# 19th Annual General Meeting and Conference

## Emerging Topics in Environmental Toxicology and Chemistry: Separating Fact from Fiction

June 13th, 2014, Guelph, ON

Laurentian SETAC
Laurentian Chapter of the Society of Environmental Toxicology and Chemistry

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# *CONFERENCE PROGRAM*

## Friday, June 13th, 2014

| Time | Location | Schedule Item |
|---|---|---|
| 8:30 – 9:00 | Lobby | **Registration**<br>OVC 1707B : poster set-up |
| 9:00 – 9:15 | OVC 1714 | **Opening Remarks** |
| 9:15 – 10:00 | OVC 1714 | ***Fate and effects of chemicals used in shale gas extraction***<br>Dr. Ulysses Klee<br>*Stantec Consulting, Guelph, ON* |
| 10:00 - 10:45 | OVC 1714 | ***Larval fish toxicity of sediments, waters, groundwaters, and snow melt waters from oil sands areas***<br>Dr. Joanne Parrott *et al.*<br>*Environment Canada* |
| 10:45 – 11:15 | OVC 1707B | **Posters** and Morning Break<br>(Student poster judging) |
| 11:15 – 12:00 | OVC 1714 | ***Field studies examining exposure and effects of neonicotinoid insecticides on bee colony health***<br>Dr. Cynthia Scott-Dupree<br>*School of Environmental Sciences, University of Guelph* |
| 12:00 - 12:30 | OVC 1714 | ***Annual General Meeting***<br>& SETAC North America update |

# *CONFERENCE PROGRAM*

## Friday, June 13th, 2014 (cont'd)

| Time | Location | Schedule Item |
|---|---|---|
| 12:30 - 2:00 | OVC 1707B | ***Lunch*** |
| 2:00 - 2:20 | OVC 1713 & OVC 1714 | ***Concurrent Platform Presentations*** **Sessions A & B** |
| 2:20 - 2:40 | | |
| 2:40 - 3:00 | | |
| 3:00 - 3:45 | OVC 1707B | **Posters** and Afternoon Break (Student poster judging) |
| 3:45 - 4:00 | OVC 1707B | **Book Draw** |
| 4:00 - 4:20 | OVC 1713 & OVC 1714 | ***Concurrent Platform Presentations*** **Sessions C & D** |
| 4:20 - 4:40 | | |
| 4:40 - 5:00 | | |
| 5:00 - 5:30 | OVC 1714 | Student Judges meet |
| | OVC 1707B | Take down posters |
| 5:00 - 7:00 | Bullring | ***Student Awards Social and Dinner*** |

## Platform Presentations

| Time | Session A: Human Health Risk Assessment<br>Room OVC 1713 |
|---|---|
| 2:00<br>–<br>2:20 | **Assessing PAH emissions from residential wood burning - An unwholesome way to heat your home?**<br>Thackeray, Nicole<br>Intrinsik Environmental Sciences Inc., Mississauga, ON |
| 2:20<br>–<br>2:40 | **Characterization of polydimethylsiloxane passive air sampler for measuring indoor semi-volatile organic compounds**<br>*Okeme, Joseph O.[1] , Amandeep Saini[1] & Miriam Diamond [1,2]<br>[1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, Toronto ON<br>[2]Department of Earth Sciences, University of Toronto, Toronto ON |
| 2:40<br>–<br>3:00 | **Alternative halogenated and organophosphate flame retardants: estimated physical-chemical properties and environmental persistence of 86 novel flame retardants**<br>*Serodio, Daniela[1], Miriam Diamond[1,2], Anna Krol[2], Xianming Zhang[3], Mark Bonnell[4] & Nils Sundin[4]<br>[1]Department of Earth Sciences, University of Toronto, Toronto, ON<br>[2]Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, ON<br>[3]School of Engineering and Applied Sciences, Harvard University, Cambridge, MA<br>[4]Environment Canada, Gatineau, QC |

* **Student presentation**

## Platform Presentations (cont'd)

| Time | Session B: Aquatic Toxicology<br>Room OVC 1714 |
|---|---|
| 2:00<br>–<br>2:20 | **Toxicity and bioaccumulation of selected pharmaceuticals to multiple life stages of the freshwater mussel (*Lampsilis siliquoidea*)**<br>Gilroy, Ève A.M.[1], Laura E. King[2], Nicholas A. Bendo[2], Joseph E. Salerno[2],Rodney McInnis[3], Patricia L. Gillis[3] & Shane R. de Solla[2]<br>[1]Green House Science, Burlington, ON<br>[2]Ecotoxicology and Wildlife Health Division, Environment Canada, Burlington, ON<br>[3]Aquatic Contaminants Research Division, Environment Canada, Burlington, ON |
| 2:20<br>-<br>2:40 | **Mining impacts on benthic invertebrates in a small, mine-influenced northern New Brunswick stream: A field ecotoxicology case study**<br>Worrall, Tyrell, Paul LePage, & Patti Orr<br>Minnow Environmental Inc., Georgetown, ON |
| 2:40<br>–<br>3:00 | **Generational effects of bisphenol A on growth and stress performance in rainbow trout**<br>*Birceanu, Oana & Mathilakath M. Vijayan<br>Department of Biology, University of Waterloo, Waterloo, ON |

*** Student presentation**

## Platform Presentations (cont'd)

| Time | Session C: Soil Toxicology<br>Room OVC 1713 |
|---|---|
| 4:00<br>-<br>4:20 | **Effect of speciation and mineral association of nickel on bioaccessibility in soil**<br>*Thorn, Ryan J.[1], Beverley Hale[1] & Mike Dutton[2]<br>[1]School of Environmental Sciences, University of Guelph, Guelph, ON<br>[2]Vale Inco Ltd., Mississauga, ON |
| 4:20<br>-<br>4:40 | **Using *Folsomia candida* to test the toxicity of weathered PHC-impacted field soil during various stages of phytoremediation**<br>*McCallum, Brianne[1], Nicole Knezevich[1], Scott Liddycoat[1,2] & Bruce Greenberg[1,2]<br>[1]Department of Biology, University of Waterloo, Waterloo, ON<br>[2]Waterloo Environmental Biotechnology Inc., University of Waterloo, Waterloo, ON |
| 4:40<br>-<br>5:00 | **Evaluating an absence of monotonic responses in soil organisms exposed to site soils contaminated with petroleum and metals**<br>Angell, Robin A.[1], Kathryn Bessie[2], Emma J. Shrive[1], Melissa Whitfield Aslund[3] & Gladys L. Stephenson[1]<br>[1]Stantec Consulting, Ltd., Guelph, ON<br>[2]Tetra Tech EBA, Calgary, AB<br>[3]Intrinsik Environmental Sciences, Inc., Mississauga, ON |

* **Student presentation**

## Platform Presentations (cont'd)

| Time | Session D: Aspects of Risk Assessment<br>Room OVC 1714 |
|---|---|
| 4:00<br>-<br>4:20 | **Towards a Canadian diagnostic framework for multiple aquatic stressors**<br>Bowman, Michelle F.<br>Forensecology, Guelph, ON |
| 4:20<br>-<br>4:40 | **Incorporating background exposure into nickel risk assessment**<br>Dutton, Michael[1,2], Luba Vasiluk[2] & Beverly A. Hale[2]<br>[1]Vale Canada Limited, Mississauga, ON<br>[2]School of Environmental Sciences, University of Guelph, Guelph, ON |
| 4:40<br>-<br>5:00 | **Laboratory vs. field-based toxicity of Ni to soil organisms: A critical review**<br>Hale, Beverley[1], Yamini Gopalapillai[1], Tyson Jennett[1], Julie Kikkert[1], Wilson Lau[1], Christian Schlekat[2] & Mike McLaughlin[3]<br>[1]School of Environmental Sciences, University of Guelph, Guelph, ON<br>[2]Nickel Producers Environmental Research Association (NiPERA), Durham, NC<br>[3]Commonwealth Scientific and Industrial Research Organisation (CSIRO), Glen Osmond, SA, Australia |

# *List of Poster Presentations*

**Predicting the chemical and biological effects of tertiary metal mixture (Ni, Cu, Cd) to the aquatic plant, *Lemna minor***
*****Gopalapillai, Yamini & Beverley Hale
School of Environmental Sciences, University of Guelph, Guelph, ON

**Assessing the validity of the concentration addition theory for uptake of metal mixtures from soil using diffusive gradients in thin film (DGT) and plant root simulator (PRSTM) probes in artificial soil**
*****Laird, Amanda E.[1], Josh Hart[1], Jessica Sowa[1], Katie Munster[2], Edward Berkelaar[2] & Beverley Hale[1]
[1] School of Environmental Sciences, University of Guelph, Guelph, ON
[2] Redeemer University College, Ancaster, ON

**Comparison of three methods for extracting sediment porewater**
Annalisa Mazzorato[1,2] & Mahon, Kim [2]
[1] University of Waterloo, Waterloo, ON
[2] Laboratory Services Branch, Ministry of the Environment, Toronto, ON

**Behavioural effects of acute exposure to fluoxetine and wastewater effluent in the invasive round goby**
*****McCallum, Erin S. & Sigal Balshine
McMaster University, Hamilton, ON

**Platinum toxicity to radish (*Raphanus sativus*) and durum wheat (*Triticum turgidum durum*) grown in arable Ontario soils**
*****Julie Kikkert, Oke, Sofia, Luba Vasiluk, Taylor Wallace, Daniel Clancy & Beverley Hale
School of Environmental Sciences, University of Guelph, Guelph, ON

*** Student presentation**

# *List of Poster Presentations (cont'd)*

**Predicting human exposure to pharmaceuticals and personal care products from plant tissue grown in biosolids-amended soil**

Prosser, R.S.[1], S. Trapp[2] & P.K. Sibley[1]
[1] School of Environmental Sciences, University of Guelph, Guelph, ON
[2] Department of Environmental Engineering, Technical University of Denmark, Lyngby, Denmark

**Investigating whether biosolids-derived triclosan adversely affects the growth of three crop species**

Prosser, R. & P. Sibley
School of Environmental Sciences, University of Guelph, Guelph, ON

**Optimizing the culturing conditions of the amphibian symbiotic alga *Oophila amblystomatis* for toxicity testing**

*Rodriguez-Gil, Jose L.[1], Richard Brain[2], Leilan Baxter[1], Keith Solomon[1] & Mark Hanson[3]
[1]School of Environmental Sciences, University of Guelph, Guelph, ON
[2]Syngenta Crop Protection, LLC, Greensboro, NC
[3]Department of Environment and Geography, University of Manitoba, Winnipeg, MB

**A correlation between nickel/metal mineralogy and its bioaccessibility in artificial (OECD) spiked soils**

*Vasiluk, Luba[1], Michael D. Dutton [2], Andrea Amendola[3], Lisa Van Loon[4] & Beverley Hale[1]
[1]School of Environmental Sciences, University of Guelph, Guelph, ON
[2]Vale Ltd., Toronto, ON
[3]Golder Associates Ltd., Mississauga, ON
[4]Canadian Light Source Inc., University of Saskatchewan, SK

*** Student presentation**

# *Plenary Speakers*

## *(OVC 1714)*

# *Fate and effects of chemicals used in shale gas extraction*

Klee, Ulysses

Stantec, Guelph, ON

The process of fracking is decades old but its integration with horizontal drilling has greatly increased the efficiency of shale gas extraction, making this resource more accessible and commercially viable. The proposed expansion of shale gas extraction has raised concerns regarding the potential effects both to human health and the environment. Part of this concern is focused on the chemicals used in the fracking fluid. The presentation will examine the most commonly used chemicals and provide an objective assessment of the potential risks. An effort will also be made to dispel some of the more common myths associated the environmental effects of this industry.

# *Larval fish toxicity of sediments, waters, groundwaters, and snow melt waters from oil sands areas*

Parrott, J.L.[1], J.R. Marentette[1], M.E. McMaster[1], W.P. Norwood[1], P.L. Gillis[1], J.V. Headley[2], A.J. Bartlett[1], G. Bickerton[1], J.W. Roy[1], C. Yang[3], Z. Wang[3], L.M. Hewitt[1] & R.A. Frank[1]

[1]Environment Canada, Burlington, ON
[2]Environment Canada, Saskatoon, SK
[3]Environment Canada, Ottawa, ON

As part of the Joint Canada-Alberta Oil Sands Monitoring Plan, the toxicology of natural and oil sands-related environmental samples was studied. One of the goals of the toxicity tests is to examine pathways and sources of contaminants that may be causing effects in wild fish and invertebrates. Samples were collected from sites where wild fish health assessments and invertebrate communities were assessed. In this way, linkages could be made between wild invertebrates and fish, in comparison to controlled studies of lab fish exposed to certain components of the environment (sediment, water, groundwater, and snowmelt). Embryo-larval fathead minnows were used to assess the chronic toxicity of the following environmental samples: river sediments, river waters, groundwaters, snow melt waters, spring freshet waters, and suspended sediments collected in the vicinity of the Canadian oil sands. Samples were collected in 2009-2013 from rivers near oil sands processing facilities along the Athabasca River and tributaries in areas of oil sands development, and compared to samples collected far from sites of oil sands mining and processing. Fertilized fathead minnow eggs were exposed for 21 days (through hatch to 7-15 days post-hatch) to samples in dose-response gradients. Most environmental samples caused no effects in larval fish in 21- day assays. Samples that caused effects in larval fathead minnows were several snow melt samples,

several groundwaters, sediments from the Steepbank and Ells Rivers, and waters from the Muskeg River. Some of the toxic samples were from sites close to industry (Steepbank River sediments, snow samples close to stacks, Muskeg River waters). Other samples (groundwaters, Ells River waters) showed toxicity far from oil sands activities, with effects in lab fish seen at "background' sites where natural oil sands weathering or water movement thru bitumen occurs. Samples were analyzed for naphthenic acids, PAHs, C1-C4 alkylates, PAHs, and metals. Sites where sediments and waters were toxic in lab fish bioassays are being assessed to determine whether wild young-of-year fish are abundant and growing normally in these areas of potentially toxic sediments or waters. The results of this work will help guide future studies and locations to sample wild fish and invertebrates to fully assess environmental health in the oil sands area.

# *Field studies examining exposure and effects of neonicotinoid insecticides on bee colony health*

Scott-Dupree, Cynthia D.

School of Environmental Sciences, University of Guelph, Guelph, ON

Neonicotinoid insecticides are widely used plant-systemic compounds that contain the active ingredients imidacloprid, thiamethoxam, and clothianidin. This class of insecticide has perhaps been subject to more scrutiny than any other potential cause of recent honey bee and wild pollinator declines. Laboratory-based studies have shown that neonicotinoids may elicit various acute or chronic effects on bees. However, higher-tier studies, where dietary exposure to pollen and nectar occurs through plants grown from soil or seed-treatment applications, have failed to demonstrate significant effects. In this talk, we describe results from field studies we have conducted with honey bees and bumble bees that suggest exposure to neonicotinoid-treated crops has no significant effect on colony health. These results will be framed within the context of other field studies, and other observations and analyses regarding declines and health of pollinators over the past few decades.

# *Platform Presentations*

*(In alphabetical order by family name of presenter)*

# Evaluating an absence of monotonic responses in soil organisms exposed to site soils contaminated with petroleum and metals

Angell, Robin A.[1], Kathryn Bessie[2], Emma J. Shrive[1], Melissa Whitfield Aslund[3] & Gladys L. Stephenson[1]

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[2]Tetra Tech EBA, Calgary, AB
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Key Words: soils ecotoxicity, bioremediation, petroleum hydrocarbons, metals

Ecotoxicity assessments were conducted using soil organisms to provide ecologically relevant information with which to identify potential risks associated with exposure of soil organisms to site soils contaminated with petroleum hydrocarbons (PHCs) and metals. The goal was to determine whether exposure to the site soils resulted in adverse effects, and whether these adverse effects were attributable to contaminants remaining in the site soils.

Testing was with reference control soils and contaminated soils. Adverse effects, as defined in the Alberta Tier 2 Soil and Groundwater Remediation Guidelines, were observed for test organism performance in the contaminated site soils when compared to that in the reference control soil(s). However, there was not a monotonic increase in test organism response with increased PHC concentrations in soil. Partial least squares (PLS) regression procedures were applied to available site and toxicity test data, and lent further weight of evidence to that generated by ecotoxicity testing. Based on both graphical and PLS regression analyses of the test organism responses, it was concluded that the adverse biological effects observed for test organisms exposed to the site soils were likely not attributable to contamination with metals and PHCs.

## Generational effects of bisphenol A on growth and stress performance in rainbow trout

Birceanu, Oana & Mathilakath M. Vijayan

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Key Words: rainbow trout, bisphenol A, stress and growth, generational effects

Bisphenol A (BPA) is a chemical commonly used in the plastic industry and it is widely detected in the aquatic environment. However, little is known about its impact on aquatic biota. BPA is slightly lipophilic and thus accumulates in lipid-rich tissues and may be transferred from the mother to the eggs. We tested the hypothesis that oocyte BPA accumulation, mimicking maternal transfer, leads to disruption in growth and stress axes functioning in rainbow trout (*Oncorhynchus mykiss*). Rainbow trout oocytes were exposed to BPA (0, 0.3, 3 and 30 mg/l) in ovarian fluid for 3 h, after which the oocytes were fertilized (F1 generation), and their growth and stress performance were monitored in clean water. The BPA that accumulated in the oocytes following the 3 h exposure was completely eliminated by hatch. To obtain the F2 generation, oocytes were collected from mature F1 generation females (3+ years) and fertilized with milt from clean males. Overall, BPA accumulation in F0 oocytes led to a reduction in specific growth rate in trout in the F1 and F2 generations. BPA treatment also impaired the acute stressor-mediated plasma cortisol response in juvenile trout in the two generations. Our results demonstrate, for the first time, that the growth and stress axes in trout may be affected by ancestral exposure to BPA. Together, the study underscores the potential impact of maternally transferred BPA on long-term and generational defects in growth and stress performances in fish.

## Towards a Canadian diagnostic framework for multiple aquatic stressors

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Key Words: aquatic ecosystems, multiple stressors, Forensecology

The overarching goal of applied ecology is logically evolving from documenting the extent of environmental impacts to isolating the specific cause(s) of environmental stress. This evolution is essential for effective ecosystem management and restoration and is especially important in multiple stressor situations. As in traditional forensic science, there are numerous existing & potential *Forensecology Indicators* that could be used to untangle the effects of multiple stressors; both directly (e.g., chemical fingerprints) & indirectly (e.g., novel ways of thinking about issues). Just as important as the indicators, is organizing them in an accessible framework. The overall goal of Forensecology is to promote development of the novel indicators & frameworks we need to diagnose the precise cause(s) of existing & emerging environmental issues.

## Incorporating background exposure into nickel risk assessment

Dutton, Michael,[1,2] Luba Vasiluk[2] & Beverly A. Hale[2]

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Key Words: nickel, risk assessment, background risk

The past decade has seen considerable regulatory activity surrounding nickel. The primary tolerable daily intake (TDI) value used for risk assessment (oral) and soil quality guideline development is 0.011 mg/kg/d, derived from the Springborn Labs 2-generation reproductive toxicity test for nickel sulphate hexahydrate.

The Springborn TDI was developed based on the belief that the control animals received no Ni exposure. In fact, although the control diet received no added $NiSO_4 \cdot 6H_2O$, it did contain Ni from the naturally sourced dietary ingredients (1.5 mg/kg). The background Ni intake from un-spiked food used in the Springborn study was actually 0.098 mg/kg/d (9-times higher than the TDI derived from it). Background Ni exposure has not been appropriately considered in the development of the Ni TDI, and this error is propagated by soil quality guideline development such that novel approaches (e.g. the "10% of EDI" approach of the CCME) are required when background exposures are a significant proportion of the TDI. Otherwise, SQG would not be significantly different from geological background.

An acceptable daily intake (ADI) used in conjunction with TDI would provide a reasonable and practical alternative for deriving SQGs and contaminated site risk assessment for Ni. It should be understood that background dietary Ni exposures simply reflect the Ni content of animal and plant food sources derived from natural soils uncontaminated with Ni (i.e. geogenic background). There is no indication that background Ni exposures associated with geogenic background present a risk of toxicity; this should be correctly attributed in the calculation of toxic burden and risk.

# Toxicity and bioaccumulation of selected pharmaceuticals to multiple life stages of the freshwater mussel (*Lampsilis siliquoidea*)

Gilroy, Ève A.M.[1], Laura E. King[2], Nicholas A. Bendo[2], Joseph E. Salerno[2],Rodney McInnis[3], Patricia L. Gillis[3], and Shane R. de Solla[2]

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Key Words: pharmaceuticals, freshwater mussels, chronic toxicity, bioaccumulation

We investigated the toxicity and/or bioaccumulation of five pharmaceuticals: the tricyclic antidepressant Amitriptyline (AMI), the selective serotonin reuptake inhibitors Citalopram (CIT) and Sertraline (SRT), the injectable nonionic iodinated X-ray contrast medium Iopamidol (IOP), and the antihistamine Diphenhydramine (DIP), using various life stages of freshwater mussels (*Lampsilis siliquoidea*). Our assessment included a suite of endpoints including mortality, behaviour (filtering frequency), algal clearance rate, dissolved oxygen consumption and bioaccumulation.

Chronic exposures to SRT and AMI were conducted with adult (3 weeks) and juvenile (4 weeks) mussels. The juvenile 28-day $LC_{50}$s were 0.35 and 5.00 mg/L (nominal), respectively. The adult 21-day $LC_{50}$ for AMI was 7.5 mg/L, while all adult mussels survived the SRT exposure at concentrations up to 1 mg/L (NOEC=1mg/L). Glochidia (larvae) exposed to SRT were the most sensitive life stage (48-h $LC_{50}$=0.14 mg/L). IOP was not toxic to any of the life stages tested (NOEC=100 mg/L).

We observed concentration-dependent decreases in filtering activity and/or clearance rate, quantified by the disappearance of an algal suspension over time. These behavioural responses were not reflected by significant changes in oxygen consumption. Bioconcentration factors (BCFs) were calculated for IOP and SRT after a 21-d exposure in adult mussels. The BCF for IOP was low (0.1 kg/L), which is consistent with its low log $K_{OW}$ (-2.42). Conversely, the preliminary BCF for SRT was relatively high (627-306553 - log $K_{OW}$ of 5.29), approaching that of some persistent organic contaminants. Overall, the pharmaceuticals examined were most toxic to early life stage mussels: glochidia were more sensitive than older age classes, and juveniles were more sensitive than adults.

# Laboratory vs. field-based toxicity of Ni to soil organisms: A critical review

Hale, Beverley[1], Yamini Gopalapillai[1], Tyson Jennett[1], Julie Kikkert[1], Wilson Lau[1], Christian Schlekat[2] & Mike McLaughlin[3]

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Key Words: risk assessment, soil ecotoxicity, nickel, site-specific

Field studies at Ni refining and smelting operations in Port Colborne, ON and Sudbury, ON, as well as the 'Metals in Asia' (MIA) study, have suggested that bioavailability and toxicity of aged Ni in field soils is lower than in soils amended with soluble Ni species, even after leaching and aging. The EU RA which determined a bioavailability-based $HC_5$ (50%) for soil organisms exposed to Ni-amended soils included an Application Factor (AF) of 2 because there was no validation by higher-tier data. The toxicity thresholds determined in these field studies were not greater than, and in most cases much less than, those identified in the EU RA. Mineralogical studies of soils amended with soluble Ni forms have identified that even with aging, the Ni species in smelter or refinery contaminated soils (i.e. spinels) are less bioavailable. This is confirmed by the very large difference in toxicity thresholds for plant growth in anthropogenically-contaminated soils when expressed as extractable-soil [Ni] compared to total-soil [Ni], a gap that is much smaller for soluble Ni-amended soils. The conclusion of the review is that the outcome of the EU RA is a conservative screen, suitable for prospective RA. However, for retrospective, site-specific RA, the bioavailability-based $HC_5$ may be exceeded, substantially, without there being a true risk, depending on the original source of the Ni and the current speciation. Such information as well as field-based ecotoxicity data, needs to be collected for site-specific RA, and then thoughtfully integrated into the decisions surrounding risk management, otherwise there is a risk of costly, unnecessary mitigation.

## Using *Folsomia candida* to test the toxicity of weathered PHC-impacted field soil during various stages of phytoremediation

McCallum, Brianne[1], Nicole Knezevich[1], Scott Liddycoat[1,2] & Bruce Greenberg[1,2]

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Key Words: petroleum, weathering, toxicity, *Folsomia candida*, phytoremediation

The Canadian Council of Ministers of the Environment (CCME) developed Tier 1 guidelines for PHC-impacted soils based on the "worst case" scenario of a fresh petroleum spill. These guidelines were conservative enough to identify any PHC-impacted soil that had the potential to cause toxic effects to soil organisms. However, these guidelines may be too conservative to apply to weathered PHC-impacted field soil. The hypothesis for this research was that the toxicity of weathered PHC-impacted field soil will occur at higher concentrations than the CCME Tier 1 guidelines.

Chronic toxicity tests with endpoints of adult survival, adult weight and juvenile production of *Folsomia candida* were used to determine the toxicity of soil from two different weathered PHC-impacted field sites. The highest PHC concentration at AB1 (610 mg F2/kg and 2,900 mg F3/kg) did not have a statistically significant effect on adult survival, adult weight or juvenile production. The BC1 site soil showed a statistically significant decrease in adult survival, adult weight and juvenile production at a concentration of 3,500 mg F2/kg and 3,200 mg F3/kg. The toxicity noted at BC1 was postulated to be caused by the high F2 concentration. Overall, results obtained indicated that the CCME Tier 1 guidelines are likely too conservative to apply to weathered PHC-impacted field soil.

# Characterization of polydimethylsiloxane passive air sampler for measuring indoor semi-volatile organic compounds

Okeme, Joseph O.[1], Amandeep Saini[1] & Miriam Diamond [1,2]

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Key Words: passive sampling, SVOCs, PDMS, air

Passive air sampling (PAS), for practical reasons, has gained popularity over active air sampling for studying semi-volatile organic compounds (SVOCs), some of which are of concern because they are persistent, bioaccumulative, and potentially toxic. SVOC chemicals of concern include; brominated flame retardants (BFRs), organophosphate ester flame retardants and plasticizers (OPEs), phthalate plasticizers, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). Some sources of SVOCs indoors are emissions from products such as electronic equipment, plastics, furniture, children's toys, and personal care products or from combustion processes. This project aimed to characterize the chemical uptake by polydimethylsiloxane (PDMS) – a polymer which shows promise for collecting a wide range of SVOCs due to its hydrophobicity, flexibility, and high permeability to gas-phase SVOCs. A 7-week indoor air calibration study, to determine passive sampling rates and equilibrium times for target chemicals, was conducted. In addition, a 4-week sampling campaign of 22 Toronto homes during summer 2013 was undertaken. The preliminary results, obtained from the gas chromatographic analysis of samples, demonstrate the utility of PDMS as a semi-quantitative PAS tool for the routine measurement of BFRs, OPEs, phthalates, and PAHs.

# Alternative halogenated and organophosphate flame retardants: estimated physical-chemical properties and environmental persistence of 86 novel flame retardants

Serodio, Daniela[1], Miriam Diamond[1,2], Anna Krol[2], Xianming Zhang[3], Mark Bonnell[4] & Nils Sundin[4]

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[2]Chemical Engineering & Applied Chemistry, University of Toronto, Toronto, ON
[3]School of Engineering & Applied Sciences, Harvard University, Cambridge, MA
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Key Words: novel flame retardants, physical-chemical properties, environmental modelling, persistent organic pollutants

In the wake of the listing by the Stockholm Convention of pentaBDE, octaBDE and HBCD, and the nomination of decaBDE, an increasing number of alternative flame retardants are being used in products. Some of these compounds are being measured in indoor dust, urban watersheds and remote Arctic air. Though currently in use, there is very little information regarding the physical-chemical properties, environmental fate, and persistence of these chemicals. As such, we compiled a list of 86 halogenated and organophosphate compounds that are used or marketed as novel flame retardants (NFRs).

The physical-chemical (p-c) properties of the NFRs were estimated using EPI Suite, SPARC, and Absolv. Ultimate and primary biodegradation rates were estimated using EPI Suite, a semi-qualitative estimation model, and CATALOGIC, a quantitative one. Overall persistence ($P_{ov}$) and long-range transport potential (LRTP) were modelled using the OECD $P_{ov}$ & LRTP Screening Tool. 48% of the NFRs have an air characteristic travel distance (CTD) of over 2000 km, or a high LRTP. Additionally, by comparing NFR maximum $P_{OV}$ and CTD estimates to those of penta- and octaBDE, 35% have been identified to have similar environmental behaviour as the PBDE they are replacing. Finally, persistence indoors was modelled using the simplified Multi-media Indoor Model (sMIM). For comparative purposes selected PCBs, PBDEs, and PAHs were also modelled.

## Assessing PAH emissions from residential wood burning - An unwholesome way to heat your home?

Thackeray, Nicole

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Key Words: Polycyclic Aromatic Hydrocarbons, residential wood burning, emissions

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals emitted into the environment from both natural and anthropogenic sources. PAHs are of concern because they are persistent, can be transported over long distances, and can cause various adverse effects on the environment and human health, including increased cancer rates. Major sources of PAHs into the environment include industrial sources, such as those from aluminum smelting or iron and steels industries, as well as from non-industrial sources, such as residential fuel wood combustion or forest fires. For the last 25 years, industrial sources of PAHs have decreased considerably while non-industrial sources of PAH emissions have remained relatively constant, with residential wood combustion making up the bulk of this emissions sector. Ten years ago, non-industrial sources became the primary emission source of PAHs released into the Canadian environment, surpassing industrial source emissions. With the rising cost of gas prices to heat residential homes, it is expected that families will become more dependent on residential fuel wood combustion. This presentation will examine historical, present, and future sources of PAH emissions to the environment and the potential adverse effects they have to humans, as well as programs implemented in the US and Canada that have led to both inclines and declines in emissions.

# Effect of speciation and mineral association of nickel on bioaccessibility in soil

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Key Words: Bioaccessibility, speciation, mineralogy, sequential extraction

The bioaccessibility of Ni in soils commonly tends to decrease with aging and weathering, due to the transformation to less soluble species (i.e. NiO, NiS, etc.) and the formation of stronger associations with mineral structure. The effect of aging on Ni bioaccessibility in soil was investigated using packed soil columns. Clay loam soils were spiked with highly soluble nickel sulphate ($NiSO_4$) at three different concentrations (500, 1000, and 3000 mg $kg^{-1}$), and subjected to varying leaching rates. In addition, organic matter content was increased in half of the columns, to investigate the complexation of Ni with organics. An aging and leaching period of 168 days was used, and soil, pore water, and leachate samples collected throughout. Samples were analysed using a sequential extraction technique known as Chemometric Identification of Substrates and Element Distribution (CISED), to identify mineral associations of Ni, as well as mineral liberation analysis (MLA) for species identification and mineral interactions. It is expected that with increasing time, Ni species present in the soil will transform to less soluble forms, and become increasingly incorporated into the crystal structures of clay, therefore, substantially decreasing the accessibility of Ni. The bioaccessibility suppression will be further influenced by environmental variables (i.e. OM, weathering, and Ni content), as number of binding sites, pH, and residence time are altered. This study will better describe the effect of ageing on Ni bioaccessibility in heavy clay soils, in turn, contributing to tools that may better estimate “bioaccessible dose”, which in most cases is significantly less than “total dose”.

# Mining impacts on benthic invertebrates in a small, mine-influenced Northern New Brunswick stream: A field ecotoxicology case study

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Key Words: water quality, benthic invertebrate

Operation of a large underground zinc/lead mine in Northern New Brunswick since the early 1960s historically led to severe biological effects in the waters receiving mine discharges. Although substantial improvement in treatment of mine wastewater has occurred since the 1990s, recent environmental effects monitoring studies have indicated that some biological effects still remain.

In 2012, an investigation of cause study was undertaken to determine the relative contribution of current effluent discharge towards observed effects to benthic invertebrates, compared to those related to historical mine contaminant sources and natural sources of contaminants within the study area. Specifically, the study focused on isolating influences that mine effluent, floodplain and streambed sediment, various tributaries, and fluctuating water levels had towards effects to benthic invertebrates in the mine receiving waters.

The results suggested that current effluent discharges, combined with shallow floodplain groundwater, are the main two drivers affecting mine-exposed benthic communities.

The study also identified a wetland complex that drains to the impacted stream and may contribute towards the observed biological effects and thus, will serve as a focus for future investigation.

# *Poster Presentations*

*(in alphabetical order by family name of presenter)*

# Predicting the chemical and biological effects of tertiary metal mixture (Ni, Cu, Cd) to aquatic plant, *Lemna minor*

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Key Words: Metal mixture toxicity, concentration addition, water quality guideline

In nature, contamination of aquatic environments may be a mixture of metals and this is particularly true of natural waters contaminated by mining effluents since mineral deposits are commonly an association of multiple metals. For example, nickel mineral deposits mined from Sudbury (Ontario, Canada) are often associated with copper and cadmium. However, water quality guidelines (WQGs) for protection of aquatic life are not designed for multiple contaminants or multiple forms of the same contaminant that co-occur. Rather, WQGs are overwhelmingly based on dose-response studies of single contaminants. Resolving the inability to predict risk from metal mixtures in waters surrounding Canada's many current and legacy extractive mining sites is a high priority for Environment Canada, Health Canada, as well as base metal mining companies. Mixtures of forms of the same metal and mixtures of different metals may have toxicity that would not be predicted additively. Our study aimed to validate the 'concentration addition' approach to predicting the toxicity of a tertiary metal mixture (Ni, Cu, Cd) to *Lemna minor* (one of Environment Canada's recommended test plant species for bio-monitoring of mining effluents) using a central composite design (CCD). The CCD is an efficient experimental approach that uses a rotatable incomplete factorial design to model a response surface, without requiring a complete three-level factorial, which is very resource intensive for conducting toxicity studies. The long-term objective is to determine of correction factors for single-metal WQCs for use with mixtures. Preliminary results show that toxicity of Ni, Cu, and Cd may be additive, and data analysis to determine a mixture toxicity threshold is ongoing.

# Assessing the validity of "concentration addition" for uptake of metal mixtures from soil using diffusive gradients in thin film (DGT) and plant root simulator (PRS™) probes in artificial soil

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Key Words: soil, metal mixtures, DGT, PRS™

Metal contamination in soils most often occurs as mixtures of more than one metal. Though there have been studies on how single metals are taken up from soil and cause toxicity to soil organisms, the uptake and toxicity of metal mixtures remains largely unstudied and unknown. The concentration addition theory proposes that uptake of each individual metal is independent of the presence and concentration of additional metals. Other possibilities include synergism, where the presence of other metals increase uptake, while the idea of antagonism suggests that metals compete with other like-charged metals for uptake as is proposed by the Biotic Ligand Model of metal toxicity. The theory of concentration addition was tested for combinations of Cd, Ni and Cu added to artificial soils, using diffusive gradients in thin film (DGT) and plant root simulator (PRS™) probes. Analysis of this data is ongoing, but preliminary results suggest that the PRS probes registered little interaction among the three metals, i.e. that additivity is probably an appropriate model for estimated mixture dose.

# Comparison of three methods for extracting sediment porewater

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Key Words: porewater, sediment, centrifuge

Many factors influence the response of aquatic organisms to toxicants. One factor is the location of an organism within an aquatic environment. Organisms that occupy both the sediment and the sediment/water interface are popular test organisms for assessing contamination of sediment. These organisms can be directly associated with porewater or interstitial water, water that lies in between the spaces of particles in sediment. This water is in constant contact with the sediment and the overlying water. Interstitial water also has the ability to partition out of the sediment into the aquatic system and reach equilibrium with the surface water or ground water. There currently is little guidance on how to collect/extract porewater from sediment samples. This study examined how different approaches of collecting porewater influence measured pH, ammonia, and contaminates of concern. Three different extraction protocols were conducted on 3 different sediments, stored for 3 different periods of time. The extraction techniques included centrifugation, removal of settled water, and removal of settled water followed by centrifugation. The results indicated no difference among pH and ammonia results across all treatments. While there was high variability among measured metal and PAH levels. Most notably there were elevated levels of PAH compounds in both of the centrifuged treatments compared to the settled water. Results suggest that among the 3 different extraction protocols examined there is little impact on pH and ammonia measurements. However if it is of interest to examine contaminates of concern in the porewater, the extraction method should be taken into consideration.

# Behavioural effects of acute exposure to fluoxetine and wastewater effluent in the invasive round goby

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Key Words: fluoxetine, wastewater, round goby

Pharmaceuticals and personal care products are increasing in the environment, and even nominal amounts of these compounds could influence the behaviour and physiology of aquatic organisms. The bulk of the research conducted to date has examined the effects of single compound exposures in the laboratory, but the effects of real world exposure to treated wastewater effluent – the combination of contaminants that aquatic organisms experience in the wild – have received much less attention. Combinations of pharmaceuticals in effluent may have interactive impacts on aquatic organisms, and so this area represents a significant gap in our understanding. In order to assess the effects of a pharmaceutical alone versus the mixtures found in environmentally relevant wastewater, we exposed male and female round goby to treated wastewater effluent (0%, 10%, 50%), or a single exposures of the antidepressant fluoxetine in environmentally relevant concentrations (0ug/L, 1ug/L, 40ug/L). After 72 hours, we assessed the behavioural effects of these exposures using three assays targeting a range of behaviours: dispersal and exploration, aggressive contests, and social affiliation. We found that exposure to fluoxetine resulted in a decrease in aggression in both the contest and social affiliation assays, but did not impact dispersal and exploration. In contrast, we found reduced activity after exposure to wastewater effluent, but no clear trends in aggression and social affiliation. In combination, these experiments highlight the importance of linking studies of the real-world impacts of wastewater to single compound exposures in order to understand both the realistic and underlying mechanistic effects in wild animals.

# Platinum toxicity to radish (*Raphanus sativus*) and durum wheat (*Triticum turgidum durum*) grown in arable Ontario soils

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Key Words: platinum; plant; soil; toxicity

Platinum (Pt) is a data poor transition metal that is used in car catalytic converters and chemotherapeutics. There are currently no soil quality guidelines for Pt for the protection of human and/or ecological health in Canada. The aim of this study was to determine the toxicity thresholds of platinum in radish (*Raphanus sativus*) and durum wheat (*Triticum durum*). Three uncontaminated soils from Simcoe, Elora and Kettleby, Ontario were chosen to assess the effect of a range of soil characteristics on platinum toxicity to plants. Soils were amended with 0 to 20 mg Pt $kg^{-1}$ soil, applied as a Pt solution, before plants were exposed to the contaminated soils for 14 days. Toxicity thresholds for Pt (measured as $EC_{25}$ and $EC_{50}$ of a selected endpoint) were expressed as total soil Pt or tissue [Pt], using Comprehensive Environmental Toxicity Information System (CETIS$^{TM}$). With respect to shoot mass, the $EC_{50}$ of Radish species differed greatly among soil types. Shoot mass $EC_{50}$ for plants grown in Elora soils was 17.65 mg/kg while the $EC_{50}$ for shoot mass in Simcoe soils 8.26 mg/kg. Overall, root tissue in all soil and plant species accumulated approximately eight times more Pt than the corresponding shoot tissue ($p < .0001$). Pt accumulation in plants was reduced by the soil physicochemical properties that limit its bioavailability in soil. Plant roots grown in soil from Simcoe, a sandy soil with a low CEC, had the greatest Pt accumulation. Species also influenced Pt accumulation: radish (dicotyledon) accumulated higher concentrations of Pt in comparison to wheat (monocotyledon).

# Predicting human exposure to pharmaceuticals and personal care products from plant tissue grown in biosolids-amended soil

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Key Words:

Application of biosolids to agricultural land provides valuable nutrients and organic matter and represents an essential pathway for rural-urban nutrient cycling. Biosolids have been found to contain pharmaceuticals and personal care products (PPCPs) as a result of their production at wastewater treatment facilities. A number of studies have shown that plants can take up PPCPs when grown in biosolids-amended soil. However, data on PPCPs residues in the tissue of plants grown in biosolids-amended soil is limited. The current study evaluates the ability of two models, specifically designed to estimate the uptake of chemicals from biosolids-amended soils into plants, to estimate human exposure to PPCPs. Utility of the Biosolids-amended Soil Level IV (BASL4) model and the Dynamic Plant Uptake (DPU) model was assessed by comparing concentrations in tissue predicted by the two models to experimentally determined concentrations reported in literature. A number of different environmentally relevant biosolids amendment scenarios were modeled to estimate the range of concentrations that could be present in the edible portion of plants. Concentrations of PCPPs predicted by the models were used to calculate estimated daily intake values. Hazard quotients for each PCPP were determined by comparing estimated daily intake values with acceptable daily intake values. Estimated concentrations of PPCPs residues generated by the BASL4 model were one to two orders of magnitude greater than concentrations predicted by the DPU model and concentrations reported in literature. Consequently, concentrations of PPCPs predicted by the BASL4 model resulted in an over-estimate of the potential hazard. For example, hazard quotients for triclocarban calculated based on concentrations estimated from the BASL4 model ranged from 0.77 to 6. The range of concentrations predicted by the DPU model contained the majority of experimentally determined concentrations reported in literature, which resulted in a more accurate hazard assessment. Hazard quotients calculated for triclocarban based on estimates from the DPU model ranged from 0.000000089 to 0.068, while

hazard quotients based on experimental data ranged from 0.000013 to 0.065. The DPU model was shown to be an effective tool for predicting environmental relevant concentrations of PCPPs in plants grown in biosolids-amended soil and, therefore, in characterizing potential exposure to humans through the consumption of plants.

## Investigating whether biosolids-derived triclosan adversely affects the growth of three crop species

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Key Words: triclosan, biosolids, phytotoxicity

Biosolids used in the amendment of agricultural fields have been shown to regularly contain triclosan (TCS), a broad-spectrum antimicrobial chemical, at relatively high concentrations. There is little data on the toxicity of TCS to terrestrial plants. Soybean (*G. max*), carrot (*D. carota*), and radish (*R. sativus*) plants were grown under controlled environmental conditions in TCS-spiked soil or soil amended with TCS-spiked biosolids. Seedling emergence was monitored. Shoot length, root length, shoot dry and wet weight, and root dry and wet weight were measured midway through the life cycle and at maturity for each plant species. The yield of soybean plants (number of seed pods, number of seeds, total mass of pods, and total mass of seeds) at maturity was also measured. Seedling emergence was significantly lower in some triclosan-spiked soil and triclosan-spiked biosolids treatments compared to control treatments ($p<0.05$). Triclosan exposure did not significantly adversely affect any of the growth parameters in soybean, carrot, or radish plants relative to control plants ($p>0.05$). In general, growth parameters were higher in biosolids treatments but only significantly higher in one biosolids treatment of soybean plants ($p<0.05$). There was no significant difference in measures of soybean plant yield across treatments ($p>0.05$). No concentration-response relationship was observed across triclosan treatments. Results indicate that biosolids-derived triclosan do not have a significant adverse effect on the growth of the three species of plants examined in this study.

# Optimizing the culturing conditions of the amphibian symbiotic alga *Oophila amblystomatis* for toxicity testing

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Key Words*: Oophila amblystomatis*, Yellow-Spotted Salamander, culture, toxicity

The symbiotic alga *Oophila amblystomatis* is known to play an important role in the embryonic development of the Yellow-Spotted Salamander (*Ambystoma maculatum*). The alga is found in the eggs of the salamander, where it is believed to utilize the nitrogenous waste of the embryo while providing additional oxygenation. Oophila shows both sexual and asexual reproductive cycles with sexual reproduction involving cell aggregation. There is concern that contaminants that are preferentially toxic to algae may impair the symbiotic relationship, and indirectly affect the salamander. To allow for the screening of contaminants, especially herbicides, it is necessary to develop culturing conditions that allow for toxicity testing in a near-standard and efficient manner. To this end, we sought culturing conditions providing maximum growth rates under asexual conditions and minimal aggregation so that 96-hr tests with standard endpoints (e.g., growth rate) could be performed. After preliminary tests, a modified Bristol's media with ammonium chloride as the nitrogen source was selected. From this selection, nitrogen content, light intensity and temperature were optimized. With this method, we are now able to screen for impacts of contaminants and rank the sensitivity of *O. amblystomatis* relative to other standard test species for the purposes of risk assessment.

# A correlation between nickel/metal mineralogy and its bioaccessibility in artificial (OECD) spiked soils

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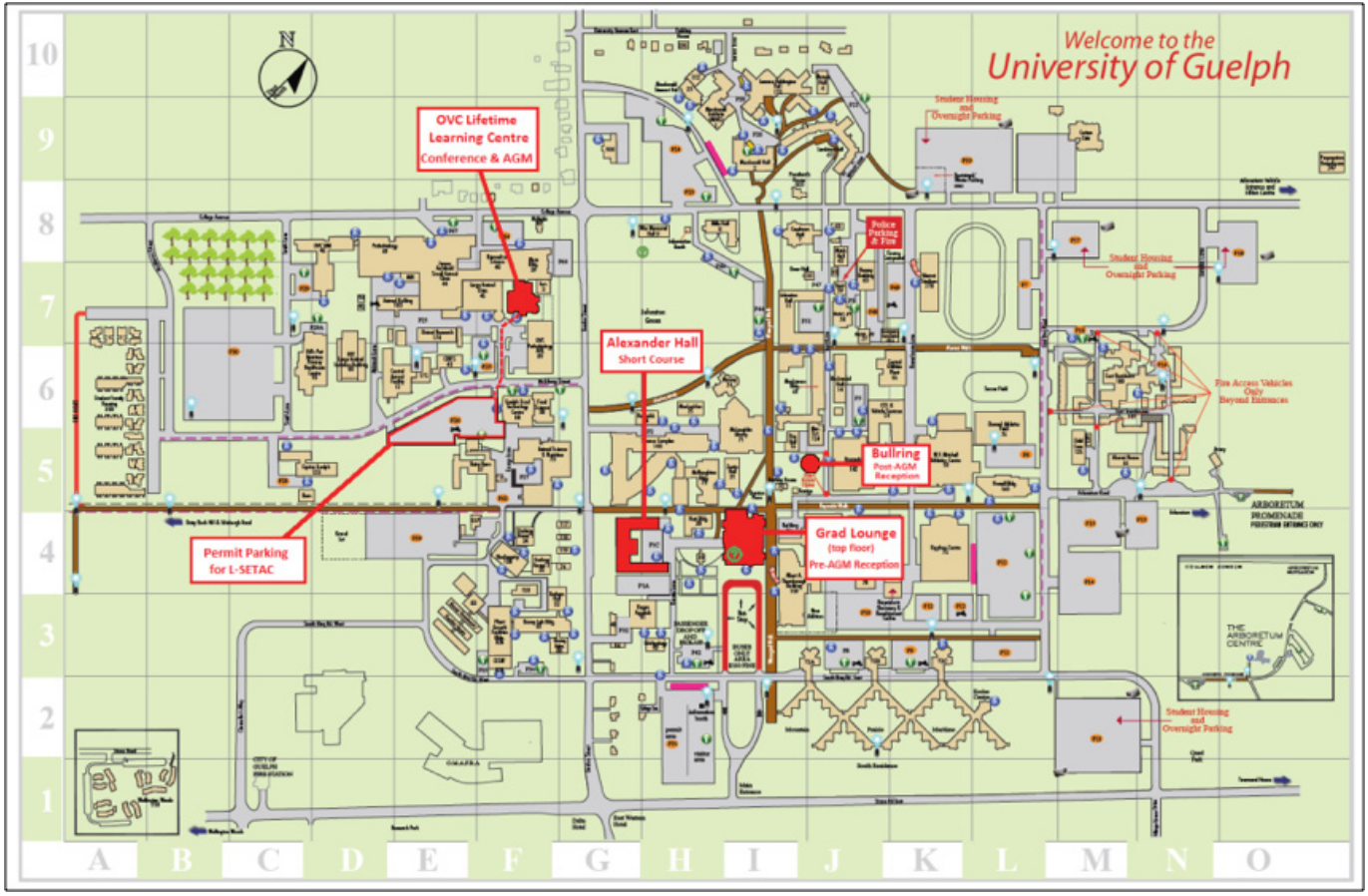
Key Words: nickel, ageing, speciation, bioaccessibility, in vitro

In Ontario, soil guidelines are based on the "total" metal concentration, but metal forms vary in bioavailability. The effect of ageing on nickel (Ni) concentration in soil was studied using artificial OECD soils spiked with four Ni forms ($NiSO_4$, NiO, NiS, and Ni3S2) either alone or in mixture ($NiO/Ni_3S_2$ and $NiS/Ni_3S_2$). XANES and Zatka sequential extraction characterized mineralogy after ageing. Total Ni recovery after ageing, was variable among different Ni forms and lowest for $NiSO_4$: the greater the solubility of the Ni compound, the greater the Ni leached from the soil and the poorer the total Ni recovery. The NiO was not influenced by ageing; the predominant Ni species of the other Ni amendments after ageing were $Ni^{2+}$ salts and NiO. Zatka sequential extraction of soils spiked with NiO alone was in a good agreement with the XANES results: NiO remained unchanged after ageing. Zatka analysis showed that $Ni^{2+}$ salts in the artificial soils were not water soluble, but were solubilized by ammonium citrate, thus most likely to be $NiCO_3$. Bioaccessibility of Ni and its correlation with mineralogical phase was determined using *in vitro* extraction. Overall, Ni bioaccessibility assessed using SBRC was twice that of gastric PBET. Linear regression analysis between bioaccessible Ni and ionic Ni estimated by XANES was better correlated to SPRC values.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