Application Form for World Centre of Excellence on Landslide Risk Reduction 2020-2023

1. **Name of Organization:** *University of Alberta*
2. **Name of Leader:** *Michael T. Hendry*

   Affiliation: *Associate Professor*, *University of Alberta*

   Contact: *9211 116th Street, University of Alberta, Edmonton, Alberta, Canada T6G 1H9*

   Phone: *+1-780-492-0200;* **Email:** *hendry@ualberta.ca*

   Core members of the activities: *Renato Macciotta Pulisci / University of Alberta*
   David Elwood / University of Saskatchewan
   David Huntley / Geological Survey of Canada
   C. Derek Martin / University of Alberta
3. **Date of Submission of Application:** *July 2, 2019*
4. **Activity scale and targeted region:** *National & International*
5. **Short Title (10 words maximum) characterizing past and planned activities**

Slow moving translational landslides in argillaceous soils and weak rocks.

6. **Objectives for the initial 3 years:** (5 lines maximum; what you expect to accomplish?)

(1) *Develop current investigation of large translational landslides in shale on the Assiniboine river valley (near St. Lazare, Manitoba) into a national study site with high frequency pore pressure measurements, displacement monitoring with SAAs, dGPS, and SB-InSAR, and laboratory testing of weak shales.*

(2) *Develop susceptibility models and mapping for translational landslide in valleys with argillaceous soils and weak rocks, calibrated to landslides in the Thompson, Assiniboine and Peace river valleys.*

7. **Background Justification:** (10 lines maximum)

Canadian transportation infrastructure traverses a continent and extends to the Atlantic, Pacific and Arctic oceans. There are several large river systems that have been incised into heavily consolidated clays and weak shales, and result in large regions that are susceptible to developing translational landslides along weak sub horizontal bedding planes. Examples of this can be found in the Thompson, Fraser, Peace, North Saskatchewan, South Saskatchewan and Assiniboine river valleys. Though these rarely impact populated areas due to the low population density, these landslides pose long-term hazards to transportation infrastructure that cross or run along these valleys.

8. **Resources available for WCoE activities**

Personnel, Facilities, Budgets, and Affiliation and Contribution to ICL/IPL-GPC.

The University of Alberta research group includes Drs. Michael T. Hendry, Renato Macciotta Pulisci, David Elwood, David Huntley and C. Derek Martin; two research engineers (Drs. Mahya Roustaei and Parisa Abdulrazagh), and over the next 3 years we expect to work with 5 PhD students and 4 MSc student on natural hazard related projects.

Our facilities include: extensive laboratory testing equipment including triaxial cells (strain controlled and stress path controlled) direct shear, direct simple shear, ring shear testing etc.; and, our field monitoring systems include GPS surveying equipment, long range Optech LiDAR system, two IBIS-L GB-InSAR systems, dGPS system surface displacement monitoring (GeoCubes) and an assortment of drones. We have also recently developed low cost data loggers using open source micro controller that can be used for a majority of geotechnical sensors (including vibrating wire piezometers) for a small fraction of the cost of those commercially available, an expertise that we wish to share.

The current research budgets for natural hazard related research at the University exceeds $130,000 CAD/year (combination of private sector and government grants), with most of this funding being used for support of students. In addition, the GSC has $200,000 CAD/year to facilitate research at these studies sites. Our private sector and government collaborators also provide in-kind support through the purchase of instrumentation, or for site investigation (drilling, geophysical surveys, airborne LiDAR surveys etc.).

The University is currently a fully paid member of the ICL, and has begun to participate in annual workshops (starting in Kyoto 2018) and WLFs. We have worked to develop heavily instrumented national test sites on large landslides, we are open to having members of the ICL collaborate on these sites, and to host students and faculty from ICL affiliated universities to further their studies.

9. Description of past activities related to risk reduction of landslides and other related earth system disasters (30 lines maximum)

The focus of the research at the University of Alberta has been to evaluate the performance of monitoring technologies and remedial methods to mitigate natural hazards, and the use of these technologies to find previously unidentified natural hazards. Through the Railway Ground Hazard Research Group (RGHRP), the University of Alberta has made significant contributions to the understanding of natural hazards that impact railway operations and other types of linear infrastructure. This included quantifying the hazard posed by rock falls and developing correlations between the temporal distributions of rock falls to climatic conditions (such as precipitation, freeze-thaw cycles and snow accumulation for the monthly average distribution and the hydrological year), as well as the effect of large-scale weather events such as El Niño or La Niña [1,2].

Notable contributions have been made in landslide research, particularly at the Ripley Landslide, an existing slow-moving landslide affecting Canadian National's (CN) and Canadian Pacific's (CP) main lines. The research was conducted in collaboration with the GSC with funding from Transport Canada, CP and CN.

Our collaboration has made the Ripley Landslide into a national laboratory for testing multiple landslide monitoring technologies, ranging from space-based InSAR (provided by the Canadian Space Agency) [3] and novel acoustic systems to traditional natural instruments [4,5]. This comprehensive technology testing program has allowed comparisons of the accuracy of these systems and their suitability and usefulness [4]. We have also conducted a very thorough concurrent investigation of the site with boreholes, geophysics and laboratory testing [6]. This work represents cumulative investment of over $1,000,000 CAD in instrumentation, drilling, laboratory testing and geophysics. The site is currently being opened to other researchers who wish to try new monitoring technologies at this site; this has already led to collaboration with the Chinese Academy of Sciences, the British Geological Survey, and the University of Loughborough in the UK.

10. Planned future activities /Expected Results: (20 lines maximum; work phases and milestones)

In addition to the research outlined above (§5&6), the natural hazards research group at the University of Alberta (next 5-years) will continue development and evaluation of monitoring technologies for investigation of natural hazard mechanism, and the development of early warning systems; and, investigate the susceptibility of transportation infrastructure (roads, railways and pipelines) to damage from extreme weather events to facilitate adaptation to a changing climate.

The evaluation of monitoring technologies will include the use of UAV photogrammetry, dGPS system and satellite and ground-based radar at two sites (one to monitor a rock slope, and one to monitor a soil landslide). The objective will be to assess these tools for early warning systems; as well as their logistics and effectiveness under different site conditions (e.g., geohazard type, remoteness, weather); and provide insights into the failure mechanisms, and relationship with weather and anthropogenic activities.

The investigation of the susceptibility of transportation infrastructure to extreme weather events will conduct a review of large-scale flooding and fire events as examples of stress-tests and scenario modelling on infrastructure, and the susceptibility of the surrounding terrain to natural hazard events. This review will be used to develop a framework for modelling extreme weather events at local and regional scales, calibrated to documented events, then applied to other regions to identify critical locations and systems that require an increase in resilience.

11. Beneficiaries of WCoE: (5 lines maximum; who directly benefits from the work?)

All of the research conducted at the University of Alberta is carried out with the goal of being published in peer reviewed journal papers, presented at national and international conferences, and made freely available through the University of Alberta's online repository. The focus of the research program (as per our funding agencies) is to provide support for the private and public sectors that maintain transportation infrastructure in Canada, however, the geotechnical research and developed technologies are internationally applicable.

12. References: 10 lines maximum, i.e., relevant publications, international/regional/national recognition supporting items 9-10.

1. *Macciotta, Hendry, Cruden, Blais-Stevens, & Edwards, T. (2017) "Quantifying Rock Fall Probabilities and Their Temporal Distribution Associated with Weather Seasonality" Landslides, 14(6).*
2. *Macciotta, Martin, Cruden, Hendry, & Edwards (2017) "Rock fall hazard control along a section of railway based on quantified risk" Georisk, 11(3).*
3. *Journault, Macciotta, Hendry, Charbonneau, Huntley & Bobrowsky (2018)." Measuring the Activity of the Thompson River Valley Landslides, South of Ashcroft, BC, Canada, Using Satellite InSAR" Landslides 15(4).*
4. *Macciotta, Hendry & Martin (2016) "Developing an early warning system for a very slow landslide based on displacement monitoring." J. Natural Hazards, 81(2).*
5. *Hendry, Macciotta, Martin & Reich (2015) "The Ripley Landslide: the effect of river level on velocity and instability of natural slopes", Can. Geotech. J., 52(3).*
6. *Huntley, Bobrowsky, Hendry, Macciotta, Best (2019) "Multi-technique geophysical investigation of a very slow-moving landslide near Ashcroft, British Columbia, Canada" J. Env. Eng. Geophysics, 24(1).*

13. If your organization is an ongoing WCoE 2014-2017, please attach the articles reporting activities of WCoE, IPL project and ICL network published/contributed to either in *Landslides:* Journal of International Consortium on Landslides or/and the Fourth World Landslide Forum 2017.

Not applicable

14. List of published or planned reports of WCOE 2017-2020 in journal "Landslides" or "WLF5 books" for ongoing WCOE organization.

Macciotta, Hendry, Cruden, Blais-Stevens, & Edwards (2017) "Quantifying Rock Fall Probabilities and Their Temporal Distribution Associated with Weather Seasonality" Landslides, 14(6).

Carlà, Macciotta, Hendry, Martin, Edwards, Evans, Intrieri, Farina & Casagli (2018) "Displacement of a landslide retaining wall and application of an enhanced failure forecasting approach based on inverse velocity" Landslides, 15(3).

Journault, Macciotta, Hendry, Charbonneau, Huntley & Bobrowsky (2018) "Measuring the Activity of the Thompson River Valley Landslides, South of Ashcroft, BC, Canada, Using Satellite InSAR" Landslides, 15(4).

Huntley, Bobrowsky, Hendry, Macciotta, Elwood, et al. (2019). "Application of multi-dimensional electrical resistivity tomography datasets to investigate a very slow-moving landslide near Ashcroft, British Columbia, Canada." Landslides, 16(5).

Rodriguez, Macciotta, Hendry, Roustaei, Gräpel, & Skirrow (2019) "Case Study of the use of an unmanned aerial vehicle for monitoring, investigation and mitigation design of a rock slope with multiple failure mechanisms" Landslides, submitted July. 2019

Macciotta (2020) "Transportation infrastructure vulnerability to landslides in Western Canada", accepted for presentation at WLF5, Kyoto, Japan

Hendry (2020) "Development of Active landslides and ground hazards into full-scale laboratories: outcomes and benefits", accepted for presentation at WLF5, Kyoto, Japan

Note: Please fill and submit this form by 15 August 2019 to ICL secretariat <secretariat@iclhq.org>