, E.A. and **Bacigalupo, C.M.** 2007. Conducting a Large Scale HHRA in an Ongoing Smelting Community: Challenges and Lessons Learned. Presented at Sudbury 2007. Session 7-C: Risk Assessment Symposium. October 24, 2007.
- Sigal, E., Archbold, J.A., Ferguson, G.M., **Bacigalupo, C.M.,** Moore, D.R.J., and Richardson, G.M. 2006. *The Development and Application of Probabilistic Methods in the Derivation of Estimated Daily Intakes for Typical Canadian Populations.* Presented at the Health Canada Contaminated Sites Workshop, Ottawa, Ontario, March 2006.
- Ferguson, G., **Bacigalupo, C.,** Musca, G., and Sigal, E. 2005. *The Use of Speciation and Bioaccessibility Methods to Evaluate Contaminant Behaviour as part of Human Health Risk Assessment at Metal-Impacted Sites.* Presented at CIM Mining Rocks! Mining Industry Conference and Exhibition, Toronto, Ontario, April 24-27, 2005.
- Sigal, E., **Bacigalupo, C.,** and Ferguson, G. 2003. *Assessing Human Health Risks from Arsenic Exposure using a Weight-of-Evidence Approach.* Presented at the Sudbury 2003 Mining and the Environment Conference, Sudbury, Ontario, May 26-28, 2003.
- Sigal, E., **Bacigalupo, C.,** Moore, R., Ferguson, G., and Fleming, S. 2002. *A Case Study in Arsenic Risk Assessment: Deloro Village, Ontario.* Presented at the 2002 Annual Society for Risk Analysis Meeting, New Orleans, LA, [DATE] 2002.
- Sigal, E., **Bacigalupo, C.,** and Moore, R. 2002. *The Use of a Weight of Evidence Approach to Assess Health Risks from Arsenic Exposure.* The Toxicologist 66(1-S):103.

- Sigal, E.A., Ferguson, G.M., **Bacigalupo, C.M.**, Willis, R.D., and Marshall, L. 2001. *Potential Implications of Inappropriate Assumption Selection on Environmental Modelling Results: A RBCA Case Study. In: Environmental Toxicology and Risk Assessment: Science, Policy, and Standardization – Implications for Environmental Decisions*: Tenth Volume, ASTM STP 1403, B.M Greenberg, R.N. Hull, M.H. Roberts, Jr., and R.W. Gensemer, Eds., American Society for Testing and Materials, West Conshohocken, PA, April 2001.
- Bryant, D.W., Chadder, D.S., **Bacigalupo, C.M.** 2000. *Exposure Assessment to PM₁₀ for Local Residential Areas in an Urban Environment*. Proceedings of the Joint International Specialty Conference “Recent Advances in the Science and Management of Air Toxics”, Banff, Alberta, [DATE] 2000.
- Wilson, R.M., Sigal, E.A., **Bacigalupo, C.M.**, Willes, R.F., and Munro, I.C. 2000. *Derivation of Risk Management Criteria for Chemicals of Unknown Toxic Potency At Contaminated Sites*. Human and Ecological Risk Assessment. Vol 6, No. 1, pp131–139.