

In his 19 years of experience in environmental consulting, Mr. Hammer has focused on water quality permitting, wastewater treatment, remedial investigation and feasibility studies, and remedial design.

TECHNICAL AND PROJECT EXPERIENCE

Water Quality

- **Effluent Pump Station, Pipeline, Discharge Permit, and Mixing Zone Study:** Managed the permitting and engineering design for the new discharge pipeline for Pacific Surimi and Pacific Coast Seafood. The City of Warrenton, Oregon and Pacific teamed together to build a new effluent diffuser in the Columbia River estuary. Mr. Hammer was responsible for preparing Pacific's NPDES wastewater discharge permit application; conducting water quality modeling including a mixing zone study; evaluating whether the generation of hydrogen sulfide in the pipeline would occur and would affect water quality; evaluating the effect of the effluent on dissolved oxygen concentrations in the Columbia River; and designing a 3,200-foot-long pipeline and pump station from Pacific to the City's outfall pipeline.
- **Mixing Zone Study:** Conducted a mixing zone study for Bornstein Seafood in Astoria, Oregon. For the study, Mr. Hammer used the hydrodynamic model Visual Plumes to evaluate dilution of the facility's effluent in the Columbia River estuary. The model accounted for tidal variability in the velocity and salinity of the Columbia River receiving water. The predicted dilutions and historical effluent concentrations were used to evaluate whether the diluted effluent meets water quality standards at the edge of a 100-foot mixing zone.
- **NPDES Permit Application and Mixing Zone Study:** Conducted a mixing zone study for the NPDES permit application for a barley malting facility proposed for construction on the Willamette River at the Port of Portland. The CORMIX model was used to evaluate the effect of diffuser configuration and location on effluent mixing in the river, which is tidal at this location. The results demonstrated that the proposed BOD loads would have no measurable impact on dissolved oxygen levels in the river. Due to unrelated economic issues, the facility was not constructed.
- **Review and Comment on Draft TMDL:** Reviewed the Draft Total Maximum Daily Load (TMDL) for the Klamath River published by the Oregon DEQ. Evaluated the proposed waste load allocation (WLA) for SLR's client and compared the allocation to the existing discharge requirements. Determined that the WLA for SLR's client was derived inequitably in comparison to the WLAs derived for other point source dischargers and prepared a comment letter for submittal to the DEQ.
- **Willamette River Temperature Monitoring:** Managed a collaborative effort with an industry association and the Oregon DEQ, in which over 50 temperature-monitoring stations were installed in the Willamette River and its tributaries. The stations were installed to record river and stream temperatures during the summer and fall months in

order to develop temperature data for use in calibrating the Willamette River water quality model that was used by DEQ in the development of the Willamette River TMDL. Data was submitted to DEQ and used in the development of the model.

- NPDES Permit, Juneau, Alaska: Provided support during the final review of the NPDES permit governing the discharge of waters that had accumulated in an abandoned gold mine in Juneau, Alaska. The waters accumulated in the mine through storm water infiltration. Mr. Hammer managed the development of a geochemical model of the mine rock and waters using geological surveys of the mine rock, existing water analyses, and other data to show that the geochemistry of the mine rock is not favorable to the dissolution of heavy metals.
- SPCC Plans. Steve has prepared dozens of Spill Protection, Control, and Countermeasures (SPCC) plans and storm water pollution prevention (SWPPP) plans for refineries, bulk storage terminals, airline facilities, and other manufacturing facilities throughout the United States.

Storm Water and Wastewater Engineering

- Wastewater Treatment System Upgrade: Designed upgrades to an existing 70-gpm wastewater treatment system to accommodate flows as high as 180 gpm. The system incorporates acid neutralization using lime slurry, flocculation, clarification, sludge settling, and sludge pressing. The upgrades are being installed in response to a doubling of the plant's operating capacity. Mr. Hammer worked with multiple plant engineering resources and environmental staff to develop, discuss, and decide upon options for upgrading the system. Bench testing was conducted to evaluate the rate of the applicable reaction. The recommended upgrades were installed, and the system is operating at the higher flow capacity.
- Storm Water and Process Water Segregation: Managed an engineering feasibility study to evaluate options for segregating process water and storm water sewer systems at a metal refining and casting facility in Albany, Oregon. All facility drains and manholes were surveyed, and the hydraulic capacity of each line was calculated for comparison to expected storm water flows. Based on the results of the evaluation, the feasibility of various options for segregating the sewer systems was evaluated, and major upgrades to portions of both sewer systems were recommended. Following the feasibility study, a \$750,000 design-build project to segregate the process water and storm water systems was implemented.
- Drainage Pipeline Liner: Managed a 3-year project to upgrade the chemical spill collection system at a metal refining facility. Steve completed the design and specifications for the upgrade of a 30-year-old drain system to prevent releases of corrosive chemicals and toxic solvents into the subsurface. Existing clay pipelines were lined with cured-in-place vinyl ester pipe. Manholes were coated with chemical-resistant epoxy coatings. The project was implemented in three phases during plant shutdowns in 2001, 2002, and 2003.

STEVEN R. HAMMER, P.E.
SENIOR CHEMICAL ENGINEER



EDUCATION, CERTIFICATIONS, AND TRAINING

B.S., Chemical Engineering, 1991, University of Illinois, Urbana, Illinois
Registered Professional Engineer, Environmental (Missouri, Oregon, Washington)
40 Hour HAZWOPER training, Site Supervisor training, up-to-date 8-hour refresher training

STEVEN USHER, B.Sc., P.Eng., M.Sc., P.Geo.

Senior Hydrogeologist

Biography

Steven Usher has been a senior technical specialist with SLR Consulting since late 2009. Previously with Gartner Lee Limited since 1979, where he has consulted across the country, including many projects in the Yukon Territory, he now continues this role with SLR Consulting Ltd. His postgraduate training in hydrogeology, coupled with his earlier training in civil and geotechnical engineering provides an excellent basis for his over 30 years of experience in cross-disciplinary projects. In addition, Steven believes in contributing to his profession and served as President of the APGO for 2007-2008, an organization he helped found in 2000. He has successfully appeared as an expert witness in front of the OMB, the ERT and in court, and is noted for his ability to successfully convey difficult technical matters to a non-technical audience.

Project Experience

Water Supply

- **City of Whitehorse, Municipal Water Supply** – 2004 - 2005
 - ❖ Steven directed a project to convert the City of Whitehorse water supply from surface water to groundwater. The study team drilled and geophysically logged five test wells, tested them for Transmissivity, and selected a location for detailed testing. A three dimensional ground water flow model was conducted, to look at the influence of surface water and the long term sustainability of the water taking. The study team eventually constructed a 2000 IGPM well that was highly efficient and has become the City's primary water supply.
- **Bottled Water Sector, Multiple clients** – 1997 - Present
 - ❖ Natural spring water is an important product for most bottled water companies in Canada. The collection of spring water has the potential to affect the natural heritage features it typically feeds. Steven has worked for the major water bottling companies in Canada: Ice River, Canadian Springs, Nestle, and others. He has identified new sources, evaluated existing sources, obtained Permits to Take Water, and provided expert testimony. His services have been retained across the country, having evaluated existing or potential sources in the Yukon, British Columbia, Alberta, Ontario, Quebec, New Brunswick and Nova Scotia.
- **Ski Resorts, Golf Courses, Communal Supplies** – 1986 to Present
 - ❖ Mr. Usher's work with high capacity wells has covered many commercial sectors. He has worked for several ski resorts where a high capacity supply was needed on a seasonal basis. Often these were a combination of ground and surface water sources, and usually involved the use of pond storage to develop the instantaneous high capacity for snow making. Examples of facilities he has worked for include Lakeridge Ski Resort and Moonstone Mount Saint Louis.
 - ❖ Another area where Steven has assisted clients has been in finding and/or permitting of irrigation supplies for golf courses or Nurseries. This works include an inventory of local wells, ecologic features (wetlands, streams), comprehensive pumping tests, reporting and permitting. Golf courses include Aurora Highlands, Baywinds, Caitlyn Golf Academy and others. These same services have been provided to agricultural operations such as Sheridan Nurseries or Dutchmaster Nurseries.
 - ❖ Steven has also done the hydrogeological work on many rural residential developments that now rely on private wells and septic system, which are too numerous to mention. Of interest he was an instructor for the MOEE in their course to engineers, planners and hydrogeologists on these types of investigations, given across Ontario in 1996.



EDUCATION

- M.Sc. (Hydrogeology) 1986
University of Waterloo Earth Sciences department.
- B.Sc. (Geotechnical Engineering and Water Resources) 1979
Queens University Department of Civil Engineering

MAIN SPECIALTY

- Ground Water Resources

AREAS OF EXPERTISE

- Groundwater to Surface Water Interaction with Ecologic Systems
- Municipal Water Supply and Source Protection
- Contaminant Hydrogeology
- Watershed Planning
- Water Resources

RELEVANT INDUSTRY EXPERIENCE

- Land Development
- Waste Management
- Municipal Planning
- Aggregate Extraction
- Commercial Water Supply
- Construction Dewatering
- Transportation and Infrastructure Corridors
- Permits to Take Water
- Expert Testimony

MEMBERSHIPS & ASSOCIATIONS

- Association of Professional Geoscientists of Ontario
- Professional Engineers Ontario
- International Association of Hydrogeologists

ISTEVEN USHER, B.Sc., P.Eng., M.Sc., P.Geo.

Senior Hydrogeologist

Municipal Services

- **Town of Georgina - Hydrogeological Peer Reviewer** – 2005 - 2009
 - ❖ Provided peer review of land development applications to the Town of Georgina. This included review of hydrogeological reports, support to the ecologic peer reviewer, attendance at public meetings and presentations to Council. Worked directly with senior planning staff, and advocated meditative consultation with other professionals, to avoid adversarial impediments to resolving issues, thus saving time and resources.
- **Regional Municipality of Halton – Senior Project Manager** – 1993 - Present
 - ❖ Black Creek Baseflow Study, 1993-1994. Steven was the first to apply ground water based techniques to measurement of baseflow contributions to a cold water stream in Acton. This \$15,000 study resolved issues that traditional surface water engineering studies costing \$300,000 could not. It was found that the nearby Acton Municipal wells were not affecting the baseflow contribution to Black Creek in an adverse way, as sensitive fish habitat was remote from the significant zone of influence.
 - ❖ Spring Creek Impact Study – Test Well 15, Georgetown, 1998. Using the techniques first used above (seepage meters, mini-piezometers, water quality, continuous streamflow and temperature measurement), Mr. Usher assessed the effect of a proposed municipal well on a nearby ground water fed Fen, by conducting a long term pumping test at the well. The study results led the municipality to abandon their plans for a high capacity production well, and thus avoid harming the natural environment.
 - ❖ Permit To Take Water – Lindsay Court Well, Georgetown, 2002. Using the same techniques of detailed ecologic instrumentation and extended pumping tests, the existing PTTW was extended from 4,000 m³/day to 6,545 m³/day. This was accomplished by demonstrating to the MOE, who were aware of sensitive ecologic conditions in the area, that the water taking could not affect these natural heritage features. Work is currently underway to further increase this amount.
 - ❖ Tier III Source Protection Study – Halton Hills, 2008 to present. While with AECOM Canada Ltd., Steven directed this two million dollar project on behalf of the Region. The work involved a gaps analysis and extensive drilling, instrumentation, investigation and testing program to support an update of the Region's ground water flow model. The purpose of the work is to identify and protect the source of the municipal water supply by delineating wellhead protection zones, identifying threats of contamination, and relating them through transient three dimensional ground water flow modelling. The work is ongoing, and Mr. Usher has been retained by AECOM for ongoing senior advice.
- **Town of Orangeville - Project Manager** – 1994 - present
 - ❖ Assisted River Oaks Group in obtaining PTTW for a 90 day test on proposed municipal well beside cold water fish habitat. Also prepared infiltration study reports which contributed successfully for approval for land development by demonstrating enough lot level control to prevent a loss of recharge.
 - ❖ Prepared Ground Water Management Plan for Town's eight municipal well sites in 1998, including detailed testing and environmental instrumentation. The work included a contaminant inventory and wellhead protection area delineation. This work led to ongoing consultation on a variety of issues with the Town wells, with respect to localized contamination, and/or ecologic interference.
 - ❖ Assisted other developers in area in gaining approval for various plans of subdivision through Environmental Impact Studies, or Conditions of Draft

ISTEVEN USHER, B.Sc., P.Eng., M.Sc., P.Geo.

Senior Hydrogeologist

Approval. Often these required a firsthand knowledge of the sensitive natural environment conditions in different parts of the Town.

- ❖ Helped conduct a review of the Official Plan in 2003 as it pertained to hydrogeological and natural environment sections.

Mine Dewatering

- **Peer review - Various Mines across Canada 1995 - Present**
 - ❖ In his role as senior hydrogeologist with Gartner Lee Limited, Mr. Usher has been called upon to provide strategic guidance on many mine sites with respect to closure, dewatering and other ground and surface water issues. This is a role he has continued at SLR, most recently providing a peer review on behalf of the Yukon government on the Selwyn Resources Project. Selwyn expects to extend a test adit into their zinc-lead ore zone, and will have to dewater an existing adit to do so, and must consider the effect of the discharge on the aptly named Acid Creek.
 - ❖ Other projects while with Gartner Lee included the review of the ground water monitoring at the closed Mount Nansen mine (Yukon), senior internal peer reviewer on a ground water modelling project for Nexen Oil Sands (Fort McMurray), coordinated the expert testimony on a confidential monument stone mine (Ontario), and senior director of the groundwater modeling of the closed Gunnar uranium mine in North Saskatchewan.
- **Adams Mine – Kirkland Lake, Ontario, Canada 1995 - 2003**
 - ❖ Steven's first mine dewatering project came about ironically as the result of a municipal waste management project. Mr. Usher had served as a technical peer reviewer on a proposal to fill a large open pit iron mine with municipal waste. He served as peer reviewer and provided testimony at the 1998 public hearing in front of a panel of the Environmental Review Tribunal. The site was given a Certificate of Approval and the first step for development was to obtain a Permit To Take Water to dewater the mine. Mr. Usher, then with Gartner Lee Limited (since 1979), was retained in early 1999 by Notre Developments to make application and obtain this PTTW. The pit itself would hold up to 50 years of runoff and rainfall, but ground water input was minimal (only 6 L/s). Thirteen years of water had accumulated. Water balance calculations showed that pump out at 150 L/s for 11 months, or with two large pumps in tandem, 300 L/s for 6 months, could be achieved. Scaling of the pit walls was planned as the water level was lowered. It was found that the discharge water was of better quality than the receiving stream, and that the watercourse would remain hydrologically stable at the sustained higher rate. The permit, after much public opposition, was issued in 2000. Due to political pressure the facility never went ahead and continues to collect water.
- **Vedron Gold Inc. - Timmins, Canada 2006 - 2008**
 - ❖ In 2006, Mr. Usher and his staff at Gartner Lee Limited were retained to obtain three Permits To Take Water for three closed underground mines near Timmins, Ontario, Canada. The dewatering was necessary to conduct subsurface drilling as part of a testing program on the viability of re-opening the mines. Using existing information obtained from the current owners, and from historic files at the ministry of Northern development and Mines, the study team determined likely dewatering rates, examined historic water quality and conducted an impact assessment on each mine. Confirmatory water quality sampling was undertaken in the field and discharge locations selected. Two of the mine sites were near private residential wells, and thus the applications had to demonstrate how these wells would be protected. Permits were successfully obtained from the Ontario Ministry of the Environment, one of which has recently been renewed.

ISTEVEN USHER, B.Sc., P.Eng., M.Sc., P.Geo.

Senior Hydrogeologist

Waste Management

- **City of Peterborough - Hydrogeological Expert Witness – 1988-1993**
 - ❖ Conducted investigation for EPA approval of this hydraulic trap landfill. After extensive public scrutiny, this site was approved verbally by the Board which cited the cooperative manner in which all parties participated. This was partly possible due to the detailed and thorough hydrogeological work directed by Mr. Usher.
- **Regional Municipality of Halton - Hydrogeological Investigator – 1988-1996**
 - ❖ Implementation of this lined landfill on the Halton clay till plain was publically scrutinized after a controversial hearing in 1987. Highly technical studies for potential fracturing of the host clay soils were undertaken using Mr. Usher's graduate work and long term pump testing in the underlying aquifer. This work resulted in the implementation of a recompacted clay liner, to compliment the planned leachate collection system, and underlying thick clay soils.
- **Taro Properties - Project Manager Hydrogeological Investigator – 1988-2003**
 - ❖ This double lined, hydraulic trap landfill was ultimately constructed in a worked out dolostone quarry on the brow of the Niagara Escarpment. Mr. Usher directed the hydrogeological investigation which was key to the public consultation over that period. The landfill was approved by the Minister without a hearing (due to an innovative stakeholder consultation program) and began operation in 1994 and has been operating according to design. In subsequent review, ordered by the MOE, conducted by leading waste management engineers, the site was declared a world class facility of its kind.
- **Township Municipalities in Renfrew County - Project Manager – 1996-Present**
 - ❖ In response to a County initiative to establish a regional waste disposal site, Mr. Usher teamed with Janota Patrick Limited of Pembroke to advise several small municipalities on their waste management options. It was found that it was more environmentally sustainable to continue to operate small local sites than to haul waste by truck many tens of kilometers to a remote regional site. The study team did however recommend that the Townships bring their existing sites up to standard, which included drilling and site assessment. Negotiation with the MOE was undertaken to scope the degree of effort to the size and setting of each site, ensuring monitoring and upgrade dollars were spent where necessary, and not to a formula set elsewhere. Ultimately, Mr. Usher was providing landfill investigation and monitoring services for up to 22 sites on behalf of 15 clients in any given year. These works addressed landfill design, ground and surface water monitoring, methane gas generation, and negotiation of regulatory buffers.
- **Infrastructure Planning and Construction – 1995 to Present**
 - ❖ Linear infrastructure such as roads, sewers, watermains, and railines are constantly being built, replaced or upgraded in Ontario. Steven has worked within the Environmental Assessment Act to conduct route selection from a hydrogeologic perspective for all of these types of works. For example he directed the hydrogeological EA work on the proposed 72 km extension of the 407E highway, as well as the preliminary assessment of all stream crossings and structures. He has participated in several road grade / rail bed grade separations, particularly where permanent dewatering was necessary. His recent work on the Ninth Line and 16th Ave. sewers in Markham assisted York region in demonstrating the lack of effect of dewatering on the creeks and wetlands overlying these tunneled sanitary sewers.

ICELINE M. TOTMAN, M.Sc., R.P.Bio.

Environmental Scientist/Risk Assessor

Biography

Ms. Celine Totman has her masters in environmental science, is a registered biologist and has ten years of experience in the field of environmental consulting. Prior to joining SLR Consulting (Canada) Ltd in March 2009, Ms Totman worked at Triton Environmental Consultants Ltd. Her project work focuses on human health and ecological risk assessment, surface water quality, environmental impact assessment and fate and transport of environmental contaminants. Ms. Totman has also prepared information and documentation for clients in response to contraventions and charges under environmental legislation.

Selected Project Experience

Mining

- **Keno Hill Silver District Technical Review, YT (Ongoing)** – Retained by the government of Yukon, Energy Mines and Resources Department to assist in preparing the Yukon Government Intervention to the Yukon Water Board. Responsibilities include reviewing and providing technical recommendations on the following components: valued ecosystem components, proposed effluent quality standards, monitoring programs, adaptive management plans and closure and reclamation plan.
- **Development of Water Quality Management Criteria for Cobalt (Ongoing)** – Retained by Peace River Coal Inc. to develop management criteria for Cobalt as part of the Roman Mine Environmental Impact Assessment process. Responsibilities include: methodology development, reporting on toxicity tests results and setting site-specific water quality criteria for cobalt in the receiving environment downstream of the mine.
- **Bear Creek Mining Complex, Site Investigation and Risk Assessment (2009)** – Retained by Park Canada Agency to conduct a detailed site investigation and a screening ecological and human health risk assessment (SLRA) of the Bear Creek Historical Mining Complex. Media evaluated included sediment, soil, surface water, ambient air, and groundwater. Responsibilities included: reviewing of the previous environmental investigations, conducting the ecological risk assessment (EcoRA) and deriving risk based targets and remediation options based on the EcoRA results.
- **Selwyn Underground Exploration, YT (2009-2010)** – Retained by the government of Yukon, Energy Mines and Resources Department to complete an external review of the Project Proposal submitted by Selwyn Resources Ltd. The Project Proposal was submitted in support of an application for Type IV Quartz Mining Land Use Permit (LQ00250) Amendment and a Type B Water License under the *Yukon Environmental and Socio-economic Assessment Act*. Responsibilities included reviewing and providing recommendations on the following components: background surface water quality, proposed site-specific water quality objectives, proposed effluent quality standards, monitoring programs and adaptive management plans.
- **Minto Mine Emergency Amendments of Water Licence and Review of Project Proposal (2009-2010)** – Retained by the Government of Yukon, Department of Energy, Mines and Resources (EMR) to complete external reviews of two emergency water discharges at Minto Mine and to complete an external review of the Project Proposal submitted by Minto Explorations Ltd. (MintoEx) to the Mayo Designated Office of the Yukon Environmental and Socio-economic Assessment Board (YESAB). Responsibilities included review of the work completed by MintoEx consultants, identification of any information gaps or additional studies needed, assessment of potential risks to the receiving environment from the emergency releases as well as proposed effluent quality standards, recommendations on appropriate conditions for water releases and effluent



EDUCATION

- Masters in Environmental Sciences, University of Sciences of Geneva, Switzerland, 1998 - *Evaluation of anthropogenic impact on a river basin: chemical, biological and ecotoxicological study of water*
- B.Sc., Biology, University of Geneva, Switzerland, 1996

MAIN SPECIALTY

- Human Health & Ecological Risk Assessment

AREAS OF EXPERTISE

- Risk Assessment and Toxicology
- Contaminant Fate and Transport
- Surface water and sediment quality assessment

RELEVANT INDUSTRY EXPERIENCE

- Government (Federal, Provincial & Municipal)
- Mining
- Utilities

MEMBERSHIPS & ASSOCIATIONS

- R.P.Bio

HEALTH & SAFETY TRAINING

- Emergency First Aid Industry
- TDG
- WHMIS



ICELINE M. TOTMAN, M.Sc., R.P.Bio.

Environmental Scientist/Risk Assessor

standards, such as metal levels, volumes of water and environmental monitoring requirements.

- **Prosperity Gold Copper , Mining (2008-2009)** – Retained by Taseko Mines to develop the Fish and Fish Habitat Compensation Plan for the Prosperity Gold Copper Project in order to receive an Environmental Impact Certificate. Responsibilities included: development of technical plans to create a man-made 113 ha lake including morphometric characteristics of the future lake, modeling and assessing expected water quality, mercury redistribution and productive capacity.
- **Kemess Mine (2006-2007)** – Retained by Klohn Crippen on behalf of Northgate Minerals to develop site-specific water quality objectives (WQO) for the Kemess North Expansion Project. Developed WQOs for cadmium, copper and sulphate through the recalculation methods using sensitive species distribution (SSD) and the biotic ligand model (BLM). The project included a comprehensive search and review of the available toxicity data for cadmium, copper and sulphate. The BC Ministry of Environment and Environment Canada reviewed the PWQOs and supported the proposed limits.

Human Health and Ecological Risk Assessment

- **Penetanguishene Harbour, Ontario (Department of Fisheries and Ocean Canada) (2009-2010)** – Participated in a Phase III Environmental Site Assessment (ESA) and Sediment Toxicity Study at Penetanguishene Harbour. Specific tasks include assessing sediment toxicity and impacts of contaminants to benthic life to assist in the development of remedial action and/or risk management plan for contaminated sediment.
- **Esquimalt Harbour (DND Pacific Maritime Forces) (Ongoing)** – Participate in a detailed quantitative ecological risk assessment (DQERA) for waterlot at Esquimalt Graving Dock in Esquimalt Harbour Vancouver Island, British Columbia (DND Pacific Maritime Forces) on behalf of Public Works and Government Services Canada to support the development of a comprehensive risk management plan for the harbour. The ongoing DQERA will evaluate risks to a variety of ecological receptor groups associated with exposure to contaminated environmental media at the site. The ecological receptor groups that will be evaluated in the DQERA include microbiota, invertebrates, fish, aquatic-dependent birds, and aquatic-dependent mammals. The contaminants of concern that will be evaluated include metals, organometals, pesticides, phthalates, chlorophenols, polychlorinated biphenyls, dioxins and furans and hydrocarbon petroleum. The DQERA also includes the collection of sediment, water and tissue samples to supplement the available site investigations and provide additional data to be used in the risk assessment.
- **Bear Creek Complex, Park Canada (2009)** – Participated in a Screening Level Risk Assessment (SLRA). The SLRA included the following tasks: reviewing and interpreting all results of sample collected by SLR as part of the detailed site investigation, developing a conceptual site model – COC, ROC, exposure pathways, determining potential risks of current contamination levels to human health and safety and the environment, comparing contaminant values with CCME benchmark criteria for soil, sediment, and aquatic life, developing site specific, risk based standards and target concentrations for remediation and identifying conceptual remedial options to address contaminants that exceed site specific criteria.
- **Regina Landfill, City of Regina (2009)** – Completed a quantitative risk assessment to estimate potential risks from contaminants in the Regina Landfill waste oil pit to human and environmental receptors.). The risk assessment evaluated risks associated with elevated petroleum hydrocarbon concentrations, and complete human and ecological receptor pathways. The findings of the risk assessment supported remedial option planning to minimize the risks from the oil pit.

HEALTH & SAFETY TRAINING

- Laboratory chemical safety certificate, Department of Health, safety and Environment, UBC

ADDITIONAL TRAINING

- Predicting the toxicity of metals to aquatic organisms: an Introduction to the Biotic Ligand Model. Aquatic Toxicity Workshop, Saskatoon, 2008
- Advanced Principles of Toxicology, Centre for Toxicology, University of Guelph, 2005
- EENG, Risk Assessment, British Columbia Institute of Technology - Industry Training, 2003
- Urban Watershed Management, Institute for Resources, Environment and Sustainability, University of British Columbia, September-December 2002
- Backpack Electrofishing - Crew Supervisor, 2001

PUBLICATIONS AND PRESENTATIONS

- Ritter, L., Totman, C., Krishnan, K., Carrier, R., Vezina, A., Morriset, V. *Toxicological Evaluations: Extrapolation Beats Uncertainty – Response*. Journal of Toxicology and Environmental Health, Part B, 11, 611, 2008
- Ritter, L., Totman, C., Krishnan, K., Carrier, R., Vézina A., and Morriset, V. 2007. *Deriving uncertainty factors for threshold chemical contaminants in drinking water*. Journal of Toxicology and Environmental Health, Part B, Volume 10, Issue 7, pp 527-557.
- Krishnan, K, R.Carrier, C.Totman and L Ritter. 2007. *Fugacity modeling and estimation of source allocation factors for drinking water contaminants*. Society of Toxicology Annual Meeting. The Toxicologist (suppl Toxicological Sciences) 96 (1), March, 2007.

ICELINE M. TOTMAN, M.Sc., R.P.Bio.

Environmental Scientist/Risk Assessor

Human Health and Ecological Risk Assessment

- **Esquimalt Harbour (DND Pacific Maritime Forces) Sediment Pilot Study (2009)** – Conducted a Pilot Sediment Investigation to support selection of reference sites and toxicity tests for the detailed quantitative ecological risk assessment (DQERA) for waterlot at Esquimalt Graving Dock in Esquimalt Harbour Vancouver Island, British Columbia. The DQERA is being completed by SLR on behalf of Public Works and Government Services Canada. Tasks included collection of sediment samples for chemical and toxicological analysis, results interpretation, selection of toxicity tests and reporting. The results of this study have been incorporated in the DQERA Problem Formulation Report.
- **Confidential Site, BC Hydro (2009)** – Conducted a quantitative human health and ecological risk assessment in support of a Certificate of Compliance for a contaminated agricultural site in Abbotsford, BC. Contaminants of potential concern include metals, hydrocarbons and pesticides. Tasks included design of the problem formulation, completion of the hazard assessment, exposure assessment, risk characterization and uncertainty analysis as well as completion of the site visit. The Final Report was reviewed by a BC Approved Professional and a Certificate of Compliance was received for the site.
- **BP Screening Level Development (2009)** – Part of a team made of SLR Canadian and US employees conducting portfolio-based ecological risk assessments for 43 reserve pit sites in the North Slope of Alaska. Work is being conducted under a USEPA RCRA Order. Tasks included development of site-specific target levels involving extensive literature search for toxicity data on species relevant to the North Slope, and generation of values for over 60 chemicals.
- **Evaluation of Assumptions Used in Risk Assessment when Developing Canadian Drinking Water Guidelines for Chemical Contaminants, Phases I and II (2004-2005)** – Retained by the Water Quality and Health Bureau of Health Canada in association with Dr. Leonard Ritter, Fellow, ATS University of Guelph to ensure guidelines are scientifically sound and address the health risks facing Canadians from chemical drinking water contaminants. Evaluated the scientific rationale behind the assumptions used in risk assessment conducted by Health Canada, reviewed and advised Health Canada on the assumptions utilized by other major regulatory jurisdictions (USEPA, WHO, Australia and EU), compared and contrasted these assumptions and recommended a framework for establishing allocation and safety factors that could be used in developing chemical drinking water guidelines.
- **Human Health Risk Assessment of Monosodium Methyl Arsenate (MSMA) (2004)** – Retained by Canadian Forest Product to conduct a review of the use of the pesticide MSMA in BC and complete a screening level risk assessment of its potential to adversely affect human health. The screening risk assessment followed Health Canada, 2003, guidance for human health screening level risk assessment (SLRA). Findings were presented to stakeholders during a presentation held at Canfor Huston Operations, BC.
- **Composting Operations (2003)** – Retained by Consolidated Envirowaste Industries Ltd. to complete a probabilistic risk assessment combining information on species sensitivities to ammonia and ammonia concentrations in the water column to assess the likelihood of exceedances of effect thresholds and the risk of adverse effects on fish species in receiving ambient waters downstream of the composting operations.

■ PUBLICATIONS AND PRESENTATIONS

- Carrier R, Ritter L, Totman C and Krishnan K. *A Consistent Framework for Application of Source Allocation Factors in the Risk Assessment of Drinking Water Contaminants*. Submission for the Society of Toxicology. 2007 Annual Meetings.
- Watson T.A., Totman C, Long M. and L. Patterson. Screening Assessment of Ecological Effects following a Rail-Car Derailment of Sodium Hydroxide into the Cheakamus River, BC – A Tool Towards Recovery Planning. 2006 Aquatic Toxicity Workshop, Jasper, AB.
- Sauter A. and Totman C. 1998. Congress SETAC-Europe April 1998. *Anthropogenic Impact Assessment of a River Basin by Chemical, Biological and Ecotoxicological Study of the Characteristic Tributaries*. Poster Presentation.

ICELINE M. TOTMAN, M.Sc., R.P.Bio.

Environmental Scientist/Risk Assessor

Environmental Impact Assessments

- **Independent Power Producer (IPP) (2006-2008)** – Part of a multidisciplinary team assessing the environmental impacts of a hydroelectric project on the Klinaklini River in BC. Responsibilities included designing and implementing the water quality baseline data collection programs, assessing the project effects on ambient water quality, developing mitigation and compensation measures and developing environmental management programs for project construction and maintenance.
- **Environmental Scientist, Proposed Sewage and Treatment Effluent Disposal Project, Gitanyow, BC Environmental Impact Study (2008)** - Participated in the EIS completed for the construction and operation of a sewage treatment plant for the Gitanyow First Nation. The EIS was completed according to the MSR Regulation and evaluated the proposed use of reclaimed water to augment flow to a restricted public access wetland.
- **Culvert Replacement (2007)** – Retained by Canadian National Railway Company to complete a culvert replacement on the Burlington Northern Railway Line, New Westminster Subdivision. Completed several site visits, assessed fish and fish habitat, deployed minnow traps to confirm fish presence, prepared the permit application, liaised with BC Ministry of Environment and Fisheries and Oceans Canada, developed the environmental management plan (EMP) for the site and served as environmental monitoring during construction activities.
- **Sunshine Coast Regional District (SCRD) (2005)** – Retained by the SCRS to complete a Drinking Water Source Assessment of the district drinking water source, Chapman Creek Watershed. The goal of the assessment was to identify current and/or future drinking water health hazard(s), characterize the risk posed by each identified hazard, and, provide guidance for the development of a drinking water risk management strategy.
- **Squamish-Lillooet Regional District (SLRD) (2007)** –Completed a peer review of the predicted effects of the discharge of secondary treated effluent from the proposed Porteau Cove Development into Howe Sound and provided an opinion on the potential impacts of the discharge on the marine environment and human health. The peer review also considered the impacts of cumulative effects of sewage disposal in Howe Sound and provided an opinion on whether tertiary (advanced) treatment would be warranted for the proposed development.
- **Aluminum Industry (2000-2002)** – Retained by Alcan Primary Metal Group to assess the impact of mercury remobilization in the Nechako Reservoir consequently to dredging and drawdown. Collected water, sediment and fish tissue samples following ultra-clean protocol for the collection of mercury samples. Compiled baseline data and attended and presented information at Environmental Review Team meetings in the context of an ultimate CEAA review/screening.

Preparation of Legal Material Pertaining to Environmental Contamination

- **Confidential Class Action Quebec (Ongoing)** – Currently completing toxicology review and providing support to one of Justice Canada Expert Witness.
- **Insurance Claim (2008)** – Retained by Guild Yule LLP to review an insurance claim regarding a fire at an industrial facility. Evaluated potential for human health concerns, reviewed documentation and correspondence pertaining to Fisheries Act implications, status of repairs and By-law considerations.
- **Highway (2005)** – Retained by Justice Canada to serve as an expert witness to testify to the water quality and habitat values observed in a creek affected by acid rock drainage from highway construction. Tasks included completing a site visit, reviewing information and results of water quality samples, participating in meetings/teleconferences with Justice Canada prosecutors and the Departmental Representative regarding those results and their interpretation and preparation for testifying.



ICELINE M. TOTMAN, M.Sc., R.P.Bio.

Environmental Scientist/Risk Assessor

- **Insurance Claim (2004-2005)** – Retained by Guild Yule LLP to review an insurance claim based on historical and potential future environmental liabilities at contaminated sites (mining). Reviewed existing Phase 1 and 2 ESA, alleged environmental contamination and impacts, proposed remedial actions and the costs associated with impacts to natural resources including historic remediation costs, future remediation costs and natural resource damage costs and prepared briefs and presentations.
- **Log Booming Industry (2004)** – Retained by Bull Housser & Tupper to evaluate the environmental effects of log booming activities and storage in the Nanaimo Estuary as they relate to fisheries and environmental issues being raised by the Snuneymuxw First Nation. Gathered and reviewed information on the environmental resources in the estuary, other potential sources of environmental impacts, proposed Best Management Practices to be adopted by the Industry Groups and prepared an opinion report.
- **Pesticide Contamination (2004)** – Retained by Lawson and Lundell to conduct field sampling of soil, water, sediment and vegetation to evaluate pesticide distribution from an alleged over-spray of glyphosate on behalf of a prominent rail company. Interpreted results and prepared an opinion report to be used by a senior scientist during appearance as an expert witness.
- **Highway (2002-2003)** – Retained by Lawson Lundell to evaluate the effects of acid rock drainage and metal leaching into a stream from highway construction. Undertook field visits to collect water quality and benthic invertebrate samples and evaluate fish habitat. All samples were collected following strict legal protocol in order to be used as legal evidences. Findings were used to provide an expert opinion on the effect of acid rock drainage from highway construction on water quality and aquatic life in the affected Creek.
- **Permit Appeal (2003)** - Retained by Lawson and Lundell to review Canadian National Railway Company's Pesticide Management Plans and the scientific literature for information on the behavior, fate and toxicity of six pesticides in soil, water and sediment. Performed soil pits sampling for physical and chemical analysis. Assessed residual environmental concentration in water and soil using obtained soil concentrations and specific pesticide properties to evaluate the potential environmental consequences of the company's use of pesticides along its rail lines. Prepared briefs and summaries to be used during the Environmental Appeal Board hearings.
- **Westshore Terminals (2002)** – Retained by Lawson and Lundell to review the scientific literature on the bioavailability and toxicity of PAHs from coal to aquatic biota living within the marine sediment. Reviewed data on the concentrations of PAHs in marine sediments adjacent to coal loading activities. Evaluated potential bioavailability and toxicity to marine flora and fauna and prepared an opinion report.

Glenn Reynolds, M.Sc., P.Geo.

Senior Hydrogeologist, Director of Operations - GTA

Biography

Glenn Reynolds has over 30 years of consulting experience. Prior to joining SLR, Glenn was a Director of Gartner Lee Limited for 10 years and was the National Leader of the Remediation Consulting Practice Area with AECOM. Glenn's technical expertise is in the areas of contaminant hydrogeology and hydrogeochemistry. Glenn obtained his Bachelor's degree in Earth Science from the University of Guelph and his Masters degree in Hydrogeology from the University of Waterloo. Glenn has made numerous presentations to public groups, clients, regulators and special interest groups. Glenn has also given expert testimony on contaminant hydrogeology to environmental hearing panels and has provided peer review and litigation support for legal counsel.

Examples of the some of the projects Mr. Reynolds has been involved with are described below.

Project Experience

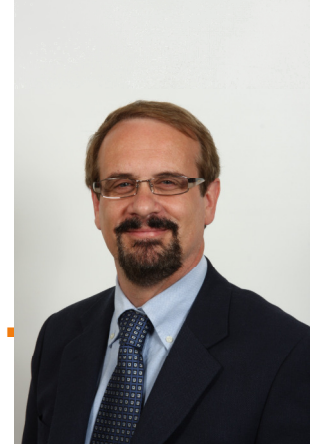
Mining and Quarries

Mining Peer Review – Hydrogeology - Government of Yukon

Mr. Reynolds was retained by the government of Yukon, Energy Mines and Resources Department to review a Project Proposal submitted by Selwyn Resources, and to provide advice as required. The Project Proposal was submitted in support of an application for Type IV Quartz Mining Land Use Permit (LQ00250) Amendment and a Type B Water License under the *Yukon Environmental and Socio-economic Assessment Act*. SLR reviewed the Project Proposal and associated documents posted on the YESAB Online Registry and provided EMR with comments. Specific project responsibilities included: review of hydrogeology, ground water flow aspects, development water quality and ARD and mass balance modeling completed for the project.

Mining Peer Review – Hydrogeology – Attawapiskat First Nation

Mr. Reynolds was retained by the Attawapiskat First Nations to review the Comprehensive Study Report (CSR) and associated technical reports submitted in support of the Canadian Environmental Assessment for the Victor Diamond Mine. The mine is located in an the James Bay Lowlands, which consist of large expanses of poorly drained muskeg underlain by thick (30+ m) clayey till followed by a thick (200 m+) sequence of sedimentary bedrock. An open pit mine of approximately 275 m deep through the Kimberlite pipe is proposed. Mr. Reynolds' project responsibilities included review of: hydrogeology of the mine site and area; groundwater modelling undertaken to predict the amount of dewatering and its effects on the bedrock; geochemical modelling undertaken to predict the quality of water being extracted during dewatering; predictions of dewatering impacts on the overburden and muskeg; and, proposed monitoring programs and contingency plans. Mr. Reynolds prepared the hydrogeological aspects of the Attawapiskat First Nation's formal submission on the CSR; review of responses from DeBeers and their consulting team; presentation to the regulatory agencies and proponents' EA team; review of technical documentation submitted in support of specific permits (such as the Permit-to-take-Water).



Hydrogeology, University of Waterloo, 1985

MAIN SPECIALTIES

- Waste Management
- Contaminated Sites
- Mining Peer Review

AREAS OF EXPERTISE

- Contaminant Hydrogeology
- Impact Assessment
- Non-aqueous Phase Liquids
- Forensics
- Approvals, Regulatory, Liaison/Negotiation & Public Consultation

RELEVANT INDUSTRY EXPERIENCE

- Municipal Waste Management
- Chemical Manufacturing
- Private Waste Management

MEMBERSHIPS & ASSOCIATIONS

- Ontario Professional Geoscientists Designation (P. Geo.), 2002
- International Society for Environmental Forensics
- National Groundwater Association

Quarry Environmental Impact Assessment – Hydrogeology - Confidential Client

Mr. Reynolds was retained by a multi-national aggregate company to evaluate the impacts of a large dolostone quarry on groundwater quantity and quality. Mr. Reynolds project responsibilities included: development of investigative and monitoring programs to assess quarry impacts on the quality and quantity of groundwater supplying adjacent private wells; assessment of the effects of quarry dewatering discharge on local creeks; design and implementation of a large pumping test to assess impacts on adjacent wetlands; response to well interference complaints; and, preparation of annual reports to meet permitting and licence conditions.

Waste Management

Glenn has managed and completed studies involving the siting, assessment and approval of greenfield landfill sites; evaluation and approval of landfill site expansions; expert testimony; public presentations, consultation and conflict resolution; regulatory agency liaison, negotiation and conflict resolution; Certificate of Approval negotiations; environmental assessments of operational and closed landfill sites; compliance monitoring; landfill design, operations and optimization; and, landfill remediation. Examples of some of the major municipal landfill projects that Glenn has undertaken include the following: The Glenridge Quarry Landfill in St. Catharines, which is one of the first clay lined landfills in Ontario. The Trail Road Landfill in the Region of Ottawa-Carleton, which is a landfill site with both a single plastic liner and a plastic cover. The Region of Halton Waste Management Facility, which is a clay-lined site utilizing the hydraulic trap concept. The closed Brampton Street Landfill in Hamilton, which is an old industrial and municipal co-disposal site. The Humberstone Landfill in Welland, which was originally a natural attenuation site located in a thick clay plain subsequently retrofitted with a perimeter leachate collection system. As well, Glenn has undertaken landfill studies for private sector waste management companies such as Taro (which is one of the first landfill sites in Ontario with a double composite plastic and clayliner), BFI, Canadian Waste and Sanifill. Glenn has completed studies of hazardous waste landfills containing radioactive waste and solvents as well as the landfill proposed by the former Ontario Waste Management Corporation. Some examples of the waste management projects Glenn has successfully undertaken are:

- **Region of Halton Waste Management Facility** – The Halton Waste Management Facility is a municipal landfill designed to serve Halton's population of 100,000 people for the next 20 years. It is one of the first sites in Ontario to utilize the hydraulic trap concept. The site was approved in 1990 with a Certificate of Approval requiring several tasks to be completed before the site could be constructed. These tasks included final design and resolution of certain aspects of the hydrogeologic conditions. Glenn managed all of the hydrogeologic, hydrologic, climatic and geotechnical studies needed to meet the Certificate of Approval conditions and to complete final design. The site was opened in the autumn of 1992. For approximately one decade following opening of the site, Glenn was responsible for the ongoing compliance monitoring program. As well, Glenn has overseen the six dewatering programs undertaken during construction of each of the landfill cells.
- **Region of Niagara, Glenridge Quarry Landfill** – The Glenridge Quarry Landfill is a municipal domestic waste landfill, which served the 125,000 people of St. Catharines from 1978 until the end of 2001. The site is located in a former rock quarry lined with clay and a leachate collection system. Glenn managed the environmental compliance monitoring program annually at this site for approximately 15 years. This program involved groundwater, surface water and vegetation monitoring as well as liaison with the citizen's committee and regulatory agencies. Glenn also participated in the studies, which evaluated the site's contingency system and redesigned this system. Glenn also managed all of the environmental studies that were completed to gain approval to modify the operation and design of the site, which resulted in a higher but smaller disposal area.

- **Region of Ottawa-Carleton Trail Road Landfill** – The Trail Road Landfill accepts all of the municipal waste from the Regional Municipality of Ottawa-Carleton, including the City of Ottawa. The site has been in operation since the mid-1970s. This is one of the first landfill sites in Canada to utilize both a plastic cover and a plastic/clay composite bottom liner. Glenn provided the hydrogeologic inputs necessary to design both the cover and liner. As well, Glenn managed the groundwater, surface water and landfill gas components of the annual compliance monitoring program for several years.
- **Region of Ottawa-Carleton, Nepean Landfill** – The Nepean Landfill is an old, closed landfill site adjacent to the Trail Road Landfill site. Glenn directed a number of subsurface investigations at this site to confirm hydrogeologic conditions and assess the extent of offsite groundwater and surface water quality effects. He also managed the groundwater, surface water and landfill gas components of the annual compliance monitoring program for several years, including interpretation of the data and preparation of the annual monitoring report.
- **City of Hamilton, Closed Landfill Sites** – Glenn has assisted the City with evaluating two of their closed landfills sites. The Brampton Street Landfill is an old closed site located on the banks of Redhill Creek. Glenn directed the evaluation of this site to determine impacts on groundwater and Redhill Creek, as well as to assess potential hazards associated with subsurface combustible gas migration towards nearby homes. Glenn has also assisted the City with development and implementation of the remedial strategy for this site, which includes remediation of leachate seeps and installation of a perimeter drain to cut off the flow of contaminated groundwater to the creek. The Stoney Creek Landfill is an old closed site located in a rural area. Glenn managed the groundwater and surface water impact studies for this site. Glenn also assisted the City with development and implementation of the remedial strategy for this site, which included addressing areas of leachate seepage and contaminated soil.
- **City of St. Catharines, Closed Landfill Sites** – The City of St. Catharines has several old closed landfill sites located along the alignment of the former Welland Canal. These sites were filled with waste in the sixties and seventies and are now surrounded by residential and commercial development. Glenn assisted the City in evaluating the potential hazards at these sites due to subsurface migration of combustible landfill gases. This involved development of combustible gas monitoring programs, interpretation of the data and preparation of annual monitoring reports. At two of the sites, the assessment included evaluating the performance of gas control systems installed about twenty years ago. At another site, surface seepage of leachate was identified and Glenn provided recommendations regarding control and remediation of the seepage. The need for a gas control system was identified at one of the sites and Glenn directed the project to design and install a 500 m long passive gas venting trench. This project also involved removal of waste from private properties, obtaining air approvals for the venting system, negotiation of construction monitoring requirements with the Ministry of Environment, obtaining approval to temporarily discharge leachate into the sanitary sewer during construction, installation of continuous gas monitoring equipment inside the adjacent homes and public consultation. Glenn also obtained approval to increase the rate of daily fill at the local landfill, which allowed the waste removed during construction of the venting trench to be disposed locally at a low tipping fee. This resulted in a savings of about one million dollars in disposal costs
- **City of Ottawa, Closed Landfill Sites** – The City of Ottawa was responsible for 19 old closed landfills within their urban boundary. Glenn evaluated the potential risks associated with subsurface combustible gas migration at these old sites. This study involved discussions with staff who had knowledge of the old sites, a review of historical records and air photos plus hand augering for initial soil gas readings. More detailed investigations were recommended at four of the sites, which involved installation of gas monitoring wells, routine monitoring and gas pumping tests. As a result, systems to prevent control subsurface combustible gas migration were installed at two of the sites.

- **City of Orillia Landfill** – The City of Orillia planned to expand their municipal landfill. Glenn managed all of the ground and surface water studies that were required to assess the best approaches to expansion and the potential impacts of the expansion. Glenn also provided input to site design and operations and developed the long term monitoring and contingency plans for the site. Glenn was an expert witness at the Environmental Protection Act Hearing which approved the expansion.
- **Sanifill, Southern States Landfill, Atlanta, Georgia** – Chlorinated organic contaminants were found in the groundwater below a landfill developed adjacent to the older Southern States Landfill. The owners of the new landfill attributed the presence of these organic compounds to leakage from the Southern States site. Glenn was retained by the owners of the Southern States site to compare the chemistry of the groundwater on the adjacent site to the nature of the Southern States Landfill leachate to determine whether the chlorinated organic compounds may have originated from their landfill. By fingerprinting the leachate to identify indicator parameters that should be in the groundwater, if the landfill was the source, Glenn showed that the nature of the contaminants and chlorinated organic compounds on the adjacent site could not have come from the Southern States Landfill. The contamination was due to previous industrial uses of the adjacent property before it was developed into a landfill.
- **Saint Nicephore Landfill, Quebec** – A number of groundwater seepage zones were noted in the water courses around the Saint Nicephore Landfill that were reddish in colour and rich in iron. Glenn undertook an investigation to determine whether these seepages were due to leakage from the landfill. The site hydrogeology, including groundwater flow and quality were assessed. The quality of the leachate, the seeps and groundwater in intervening monitors were all evaluated. The results showed that the reddish staining was due to naturally high levels of iron in the groundwater and not from leachate impacts.
- **Siting Task Force Secretariat** – The Town of Port Hope has been the site of uranium refining for many decades. This has resulted in deposits of low level radioactive waste disposed throughout the town. One such disposal site was the Highland Drive Landfill where both domestic and radioactive (mainly uranium) wastes were placed. A computer model was developed under Glenn's direction to assist the Community Liaison Committee in visualizing where the radioactive wastes were placed in relation to the water table and domestic waste. This model was intended to assist in planning remediation strategies and illustrate various scenarios to the public.
- **Ontario Waste Management Corporation** – The Ontario Waste Management Corporation was a government agency responsible for the management of hazardous wastes in Ontario. Part of their mandate was to locate and develop a hazardous waste treatment facility. This facility was also to have a landfill for disposal of the residues from treatment. Glenn was a key member of the team responsible for advancing this project through the Environmental Assessment process. During the site selection phase of this project Glenn worked with the internal team plus an external multidisciplinary team to assist OWMC in finding a preferred site. This process started with the entire province as the study area and reduced the options through selection and comparison of candidate regions, candidate areas and candidate sites. Glenn also did an evaluation of the various residue disposal technologies available to OWMC such as engineered landfill sites versus natural attenuation landfill sites and disposal in mined space versus landfilling. Once the preferred site was selected, Glenn managed all of the site specific geologic and groundwater studies to assess the suitability of the site, predict future impacts of the site and help develop the site design, mitigation measures and plans for long term care. Glenn presented the results of his studies to the public and regulatory agencies and gave expert testimony at the Environmental Hearing.
- **Oxford County Landfill Site** – Following approval of the Oxford County Landfill, Glenn undertook the additional investigations that were completed to provide hydrogeologic input to the landfill design team and to establish the groundwater monitoring. This included drilling, installation of groundwater monitors, permeability

testing, hydrogeologic interpretation of geology and groundwater flow, groundwater quality sampling and working with the design team on groundwater control issues associated with construction and with respect to design of the leachate control system.

- **Environmental Protection Service, Handbook for Conducting Hazard Assessments of Existing Waste Disposal Sites** – Glenn developed a handbook as a guide for staff at Environment Canada's Environmental Protection Service – Waste Management Division to use when setting up studies for assessing the potential environmental and human hazards from landfill sites.

Industrial Facilities

Glenn has managed and completed studies involving soil, groundwater, surface water and non-aqueous phase contamination from facilities with creosote, chlorinated and fluorinated solvents, polymers, fuels and lubricants. These projects have involved Phase 2 and 3 site investigations; evaluation of compliance with clean-up guidelines and regulations; development and implementation of remedial action plans; facility process and operations reviews and optimization; regulatory agency liaison; Certificate of Approval negotiations; routine and compliance monitoring; and, public presentations. Some examples of the projects Glenn has successfully completed at industrial facilities are:

- **Wood Preserving Facility** – A series of interception trenches had been installed previously in the shallow fractured bedrock at a former wood preserving site to prevent movement of creosote product and contaminated groundwater into an adjacent river. Due to the on-going occurrence of contaminated sediments in the river, the regulatory agencies expressed concern that the interception trenches may not be effective. Mr. Reynolds was retained to do a data gap analysis for this complex site and from this, complete additional work to refine the understanding of the site geology and hydrogeology and further delineate the extent of groundwater and product contamination. The products at this site were mainly denser-than-water creosote as well as pentachlorophenol. Mr. Reynolds also completed hydraulic testing to assess the effectiveness of the existing groundwater collection trenches. This project involved: drilling and monitoring for dense non-aqueous phase liquids (DNAPL) in fractured rock and overburden; groundwater monitor installation and sampling for DNAPL and dissolved levels of polyaromatic hydrocarbons (PAHs) and pentachlorophenol; surface water and river sediment sampling; source zone investigations; groundwater pumping tests; development of remedial strategies; regulatory liaison and negotiation; and, data interpretation and reporting. The investigations showed that most (but not all) of the interceptor trenches were hydraulically effective and that multiple sources of contamination were contributing to the river sediments (product and contaminated groundwater by-passing some of the trenches in combination with historical sediment contamination in the river). Remedial actions included sediment traps in the river, localized product recovery wells and proposed changes to some of the interceptor trenches to improve their hydraulic effectiveness.
- **Chemical Manufacturing Facility** – Groundwater contamination by fluorinated and chlorinated hydrocarbons at parts per million levels was detected in the fractured bedrock and overlying overburden during an environmental site assessment of a chemical manufacturing facility. Mr. Reynolds was the project principal overseeing the team of hydrogeologists and engineers retained to investigate the three dimensional extent of the groundwater contamination and develop a remedial strategy. This project involved specialized drilling and monitoring well installation techniques to investigate groundwater flow and quality in the bedrock without introducing shallow contamination into the deeper units. This project also included an investigation of the source areas for DNAPLs (dense, non-aqueous phase liquids) in both the sandy overburden and the fractured rock. Conditions were complex, with three aquifers in the dolostone and sandstone rock separated by semi-confining conditions, along with artesian flow in some parts of the deepest sandstone aquifer.

Groundwater contamination in the bedrock was found to be impacting adjacent water supply wells and was moving towards a nearby river. The remedial actions implemented included installation of activated carbon on the water supply wells; modifications to prevent contaminant movement to the wells; design, pilot testing, regulatory approval and implementation of a purge well system; and, installation of specialized pumps to remove the DNAPLs from the source areas. An annual groundwater monitoring program was subsequently developed to assess the effectiveness of the remedial actions and to track any changes in the extent of groundwater contamination. Staff from the industrial facility were trained to undertake this monitoring with the interpretation and reporting completed by Mr. Reynolds and his team.

- **Electronics Manufacturing Facility** – Groundwater contamination by trichloroethylene and its degradation products was detected during an environmental site assessment of a closed electronics manufacturing facility. Glenn was retained by legal counsel for the property owner to peer review the investigations and the remedial approach proposed by their consulting team.
- **Pesticide Disposal Site** – In the 1960s, a few tonnes of off-spec pesticide were disposed on a farm property. Two decades later, the pesticide manufacturer wished to find and remove the pesticide. Glenn managed this project which involved using a geophysical survey to locate the disposal area, obtaining regulatory approval for excavation and cross-provincial transport of the wastes for proper disposal, and post-remedial monitoring of groundwater and soil.
- **Automotive Parts Manufacturing Facility** – During an environmental site assessment, a brownish fluid was found seeping into a ditch adjacent to an automotive parts manufacturing facility. Glenn was retained to determine the nature, source and extent of the fluid and to develop a remedial strategy. The fluid was contaminated groundwater with a very alkaline (12) pH and high concentration of ammonia salts. The source was traced to past leakages and spills from on-site treating processes. The contaminated groundwater was migrating in a permeable layer of fill material overlying native clay soils. Movement was enhanced by an excessive build-up of water under the plant caused by roof drains. The remedial actions involved re-designing the roof drainage system to direct water away from the building and installation of a shallow drain to capture contaminated groundwater before it discharged to surface in the ditch.
- **Chemical Manufacturing Facility** – Routine surface water monitoring at a manufacturing facility found elevated concentrations of acrylate compounds in the plants' stormwater discharge to the adjacent river. Glenn was retained to determine how the acrylates were entering the sewer system. A detailed review of plant processes in combination with a detailed stormwater sampling program, found that a pump used for transferring raw product was the source of the contamination. The pump used a water seal and some of the water from the pump seal, which had been in contact with the raw product, was found to be discharging to the sewer through a previously unknown connection. Initially, the connection to the sewer was removed and the contaminated water from the pump was re-directed to a treatment unit. At a later date, the pump was replaced with a system that did not require a water seal. At this same plant elevated concentrations of toluene were also detected on a subsequent occasion in the stormwater discharge. Based on detailed monitoring and a review of the stormwater system, it was determined by Glenn that the toluene was entering the system via the discharge of condensate from the steam tracing pressure relief lines in one of the tank farms. These lines discharged into an old clay tile drain system that ran below the tank farm and discharged into the storm sewer. Soil below the tank farm had been impacted by toluene from drips and spills over the years and as the hot condensate moved through the tile drains, it was leaching toluene from the soil. New above ground lines were installed to carry the condensate and the connection to the sewer from the old tile drains was sealed.
- **Lubricant Spill** – A spill of a specialized lubricant occurred at a natural gas pipeline compressor station. The lubricant flowed offsite where it was ingested by cattle,

causing some of them to die. After an initial emergency clean-up of the spill, Glenn investigated the extent and level of residual soil contamination and quality of surface water run-off to determine the need for further clean-up and to develop a strategy to prevent further off-site spills.

- **Chemical Manufacturing Facility** – During an environmental site assessment of a chemical manufacturing facility, acrylic monomer and polymer contamination as well as salt impacts were detected in the shallow groundwater down gradient from an old lagoon. Glenn managed the investigations to assess the extent of contamination, develop and implement a remedial strategy and conduct post-remedial monitoring. The remedial approach involved excavation of the sludges out of the lagoon followed by infilling and capping of the lagoon with clay. Mr. Reynolds also managed the annual groundwater and surface water monitoring program at this facility over 20 years, including data interpretation and reporting.