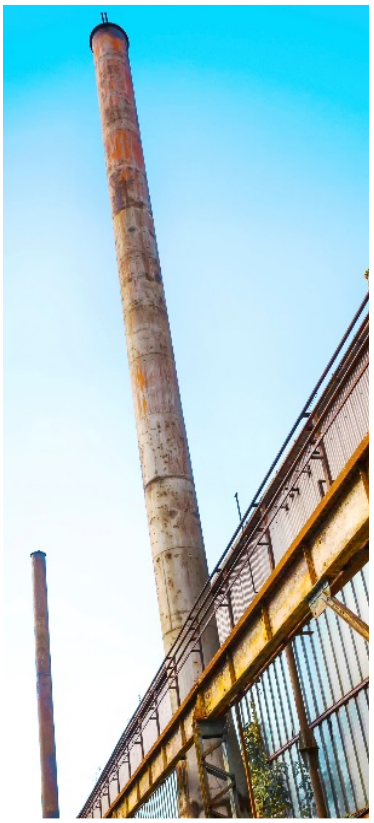
Update of Geotechnical Investigation, Feasibility Study & Slope Stability Assessment

2L49 Lakeshore Road
Wainfleet, Ontario

South Coast Consulting, Land Use Planning, and Development Project Management.
Attn: Steven Rivers



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1. Introduction

1.1 GHD Overview

GHD is one of the world's leading professional services companies, operating in the global markets of transportation, water, energy and resources, environment, and property and buildings. We provide engineering, environmental, and construction services to private and public sector clients.

Driven by a client-service-led culture, we connect the knowledge, skill, and experience of our people with innovative practices, technical capabilities, and robust systems to create lasting community benefits. Our network of engineers, planners, scientists, project managers, and designers collaborate to improve the built, economic, and social environment of the communities we serve.

Safety Means Awareness Responsibility Teamwork

Core to GHD's values is the health and safety of our people, clients and partners. GHD's industry leading health and safety program is called Safety Means Awareness Responsibility Teamwork (SMART), and focuses on developing a robust behavior based culture of safety that has helped protect our staff on some of the most demanding job sites in North America.

Established in 1928 and privately owned by our people, GHD operates across five continents – Asia, Australia, Europe, North and South America – and the Pacific region. We employ more than 10,000 people in 200+ offices, including more than 1,000 people in 15 Ontario offices, to deliver projects with high standards of safety, quality, and ethics across the entire asset value chain. The firm is financially stable, with global revenues of over CDN$1.6 billion last year, including almost $200 million in Canada.

GHD Quick Facts	
Date GHD established	1928
Total Employees World-Wide	10,000
Employees in Canada	1,850
Employees in Ontario	1,000
Countries of Operation	10
Offices World-Wide	200

1.2 Project Understanding

Based on the previous consultation undertaken, we understand that a building with full basement and sewage disposal system is to be built on the currently undeveloped property. This opportunity was previously assessed by AMEC in 2010, and the now 10-year old documents require updating in order to align current regulations and guidelines. Based on the Record of Pre-Consultation document, we have concluded that the following scope is required in order to attain the required permitting to develop the property:

1. Slope Stability Assessment
    a. Review of 2010 study
    b. Update to include coastal study which will address existing wave-based erosion and flood hazards and list potential mitigation methods (if necessary)
2. Geotechnical study

a. Review of 2010 study

b. Recommendations of updates if found necessary

3. Private servicing plan

    a. Review of existing 2010 study

    b. Recommendations for septic bed location

4. Environmental Impact Study

    a. As required when a development is proposed within 30m of a Type 1 Fish Habitat

Please note that Stormwater Management/Lot Grading was not included at this stage as a layout of the proposed structure would be required to complete these. As such, we are providing the scope required to determine the developable area of the property, before going into development detail that would require the proposed structure to be at a minimum of preliminary design phase.

1.3 Project Team

The proposed Project Team consists of Professional Geoscientists, Professional Engineers, Specialists and Technologists who have diverse public and private sector experience, and offer comprehensive consulting services. Members of our Project Team specialize in coastal geomorphology, coastal engineering, and geotechnical engineering. Engineering and geo-scientific/-engineering practice demand the appropriate application of current methods and theory. As such, we continually explore new and emerging techniques, and strive to apply the most recent academic research to provide state-of-the-science solutions. Our ability to work closely with stakeholders and regulatory agencies, and our unique expertise allow us to provide results that benefit both our clients and the environment.

The capabilities and roles of our Project Management Team including Maritime & Coastal Project Manager (Jennifer Penton) and Project Director and local Engineering Lead (Marc Gaudet) as well as key Project Team members are listed in Table 1 below. Table 1 also provides a summary of project team member's qualifications and years of experience, CVs are presented in Appendix A.

Contact Details:

Jennifer Penton, Ph.D.
Phone: 519-340-4431
Email: Jennifer.Penton@ghd.com

Table 1 Key Project Team Members

Name	Project Role and Responsibility	Years of Exp.	Location
Jennifer Penton, Ph.D	Maritime and Coastal Project Manager	8	Hamilton, ON
Marc Gaudet, P.Eng.	Project Director / Engineering Lead	29	St Catherines, ON
Pat Prodanovic, Ph.D., P.Eng, Ontario	Coastal Engineering Lead / Technical Reviewer. Ontario P.Eng.	11	Waterloo, ON

Name	Project Role and Responsibility	Years of Exp.	Location
Hassan Gilani, M.Sc., P.Eng. Ontario	Geotechnical Engineer / Geotechnical and Private Servicing Lead	35+	Waterloo, ON
Christine Pritchard, B.Sc., CAN-CISEC	Aquatic Ecologist / Permitting Specialist	15	Mississauga, ON

Technical staff

Other members of our team have extensive experience in geomorphic and coastal engineering field techniques and analysis, CAD design, GIS, and ecology. We also have an arborist certified under the International Society of Arboriculture (ISA), and a certified Butternut Health Assessor. Team members will be deployed as necessary.

2. Scope

2.1 Review of Slope Stability Assessment and Coastal Study

The lot is located in an area covered by Aeolian (windblown) fine sand deposits[1]. The limestone bedrock is anticipated to be 8 to 15 m deep below the existing grades[2].

Building on the outcomes of the 2010 AMEC report, a new topographic survey would be required to determine the current slopes on the property, with a focus on the shoreline bank, which can has likely eroded since the last topographic survey. The property was noted by NPCA to be impacted by shoreline hazards, which include flooding and erosion. The AMEC report addressed wind effect based erosion, which may now, due to higher lake levels, be exaggerated by wave based erosion. In order to minimize the hazardous zone (and hence increase the zone in which the property may be developed), the property may require further stabilization and erosion mitigation methods, such as an armour stone revetment, rather than the suggested “layer of clayey materials and vegetation” as these would be easily displaced by wave action. Should the Slope Stability Assessment determine that further shoreline erosion mitigation methods are required in order to minimize the dynamic beach hazard (note NPCA Policy 5.25), a coastal study (wave run-up and overtopping of the shoreline, which may require a bathymetric survey to be completed, depending on an assessment of the proposed topographic survey) would be undertaken to determine the height, slope, and size of the required protection. The Coastal Study would also be utilised in the permit application to NPCA, DFO, and MNRF, should these be required for the construction of the coastal structure. The coastal study (which will preliminarily outline proposed erosion/flood mitigation methods), has been included as a provisional item in this proposal. This proposal does not include the detailed design of the mitigation methods.

[1] Feenstra, B.H., (1972): Quaternary Geology of the Welland Area, Southern Ontario, Ontario Div. Mines, Preliminary Map P.796, Scale 1:50,000

[2] Feenstra, B.H., Troper, M (1982): Drift Thickness of the Welland-Fort Erie Area, Southern Ontario, Ontario Geological Survey Map P.2486, Scale 1:50,000

2.2 Review of Geotechnical Study

Aerial photography from 1934 to 2018 on the Navigator Niagara website shows that the Lot has never been developed. The soil samples and geotechnical data collected in 2010 by Wood therefore may still be considered applicable, subject to the Site geomorphological conditions not having significantly changed due to natural processes or man-made activities in the last ten years. A site visit will be made to confirm this fact.

Should the review of the geotechnical study indicate that it is sufficient based on current site conditions, GHD will provide a letter confirming its suitability. If the geomorphology of the Site has not changed significantly based on a Site inspection and review of the updated topographic survey, further work may be required to update the 2010 geotechnical study. Any additional geotechnical work that may be required is not included in this proposed scope of work.

2.3 Private Servicing Plan

GHD will review the 2010 Private Servicing Plan Study to confirm the allowable size for a septic tank and leaching bed (absorption field). A leaching bed is a function of the following three factors:

- Percolation 'T' Time of subgrade soils
- Design Daily Flow
- Treatment of the sewage effluent

Wood (AMEC) has determined that the T time of Site subgrade soils is 2 to 5 minutes/centimeter. Daily design flow will be a function of the number of bedrooms and livable built-up area of the residential structure. It is anticipated that the level of treatment will be primary (septic tank) coupled with a leaching field.

GHD will review the latest topographic survey and proposed building location and advise the client of a suitable septic tank and leaching bed location meeting all the setback requirements required by the 2012 Ontario Building Code and the maximum daily domestic sanitary effluent that can be disposed of in the septic system, The design details of the leaching bed will also be provided.

2.4 Value Add: Environmental Impact Statement

Based on our understanding of the proposed site development, the following scope will likely be required as part of approvals of the minor variance as it has been requested by the approving agencies during pre-consultation. The purpose of the Environmental Impact Statement (EIS) is to determine an acceptable development limit based on a characterization of the natural environment of the site, applicable policies, and mitigation measures to address any potentially negative impacts.

The following tasks are proposed:

1. **Phase 1, Initial Consultation and Background Data Review**: GHD will undertake initial consultation with the Region, Town, and Niagara Peninsula Conservation Authority (NPCA) on the Terms of Reference (TOR) for the EIS to determine the specific tasks required in order to obtain approvals. GHD will submit background data requests to NPCA, Ministry of Environment,

Conservation and Parks (MECP), and Ministry of Natural Resources and Forestry (MNRF) for the Site.

2. **Phase 2, Field Work and Reporting.** The following proposed scope is based on a review of available data for this Site and professional experience completing numerous similar studies. This scope will be confirmed through the Phase 1 consultation on the Terms of Reference and may need to be adjusted based on the outcome of that task.

    a. **Field Work**. Anticipated work required based on the features present and professional experience (to be confirmed through TOR with agencies) includes the following tasks. Some of this work can still be carried out within the 2020 summer season and some may need to be delayed until 2021:

        i. Aquatic habitat assessment (1 visit, summer 2020). Existing aquatic habitat conditions adjacent to the Site will be documented and will include presence/absence of near shore cover (e.g. woody debris, vegetation, cover), littoral zone gradient, substrate characteristics, and point source impacts to water quality. The assessment will also identify any critical or limiting habitat (e.g. spawning, rearing, foraging, refuge habitat). Fisheries data will also be requested from NPCA, MNRF and Fisheries and Oceans Canada (DFO).

        ii. Breeding bird surveys (2 rounds in accordance with Ontario Breeding Bird Atlas protocols, between May 24 and July 10, can still be carried out summer 2020)

        iii. Vegetation mapping (Ecological land classification) and botanical inventory of the Site (1 visit, summer 2020)

        iv. Initial species at risk habitat screening and incidental observations (1 visit, summer 2020). The potential for species at risk to use the habitats present on the Site will be assessed. Due to the possible presence of Fowler's Toad habitat on the Site, we have also included time to consult with MECP regarding any targeted surveys that may be required for this species. Should the need be identified, preparation of any species-specific work plans for MECP approval and associated field work to determine occupancy, will be an additional scope of work to be discussed with the client.

    b. **EIS report.** The report will provide recommendations on an acceptable development limit based on field results and conformity with applicable legislation and policies. One round of client and agency comments for the Draft EIS has been included in our cost estimate.

    c. **Meetings.** We have included time for two agency conference calls to discuss the project, one at project outset to assist in development of the TOR, and one to discuss agency comments on the report.

3. Pricing and Schedule

Table 2 and Table 3 present the fees related to the scope and provisional items respectively. Project disbursements are incorporated and include equipment, supplies, reproduction costs, and travel.

Table 2 Proposed Project Scope Fees

Item	Fee (CAD, excl. HST)
Project Management	$1,300
Review of Slope Stability and Geotechnical Assessment (including topographic survey)	$7,100
Review of Private Servicing Plan	$2,450
Total	**$10,850**

Table 3 Proposed Provisional Item Fees

Provisional Item	Fee (CAD excl. HST)
Coastal Study	$8,850
Environmental Impact Statement	$16,800

GHD can commence the proposed scope of work within one week of notification to proceed with anticipated completion within six weeks of notification to proceed..

The Coastal Study could be conducted concurrently with the requested scope. The Environmental Impact Statement would take place over the remaining summer months of 2020 (June – September 2020) If additional spring work is required by MECP, it could be completed throughout April – June 2021.

All of Which is Respectfully Submitted,

GHD

Jennifer Penton, Ph.D.
Project Manager

Marc Gaudet, P.Eng.
Project Director

Appendix A

Curricula Vitae

Jennifer Penton, Ph.D.
Project Manager

Qualified: Ph.D. Coastal Engineering, University of Western Australia, 2015; M.Eng. Coastal Engineering, University of Western Australia, 2011; B.A.Sc. Advanced Marine Biology, James Cook University, 2010

Connected: Advanced Open Water Diver, Professional Association of Diving Instructors (PADI); Committee Member, Engineers Australia Coastal, Ocean and Port Engineering Panel (COPEP); Member, Institute of Marine Engineering, Science & Technology (IMarEST); Member, Society of Underwater Technology (SUT); Member, Australian Marine Science Association (AMSA)

Professional Summary: Jen is a highly resourceful Project Manager with 8 years of experience in civil and coastal engineering, proceeded by 4 years of marine science background. She has managed and undertaken numerous projects involving detailed design, including for M5 Interlink Roads, plus a broad range of other civil engineering structures (e.g. of seawalls, revetments, port planning) including technical specifications, risk assessments, safety in design registers, quantity estimates, and preparation and assessment of For Construction documents including procurement and Request For Tender documents. She excels at all aspects in the asset management cycle and investment planning, applying her a keen eye for resilience and opportunities to include risk management. Her experience in developing numerical models has provided her with the required skills to collect, manage, and assess large amounts of data, and to process these to be presentable for management decision making and public/stakeholder consultation.

Project Management

Coastal Engineer, Project Manager
Waterfront Flood Mitigation Alternatives | Village of Youngstown | Youngstown, NY | 2019-2020

Extremely high water levels in Lake Ontario has led to increased flooding and erosion on both sides of the boarder. Jen managed the options design study for the REDI funded flood mitigation project, which aims to relieve local businesses and property owners from repeating flood events along Water Street in Youngstown. Jen is now leading the detailed design phase of the preferred option.

Project Manager
Sarnia Oversized Load Corridor Dock Expansion | City of Sarnia | Sarnia, ON | 2020 – ongoing

An ever-growing industry and economy has increased demands on ports around the world. Jen is assisting the City of Sarnia achieve their maximum capacity of shipments by leading the dock expansion project. This project requires a multi-disciplinary team to address capacity design, stakeholder engagement, permitting (federal and provincial), and various engineering studies.

Project Manager/Environmental Assessment/Stakeholder Engagement
Solomon Islands to Sydney Submarine Cable | Solomon Oceanic Cable Company | Australia | 2016

Jen worked with the Solomon Oceanic Cable Company to undertake an environmental impact assessment for Australian waters and engaged with stakeholders in all government levels to seek permits for the installation of the proposed submarine cable. Jen's contribution to the EIA consisted of completing the physical impact component, considering currents, seafloor conditions, and potential risks posed to the cable as well as the environment.

Project Manager, Coastal Engineer/Stakeholder Engagement
Navigable Waterway Signage Design and Installation | Essential Energy | Australia | 2018

Due to solid work, timely delivery, and a good client relationship, Jen managed and worked on the design of navigable waterway signage for Essential Energy for over 2 years, leading to the installation of over 500 signs. The design included consideration of ground and flood conditions, local land and water use, heritage and environmental concerns, as well as local stakeholder engagement and safety.

Project Manager/Coastal Engineer
Georges River Foreshore Revetment | Interlink Roads Pty Ltd. | Australia | 2017

Jen undertook project management and detailed design of a revetment, aimed at mitigating the erosion of the Georges River foreshore. Furthermore she provided the design drawings, safety in design register, risk assessments, specifications, and quantity estimates, which will be utilized for construction.

Project Manager/Environmental Engineer
Groundwater Flood Mitigation | City of Gosnells | Gosnells, Australia | 2014

The groundwater situation and flood mitigation options were analyzed regarding the flooding of streets, suburban basements, and parks. The preferred solution was formally submitted to the local council and implemented in further suburban designs. Jen was the Project Manager, she led the multi-disciplinary team through assessment of the region and issue, mitigation options design, selection, and detailed design of the preferred option.

Project Manager/Environmental Engineer
Saltwater Intrusion Mitigation | Geraldton City Council | Geraldton, Australia | 2014

An increased rate of water usage lead to a saltwater wedge intrusion in the region, with negative impacts on local farmland, parks, and potable water supply. Mitigation options included sumps and stormwater waterway variations to decrease the outflow into the ocean before entering the groundwater supply. Under Jen's project management, the team designed all mitigation solutions under Jen's project management lead. The preferred solution was formally submitted to the local council and implemented in further suburban designs.

Project Manager/Coastal Engineer
Data Collection and Analysis | City of Perth | Swan River, Australia | 2014

Ongoing analysis were undertaken by a multi-disciplinary team, led by Jen over a 4-year period of the currents, water quality, stratification, and depth of the Swan River was performed and compared to the 1:100 scale Swan River physical model, as well as the Mike21 numerical model results. Live data were collected using ADCPs and analyzed using MATLAB.

Project Manager/Coastal Engineer
DUKC Forecasting Model Improvement Study | OMC International | Melbourne, Australia | 2013

Improvement to under keel clearance model by integrating live measurements at various time frames. Improvements were analyzed with MATLAB using hindcasts of the DUKC model.

Project Manager/Coastal Engineer
Western Australia Continental Shelf Surface Currents Analysis | University of Western Australia | Perth, Australia | 2015

High frequency data from two deployments (4 years at 10 minute intervals over several hundred km^2) were analyzed using MATLAB, ADCP and satellite data, leading to discovery of Leeuwin Current billows and seasonal eddies in the Perth Canyon region.

Environmental Impact Assessments

Engineer/Stakeholder Engagement
Subsea Fibre-Optic Telecommunications Cables Installation Permitting | Southern Cross Cables Network | Australia | 2017

The permitting of subsea cable installation required a full Environmental Impact Assessment and stakeholder engagement on various levels. Jen helped complete the EIA and undertook the required stakeholder engagement for all sectors from local council to commonwealth regulatory bodies. Jen's role within the EIA consisted of completing the physical impact component, considering currents, seafloor conditions, and potential risks posed to the cable due to physical processes.

Engineer/Stakeholder Engagement
Hawaiki Submarine Cable Environmental Impact Assessment and Permitting | Hawaiki | Australia | 2016

Jen and the team worked with Hawaiki to identify most optimal cable route concerning environmental matters. Jen liaised with local, state and commonwealth government agencies to seek all necessary environmental approvals, and undertake the environmental assessment (marine ecology, coastal and oceanic processes, geology, geomorphology, social, heritage, cultural influences). Jen also managed the coastal and oceanic processes section.

Engineering

Coastal Engineer
Lake Flooding and Wave related Hazards Technical Training | Long Point Region Conservation Authority | Long Point, ON | 2020

Jen supported her colleague in reviewing recent flood and wave related hazard studies as a peer review. She then composed a presentation detailing the technical background in hazard mitigation calculation and addressed appropriate mitigation methods.

Civil/Coastal Engineer
Palace Pier Court Revetment | Toronto and Region Conservation Authority (TRCA) | Toronto, ON | 2019

Jen completed the wave modelling (ARI analysis), overtopping analysis (EurOtop), as well as stability calculations, resulting in the detailed design of a revetment for Palace Pier Court. The detailed design included the determination of the armourstone and adjacent walkway path specifications.

Civil/Coastal Engineer
Prince of Wales Revetment | TRCA | Toronto, ON | 2019

Due to high water levels, erosion and failure of existing foreshore protection along Lake Ontario has been frequent. Jen undertook the technical review of the

detailed design of the Prince of Wales revetment, including design and stability calculations.

Civil/Coastal Engineer
Seawall Upgrade | Hunter Development Corporation | Australia | 2018

The project involved detailed design of a seawall upgrade and removal of existing old seawall and piles. Jen undertook the quality control of detailed design drawings, including technical specifications and risk assessment.

Civil/Coastal Engineer
Nepean Dam Stability Review | Water NSW | Australia | 2017

Jen conducted 2D and 3D stability analysis of the dam to account for arching effects. She also assisted data collection and quality control.

Coastal Engineer
Seawall Overtopping Study | Darwin Port | Darwin, Australia | 2016

EurOtop analysis of the overtopping of a seawall and gate was undertaken to support the detailed design of the marina's upgrade. Additionally, predicted sea level rise scenarios were considered and superimposed upon LiDAR data to further inform the flood risk within the marina.

Fluid Dynamics Engineer
Hydraulics Laboratory | University of Western Australia | Perth, Australia | 2011

Developed and performed hydraulic laboratory experiments, with a focus on Bernoulli's principle, tidal upstream saltwater wedge intrusion, wave propagation, and turbulent flow patterns.

Physical Oceanography Teaching Assistant
University of Western Australia | Perth, Australia | 2010

Higher mathematic applications were used to solve complex oceanographic problems. Jen was able to present technical data and formulas to students of all levels in a comprehensive manner.

Asset Management

Asset Manager (Secondment to Snowy Hydro)

Dam and Instrumentation Upgrades | Snowy Hydro Ltd | Australia | 2018 – 2019

Concluding the upgrades on Dam Safety Emergency Plans and Functional Descriptions, Jen was seconded to Snowy Hydro to manage multiple dam upgrades, from the Request for Proposals, through to contractor engagement.

Project Manager/Civil Engineer
Dam Safety Emergency Plan Updates | Snowy Hydro Ltd | Australia | 2018

Updates and amendments to 16 different Dam Safety Emergency Plans, based on new regulations, feedback from NSW State Emergency Service, and amendments undertaken on dams.

Project Manager/Civil Engineer
Dam Spillway Gates Functional Descriptions | Snowy Hydro Ltd | Australia | 2018

Jen wrote the functional descriptions for spillway gates at various dams throughout the Snowy Hydro scheme. These functional descriptions described operating, failure, and maintenance procedures, which give guidelines to the operating staff for all possible flow/flood rates.

Project Manager/Civil and Coastal Engineer
Port Planning and Upgrade Design | Tasmanian Ports Corporation Pty Ltd | Australia | 2017

Development of best practice and innovative plan for two ports to fit the 30-year vision for Tasmania's increase in state and industry freight needs. Jen completed initial technical specifications and risk register for safety in design documents required for the installation and use of navigational aids and fenders.

Civil/Environmental Engineer
Australian National Infrastructure Adaptation Stocktake Scoping Study | National Climate Change Adaptation Research Facility (NCCARF) | Australia | 2016

Jen supported overall implementation of the nation-wide study on the current status of climate change risk management and adaptation planning, as part of major infrastructure business development/construction and project operations. The project involved surveys, interviews, workshops and the facilitation of a new Adaptation Infrastructure Panel to address the future needs of climate change adaptation for national infrastructure proponents.

Stakeholder Engagement

Event Superintendent
Various Events | NSW Development Corporation | Australia | 2015 – 2019

Jen has acted as a superintendent for various functions with the NSW Development Corporation, including UrbanGrowth NSW. Sites and stakeholders offered various challenges, which Jen handled in a diplomatic and professional manner, leading to the success of many events.

Site Superintendent/Stakeholder Engagement
Mt Gilead Shopping Centre | LendLease | Australia | 2018

During the development of the Mt Gilead shopping centre, significant stakeholder engagement was required, including Aboriginal Heritage engagement and management. Jen attended the site every day for a three month period, engaging with and managing Aboriginal Representatives, archaeologists, engineers, and site workers. The site investigations ended with GHD having gained the complete trust of the client, and lead to further work in more nearby projects.

Stakeholder Engagement
Manns Road Upgrade | Transport NSW | Australia | 2017

Jen cold called all stakeholders affected by the Manns Rd upgrade and informed them of the upcoming changes and related works. She showed emotional intelligence and applied insight to the fears and concerns the affected stakeholders showed, and aided in the smooth flow of the project overall.

Other related areas of interest

Recognized (Certification/Training)

- Metocean Awareness Course, IMarEST, 2012
- MATLAB Data Processing and Visualization, Mathworks, 2011
- Introduction to Materials and Corrosion, Society of Underwater Technology, 2013
- Introduction to Commercial Diving, TUCF Marine Logistics and Training, 2013

Awards

- Coasts & Ports Student Award, 2011
- Annual UNESCO IOC Perth/IMarEST Australian Marine Studies Award, 2011
- Golden Key International Honors Society Membership Invitation, 2007
- SUT Educational Support Fund, 2013

Published

- Penton, J. & Pattiaratchi, C., 2011. Accuracy of wave forecasts as a function of forecast time horizon in south-western Australia. “Proceedings of the 20th Australasian Coastal and Ocean Engineering Conference and the 13th Australasian Port and Harbour Conference: diverse and developing.” Barton ACT, Australia: Engineers Australia and New Zealand and the Institute of Professional Engineers New Zealand, p. 582-586
- Pattiaratchi, C & Penton, J., 2013. “The Effects of Wind Forcing on Surface Currents on the Continental Shelf Surrounding Rottnest Island.” *International Journal of Environmental, Ecological, Geological and Mining Engineering*. Vol. 7, 1, p. 13-18.
- Penton, J. & Pattiaratchi, C., 2015. “Surface currents on the Rottnest continental shelf, Western Australia”. *Australian Coasts and Ports 2015 Conference*. Vol. N/A, p. 670-675
- Uslu, B., Hibbert, G. K., Lesser, G. & Penton, J., 2015. « Ensemble turning-point water level predictions for uncertainty estimation for short-horizon planning and risk assessment.” *Australian Coasts and Ports 2015 Conference*. Vol. N/A, p. 913-918
- Schaeffer, A., Cosoli, S., Gramoulle, A., Janekovic, I., Mantovanelli, A., Mihanovic, M., Pattiaratchi, C., Penton, J., Roughan, M., 2016. “Submesoscale eddies observed by HF radars along the East Australian Current and the Rottnest continental shelf.” *ACOMO 2016 Conference proceedings*.

Work history

2015 – present	GHD, Waterloo, Ontario, and Sydney, Australia
2013	OMC International, Australia
2012 – 2015	University of Western Australia

Julie Bui, P.Eng.

Marine Structural Engineer

Qualified: B.E.Sc., 2006; Structural Engineering, The University of Western Ontario, London, Ontario, Canada.

Connected: Registered Professional Engineer: Ontario and Manitoba

Professional Summary: Julie is a marine structural engineer with 14 years of experience in small craft and commercial harbour facilities throughout the Great Lakes region. Her key areas experience include waterfront facilities condition/structural assessments, preparation of plans and specifications, as well as supervision and administration of construction projects. She is knowledgeable in structural analysis using finite element modeling and various propriety design software. Julie has performed structural analysis and design of steel sheet piling, pile supported wharfs/piers/jetties, floating docks and breakwater, concrete parapet and deck slab, timber superstructures and various aluminium components (gangways, ramps, etc).

Condition Assessment Experience

Marine Structural Engineer
West Wall and Fishermen's Basin Rehabilitation | Department of Fisheries and Oceans Canada | Port Dover, ON | 2015 - 2017

Carried out two detailed above and below water site investigations at Port Dover harbour – West Pier and Fishermen's Basin. The harbour structures consists of steel sheet pile bulkhead walls, timber cribs and pile supported jetties. Prepared a detailed condition assessment report that includes site observations, assessment of fender alternatives for both the west pier and fishermen's basin, assessment of the cracks in the precast deck slabs of the existing jetties, evaluated the jetties' composite laminated timber and concrete deck cores, provided recommendations for repairs and cost estimates. Evaluated four options to encapsulate the existing timber crib on west pier. The chosen rehabilitation consists steel tube lagging between existing piles to form a wall and underwater grouting between the voids. Prepared contract plans and specifications, as well as cost estimates for chosen the rehabilitation option on the west pier and fishermen's basin. The rehabilitation project also included new concrete deck and parapet repairs for full length of the west pier; as well as, new concrete parapet and fenders along the north wall of the fishermen's basin.

Marine Structural Engineer
Dockwall Structural Assessment | Toronto Port Lands Company | Toronto, ON | 2015

Responsible for the structural assessment of the existing walls using steel sheet pile design software that focus on the classical limit equilibrium methods. Compiled portion of the assessment report.

Marine Structural Engineer
Ferry Terminal Fender System Improvement Study | Public Works and Government Services Canada| Tobermory and South Baymouth, ON | 2012

Carried out a detailed condition survey of the existing fender system in both Tobermory and South Bayouth and provided a report that presents the observations, findings and repair recommendations with cost estimates for various options. The fender system consists of vertical timbers secured to a steel frame that is hung to the reinforced concrete parapet by chains, the steel frame was braced against V-shaped rubber fenders anchored to the parapet.

Marine Structural Engineer
Tobermory Ferry Terminal | Public Works and Government Services Canada| Tobermory, ON | 2012

Carried out a detailed above and below water condition survey of the ±300 metres ferry terminal. The terminal structure consists of a breasting dolphin, steel sheet pile bulkhead with concrete parapet and timber cribs. Prepared detailed report that includes site observations, evaluation of useful residual life of the structural components, recommendation for repairs and cost estimates.

Marine Structural Specialist
Routine Detailed Inspection 2010 | Public Works and Government Services Canada | Wheatley, ON | 2009 - 2010

Carried out a detailed above and below water condition survey of over one kilometres existing harbour structures. Wheatley harbour structures consists of steel sheet pile bulkhead walls, box piles and battered piles, floating docks, and off-shore breakwater. The superstructure consists of concrete parapet, concrete deck slab and asphalt pavement. Prepared detailed report that includes site observations, evaluation of useful residual life of the structural components, recommendation for repairs and cost estimates.

Marine Structural Specialist
Condition Survey/Investigation of Lower Don

Lands Dockwalls | Waterfront Toronto | Toronto, ON | 2009

Carried out a detailed above and below water condition survey. Prepared detailed report that includes site observations, evaluation of useful residual life of structural components, recommendations for repairs and cost estimates.

Marine Structural Specialist
Canada Centre for Inland Waters Routine Detailed Inspection 2008 | Public Works and Government Services Canada | Burlington, ON | 2008 - 2009

Carried out a detailed above and below water inspection of the Canada Centre for Inland Waters (CCIW) in Burlington. Prepared detailed report that includes site observations, evaluation of useful residual life of the structural components, recommendation for repairs and cost estimates. The ±1.5 kilometres facility consists of a small craft basin, the main wharf and a breakwater. The small craft basin piers are typically reinforced concrete cap on piles, the main wharf is a steel sheet pile bulkhead and concrete parapet, the breakwater is comprised of a concrete copewall supported on pile bents and concrete panels secured to the copewall and piles.

Marine Structural Specialist
Little Tub Harbour Condition Survey 2007 | Public Works and Government Services Canada | Tobermory, ON | 2007

Carried out a detailed above and below water condition survey of approximately 250 meters existing harbour structures consisting of steel sheet pile bulkhead walls and stone-filled timber crib, concrete parapet, timber boardwalk and asphalt pavement; as well as, floating docks. Prepared detailed report that includes site observations, evaluation of useful residual life of the structural components, recommendation for repairs and cost estimates.

Marine Structural Specialist
Routine Detailed Inspection 2007 | Public Works and Government Services Canada | Port Stanley, ON | 2007

Carried out a detailed above and below water condition survey of approximately three kilometres existing harbour structures consisting of steel sheet pile bulkhead walls, concrete decks, fenders, timber crib with concrete superstructure breakwaters and rubble mound breakwaters. Prepared detailed report that includes site observations, evaluation of useful residual life of the structural components, recommendation for repairs and cost estimates.

Marine Structural Specialist
Routine Detailed Inspection 2006 | Public Works and Government Services Canada | Owen Sound, ON | 2006

Carried out a detailed above and below water condition survey of over two kilometres existing harbour structures consisting of steel sheet pile bulkhead walls, timber pile bulkhead walls, timber pile bents, concrete decks and parapet, gabion and rubble revetments. Prepared detailed report that includes site observations, evaluation of useful residual life of the structural components, recommendation for repairs and cost estimates.

Design and Construction Experience

Marine Structural Engineer
Harbour Rehabilitation | Department of Fisheries and Oceans Canada | Grand Bend, ON | 2019 - 2020

Carried out a site reconnaissance and reviewed background inspection report to determine limits of recommended repairs. Prepared construction specifications and cost estimates in advanced of the geotechnical investigation and rehabilitation design/plans. The inspection report recommended new concrete parapet, replacement of existing concrete deck, new steel sheet pile bulkhead encapsulation and new appurtenances.

Marine Structural Engineer
Wharf Reconstruction | Department of Fisheries and Oceans Canada | Little Grindstone Point, MB | 2019 - 2020

Reviewed historical drawings and geotechnical investigation. Carried out the redesign of the wharf using various proprietary steel sheet pile software, the results were used to determine the size of steel sheet pile, tie rods and double channel wale. Reviewed contract plans, prepared specifications and construction cost estimates. Provide support to DFO representative during construction.

Marine Structural Engineer
Harbour Entrance Improvements | Township of Malahide | Port Bruce, ON | 2017 - 2019

Carried out a site reconnaissance, reviewed background reports and geotechnical investigation. Reviewed construction plans and prepared specifications.

Marine Structural Engineer
2018 New Launching Ramp | Norfolk County | Port Dover, ON | 2017 - 2019

Following the commercial basin's jetties removal, Norfolk County requested a design and preparation of contract documents for a new double launching ramp within the

commercial basin. Reviewed plans issued for tender and prepared contract specifications.

Marine Structural Engineer
Dock Street Shorewall | Norfolk County | Port Rowan, ON | 2015 - 2019

The Dock Street boathouses are known for its rustic look and is considered a photographer's favourite, but the unpaved Dock Street is a liability risk for the county due to the mismatched steel sheet pile walls installed by various boathouse owners. As-built records of the steel sheet pile walls were not available. Carried out a site reconnaissance and reviewed in-house field report and topographic survey to prepare a short inspection reported with repairs options. Determined new asphalt grades and designed a steel sheet pile wall encapsulation that jogs along the boathouses. The walls were secured with tie rods that extend the full width of the street. Prepared contract plans and specifications as well as cost estimates.

Marine Structural Engineer
Commercial Basin, Jetty Removal | Norfolk County| Port Dover, ON | 2015-2016

Prepared a fees proposal. Reviewed background documents and carried out a site investigation of the existing commercial basin to assess and identify removals. Prepared contract plans and specifications for the removal of four jetties and pile cut offs near harbour bottom. Provided client with several layout options of possible new fixed and floating docks as well as a new double launching ramp to meet their future needs.

Marine Structural Engineer
West Harbour Soil Remediation | Arcadis | Port Stanley, ON | 2015

Reviewed client's plans and specifications. Prepared marine portion of the contract plans and specifications, established construction sequencing during removal of contaminated soil and backfilling of new materials and supervised the removal and backfilling between the steel sheet pile facewall and anchor wall. Sequencing of the soil remediation was required to ensure stability of the wall.

Marine Structural Engineer
Port Stanley Dredge Disposal Cell | Municipality of Central Elgin | Port Stanley, ON | 2014 - 2016

Prepared contract specifications and carried out construction supervision and administrations for the Port Stanley dredge disposal cell project. The project involved dredging of the harbour and infilling the engineered sediment containment facility, with new lands intended for public use.

Marine Structural Engineer
Pier 22 Wharf Extension | Hamilton Port Authority | Hamilton, ON | 2012

Carried out the design of the wharf, prepared contract plans and specifications, cost estimates and provided support to project engineering during construction stage. Reviewed shop drawings, evaluated design alternatives due to change of steel sheet pile profile and inspection of reinforcing steel placement. The 100 metres wharf extension consists of steel sheet piling with double channel wale and tiebacks to concrete anchor blocks and concrete parapet with pipe bollards.

Marine Structural Engineer
Batchawana Wharf Repairs | Department of Fisheries and Oceans Canada | Batchawana, ON | 2011 - 2012

Redesigned of the L-shape fixed pier, prepared contract plans and specifications, cost estimates and supervised the reconstruction of the wharf. The original wharf was made up of an inner and outer leg that consists of a timber deck superstructure supported on timber pile bents and closed face timber piles. It was reconstructed with new timber deck and stringer superstructure supported on vertical steel H-piles. Finite element analysis was used to design the wharf structural components. The initial model contain battered piles but then changed to vertical piles and moment connections due to large uplift forces from ice impact on the battered piles. The latter model provided better lateral restraint and smaller uplift forces.

Marine Structural Engineer
Wharf Paving Repairs | Transport Canada & Public Works and Government Services Canada | Sarnia, ON | 2009 & 2011

Carried out topographic survey of the East harbour wall and the Government wharf. Prepared contract plans and specifications, cost estimates, as well as supervised and administered the construction progress for both sites.

Marine Structural Specialist
Wharf Repairs| Department of Fisheries and Oceans Canada | Wheatley, ON | 2010 - 2011

Prepared detailed contract plans and specifications, and cost estimates based on the repairs recommended in the Wheatley harbour routine detailed inspection 2010. The repairs consist of concrete parapet, steel sheet pile, wale bolts, fenders and launching ramp. Provided technical support to project engineer.

Marine Structural Specialist
South Basin New Wharf 2010 | Public Works and Government Services Canada | Wheatley, ON | 2009 - 2010

Responsible for the design of a new wharf to accommodate two commercial fishing tugs, prepared contract plans and specifications, cost estimates,

supervised and administered the construction of the new wharf. The primary concern for this project was fish habitat. The wharf consists of a reinforced cast-in-place concrete deck supported on steel beams bolted at one end to a concrete anchor wall that was constructed over an existing revetment and the other end to vertical H-piles driven into the harbour bottom. The piles substructure eliminated the fish habitat concerns. Full length of wharf for two tugs were not achievable due to the low budget available; as a result, pipe piles with rubber tire fenders were installed at either end of the wharf to extend the length and provide berthage to both tugs.

Marine Structural Specialist
Wharf Repairs | Department of Fisheries and Oceans Canada | Midland, ON | 2010

Carried out a detailed above and below water inspection to verify previous engineering investigation. Prepared contract plans and specifications as well as cost estimates for the various repair components which includes subsidence repairs, concrete parapet and timber cribs restorations, new safety ladders and new steel sheet piling.

Marine Structural Specialist
Spadina, Simcoe and Rees Street Wave Decks | Somerville Construction | Toronto, ON | 2009

The original tendered documents showed custom tapered hollow structural sections as support beams for the wave decks located at Spadina, Simcoe and Rees street in Toronto, the original design was over budget and was at risk of cancellation. Was engaged by contractor to redesign the substructure, the custom hollow sections were replaced with “I” beams. Carried out an exhaustive finite element analysis of an alternative design of the substructure. The entire revised substructure and original superstructure at these three sites were modelled and analyzed with specified design criteria. The results were used to determine and verify the size of the steel components. Based on the cost saving associated with the redesign, the contractor was awarded the contract.

Marine Structural Specialist
North Wharf Repairs | Public Works and Government Services Canada | Tobermory, ON | 2008 - 2009

Responsible for the design of the superstructure, as well as supervision and administration of the construction progress. The new superstructure consists of precast L-shape concrete elements, steel cross beams, timber string and timber decking. The precast elements were designed and analyzed by both classical limit equilibrium methods and finite element analysis. It was modelled as shell elements to optimize the shape and reinforcement. The north wharf is a structure that forms a portion of Little Tub Harbour, it was constructed of stone filled timber cribs that was deteriorated above the waterline. The new wharf was constructed on sound portions of the existing timber cribs.

Marine Structural Specialist
North Basin New Steel Sheet Pile Wall | Public Works and Government Services Canada | Sarnia, ON | 2006

Carried out topographic survey of the work area using a total station prior to construction stage. Supervised and administered construction progress of the new wall. Project consists of installation of new steel sheet pile wall, anchorage system, concrete precast blocks and backfilling.

Marine Structural Specialist
Entrance Pier Wharf Repairs | Public Works and Government Services Canada | Port Dover, ON | 2006

Supervised and administered construction progress during steel sheet pile installation, drilling and placement of toe pins, placement of reinforcement and cast-in-place concrete pour.

Marine Structural Engineer
Randle Reef Sediment Remediation | Various Clients: BBL, Aradis BBL, Hamilton Port Authority, Environment Canada & Public Works and Government Services Canada | Hamilton, ON | 2006 - 2019

Provided significant structural analysis for the design of a double steel sheet pile wall confinement port facilities, developed and customized excel spread sheets to confirm and evaluate the factor of safety for the steel sheet piles and tie rods; as well as prepared contract specifications. The analysis included classical limit equilibrium methods, various steel sheet pile and finite element analysis software. Sections of the port facility’s steel sheet piling, double channel wale, tie rods and concrete parapet were modelled to determine the effects of loading from fenders and bollards on each components. The results were input into a concrete design software to optimize the parapet size and reinforcement. These engineered confinement facilities (ECF) are located at the Hamilton harbour, valued over $20M. The ECF was designed to contain 500,000 cubic metres of contaminated sediments and to provide new land for the expansion of Hamilton Port Authority’s wharf space.

Floating Dock Experience

Marine Structural Engineer
Hornblower Floating Dock and Marine Railway Design | Hornblower Niagara Cruises | Niagara Falls, ON | 2013 - 2014

Carried out a finite element analysis and design check of the double deck aluminium floating docks, aluminium gangways and steel stiff arm dock restraint system. The

modelled considered normal berthing impacts and exception collision impacts in combined with current and wind forces to design the restraint stiff arm system. The floating dock and gangway were analyzed using dead loads, pedestrian live loads and wind loads.

Marine Structural Specialist
Point Pelee National Park, New Boardwalk | Huron District Contracting | Leamington, Ontario | 2010 - 2011

The Point Pelee National Park new boardwalk project involved replacement of a ±500 metres section of floating boardwalk, a fixed dock and two canoe/kayak docks. The floating boardwalk were designed with double aluminium pipes with filled with foam supporting a timber deck and railing. Responsible for the design and finite element analysis of the floating boardwalk and its hinge connections. The entire boardwalk was modelled using shell elements and member elements for it flotation units and structural components; it was analyzed with all load combinations, including wind load on the entire boardwalk.

Marine Structural Specialist
New Floating Docks | Municipality of Leamington | Leamington, Ontario | 2010

Responsible for the design and finite element analysis of the double and single steel pipe floating docks, hinge connections and aluminium gangways. Prepared contract specifications, cost estimates, supervised and administered the construction stage. The entire main floats and finger floats were modelled and was analyzed with all load combinations, including wind load. The results were used to verify the size of the structural steel members, timber stringers and timber decking.

Marine Structural Specialist
New Floating Docks | Harbour West Marina | Penetanguishene, Ontario | 2010

Designed a T-shape floating dock, floating breakwater and aluminium gangway using finite element analysis. The floating dock consists of quadruple and single steel pipe flotation units and timber superstructure. The floating breakwater consists of flotation units with spud piles and wave attenuator attached between the steel pipes. The entire T-dock/breakwater were modelled using shell and member elements to determine the various design conditions.

Marine Structural Specialist
Floating Dock Design | Huron District Contracting | Thornbury, Ontario | 2007

Responsible for the analysis of the floating dock's components. Calculated and verified the timber deck and stringer size. As well as established a live load rating based on the buoyancy requirements.

Marine Structural Specialist
Floating Dock Design | Huron District Contracting | Gore Bay, Ontario | 2006

Responsible for the design of the aluminium gangways and the finite element analysis of the floating. The floating dock consists of double and single steel pipe flotation units, structural steel and timber superstructure. All components of the floating dock were modelled as shell and member elements to determine the various design conditions.

Work History

2020 – present	GHD, Waterloo, ON
2006 – 2020	Riggs Engineering Ltd., London, ON

Marc Gaudet, P. Eng., QP_{ESA}

Qualified: Bachelor of Applied Science (B.A.Sc.) – Civil Engineering/Water Resources Option (The University of Waterloo)

Connected: Registered Professional Engineer (Ontario); Qualified Person (QP) as defined in Ontario Regulation 153/04

Professional Summary: Marc has 29 years of professional experience in environmental engineering and remediation with areas of specialty in environmental due diligence, multi-media investigations and monitoring, soil and groundwater remediation and brownfield redevelopment. Marc has been extensively involved in Site Investigations, Phase One and Phase Two ESAs, Site Remediation, and Brownfield Redevelopment in Canada and the United States. Through this experience, Marc has become adept at identifying brownfield funding opportunities for clients including the development of cost and cash flow models and completion of upper and lower tier Brownfield funding applications.

Risk Assessments/Brownfield Redevelopment

Project Manager

- Responsible for overseeing an MECP-approved Risk Assessment and Risk Management Plan on behalf of LIUNA for implementation at the historic William Thomas building in downtown Hamilton, Ontario to support a Record of Site Condition filing and facilitate its redevelopment as a high rise residential and commercial condominium. This included development of a Risk Management Plan and negotiation of a Certificate of Property Use with MECP on behalf of client.
- Responsible for overseeing environmental due diligence including completion of a Phase One ESA, a Phase Two ESA, Risk Assessment, and filing of a Record of Site Condition for a former chemical blending plant on behalf of Arkema Canada Inc. in Oakville, Ontario to successfully facilitate its sale for redevelopment. This included development of a Risk Management Plan and negotiation of a Certificate of Property Use with MECP on behalf of client.
- Responsible for overseeing a chlorinated solvent impacted groundwater investigation on behalf of Toronto Transit Commission involving 150 potentially impacted residential dwellings including source area investigation, groundwater monitoring, soil vapour monitoring, residential indoor air quality monitoring and a Risk Assessment to develop soil vapour and groundwater target concentrations for chlorinated solvents. Included extensive client representation to MECP and Toronto Public Health.

Records of Site Condition/Brownfield Redevelopment

Project Manager

- Responsible for overseeing a Phase One ESA, a Phase Two ESA and soil remediation on behalf of Asta Gardens Inc. at a former school board property on Oakdale Avenue in St. Catharines, Ontario to facilitate its redevelopment as low-rise residential condominiums. A Record of Site Condition was successfully obtained.
- Responsible for overseeing a Phase One ESA, a Phase Two ESA and soil remediation on behalf of Rankin Construction at the former Legion Hall Property in Port Dalhousie, Ontario to facilitate its redevelopment as a high rise residential and commercial condominium. GHD was instrumental in obtaining brownfield development funding on behalf of client. A Record of Site Condition was successfully obtained.
- Responsible for overseeing a Phase One ESA, a Phase Two ESA and soil and groundwater remediation on behalf of Court Holdings Limited at a former metal plating facility in St. Catharines, Ontario to facilitate its redevelopment for continued commercial use.
- Responsible for overseeing a Phase One ESA, a Phase Two ESA and soil and groundwater investigations on behalf of Gord's Restaurant in St. Catharines, Ontario to facilitate renovations to increase the number of upper floor residential apartment units. A Record of Site Condition was successfully obtained.
- Responsible for overseeing a Phase I ESA, a Phase II ESA and soil remediation on behalf of LIUNA at the former Lister Building in downtown Hamilton, Ontario to facilitate its redevelopment as a high rise residential and commercial condominium.
- Responsible for overseeing a Phase One ESA, a Phase Two ESA and soil remediation on behalf of Deere and Company at their former 100-year old farm implement manufacturing plant in Welland, Ontario to facilitate its sale for commercial/industrial use. A Record of Site Condition was successfully obtained.
- Responsible for overseeing the completion of a building decommissioning assessment on behalf of Libbey Glass at their former glass plant in City of

Industry, California. Included preparation and oversight of a decommissioning plan, completion of a Phase I ESA, Phase II ESA, arsenic contaminated soil remediation, and preparation of a Risk Assessment to address chlorinated solvent impacted groundwater. Project successfully supported the sale of the property for redevelopment as a shipping and receiving terminal.

Plant Decommissioning

Project Manager

- Responsible for coordination and implementation of plant decommissioning activities including designated substances and hazardous materials survey on behalf of Court Holdings Limited at their former plating plant in St. Catharines, Ontario to facilitate its sale for commercial/industrial use.
- Responsible for coordination and implementation of plant decommissioning activities including designated substances and hazardous materials survey on behalf of Deere and Company at their former 100-year old farm implement manufacturing plant in Welland, Ontario to facilitate its sale for commercial/industrial use.
- Responsible for coordination and implementation of plant decommissioning activities including building demolition on behalf of Libbey Glass at their former glass plant in City of Industry, California. Included preparation and oversight of a decommissioning plan, completion of a Phase I ESA, Phase II ESA, arsenic contaminated soil remediation, and preparation of a Risk Assessment to address chlorinated solvent impacted groundwater. Project successfully supported the sale of the property for redevelopment as a shipping and receiving terminal.

Multi-Media Investigations/Remediation

Project Manager

- Responsible for soil and groundwater investigations and overseeing a 10,000 tonne buried lime investigation at Oakdale Avenue in St. Catharines, Ontario to facilitate property severance. Included development and negotiation of Long-Term Monitoring Plan and Financial Assurance on behalf of client.
- Responsible for soil and groundwater investigations and overseeing a 3,000-tonne soil and groundwater remediation project on behalf of Court Holdings Limited related to historical petroleum hydrocarbon releases beneath a former press plant building floor in Lincoln, Ontario.
- Responsible for soil and groundwater investigations and overseeing a 20,000-tonne soil and groundwater remediation project on behalf of Court Holdings Limited. related to historical releases of petroleum hydrocarbons, metals and chlorinated solvents beneath a former plating plant, Ontario.
- Project Manager responsible for remediation/management of chlorinated solvent contaminated soil and groundwater on behalf of Libbey Glass at their former glass plant in Wallaceburg, Ontario. Remediation included chemical oxidation of chlorinated solvent impacted soil and groundwater, groundwater quality monitoring, indoor air quality monitoring, and implementation of a passive soil vapour venting system including application for and receipt of all necessary MOECC approvals.

Environmental Due Diligence

Peer Reviewer

- Responsible for corporate peer review of Phase I Environmental Site Assessments completed in Canada.

Project Manager

- Completion of over 500 Phase I Environmental Site Assessments and Phase II Environmental Site Assessments at facilities in Canada and the United States. Selected experience listed below:
  - Steel manufacturing plants
  - Automotive parts manufacturing
  - Large aggregate extraction and processing.
  - 1.5-million-square-foot diesel electric locomotive and light armored vehicle manufacturing facility
  - Funeral homes, cemeteries, and crematories
  - Metal fabrication facilities
  - Chemical blending facilities
  - Paint manufacturing facility
  - Refrigerated warehouse facility
  - Trucking and distribution facilities
  - Drycleaning facilities
  - Railway lines and service facilities
  - Numerous rental car facilities
  - Dairy facilities
  - Lighting fixture manufacturing facilities
  - Glass manufacturing facilities

Work history

May 1991 – present	Principal, GHD (formerly Conestoga-Rovers & Associates), St. Catharines, ON
	Named Principal, 2007
	Named Associate, 2002

Pat Prodanovic, Ph.D., P.Eng.

Senior Water Resources Engineer

Qualified: B.E.Sc., 2002; M.E.Sc., 2004; Ph.D., 2008 Water Resources Engineering, The University of Western Ontario, London, Ontario, Canada.

Connected: Registered Professional Engineer: Ontario

Professional Summary: Pat is a water resources and coastal engineer with 13 years of experience in civil, coastal, and water resources engineering applications within Ontario and beyond. His work focuses on modelling applications in coastal and water resources engineering, including hydrodynamics and sediment movement in coastal areas, wave climate modelling, and hydrology and hydraulics of river systems. He has been involved in various coastal and riverine studies, ranging from small (single individual assessments) to medium (large commercial and residential developments) and very large (multi-year, complex, federal-level sediment management) projects. Additionally, Pat has expertise in performing numerical assessments for riverine and coastal environments, utilizing state-of-the-art numerical solvers to support the planning, design, and construction of various projects.

Climate Change Experience

Water Resources Engineer
Response of water resources systems to climate change | Upper Thames River Conservation Authority | London, ON | 2008

Pat developed a non-parametric weather generator algorithm that is able to produce arbitrary long time series records of climatic data using historic on the ground observations as well as outputs from large scale Global Circulation Models (GCMs). The developed algorithm can produce data applicable for a future climate (associated to a particular year in the future) that are used to develop management, planning and design guidelines for urban and municipal infrastructure.

Water Resources Engineer
Seasonal flood changes under climate change in the Upper Thames River Watershed | Upper Thames River Conservation Authority | London, ON | 2011

Pat was part of the larger team that investigated anticipated impacts of climate change on the frequency and timing of floods for catchments at, and around London, Ontario. The study documented hydrologic analyses that showed that runoff magnifies when rainfall intensifies. The summer season was most critical, while rain on snow was second. Pat provided expert level guidance on matters related to developing climatological input under climate change conditions, as well working with other staff in completing hydrologic analyses, evaluating impacts of existing flood control infrastructure under climate change, and offering recommendations for adaptation measures.

Riverine Experience

Water Resources Engineer
Milton Quarry Dam Safety Review | Dufferin Aggregates | Milton, ON | 2019

Pat completed the hydrotechnical component of a larger dam safety review study for Dufferin Aggregates' main quarry reservoir (8 m high). The hydrotechnical investigations focused on completing the dam breach inundation assessment and completing a Hazard Potential Classification of the facility. Pat used a number of different methods to develop dam breach hydrographs, which were used in subsequent hydraulic modeling. He completed detailed flood inundation modelling at the project site, using simple 1D approaches as well as detailed 2D overland flow propagation modelling.

Water Resources Engineer
Fancy Hill Dam Hazard Classification and Flood Inundation Assessment | Baker Hughes | Montgomery County, AR | 2019

Pat carried out a detailed hazard classification assessment of an existing 5 m high Fancy Hill Dam and Mill Site. He assembled and processed topographic and bathymetric data at the project site and merged them into a large scale terrain model to develop a hydraulic model ready DEM. Pat completed hydrologic analysis at the project site, estimating flows required for the analysis. He also assessed spillway capacity of the existing structures at the dam site. A dam breach analysis was completed for the project site, developing breach hydrographs to be used in hydraulic analysis. Pat developed various 1D and 2D hydraulic models and assessed the consequence of dam breach to the downstream community. He developed the hazard classification at the facility, and selected the Spillway Design Flood for the control structure.

Water Resources Engineer
Backus Mill Dam Improvements | Long Point Region Conservation Authority | Norfolk County, ON | 2018 – 2019

Pat completed design and analysis activities associated with a project whose aim is to increase the hydraulic capacity of an existing dam. Working with the project team, Pat carried the necessary hydrotechnical analyses and was able to geometrically proportion a new weir (to be installed in front of the new dam) that increases the spillway capacity of the existing facility. A new emergency

spillway was also proportioned at the facility, in addition to a new upstream weir. Pat completed detailed numerical modelling using a 2D finite volume flow model of the proposed design to confirm and support the validity of the simplified hand calculations.

Water Resources Engineer
Hay Creek Dam Safety Review | Long Point Region Conservation Authority | Norfolk County, ON | 2018 – 2019

Pat carried out all necessary work associated with an existing dam safety review project at Hay Creek Dam. His work on the project included detailed facility inspections, carrying out topographic and bathymetric surveying, sediment sample collection, analysis of sediment chemistry, structural stability assessment, dam classification according to MNRF rules, development of unsteady dam breach modelling, managing a sub-consultant carrying out slope stability analyses, and preparation of the project report.

Water Resources Engineer
Webber Borne Road Construction | Municipality of Central Elgin | Glanworth, ON | 2018 – 2019

Pat carried out the necessary work to assess impacts associated with a construction project that aims to raise the road elevation at an existing road crossing. He completed the site recognisance and topographic surveying, the hydrologic analyses and modelling needed to estimate project flows, as well as a detailed hydraulic assessment using a numerical model. Pat was able to quantify the degree of impact on flooding the proposed construction activities have, and offer solutions on how to remediate the adverse impacts.

Water Resources Engineer
Cargill Dam Screw Turbine | Green Bug Energy | Cargill, ON | 2016 – 2018

Pat completed various analyses required in the regulatory approvals process for a new screw turbine project at Cargill Dam whose aim was to generate hydro power. The investigations carried out by Pat included detailed topographic survey of all structures, an unmanned aerial vehicle survey, preparations of drawings of existing conditions, verification of structural stability of existing structures, determination of dam classification, and a detailed dam break hydraulic assessment. The dam break analyses were completed using a 2D hydraulic model using a finite volume solver, focusing on the incremental impact of the dam failure on downstream residential properties.

Water Resources Engineer
Broughdale Dyke Removal Project | AECOM | London, ON | 2014 – 2015

Pat completed a detailed 2D numerical modelling study associated with the removal of an existing dyke, located along the banks of the Thames River in London, Ontario. He developed a detailed terrain model of river and floodplain lands in the north-east portion London, making sure the terrain included appropriate real-world hydraulic features needed in detailed 2D numerical modelling of the river and floodplain lands. Pat set up a TELEMAC-2D hydrodynamic model for 10 km of Thames River in London. The result of the modelling were used to evaluate the impacts of the dyke removal project, focusing on the possible changes to water surface elevations and overland flow patterns during storm conditions.

Water Resources Engineer

Lower West Don River Hydrodynamic Modelling Study | Build Toronto | Toronto, ON | 2011 – 2016

Pat developed a 3D Environmental Fluid Dynamics Code (EFDC) model for the purposes of informing detailed design of shoreline alterations around an existing meander bend required for a very large development. The model was used to examine different erosion scenarios of the river taking into account existing bridge infrastructure and proposed shoreline treatment. The modelling facilitated detailed design of the integrated bank protection system that included both rock and native vegetation.

Water Resources Engineer
Pottersburg Creek Channel Realignment | City of London | London, ON | 2010 – 2012

Pat has completed a detailed municipal Class EA Study for a channel re-alignment project, focusing on development and evaluations of options, detailed hydrotechnical analyses (hydrology and hydraulics), public consultation, and multiple agency regulatory approval processes. Shifting the creek channel avoided construction of a costly retaining wall, and thus proved to be most economical. Pat prepared the design for a bank revetment and a channel bed lining system using riprap, taking into account erosion requirements, as well as ecological, fisheries and fluvial geomorphology recommendations.

Water Resources Engineer
Thames River Reach Study | City of London |London, ON | 2012 – 2014

Pat completed the necessary hydrotechnical analyses associated with the removal of an existing weir spanning the Thames River in London, Ontario. Large scale commercial and residential development potential within the existing floodplain lands were evaluated in the project, where Pat completed the necessary hydraulic modelling using 1D and 2D numerical modelling. The impacts of changes to the water resources system resulting from the proposed development activities were evaluated and documented, which formed the basis for stakeholder evaluations of the feasibility of the overall project. Pat managed the project team that included a fluvial geomorphology, a terrestrial ecology, and fish biology.

Water Resources Engineer

Wastewater Treatment Plant Upgrades Numerical Modelling | Genivar | Napanee, ON | 2010 – 2011

A 3D Environmental Fluid Dynamics Code (EFDC) model was developed in support of the mixing zone and effluent discharge analyses related to upgrades of an existing outfall. River flows, water levels, plant discharges were inputted into the model, along with background water quality of the Napanee River. The modelling was set up to accurately take into account dynamic variation of the background water quality in the river system, which was shown to significantly influence overall results. Pat produced outputs of spatial and temporal distribution of various water quality parameters, which were used to facilitate regulatory approvals, and ultimately obtain the necessary permits required to for construction.

Coastal Experience

Coastal Engineer
Palace Pier Headland Maintenance Project | Toronto and Region Conservation Authority | Toronto, ON | 2019 – 2020

Pat carried out design calculation and performed numerical wave modeling required to complete the final design for the repair works at the Palace Pier project. The design included specification of a double layer armour stone, underlain by a layer of rip rap and geofabric. Design features included a falling toe revetment (two rows of 5 tone stones at the toe), and a layer of revetment crest stones providing protection from wave overtopping. The design included a flexible path system composed of gravel, geocells and sod with turf reinforcement. Design included taking into account an existing sewer outfall discharging through the revetment.

Coastal Engineer
Waterfront Flood Mitigation Alternatives | Village of Youngstown, NY | 2019 – 2020

Pat completed a comprehensive flood hazard assessment of the along the shoreline of Youngstown, NY. The project location was along the mouth of the Niagara River, but subject to propagating waves from Lake Ontario. Pat carried out the flood hazard assessment and documented contributions to flood characteristics from: i) Lake Ontario water levels (mean levels and surges), ii) Niagara River (including discharges from Lake Erie), iii) wave overtopping and uprush (combined sources). A number of practical flood mitigation alternatives were developed and costed.

Coastal Engineer
Lake Skaneateles New Floating Breakwater | Kehoe Marine Construction | Skaneateles, NY | 2016 – 2017

Pat carried out a comprehensive wave climate assessments for the purposes of quantifying wave attenuation characteristics and structural design of the floating breakwaters and floating docks at the marina at Lake Skaneateles, NY. He completed an assessment of statistical characteristics of historic wind data, which was used to derive large scale forcing for use in detailed numerical modelling. Pat used 2D phase averaging wave models to produce representative wave climate, and set up task automation and batch scripting used to accommodate simulations and processing of very large number of simulation cases required for the analysis and design checks.

Coastal Engineer
Lake Huron, Lake Erie, and Lake Ontario Shoreline Protection Designs | Confidential | Ontario, Canada | 2010 – 2019

Pat completed numerous shoreline protection designs at the shores of Lake Huron, Lake Erie and Lake Ontario, leading the projects from initial site visit, topographic and bathymetric data collection, obtaining regulatory permitting from local authorities, completing detailed design drawings and specifications, as well as managing construction operations. Associated with such projects are detailed environmental impact statements that look at possible influence of shoreline alteration at one location on neighbouring properties. Pat has completed a number of such environmental impact statements relying on an assortment of coastal numerical models to evaluate wave, current, and sediment transport conditions. He provided comment on how proposed works could change governing coastal processes, and what impact the proposed shoreline alterations have on the neighbouring shoreline.

Marine/Coastal Engineer
Randle Reef Sediment Remediation | Environment Canada | Hamilton, ON | 2008 – 2017

Pat undertook extensive soil structure interaction modelling of a proposed $30M wharf structure at Hamilton designed to contain 500,000 cubic meters of contaminated sediments. The analyses were undertaken to verify load capacity of the structure through the various stages of construction, filling with sediments and ultimate service loads using finite element soil-structure analysis. He also carried out a detailed wave and hydrodynamic modelling assessments at Hamilton harbour, supporting design of thin layer sediment capping, and documenting possible environmental response of the harbour during construction operations.

Coastal Engineer
Quite West Marina Expansion | Kehoe Marine Construction | Trenton, ON | 2015 – 2016

Pat carried out detailed assessment of site specific wave climate for use in the design of a new floating breakwater system at the new Municipal Marina in Trenton, Ontario. Two different phase-averaging wave models were used to quantify incident wave heights and periods for a range of environmental conditions used in sizing the new floating breakwater. The analysis required the new floating structures to meet required wave attenuation criteria, be cost-effective, and be able to withstand design loading conditions imposed by the natural environment.

Coastal Engineer
Port Stanley Dredge Disposal Cell | Municipality of Central Elgin | Port Stanley, ON | 2014 – 2016

The Port Stanley Dredge Disposal Cell project involved a design of a 1.34 ha of an engineered sediment containment facility, with new lands intended as open public space. Pat carried out various coastal analyses required for the environmental permitting and design activities of the containment cell structure (assessment of wave climate, and coastal sediment movement inside the harbour). Pat has designed the perimeter cell armour stone revetments and new offsetting fish habitat features (submerged rock berms, log tangles, rubble piles, etc) that were required.

Coastal Engineer
Southeast Bend Cutoff Channel Dredging | Public Services and Procurement Canada | St. Clair River, ON | 2014 – 2015

Pat prepared finite element simulations of the St. Clair River outlet using the TELEMAC modelling system. Being located near the mouth of the St. Clair River, sediment characteristics of the South East Bend Cutoff Channel are driven by both marine (lake circulation, wave climate) and riverine influences (upstream river inflows). Numerical simulations have confirmed that marine influences (winds and waves) play significant roles in hydrodynamics and sediment transport processes at the site of dredging project. The numerical modelling of the wave and hydrodynamics supported management of the dredging contract where the contractor employed a Trailer Hopper Suction Dredge that discharged water heavily laden with fine sediment into the environment. Pat has assisted in the environmental approvals aspects of the project.

Coastal Engineer
38 Harbour Street Development | MC Engineering | Port Dover, ON | 2012 – 2013

Pat has worked on regulatory approvals for a new 40 unit residential development located inside the Port Dover Harbour, resting on lands that were originally supported by aging sheet pile structures that have reached the end of their service life. The development being located within a known area of natural hazard, Pat completed a detailed assessment documenting how the identified natural hazards could be addressed in the project. The analysis was completed according to MNR Technical Guidelines, satisfying floodproofing, protection works, and access standards. Particularly, Pat has established a floodproofing elevation, recommendations for new wave splash structure, overland scour protection, retaining wall, anchorage, and have identified emergency site access route. Pat also identified that published water levels at the site were too conservative, and has carried out necessary analysis and modelling tasks to demonstrate that a more appropriate levels should be applied at the site.

Modelling Specialist/Coastal Engineer
Navy Bay Assimilative Capacity Study | Genivar | Kingston, ON | 2012 – 2013

Pat has completed an assimilative capacity study associated with the cooling system upgrades at a facility located in Navy Bay, Kinston using a TLEEMAC 3D hydrodynamic numerical model. He carried out the numerical modelling study required for regulatory permitting, as well as detailed design proportioning of the warm water discharges into the lake.

Other related areas of interest

Refereed Conference Publications

- Goeury, C., Zaoui, F., Audouin, Y., **Prodanovic, P**., Fontaine, J., Tassi, P., and Ata, R. 2018. Finding Good Solutions to Telemac Optimization Problems with a Metaheuristic, Proceedings of the 25th Telemac & Mascaret User Club, Norwich, UK.
- **Prodanovic, P**., Goeury, C., Zaoui, F., Ata, R., Fontaine, J. and Audouin, Y. 2018. Shape optimization of hydraulic structures: an example of an optimum design of a fish passage, Proceedings of the 13th Hydroinformatics International Conference, Palermo, Italy.
- **Prodanovic, P.** 2016. Wave library: A strategy for reducing computation times in coastal sediment transport studies, Proceedings of the 23rd Telemac & Mascaret User Club, Paris, France.
- **Prodanovic, P**. 2015. QGIS as a pre- and post-processor for TELEMAC: mesh generation and output visualization, Proceedings of the 22nd Telemac & Mascaret User Club, STFC Daresbury Laboratory, UK.
- **Prodanovic, P**. 2014. Numerical simulation of coastal climate at a harbour site in the Great Lakes, Proceedings of the 21st Telemac & Mascaret User Club, Grenoble, France.
- **Prodanovic, P**. 2013. Dispersion of suspended sediment from dredging operations in the St. Clair River, Proceedings of the 20th Telemac & Mascaret User Club, Karlsruhe, Germany.

- **Prodanovic, P**. 2013. Hydrodynamic and thermal plume modelling for waste heat discharges into coastal waters, Proceedings of the 4th Specialty Conference on Coastal, Estuary and Offshore Engineering, Canadian Society for Civil Engineering, Montreal, Quebec, Canada.
- **Prodanovic, P**., and Simonovic, S.P. 2008. Intensity duration frequency analysis under changing climatic conditions, 4th International Symposium on Flood Defence: Managing Flood Risk, Reliability and Vulnerability, Institute for Catastrophic Loss Reduction; Toronto, Ontario, Canada.
- **Prodanovic, P** and Simonovic, S.P. 2007. Integrated Water Resources Modelling of the Upper Thames River Basin, Proceedings of the 18th Canadian Hydrotechnical Conference, Canadian Society for Civil Engineering; Winnipeg, Manitoba, Canada.
- Simonovic, S.P., **Prodanovic, P** and Helsten, M. 2007. Inverse Modelling of Climatic Change Impacts in the Upper Thames River Basin, Proceedings of the 18th CSCE Canadian Hydrotechnical Conference, Canadian Society for Civil engineering; Winnipeg, Manitoba, Canada.
- **Prodanovic, P.** and Simonovic, S.P. 2006. Systems Approach to Assessment of Climatic Change in Small River Basins. XXIII Conference of the Danubian Countries on the Hydrological Forecasting and Hydrological Bases of Water Management; Belgrade, Republic of Serbia.
- **Prodanovic, P.**, Cunderlik, J.M. and Simonovic, S.P. 2005. Synthetic storm model for climate change impact modelling. Proceedings of the 17th Canadian Hydrotechnical Conference, Canadian Society for Civil Engineering; Edmonton, Alberta, Canada.

Refereed Journal Publications

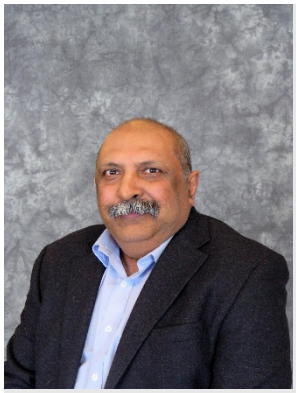
- Peck, A., **Prodanovic, P.**, and Simonovic, S.P. 2012. Rainfall Intensity Duration Frequency Curves Under Climate Change: City of London, Ontario, Canada. Canadian Journal of Civil Engineering, 37(3): 177-189.
- **Prodanovic, P.**, and Simonovic, S.P. 2010. An Operational Model for Integrated Water Resources Management. Water Resources Management, 24: 1161-1194.
- **Prodanovic, P.**, and Simonovic, S.P. 2007. Impacts of Changing Climatic Conditions in the Upper Thames River Basin. Canadian Water Resources Journal, 32(4): 265-283.
- **Prodanovic, P.**, and Simonovic, S.P. 2003. Fuzzy Compromise Programming for group decision making. IEEE Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans, 33(3): 358-365.
- **Prodanovic, P.**, and Simonovic, S.P. 2002. Comparison of fuzzy set ranking methods for implementation in water resources decision-making. Canadian Journal of Civil Engineering, 29: 692-701.

Work History

2019 – present	GHD, Waterloo, ON
2008 – 2019	Riggs Engineering Ltd., London, ON

Hassan Gilani, M.Sc., P.Eng.

Geotechnical Engineer



Qualified: Master of Science - Civil and Environmental Engineering, 1993, Bachelor of Science - Civil Engineering, 1984

Connected: Member Association of Professional Engineers of Ontario, Member Association of Professional Engineers, Geologists, and Geophysicists of Alberta, Member Association of Professional Engineers and Geo-Scientists of New Brunswick, Member Canadian Geotechnical Society, Member North American Geosynthetic Society, Member American Society for Testing and Materials, Committee Member ASTM D18 on Soil and Rock, Registered with Registry, Appraisal and Qualification System (RAQS) for Pavement Design (Low Complexity), Pavement Evaluation (Flexible), Soils and Pavement Investigation (Routine)

Professional Summary: Mr. Gilani's expertise in Geotechnical Engineering includes Finite Element Method based analyses of soils and soil-structure interaction problems. Mr. Gilani has vast experience in various aspects of geotechnical, geo-environmental, construction, materials and pavement engineering, and has worked on projects across Canada, the US and in the Middle East. He joined GHD (formerly Inspec-Sol) in 2004 after acquiring extensive technical experience in the industry over several years. Mr. Gilani has extensive experience in pavement evaluation, and design based on MTO GBE method, and the structural number method as described in the MTO's document MI-183 'Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions' dated 2008. Mr. Gilani is also well experienced in analyzing cost/benefit of different rehabilitation options for an existing pavement, and analyzing the life cycle costs of different pavement structures for a new pavement structure or pavement reconstruction project.

Relevant Experience

Geotechnical Engineer
Clean Harbors Hazardous Waste Landfill | Clean Harbors Canada Inc. | Sarnia, Ontario

Carried out analyses of failure of an approximately 18 m high below-grade side slope excavated at 1H:1V. Analyses comprised of numerical modelling of the slope failure using the available laboratory and field data consisting of triaxial shear test results and pre and post failure vibrating wire piezometers. Using the analyses the cause of failure was identified as quicker dissipation of excavation induced negative pore water pressure than rate of filling of the cell. Based on numerical analyses, due to the precious air space, the new design introduced only one 10 m wide bench approximately at 6 m depth from the ground surface in the 1H:1V slope to ensure enough time is available to place waste at the toe of the slope to buttress it before negative pore water pressure dissipates such that the factor of safety never drops below 1.1. The cell side slope was constructed as recommended and cell filled as planned without any further issues. The failure happened in June 2009; design and construction works were completed same year and filling was completed in 2009-2010.

Geotechnical Engineer
Port Hope Long Term Low-Level Radiation Waste (LLRW) Facility | Atomic Energy Canada Ltd. | Port Hope, Ontario

Carried out analyses of the proposed waste storage mound stability including its slopes, base and cap liner, and settlement potential under both under static and pseudo-static (seismic) conditions using finite element method (FEM) based suite of software. The work was reviewed by Dr. Rowe of Queens University on behalf of Atomic Energy Canada Ltd.

Geotechnical Engineer
Slope Repairs Landfill Vault | General Motors LLC| Bedford, Indiana

Compacted clay liner (CCL) over the south slope of the under-construction below grade landfill failed twice. After a site visit and field investigations comprised of crown to toe trenching and test pits, cause of failure was identified as perennial seepage from the subgrade layers. Based on FEM based seepage, stress-deformation, and slope stability analyses compacted clay liner was recommended to be constructed at a slightly flatter slope to avoid placing it on the disturbed subgrade in combination with construction seepage collection drains. CCL was completed as recommended, waste material placed and the landfill has since been capped.

Geotechnical Engineer
Geotechnical Investigation Program | Regional Municipality of Waterloo | Cambridge, Kitchener, Waterloo/Ontario

Managed the geotechnical investigations for the twenty (20) roads included in the 2011 geotechnical investigation program, and provided rehabilitation and reconstruction recommendations, and the life cycle cost analyses for each option. The rehabilitation options comprised of asphalt overlay, and overlay combined with foamed Asphalt and Cold-in-Place Recycling. The reconstruction

option comprised of flexible pavement structures. The pavement design recommendations were based on the results of visual inspections and borehole investigations. The primary cause of distress in the existing pavements was identified and design recommendations were provided accordingly. The structure number based designs were carried out in accordance with the MTO Publication 'Adaptation and Verification of AASHTO Pavement Deign Guide, for Ontario Conditions dated March 2008.

Geotechnical Engineer
Parsons Watermain Phase II | Regional Municipality of Wood Buffalo | Fort McMurray, Alberta

Planned, conducted and prepared the geotechnical investigation for the watermain proposed to be installed using directional drilling methods across approximately 0.6 km wide and 60 m deep Goat Head Creek valley. Boreholes up to 56 m were installed on either side of the valley and on the valley side slopes using conventional drilling methods with SPT sampling and HQ coring to determine continuous soil overburden and bedrock profile across the valley. Based on field and laboratory testing, potential issues such as bit balling in bituminous sand layers, loss of drilling fluid in sand layers, swelling of clay shale of Fort McMurray Formation, and deflection of bit due to embedded thin siltstone and sandstone layers in the Fort McMurray formation were identified.

Geotechnical Engineer
Burgoyne Bridge Replacement Project | Pomerleau Inc.| St. Catharines, Ontario

Carried out engineering stability evaluations of the heavy duty construction equipment with respect to their loads and vibrations on approximately 20 m high natural slopes comprised of relatively soft lacustrine deposits. Provided recommendations for allowable limits of peak particle velocities and associated frequencies. Recommendations were provided for allowable inclinations of cut and fill slopes and Reinforced Soil Slopes for working pads built on the natural valley slopes

Geotechnical Engineer
Kam Kotia Mine Rehabilitation | Ministry of Northern Development and Mines | Timmins, Ontario

Carried out geotechnical investigation comprised of boreholes and CPT at the approximately 240 hectares Mine site for the proposed sludge disposal and polishing ponds, and for evaluating the rock berm stability that dams the eastern end of the open pit. The open pit will be used for disposal of acid generating waster rock. Analyses included anticipated settlement of the tailings that were used to fill the 52 m deep open pit under the weight of the waste rock and their effect on the final cap cover, and the effect of lateral stresses on the stability of the rock berm holding the tailings at the east end of the open pit.

Litigation Support/Expert Testimony

- Expert witness before the Division of Hearings and Appeals, State of Wisconsin regarding the geotechnical aspects of design and operation of waste water storage lagoons of a dairy facility.

Other related areas of interest

Recognized (Certifications/Trainings)

- 2013 - One Day Short Course 'Horizontal Directional Drilling (HDD) Pipeline Construction, Design and Quality Assurance' Centre for the Advancement of Trenchless Technologies, University of Waterloo
- 2013 - Three Day Course 'Design and Construction of Micro-tunneling Projects' American Society of Civil Engineers (ASCE), New Jersey, USA
- 2011 - Three Day Course ‘Geotechnical Earthquake Engineering, Geotechnical Research Centre, Department of Civil and Environmental Engineering, University of Western Ontario, London
- 2011 - One Day Short Course on Cone Penetration Testing for Geotechnical Analysis and Foundation Design presented by Dr Paul Mayne of Georgia Institute of Technology,
- 2008 - Annual Geotechnical Modeling Workshop, Four day Workshop by Geo-Slope International Limited, Banff, Alberta
- 2007 - Design of Equipment (Machine) Foundations, A two day workshop by Dr. H. Al-Naggar, Two day Workshop, EPIC, Mississauga
- 2007 - Design of Piled Foundations, A one-day workshop by B. H. Fellenius, 2007 Evaluation of Soil Liquefaction and It’s Link to 2005 National Building Code of Canada, 2005, A short course by Dr. Peter Robertson, University of Alberta
- 2004 - Basics of Fall Protection, 2004
- 2004 - WHMIS Awareness, 2004
- 2004 - 40 Hour Health and Safety Training for Hazardous Waste/Contaminated Sites

Work history

2004 – present	GHD (formerly Inspec-Sol Inc.), Waterloo, ON
2003 - 2004	Courtland Engineering, Kitchener, ON
2002 - 2003	Soil Probe Ltd., Toronto, ON

2000 - 2002	Sarafinchin Associates, Toronto, ON
1993 - 2000	Nespak Pvt. Ltd, Pakistan
1984 - 1993	Ministry of Irrigation, Pakistan

Christine Pritchard, B.E.Sc.

Ecologist, Permitting Specialist

Qualified: Post-Graduate Certificate Ecosystem Restoration, 2004; Bachelor of Environmental Science (Hons), 2003

Connected: Certified Inspector of Sediment and Erosion Control (CAN-CISEC), CISEC Inc.

Professional Summary: Christine's ecology-related work includes aquatic habitat assessments, environmental monitoring, field data collection, fish rescues, vegetation monitoring and surveys, and coordination and compilation of compliance monitoring reports. Christine also provides support to environmental permitting for various projects requiring approvals from government agencies, as well as construction oversight, Erosion and Sediment Control (ESC) inspection and reporting for multiple construction sites. Christine's attention to detail and conscientious attitude results in accurate data collection, effective reporting, and efficient project implementation.

Permitting Specialist/Ecologist
Rouge River Mid-Block Connector (MBC) | York Region | 2017 – Ongoing

The Regional Municipality of York intends to construct a new four-lane MBC over Highway 404. The new roadway will also require a crossing of the Rouge River, east of Highway 404. The new roadway will connect the Town of Richmond Hill and City of Markham to support anticipated growth in the area and improve transit opportunities.

The river in this area is considered to be endangered redside dace habitat and is protected under the *Endangered Species Act (ESA), 2007* and the *Species at Risk Act (SARA*). To date, Christine has conducted an assessment of habitat and potential environmental impacts; participated in discussions with the MNRF/MECP regarding permitting and approvals, leading the project through the initial stages of an Overall Benefit permit; developed concepts of overall benefit activities appropriate as compensation works; and conducted a self-assessment under the *Fisheries Act*.

CAN-CISEC Inspector/Ecologist
QEW Improvements from West of Etobicoke Creek to the East Mall | MTO | Mississauga | 2018 – Ongoing

GHD was retained by MTO as the Contract Administrator for road improvements to a 2.3-km length of the QEW. Christine has acted as the Lead Environmental Monitor on this project, conducting weekly environmental inspections during the active construction season, with particular focus on works surrounding the QEW Bridge over Etobicoke Creek.

As erosion and sediment control (ESC) strategies are not static, Christine evaluates the efficacy of the implemented mitigation measures and provides recommendations to the Contract Administrator, if needed, as site conditions change to minimize impacts to the environment. Site observations and recommendations are summarized in a weekly report and communicated with Toronto Zenith, the Contractor, to ensure compliance with MTO contract provisions, supporting reports, and environmental permitting requirements.

In addition to weekly inspections, Christine is available on an on-call basis, in the event of an emergency or during times of high-risk works, to ensure smooth project implementation in an environmentally responsible manner.

CAN-CISEC Inspector/Ecologist
Lock 23, 24, 25 and 45 Trent-Severn Waterway | EBC and SBC | 2018 – Ongoing

Parks Canada is in the process of reconstructing multiple dams within the Trent-Severn Waterway that are more than 100 years old. Parks Canada has retained Maple Reinders as their Construction Administrator, overseeing individual contractors on a site-specific basis. GHD has been retained by the contractors EBC and SBC on Locks 23, 24, 25, and 45 to complete environmental components including the development of Site Specific Environmental Management Plans (SSEMPs); daily environmental oversite; additional oversight during High Risk activities; Species at Risk (SAR) training to on-site staff; and fish rescue and relocation prior to dewatering activities. Christine has acted as the Qualified Professional on these projects, assisting with the development of the SSEMPS, oversight during High Risk activities, completing SAR training sessions and conducting fish rescues, associated reporting, and other specialty tasks, such as walleye spawning surveys, as needed.

Ecologist
Taunton Road EA | Regional Municipality of Durham | 2018 – Ongoing

An environmental assessment related to potential road widening and culvert replacement of 10 structures along Taunton Road is ongoing. To date, Christine has conducted an aquatic habitat assessment at each crossing structure, using the MTO's (2013) Environmental Guide for Fish and Fish Habitat as guidance for the field assessment; summarized the existing conditions at each location; and provided sizing recommendations for three structures that have gone on to preliminary design, based on fish and wildlife passage criteria.

As designs progress, Christine will assist in the environmental permitting related to Central Lake Ontario Conservation Authority (CLOCA) and DFO.

Ecologist
Shoreline Improvements between Martin Rd N and Victoria Ave N | Town of Lincoln | Lake Ontario | 2019 - Ongoing

High-water levels across Lake Ontario and isolated flooding events caused the deterioration of the shoreline within Town of Lincoln limits. Shoreline erosion subsequently caused significant damage to the adjacent road surface and foundation. To date, Christine has conducted an aquatic habitat field assessment, while also assisting with a bathymetric survey. The habitat assessment will contribute towards the Class Environmental Assessment and conceptual design with respect to fish habitat enhancement features. As the design process progresses, Christine will also obtain required environmental permits and approvals from appropriate agencies.

CAN-CISEC Inspector/Ecologist
Hydro One Underground Cable Replacement | Black & MacDonald Ltd | Toronto | 2018 – 2020

GHD was retained by Black & MacDonald to provide multiple services pre- and during construction for an underground hydro cable replacement project located in the City of Toronto. Both underground directional drilling and open cut trenching were employed.

The path of the works passed through environmentally sensitive areas where public relations were deemed to be a priority. As such, during the construction phase of the project, Christine has acted as the lead Environmental Inspector, conducting weekly, pre- and post- rain event inspections. Christine has also made herself available to respond to additional inspection tasks on short notice. Christine has coordinated the inspections with the client, and discussed recommendations related to ESC repairs and enhancements with the Site Foreman. Weekly reports were also submitted to document site conditions, work progression and due diligence in environmental protection.

This project is currently ongoing, with environmental inspections anticipated to continue through to completion of site restoration. Christine's commitment to the project to date has resulted in continuity in inspections and communication with the client, and adherence to environmental requirements.

CAN-CISEC Inspector/Ecologist
Block 3 Compliance Monitoring | Block 3 Landowners Group | Brampton | 2014 – 2019

GHD undertook a 1,532-m natural corridor design for the realignment of Tributary 8B within the Block 3 Development Lands. This residential development was adjacent to two tributaries designated as redside dace habitat, which is listed as endangered under the *Endangered Species Act, 2007*. Construction of the natural corridor design was integral to the overall development activities within the site.

GHD was further retained to ensure that all environmental monitoring conditions were met in support of the site development activities. During her time at GHD, Christine has completed the annual monitoring activities required for this development as part of the MNRF and Credit Valley Conservation (CVC) permitting approvals. Monitoring activities include general site inspections; vegetation assessments; benthic invertebrate sampling and channel morphology surveys following the Ontario Stream Assessment Protocol (OSAP); surface water quality sampling and temperature monitoring.

In addition, during construction of the subdivision adjacent to the corridor, Christine conducted bi-weekly and event based ESC inspections of the active construction areas. Christine reported any deficiencies in the ESC measures and recommendations for improvements to the site engineer and regulatory agencies through memos and bi-weekly reports, ensuring compliance with all approvals, smooth project implementation and protection of sensitive aquatic habitat.

Ecologist
Block 5 Ongoing Compliance Monitoring | Fieldgate Developments | City of Brampton | 2014 - 2019

Within the Block 5 Development Lands, located in the City of Brampton, a residential development was proposed adjacent to two tributaries designated as redside dace habitat, which is listed as an endangered species under the Endangered Species Act, 2007. GHD was retained to ensure that all environmental monitoring conditions were met in support of the site development activities.

During her time at GHD, Christine has completed the annual monitoring activities required for this development as part of the MNRF and Credit Valley Conservation (CVC) permitting approvals. Monitoring activities included general site inspections; vegetation assessments; benthic invertebrate sampling and channel morphology surveys following OSAP; surface water quality sampling and temperature monitoring. Christine evaluated this data with respect to the development's impacts on fish and fish habitat and reported annually to the relevant regulatory agencies.

CAN-CISEC Inspector/Ecologist
Block 51-1 ESC Compliance Monitoring | Mount Pleasant Landowners Group | Brampton | 2017 – 2019

GHD has undertaken extensive ESC monitoring on behalf of the Mount Pleasant Landowners Group for over five years in an effort to limit any negative impacts during development of a large subdivision site to the receiving Huttonville Creek system and endangered redside dace habitat. In 2017, Christine took over the day-to-day

responsibilities of this project, which included bi-weekly and event based ESC inspections; reporting of deficiencies and recommendations to the appropriate site engineer and regulatory agencies; attendance at construction progress meetings; and liaison with the local Conservation Authority and MNRF staff.

In addition, real-time continuous turbidity monitoring following the Silt Smart Protocol (Version 1.2, March 2012) had been ongoing at this development site. Two turbidity monitoring stations have been maintained by GHD, in which alarms indicate raised turbidity levels within the watercourse. Christine had responded to these alarms, communicated observations with regulatory agencies, and maintained the equipment, as needed, ensuring a rapid and appropriate response to any issues impacting the creek.

Ecologist
Culvert Stabilization, Root River | CN Rail | Sault Ste. Marie | 2018

The culvert crossing at CN Rail Ruel Subdivision Mile 7.63 was determined to be a barrier to fish passage by Fisheries and Oceans Canada (DFO). The crossing consisted of five corrugated steel pipe (CSP) culvert barrels set at staggered elevations, with the center barrel at the lowest elevation. A scour hole had formed at the outlet of the culvert barrel resulting in perched outlets, which were unlikely to accommodate fish passage during baseflow or low flow conditions.

The proposed concept to improve fish passage was to install a constructed riffle downstream of the culvert, which would provide a pool between the riffle and end of culvert barrel. The riffle would be designed to accommodate fish passage; and the pool would help to dissipate the erosive force of flow discharging from the culverts during high flow events, as well as create a resting place for fish, prior to swimming through the culvert barrel.

Christine provided on-site construction oversight during the implementation of the design. Christine's knowledge of stream restoration techniques allowed her to provide field fit advice to the contractor in regards to the design, mitigation measures, and desired fish habitat features. The project was completed on time, with visual confirmation of salmon successfully passing through the constructed riffle and culverts.

Ecologist | Elgin East Channel Trail Improvements – Aquatic Assessment | City of Richmond Hill | 2016 - 2018

Christine's background in aquatic ecology contributed to the assessment of a highly impacted urban stream, recommendations of restoration opportunities and evaluation of alternatives for consideration by the City of Richmond Hill.

As part of this project, Christine completed an aquatic habitat assessment using a modified approach of the Ontario Stream Assessment Protocol (OSAP). She noted general observations of habitat in the field, parameters of which included:

- Substrate composition
- In-stream cover opportunities
- Width and depth (bankfull and low flow)
- Erosion and anthropomorphic impacts
- Riparian habitat composition

In addition, following OSAP protocol, Christine conducted a barrier assessment on 11 in-stream structures with respect to fish passage. This assessment looked at both structure height and flow velocity.

The resulting report proposed and evaluated five rehabilitation scenario alternatives, with a suggested preferred alternative. The preferred alternative went to detailed design, with Christine assisting with the acquisition of environmental permits. Construction was completed in summer 2018, leading to a vast improvement on existing aquatic habitat conditions.

Ecologist | Baseline Aquatic Habitat Assessment | Rambler Metals and Mining Canada | Newfoundland | 2016-2017

Christine's monitoring experience with and knowledge of Salmonid habitat allowed her to take a lead role in the organization and implementation of an out-of-province baseline aquatic habitat assessment focusing on three small lakes and their connecting tributaries in north western Newfoundland.

The assessment involved:

- Presence/absence surveys of the fish community using fyke nets, seine nets, minnow traps and backpack electrofishing
- General qualitative fish habitat assessments
- Benthic invertebrate community monitoring following the Ontario Benthos Biomonitoring Network (OBBN) protocol
- Water quality and sediment sampling

Christine compiled the collected information and subsequent results and recommendations in a comprehensive summary report to be used by the client in an Environmental Assessment and permitting process. Christine's efficient implementation of the monitoring program resulted in the completion of the multi-faceted project on time and budget.

Ecologist
CP Dublin Derailment | Canadian Pacific | Nipigon | 2015

Following a train derailment in 2015 in the vicinity of MacInnes Creek, east of Nipigon, Ontario, GHD developed a restoration plan, involving both upland and lowland components. In-stream work focused on improving habitat conditions for riverine rainbow and brook trout. Design features included riparian planting, shoreline/bank stabilization, bioengineering and in-stream structures to improve refuge and nursery habitat and connectivity upstream of a culvert.

Christine provided on-site construction oversight during the implementation of the design. Christine's knowledge of stream restoration techniques allowed her to provide advice to the contractor to ensure accurate construction of the design, guidance on implementation of techniques such as live staking and bank stabilization, and application of appropriate mitigation measures.

The project was successfully completed on time to the satisfaction of involved regulatory agencies. The site has subsequently continued to naturalize, with spawning trout reported using the habitat.

Permitting Specialist/Ecologist
John Mills Bridge Rehabilitation | Region of Durham | Town of Ajax | 2015 – 2016

Beginning at the preliminary design stage, Christine consulted with multiple regulatory agencies to ensure the rehabilitation design of an existing bridge, and associated stream rehabilitation efforts, would be supported and approved. Approvals from the Toronto and Region Conservation Authority (TRCA); MNRF, with respect to Species at Risk (SAR) and watercourse navigability; and review by the DFO under the Fisheries Act; were all necessary prior to project tender.

The project design itself required the coordination of input from multiple disciplines within GHD. In addition to the coordination of the permitting application packages, Christine also provided input into the ESC plan, which was critical to agency support.

Ecologist
Fish and Wildlife Rescue | various projects | 2014 – Ongoing

On behalf of GHD and its clients, Christine acquires all fish and wildlife collection permits from the MNRF for projects requiring un-watering activities prior to construction works. These permits allow construction to proceed in a timely manner, while meeting requirements specified by regulatory agencies.

As a result of specialized certifications, Christine is able to lead the fish rescues, salvaging fish from the isolated project areas using backpack electrofishing, dip netting, and/or seining techniques; following approved safety protocols. She communicates with the MNRF as necessary and completes all subsequent reporting associated with the permits.

Other related areas of interest

Certifications

- Offshore Protected Species Observer Training (February 2020)
- MTO/DFO/MNRF Fisheries Protocol (April, 2018)
- Certified Inspector of Sediment and Erosion Control (CISEC) (April 2017)
- Ontario Wetland Evaluation System Training, (2015)
- Class 2 Backpack Electrofishing Certification (recertified May 2017)
- OBBN Certification (2013)
- OSAP Level 2 Fish Identification (2012)
- OSAP Monitoring Protocol Certification (2011)

Safety training

- St. John's Ambulance Standard First Aid and CPR C (recertified January 2020)
- CN Contractor Safety Course (recertified March 2017)
- HAZWOPER training (February 2015)
- Working on Ice Safety Training (2012)
- Pleasure Craft Operator Card (December 2006)
- Non-Pleasure Vessel Basic Safety Course (2005)

Workshops/courses

- Tree and Shrub Identification Workshops, University of Guelph Arboretum (2016)
- Trout Unlimited Aquatic Renewal Workshop Series (2013-2014)
- Young Conservation Professionals Career Development Program (2009)
- Temperate Wetland Restoration Training (2005)
- ROM Identification of Ontario Fishes (2005)

Work history

January 2014 – present	GHD, Mississauga, ON
2004 - 2014	Ontario Streams, Project Biologist/Coordinator

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

Marc Gaudet
Marc.Gaudet@ghd.com
905 682 0510

Jennifer Penton
Jennifer.Penton@ghd.com
289 440 3244

www.ghd.com