MINISTRY OF TRANSPORTATION OF ONTARIO (MTO)

Highway Infrastructure Innovations Funding Program

Guidelines & Application Forms for
Ontario Universities and Colleges

2021/2022

November 2021

Ontario

ONTARIO MINISTRY OF TRANSPORTATION HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM

GUIDELINES 2021/2022

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ONTARIO MINISTRY OF TRANSPORTATION

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM *for Ontario Universities and Colleges* Guidelines 2021/2022

Deadline for Applications is
January 17, 2022 at 4:00PM

1.0 INTRODUCTION

The Ontario Government seeks to invest in the future of Ontario's Transportation Infrastructure through its Highway Infrastructure Innovation Funding Program (HIIFP).

HIIFP provides a challenge to Ontario's academic community to contribute to solutions in several areas including engineering materials, traffic operations, intelligent transportation systems, highway design, investment planning, environmental, bridges, geomatics, construction and maintenance. Some of these challenges involve detailed technical issues and others are open invitations for new ideas in a focus area. Your Institution is invited to submit one or more applications on how you can help us meet these challenges.

2.0 PURPOSE OF THE PROGRAM

The purpose of this program is to fund research at Ontario colleges and universities to encourage applied research in transportation infrastructure in Ontario. This program is intended to solicit innovative solutions to assist the Ministry in meeting its strategic plan and to encourage undergraduate and graduate research in transportation and infrastructure engineering by providing funding to aid in such research. The present funding program is designed to supplement the research expertise at the Ministry with that available from Ontario's academic community. The following areas of transportation and infrastructure engineering are included in this program:

- Traffic Operations
- Intelligent Transportation Systems
- Engineering Materials
- Highway Design
- Investment Planning
- Environmental
- Geomatics
- Bridges
- Construction
- Maintenance

Research needs statements have been developed that outline the background of the research need, the challenge or problem to be addressed and anticipated research deliverables. Most of the challenge statements involve specific problems that will require innovation to solve. Typically, the anticipated research deliverable includes a technical report and a presentation to a Ministry technical committee.

HIIFP is intended to support and encourage research into highway infrastructure. The Ministry has identified several specific topics that offer an opportunity for learning, innovation, and results. The Ministry will further support researchers with the opportunity for direct contact with Ministry specialists.

3.0 SCOPE OF THE HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM

3.1 Eligible Institutions

All Ontario's 22 public universities and 24 colleges are eligible for funding under the HIIFP. The principal researcher must be a member of the faculty (full or part-time) at the sponsoring Institution.

3.2 Eligible Research Topics

A diverse range of research topics in the area of transportation and infrastructure engineering are included in this program.

To be eligible for funding, HIIFP applications must cover one (or several) of the topics from the following categories:

- Specific Research Topics
- Open Research Topics

3.2.1 Specific Research Topics

Each Specific Research Topic is defined as follows:

Subject Area:	General Subject Area
Title:	Title that identifies subject area
Background:	Discussion of the subject area, work done to date, thoughts on how to solve the challenge, reference information.
Challenge:	A statement or question that outlines the challenge.
Anticipated Deliverables:	Typical deliverable is a technical report that demonstrates how the challenge was addressed and/or met and shows how improvements may be made. A presentation to a technical committee is also expected. Sometimes the anticipated deliverable provides more information on how to meet the challenge.

The following topics have been identified as priority research areas for this year:

1. Support for Spring Load Restriction Decisions
2. Impact of Cement Changes on Determination of Aggregate Reactivity
3. Automatic Road Condition Reporting**:** Sensors Development
4. Winter Severity Index (WSI) Representation Review
5. Innovative Winter Maintenance Material, Equipment and Procedures Evaluation
6. Salt-impacted Soil and/or Water Remediation Strategies

7. Development of Computer Tools to Analyze a Concrete Section Subject to Combined Loading
8. Development of Computer Applications to Determine the Roughness of Concrete Surfaces
9. Jurisdictional Scan on Utilizing Drone Technology by Transportation Agencies
10. Remote Inspection on Construction Sites
11. Introduction into the Systemic Approach to Safety for Ontario
12. Investigating Applications of the Autonomous Vehicle (AV) Technology Stack to Enhance Highway Operations

Detailed descriptions of each topic are provided in **Attachment A.**

3.2.2 Open Research Topic(s)

MTO will also accept and evaluate HIIFP proposals on topics not specified in the Guidelines that the principal researcher considers relevant to highway infrastructure innovation and the Ministry's business needs.

If you choose to submit an HIIFP application on another research topic, please carefully outline to the Ministry a clear need for the research topic(s) including how its application will enhance MTO practices and business needs.

For more information and to determine suitability of the proposed topic, contact:

Olena Czajkowski
HIIFP Program Coordinator
Transportation Infrastructure Management Division
Ministry of Transportation
HIIFP@ontario.ca

3.3 Ministry Assistance in Conducting Funded Research

For each application that is approved, a Ministry technical specialist in the relevant subject area will be assigned to liaise with the principal researcher.

Timing of periodic meetings or telephone conference calls and brief progress reports will be negotiated at commencement of the project. Brief written progress reports will be required a minimum of every 6 months; see Attachment E for sample template.

3.4 Available Funds and Eligible Expenditures

Please be advised that the award value is subject to budget approval and the Ministry may have to delay any awards until the budget has been approved.

The Ministry reserves the right not to provide any funds in its sole discretion and without any reasons.

The Ministry will consider applications that are multi-year, where funding is required in each year. In such cases the Ministry will endeavour to provide funding beyond next

fiscal year, however, cannot guarantee funding in future years and reserves the right to not provide the funding and terminate the research on written notice to the Institution.

For approved multi-year applications, Institutions will be required to provide brief progress reports to the Ministry indicating progress made on the project by the Institution; see Attachment E for sample template. Failure to provide such progress report(s) that describes substantial completion of tasks set out may result in the Institution being denied funding in subsequent fiscal years.

The salary of the principal researcher is not eligible for funding under the HIIFP, and nor is the principal researcher to charge any fee in this respect.

3.5 Fieldwork on Ministry Highways

The Ministry must approve proposed fieldwork on Ministry highways, and any proposed fieldwork on Ministry highways must be communicated by the principal researcher to the Ministry prior to submitting an HIIFP application. Approval to proceed will be given by:

Olena Czajkowski
HIIFP Program Coordinator
Transportation Infrastructure Management Division
Ministry of Transportation
HIIFP@ontario.ca

3.6 Information and Data Confidentiality

The principal researcher and the Institution agree that all information and data that the Ministry may provide in respect of the research project shall be kept confidential and that the Institution shall only use the information and data for the purposes related to the submission of a final report to the Ministry for the research project. The Institution shall ensure that reasonable methods are taken to secure the confidential information and data of the Ministry. Failing to comply with this provision may result in the termination of the project, where upon the Institution shall return all information and data, return all monies paid by the Ministry and may result in the Institution being precluded from the award of future HIIFP awards.

4.0 APPLICATION PROCEDURE, DEADLINES

4.1 Application Components

The application shall consist of the following components:

1. **MTO HIIFP Application Form (Attachment B)**
2. **Summary** of Research Proposal (300 words maximum, in plain language suitable for communicating with the public **(Attachment C).** Portions of this summary may be used in a media release, so the language should be non-technical and free of acronyms or jargon.
3. **Budget Summary (Attachment D)**
4. Detailed **Research Proposal** (maximum 10 pages in 12-point font). Note, requirements are described in Section 4.2
5. **Budget** Details (see section 5.0 BUDGET).
6. ***Curriculum vitae*** of Principal Researcher and other principal research staff named in the Application Form (component 1, above).

7. If applicable, description of and reason for request for use of MTO Facilities and or work on MTO highways.

Section 6.0 SELECTION CRITERIA outlines the criteria used to assess the applications for HIIFP funding.

The Ministry reviewers will treat information contained in the submitted applications as confidential.

4.2 Detailed Research Proposal Requirements

The detailed research proposal must include a description of:

- Understanding of the need for this research and the objective
- Methodology and details of the proposed analysis
- Proposed innovation in approaches, methodologies and potential outcomes
- Schedule of the activities to be undertaken during the project, identifying key milestone and associated dates
- Qualifications of the principal researcher in the planned area
- Related work performed by the applicant and others on the team.

4.3 Deadlines & Address for Applications

Deadline for the receipt of applications is **January 17, 2022, 4:00 PM EST.** Completed applications and all supporting documentation must be received by this deadline and submitted to:

Olena Czajkowski
HIIFP Program Coordinator
Transportation Infrastructure Management Division
Ministry of Transportation
HIIFP@ontario.ca

Please submit:

- 1 electronic digital copy

5.0 BUDGET

5.1 General

The detailed budget must include a full account of purchases and activities to be financed by the HIIFP funding. The level of budget breakdown and supporting information provided should be sufficient to justify the items relative to the Research Proposal description.

As stated in Section 3.4, multi-year funding applications will be considered and provided on condition that sufficient information is provided.

The Ministry selection committee reserves the right to disallow expenditures in the budget that are not adequately justified.

5.2 Budget Summary

Institutions must submit a budget summary as stated in 4.0 Applications Procedures, Guidelines, and having regard to the provision of Available Funds and Eligible Expenditures.

Furthermore, the following types of expenditures are eligible for funding:

5.2.1 Estimated Salaries and Benefits
Salaries, stipends, and related federal, provincial and institutional non-discretionary benefits for research work performed by research personnel (i.e., students, research associates, and technicians). The Ministry will not fund the salary of the principal researcher.

5.2.2 Estimated Equipment or Facility
Equipment or facility costs directly attributed to the research proposal may be funded. The researcher may propose to use Ministry materials and structural laboratory facilities as part of their application, where facilities are not available in their Institution. The Ministry will not normally fund the purchase of major equipment, or the rental of existing equipment. However, in exceptional cases that satisfy the Ministry, major equipment purchases, rental of large shared equipment or purchase of computer time will be considered on a case-by-case basis.

5.2.3 Materials and Supplies
Materials and Supplies include materials directly attributable to the research proposal such as the purchase of engineering materials. Where the Ministry is supplying materials, this has been indicated in Section 3.2.1 Defined Research Topics and Attachment A.

Supplies include expendable materials, printing, photocopying, and other similar office supplies.

5.2.4 Dissemination Costs
Dissemination costs include costs associated with the preparation of the final report. The Ministry will require the final technical report to be submitted in accordance with the ***MTO Style Manual for Technical Publications.*** This Style Manual will enable researchers to submit in a consistent and cost-effective format.

5.2.5 Overhead
Overhead may be included in the cost of your application. The Budget Summary form provided in Attachment D requires that you identify the rate of overhead for your Institution. **Please note that funds provided under this Program are considered a Research Grant and overhead rates should be calculated and presented accordingly and must not exceed 25%.**

6.0 SELECTION CRITERIA
Staff of the Ministry of Transportation will review applications for funds from the HIIFP. To assist Institutions/applicants in completing the forms, the selection criteria for applications are as follows:

- Experience and qualifications of the researcher(s) in the subject area(s) – maximum of 25 points

- Demonstrated understanding of the need for the research and the objective – maximum 25 points

- Innovativeness of proposed research approach, methodologies and potential outcomes – maximum 25 points

- Feasibility of accomplishing the research within estimated timelines and budgets – maximum 25 points

- Other Considerations Not Awarded a Numerical Score:
    - Value-for-money (overall costs to the Ministry including Overhead Rate)

    - Importance of research proposal to MTO

    - Level of funding secured or provided in-kind from other sources.

The Ministry selection committee may request clarification of points contained in the proposal of any applicant.

7.0 NOTIFICATION OF AWARD

A letter announcing an award will be sent from the Ministry to the principal researcher at the beginning of the award period, and a copy is sent to the financial official of the Institution designated in the application. The letter provides authority to incur project expenses for items and amounts specified in the **approved**, detailed budget. Expenses incurred in excess of the approved budget are not the responsibility of the Ministry.

The holders of research awards and their associates are not considered employees of the Ministry of Transportation Ontario or the Government of Ontario. The Ministry reserves the right to terminate an award without cause at any time by providing written notice of termination.

Any public announcements about the award of funding for the HIIFP shall be made by the Ministry, unless the Institution obtains the prior written approval of the Ministry.

8.0 FINANCIAL ARRANGEMENTS & REPORTING REQUIREMENTS

Awards will be paid to the Institution in one instalment of each year of the award in May.

Recipients of funds under this program **are required** to maintain periodic contact with MTO staff assigned to monitor the progress on the research. A **financial report** must be submitted to the Ministry by the designated official of the Institution upon completion of the research project. This report will include a full account of purchases and activities financed by the HIIFP. It will also include an itemized list of equipment that was purchased in whole or part with the funds. The following headings will be included in the financial report:

- Salaries and Benefits;

- Equipment or Facility;
- Materials and Supplies;
- Travel;
- Dissemination Costs;
- Other Costs

The Ministry reserves the right to audit any project. The Institution is required to keep for five years any records that may be required for a financial audit.

For approved multi-year applications, in order for an institution to be funded in subsequent years on a multi-year basis, Institutions will be required to provide progress reports to the Ministry indicating progress made on the project by the Institution; see Attachment E for sample template. Failure to provide such progress report(s) that describes substantial completion of tasks set out may result in the Institution being denied funding in subsequent fiscal years.

Any surplus or funds not spent must be returned to the Ministry by the Institution. If the research is not started or terminated part way through a project, any unused portion of the research funding must be returned to the Ministry within 30 calendar days.

9.0 AMENDMENTS TO A RESEARCH PROPOSAL
The Ministry must be notified either in writing in advance of any intention to:

- Alter the direction or intent of the research;
- Terminate the research;
- Reassign research responsibilities to other researchers, than those named in the original HIIFP application;
- Alter the work schedule.

The principal researcher must consult with the Ministry and obtain approval from:

Olena Czajkowski
HIIFP Program Coordinator
Transportation Infrastructure Management Division
Ministry of Transportation
HIIFP@ontario.ca

Written approval from the Ministry must be obtained before any alterations in the project are implemented. If the Institution is uncertain as to what constitutes an alteration in the project, he/she should contact the above noted contact to discuss this matter.

10.0 ANTICIPATED OUTCOME / DELIVERABLES
The Institution shall submit a final report (typically about ten to fifteen pages in length) in electronic format no later than **three months after** the end of the funding period or after termination of funding by the Ministry. Members of the Ministry application review committee that recommended support of the research will review the final report.

The final report shall be submitted in PDF format and should include:

- Conclusions and discussion of applications of the new findings to the challenge statement

- Plans for publication and/or implementation of results

The Ministry will retain the final report and make it widely available to others through the **MTO Online Research Library.**

Note: A copy of a student thesis or dissertation is **NOT** a substitute for a final report according to the above format.

Reprints of publications or manuscripts submitted to journals and copies of papers presented at scientific meetings should be included with the final report. (Manuscripts and articles *in press* will remain confidential.)

The Institution or the principal researcher shall also provide the Ministry a copy of any follow-up publications which the researcher prepares following the project and which incorporates any portion of the research outcomes.

10.1 Disclaimer

Any publication resulting from research funded under this program shall acknowledge the source of funds and include a disclaimer, indicating that the views of the authors may not necessarily reflect the views and policies of the Ministry.

> **Sample of Disclaimer to be used:**
> "This research was supported [or in part] by a grant from the Ministry. Opinions expressed in this report are those of the authors and may not necessarily reflect the views and policies of the Ministry."

Should the Institution want to make specific reference to the Ministry and/or name Ministry staff in the publication, permission of the Ministry must be obtained prior to publication. Permission requests should be sent to the contact mentioned in Section 9.0.

11.0 RESEARCH OUTCOMES

If the Ministry elect to use the research outcomes from the HIIFP applications and as a condition of funding the research project, the Ministry shall be granted a non-exclusive, royalty-free license without charge to use the outcomes and/or conclusions in the research outcomes for the Ministry's own non-commercial internal purposes including use on Ministry highway contracts and work conducted on behalf of the Ministry.

In the event the Institution is able to obtain patent protection for any of the outcomes and/or conclusions in the research outcomes, the Ministry shall be granted a royalty-free non-exclusive license without charge to use the outcomes and/or conclusions in the research outcomes with no right to sub-license to third parties. The Institution shall arrange for the execution of the appropriate documents to give such licenses to the Ministry.

Should the research outcomes be further interpreted and/or refuted by the Ministry, then the Ministry's findings and/or conclusions shall become the responsibility of the Ministry. Should the Ministry's findings and/or conclusions differ from the findings and/or conclusions in the research outcomes, the names of the principal researchers, original

authors, and Institution shall not be associated with the Ministry's findings and/or conclusions.

12.0 EXTERNAL PUBLISHING AND COMMUNICATION OF RESEARCH OUTCOMES

Researchers are encouraged to publish and present their research findings independently, but must notify the Ministry of the research findings and/or conclusions, and/or research outcomes being published or communicated must follow the procedure set out below, and must ensure the disclaimer described in Section 10.1 is attached there to:

12.1 In determining when the research findings and/or conclusions in the research outcomes, or the research outcomes should be disclosed, both the Ministry and Institution shall be sensitive to the need for timely approval of graduate student theses and essays.

12.2 The Institution, using best efforts, shall provide to the Ministry, at least sixty (60) calendar days in advance of any proposed publication or presentation, an outline and associated abstract of any research findings and/or outcomes, and/or research outcomes (or any other matter related to these Guidelines) which it intends to publish or present.

12.3 For the purpose of section 12.2 the terms "disclosure", "publication" and "presentation" include articles, seminars and any other oral or written presentations as deemed appropriate by the Institution to the public, but does not include student theses or other communications submitted for the purpose of evaluating student performance.

12.4 The Institution retains the right to have graduate student theses reviewed and defended for the sole purpose of academic evaluation in accordance with the Institution's established procedures.

12.5 All media inquiries regarding HIIFP awarded research should be referred to the Ministry. Researchers should not speak to the media directly regarding research outcomes. The researchers contacted by the media shall communicate that: "Highway Infrastructure Innovation Funding Program policy is to refer all media inquiries to MTO corporate communications." Once the request is received by MTO, staff will work with researchers on a suggested response.

13.0 OCCUPATIONAL HEALTH AND SAFETY

The Institution will be responsible for meeting all the obligations under the Occupational Health and Safety Act (OHSA) and shall ensure that the research is carried out in accordance with the OHSA and all applicable regulations.

Researchers intending to carryout fieldwork on Ministry right of way and researchers proposing to make use of Ministry laboratories must contact the Ministry for additional information on operational constraints and occupational health and safety requirements.

ATTACHMENT A – DETAILED DESCRIPTIONS OF SPECIFIC TOPICS

Subject Area:	Pavement Design and Asset Management
1. Idea Title:	Investigating Pavement Impacts in Spring to Support Spring Load Restriction Decisions and Implementation, for Improved Asset Management
Background:	The trucking industry approaches MTO to request spring load restriction harmonization across the province, and axle weight exemptions on vehicles carrying certain commodities. A study was completed to estimate the economic impact on MTO road infrastructure with modernized truck configurations, and municipal roads will bear the primary impact of any legislative changes. In order to model the pavement impact to support any spring load restriction for asset management purposes or to support possible changes in legislation, it is crucial to understand the impacts of loading on pavement strength in the spring on various pavement structures, in both provincial and municipal settings. Previous studies related to this topic were focused on the 1) effect of spring conditions on different subgrade material types, 2) use of ambient temperature to predict when to start and lift the seasonal load restrictions, and 3) validation of the need to apply spring load restrictions on a project specific basis (e.g. specific roadways or corridors). A network level study to classify the spring load impact and pavement life reduction on various pavement categories is vital to estimate the economic impact of exempting axle weight restrictions in the spring.
Challenge:	Pavement strength impacts during the spring depends on several factors, including (but not limited to) pavement thickness, subgrade type, drainage condition and frost depth. For a project level study, pavement deflection analysis is carried out multiple times in the spring and summer to determine the strength lost during the spring. However, it is not feasible to carry such onerous studies to determine the pavement strength for all road infrastructure. Therefore, developing a framework for network level impact during spring load restriction is crucial in estimating and leveraging the social and economic impacts of spring load restrictions. Also, the asset management system currently uses a 1.2 spring factor for the whole province. The spring factor for each MTO Region is not necessary the same and should be differentiated (particularly in the case of northern Regions).

Anticipated Outcome:	Develop a framework to test and validate the pavement strength impact during the spring on various pavement structures. Classify the varying pavement structures that are already under spring load restrictions in: very weak, weak, medium and strong categories. Perform pavement deflection analysis on selected pavement structures in provincial and municipal settings. Analyze the pavement strength reduction in the spring and determine the spring reduction factors on the classified categories. In addition, determine the spring load factor for each of the five MTO regions – Central, West, East, North East and North West. Determine the relationship of pavement deflection and life reduction when axle load exemptions are allowed on the classified categories.
Benefits to MTO:	The information can be used for any upcoming requests to support the exemption of axle weight for various commodities. The information can be used to estimate and justify if the secondary highway requires spring load restriction. The spring reduction factor determined from this study can be utilized in the MTO asset management system, once the methodology is available for adoption by the ministry.
Contact:	Susanne Chan EMO, Pavement Section Susanne.chan@ontario.ca (437) 244-4693

Subject Area:	Soils & Aggregates and Concrete Sections, Engineering Materials Office
2. Idea Title:	Investigating the Impact of Changing from Type GU Cement to GUL for Alkali Silica Reactivity Testing of Concrete Aggregates.
Background:	Alkali Silica Reactive (ASR) aggregates are a serious threat to the durability of concrete infrastructure. ASR, which results in expansion, internal stresses and cracking of concrete, was prevalent in MTO structures in the 1980's resulting in numerous costly rehabilitations and replacements. As a result, MTO and other agencies undertook research programs to prevent such deleterious aggregates from being used in concrete infrastructure. Over many decades MTO has been a leader in ASR research, furthering the understanding of the mechanisms of ASR and collaborating in the development of test methods to assess the reactivity potential of concrete aggregates. MTO now maintains a robust oversight program to prevent ASR aggregates from being used in concrete structures through the use of the Concrete Aggregate Sources List (CASL) and Specifications for Concrete Aggregates which include ASR screening tests. The tests that were developed are still used today and include Accelerated Mortar Bar Test (CSA A23.2-25A) and Concrete Prism Test (CSA A23.2-14A). The establishment of the ASR aggregate test acceptance limits tests were based on a correlation between laboratory test results from known aggregates, against the long-term field performance of the same aggregates. CSA has adopted the same acceptance limits as MTO, and they have not changed for many years. A key concept in the assessment of an unknown aggregate against these acceptance limits is that the test method parameters must be strictly followed and there can be no deviation from the standardized test procedure.
Challenge:	Currently the test methods prescribe the use of type GU (General Use) cement with a defined alkali content. However, recently MTO has been advised that type GU cement will be phased out and replaced by type GUL cement (diluted with over 10% interground limestone). GUL cement has gained popularity as a more environmentally friendly alternative cement. It has been suggested by industry to change the ASR test methods correspondingly to prescribe GUL cement. However, the cement type is a critical parameter to the test method and introducing the interground limestone is likely to alter the test results, which may subsequently affect whether an aggregate exceeds the

	acceptance limits. The ASR screening tests may no longer be effective at detecting deleterious aggregates, presenting a risk to MTO's concrete infrastructure. Therefore, it is critical to determine the effect of changing from GU to GUL cement on the ASR screening tests. The research requires a long-term commitment since ASR testing takes up to 1 year to obtain results.
Anticipated Outcome:	Develop and implement a research and test plan to compare ASR test results using both GU and various GUL cement types on a variety of different but known aggregate types. The scope of the testing program must be statistically significant and include both AMB and long term (1 year) Concrete Prism tests. The research may also identify any differences in development of ASR resulting from the use of the GUL cement with interground limestone. A report that sets out all the test data collected, analytical results and identifies the potential impacts of changing from GU to GUL type cement on the lab measured ASR expansions for several rock types, is a required outcome.
Benefits to MTO:	The information will be used to determine whether MTO's and CSA's acceptance limits for ASR testing are still valid if type GUL cement displaces type GU cement for the standardized ASR aggregate acceptance testing. Should a difference be noted, then type GU cement will need to be maintained in the test methods until suitable acceptance limits can be determined for the ASR tests using type GUL cement. This research will be an important step in ensuring that MTO's oversight programs and specifications continue to be effective in preventing the use of deleterious ASR aggregates in MTO concrete infrastructure.
Contact:	Joel Magnan Soils & Aggregates Section, EMO Joel.magnan@ontario.ca 416-420-0964

Subject Area:	Winter Road Maintenance
3. Idea Title:	Automatic Road Condition Reporting: Sensors Development
Background:	Improving our road condition reporting was recommended by the Auditor General in the 2015 Special Report on Winter Maintenance. An automated model using camera images has been tested but experienced limitations in low light conditions. The study will test new technologies in varying Ontario conditions, including low light conditions and analyse concept of data flow in real time to feed MTO applications. This study would be a continuation of past research into the implementation of innovative technology to be used to improve the accuracy of Automatic Road Condition Reporting. Previous research on this topic includes: - Field Test and Evaluation of Winter Road Condition Monitoring Technologies (Nov 2015) - Field Test and Evaluation of a Mobile Automated Winter Road Condition Reporting System (Aug 2014) - Probabilistic Models for Discriminating Road Surface Conditions based on Friction Measurements (Aug 2008) - Using Advanced Road Weather Information Systems (ARWIS) to Control Load Restrictions on Gravel and Surface Treated Highways (Sept 2007)
Challenge:	To develop a system to automate the monitoring of winter road conditions in real time by making use of new sensor technologies which could be installed on the Road Weather Information System (RWIS) or which could cover areas other than RWIS station locations. This work will test the system under actual Ontario winter conditions, including at night, and the accuracy of the sensors against actual reported road condition data.
Anticipated Outcome:	Trial implementation of new technologies in varying Ontario conditions, including low light, and proven concept of data flow in real time to feed MTO applications. Proven validation of accuracy and performance of method. Written report of findings performed, improvement recommendations and identify next steps. Report to be provided in both a pdf. and doc. format. Presentation of material will be expected to Ministry staff. Supporting data to be provided in an accessible format.
Benefits to MTO	The increased accuracy of road condition reporting by implementation of new technologies and hardware has the potential to:

	- Increase the efficiency of Winter Road Maintenance pre-treatment and treatment applications. An increase in efficiency is expected to result in a reduction in overall material usage on MTO Maintenance Contracts, resulting in direct savings to the Ministry. - Efficiency in materials usage would optimize salt application as per the Ministry's Salt Management Best Practices ensuring continual compliance with MTO's environmental commitments while ensuring a safe and efficient highway network. - Increase accuracy of MTO 511 reporting by automatically feeding real time consistent and accurate road conditions to 511 allowing Ontario road users to have access to the most accurate data available. - Increase contract oversight by providing an automated quantitative assessment, improving on the current limited and subjective methodology of assessment which results in frequent dispute challenges. - Support future analytics and research by incorporating additional and / or more accurate data.
Contact:	Christopher Balasa Manager, Maintenance Management Office Highway Operations Management Ministry of Transportation P : 519-200-4285 E : Christopher.Balasa@ontario.ca

Subject Area:	Winter Road Maintenance
4. Idea Title:	Winter Severity Index (WSI) Representation Review
Background:	Currently the MTO utilizes a Winter Severity Index (WSI) which was originally calibrated to winter maintenance activity (equipment-hours) based on data utilized from Environment Canada's observation network, developed in 2015. The system now supplements missing EC data with information from Ontario's Road Weather Information System (RWIS). This study would be a continuation of current research into assessing alternative winter road maintenance material. Previous relevant research includes: - RWIS Network Planning: Optimal Density and Location (June 2016) - Winter Severity Index for Ontario Winter Highways Maintenance (2018)
Challenge:	The ministry has identified the need for a review of this calibration method to ensure the supplemental source changes have not impacted the methodology, as well as exploring the possibility of using additional sources per reporting area to be more representative of the highway network and to benefit from the recent expansion of the RWIS network.
Anticipated Outcome:	Findings and recommendations for the WSI index calculation. Recommendation to support implementation and next steps. Recommendation to be provided in a written report of findings in both a pdf. and doc. format. Supporting data to be provided in an accessible format.

Benefits to MTO:	Optimization of WSI reporting to better reflect geographic distribution of areas represented can increase the efficiency of Winter Maintenance response and treatment strategies. Increase efficiency in winter maintenance operations may result in cost savings to the Ministry in terms of equipment and labour hours and material usage. Improvements in predictions of storm events can further be utilized by the Ministry's 511 reporting system to ensure Ontario road users have the most accurate data available. Additional confidence in the WSI will strengthen Maintenance Business Intelligence. It can expand use of the WSI for qualitative comparisons for cost modelling for procurement, identifying trends in other research analytics, and validation and oversight of risk sharing quantities and benchmark equipment hours. Improving our benchmark quantities for procurement is a commitment to Ontario Road Builders' Association (ORBA) through the Highway Maintenance Council.
Contact:	Christopher Balasa Manager, Maintenance Management Office Highway Operations Management Ministry of Transportation P : 519-200-4285 E : Christopher.Balasa@ontario.ca

Subject Area:	Winter Road Maintenance
5. Idea Title:	Innovative Winter Maintenance Materials, Equipment and Procedures Evaluation
Background:	The Ministry of Transportation (MTO) currently utilizes an array of treatment strategies for winter road maintenance (WRM) dependent on a variety of factors. In order to continually optimize operations (minimizing material usage and cost, increasing effectiveness) this study would be a continuation of current research into assessing alternative winter road maintenance materials and equipment through field studies. This topic is a continuation of current research which has been extremely valuable in assessing new standards for new equipment and processes such as pre-wet salt, pre-treated salt and pre-wet sand. Previous relevant research includes: - Pre-Wet Sand Application Trials (Various) - Field Testing of Innovative Snow and Ice Breaking Technology (2018-19) - Combined Analysis of Pre-Treated Salt Trials (April 2017) - Comparative Analysis of Performance of Different De-icing Materials (2016); - Sustainable Traction with Winter Sand (Aug 2016) - Winter Maintenance Study for Reduced Salt Usage - Field Trials of Pre-Treated Salt (2014) - Safety Impact of Using De-icing Salt (Nov 2012); - Field Performance Evaluation of Organic De-icing Anti-icing Products for Snow and Ice-Control (May 2011); - An evaluation on the impact of DLA (July 2008) - Effectiveness of Chemical Agents for Snow Removal on Highways (2006); - Effects of Sand Type, Gradation, Application Rate and Pre-wetting on Friction Coefficient of Snow- and Ice-Covered Asphalt (Aug 1996) - Laboratory Tests of the Performance of Highway De-icing Chemicals and Winter Sand on Compacted Snow and Ice (Sept 1994)

Challenge:	To investigate the effectiveness of alternative WRM practices by comparing their performance to traditional methods with the objective of promoting sustainable and environment friendly winter road maintenance that will enhance the safety and mobility of road users. Test routes will be determined to be representative in terms of climate conditions, different classes of highway and variety of AMC participation. Friction or skid resistance and road surface state are the criteria which the treatments will be evaluated against for costs and benefits.
Anticipated Outcome:	Recommendation to support inclusion of a new ministry material or equipment standard or best practice. Recommendation to be provided in a written report of findings in both a pdf. and doc. format. Supporting data to be provided in an accessible format
Benefits to MTO	The identification of an effective alternative material application of winter road material, that can be used on Provincial Highways, will enable the Ministry to meet its environmental obligations while maintaining a safe highway system. Previous trial results have led to changing maintenance standards. Reducing winter maintenance operations reduces impacts on environment and operational expenses. Material trials, such as the Fine Salt evaluation, can identify alternate supply opportunities for market sustainability. Can support efficient alternatives for removal of snowpack in cold weather patterns in Northern Ontario, a commitment in the Technical Review of Winter Maintenance on Highways 11 and 17.
Contact:	Christopher Balasa Manager, Maintenance Management Office Highway Operations Management Ministry of Transportation P : 519-200-4285 E : Christopher.Balasa@ontario.ca

Subject Area:	Winter Road Maintenance
6. Idea Title:	Salt-impacted soil and/or water remediation strategies
Background:	Environmental stakeholders have identified the accumulation of sodium chloride in soil and water bodies as a major concern to source water and the ecosystem. As part of the Ministry's continued review of its salt management best practices, the Ministry would like to explore remediation strategies for salt use within the MTO right of way and receiving water bodies. Previous research on this topic includes: - Five-year Review of Progress: Code of Practice for Environmental Management of Road Salts (Environmental Canada, March 2012) The Ministry has previously commissioned an investigation on the use of desalination of collected groundwater at a patrol yard.
Challenge:	Finding an economical strategy to address either the accumulation of sodium chloride along the provincial highway corridor or in receiving water bodies. Possible economic strategies may include any of the following strategies: - Identification of alternative "second" use of product (recycle) - Removal - Treatment - Mitigation
Anticipated Outcome:	Recommendation to support inclusion of new methods or processes to address saline water-management or salt-impacted soil for implementation or inclusion in ministry best practices. Written report of findings and recommendations to be provided in both a pdf. and doc. format. Supporting data to be provided in an accessible format.

Benefits to MTO:	Addressing the accumulation of sodium chloride within the soil and water bodies of the Ministry's right of way will enable the ministry to meet its environmental obligations and concerns of conservation and source water protection agency stakeholders as well as support the ministry's existing commitment to optimize salt usage on Provincial Highways as part of the ministry's Salt Management Best Practices.
Contact:	Christopher Balasa Manager, Maintenance Management Office Highway Operations Management Ministry of Transportation P : 519-200-4285 E : Christopher.Balasa@ontario.ca

Subject Area:	Bridge/Structural
7. Idea Title:	Development of Computer Tools to Analyze a Concrete Section Subject to Combined Loading
Background:	The Canadian Highway Bridge Design Code (CHBDC), which is mandated by O.Reg. 104/97, is used for the design of new bridges, as well as the rehabilitation and evaluation of existing bridges. CHBDC provides some conservative simplified equations that are adequate for new designs, but sometimes show that existing bridges need costly strengthening either during rehabilitation or to avoid load posting. CHBDC does allow refined analysis – which require a comprehensive knowledge of modified compression field theory, stress and strain compatibility, and non-linear material properties. These methods are exceptionally time consuming and easily misinterpreted. The creation of software/applications that could perform these calculations would greatly assist MTO engineers.
Challenge:	Virtually all concrete sections analyzed by computer software are subject to various types of internal loads, such as Axial, Shear, Moment and Torsion forces. The difficulty is to create a program or application that considers all these forces and provides intermediate information and a user's guide to allow the engineer to become satisfied with the results.
Anticipated Outcome:	Creation of a software or application that runs in Windows 10 environment that can readily determine section properties of common structural shapes encountered in bridges, take in various types of loading, utilize stress and strain compatibility, and produce factored resistances for the section subjected to a combination of loading. Completion could be expected by the end of 2021/22.
Benefits to MTO:	Having a tool to precisely determine the capacity of sections would allow MTO to better understand the capacity of bridge members, which could result in avoiding unnecessary bridge repair that prevent the need for load posting or costly and time-consuming strengthening during construction. Also, provide reasonable users guide or on-screen help to ensure the engineer can obtain confidence in the methodology and results.
Contact:	Walter Kenedi Manager, Structures Office Walter.Kenedi@Ontario.ca, 905-246-8711

Subject Area:	Bridge/Structural
8. Idea Title:	Development of Computer Applications to Determine the Roughness of Concrete Surfaces
Background:	The Canadian Highway Bridge Design Code (CHBDC), and several MTO specifications, require concrete to be deliberately roughened. This is either to accept a penetrating or surface coating, or to accept a second pour of concrete which is to have the correct friction between surfaces to meet the design intent. Currently, the assessment is made purely based on experience of field crew based on their past practice, or by comparison to photos of various standard degrees of roughness. Both of these are difficult to determine exactly and are thus difficult to enforce contractually. Not achieving adequate roughness and friction between components has often been a concern for all structural engineers.
Challenge:	Optic tools exist for scanning surfaces, however those are typically for factory condition where surfaces are very uniform. The research would have to study various types of roughness, angular and curved, and for surface with high degree of variability, with potential obstructions of reinforcing steel to make the determination. The optics would also have to utilize basic technology so that the application would using standard smart phone cameras and not ultra-high-resolution cameras.
Anticipated Outcome:	Creation of a software or application that runs on i-phone or Android that could be utilized in the field to determine the roughness of a concrete surface.
Benefits to MTO	Having a smart phone tool to precisely determine the roughness would aid contractors in knowing exactly what degree of roughness is required on concrete surfaces and aid in the Contract Administrator role by having a single quantitative measure that would be much more contractually enforceability than visual comparisons. This in turn provides the design engineer assurances that the structure was build in conformance with the design assumptions made in the Code, and gives MTO the assurance that the products were built as required.

Contact:	Walter Kenedi Manager, Structures Office Transportation Infrastructure Management Ministry of Transportation Walter.Kenedi@Ontario.ca 905-246-8711

Subject Area:	Transportation Infrastructure Management
9. Idea Title:	**Jurisdictional Scan on Utilizing Drone Technology by Transportation Agencies**
Background:	Innovations in camera technology have had a significant impact on the growing use of drones. By 2018, around 80% of US state departments of transportation were utilizing drones, according to a survey conducted by the American Association of State Highway and Transportation Officials. Uses include monitoring the progress of highway construction projects, surveying new sites, inspecting bridges and culverts, traffic monitoring and emergency response. According to Minnesota Department of Transportation using drones for inspections of state infrastructure helped the state save about 40% on associated costs. Ontario is in early but steady development of its drone industry. Drones, or Remotely Piloted Aircraft Systems (RPAS), can provide vital services to transportation infrastructure management by capturing high quality data on visual, spectral and thermal examination of structures, linear infrastructure network surveillance and aircraft external maintenance inspections.
Challenge:	Assessment of existing practice of drone utilization for transportation infrastructure management must be undertaken. Existing regulatory barriers for advanced operations by RPAS must be fully investigated. Thorough assessment of technical gaps, financial and operational risks of adopting and integrating RPAS technologies must be undertaken.
Anticipated Outcome:	Must include a written report and web-based presentation of the final results. The report should contain research findings, analysis and recommendations to proceed.
Benefits to MTO	The study would initiate MTO's investigation of drone technology implementation. Substantial savings on associated costs in multiple areas of Ministry's planning, construction, traffic, maintenance and daily operations. Potential increased road safety throughout the province.
Contact:	Ron Berg Manager, Geomatics Office Transportation Infrastructure Management Ministry of Transportation P: 905-359-8598 E : ron.berg@ontario.ca

Subject Area:	Transportation Infrastructure Management
10. Idea Title:	**Remote Inspection on Construction Sites**
Background:	Current widespread uses of remote technical inspections include monitoring of construction projects through analyzing construction progress with regularly captured data. On road constructions, camera technology is also has been known for use in monitoring and gauging topography and soil type throughout the construction lifecycle. While ground surveying is still a critical part of construction planning and monitoring, various UAVs offer software that helps considerably enhance project monitoring, inspections and construction site management resulting in overall savings in costs and timing of construction, the later being of a particular significance to the transportation infrastructure management.
Challenge:	Assessment of existing practice of remote inspections and management on construction sites for linear infrastructure must be undertaken. Thorough assessment of technical gaps, cost analysis and operational risks of adopting and integrating remote technologies in highway construction management, inspections and daily operations must be undertaken.
Anticipated Outcome:	The study would assess the available equipment and technology and their application for remote monitoring and management of construction operations. Must include a written report and web-based presentation of the final results. The report should contain research findings, analysis and recommendations to proceed.
Benefits to MTO	Substantial savings in associated costs in areas of Ministry's planning and construction management. Potential for reducing timelines of completion for transportation infrastructure construction, emergency and maintenance repair projects.
Contact:	Ron Berg Manager, Geomatics Office Transportation Infrastructure Management Ministry of Transportation P: 905-359-8598 E : ron.berg@ontario.ca

Subject Area:	Safety & Information Management Section, Traffic Office, HOMB, OD
11. Idea Title:	Introduction into the Systemic Approach to Safety for Ontario
Background:	The MTO utilizes a traditional site analysis approach for safety improvement. The provincial network is screened for sites with less than desired safety improvements, those sites are investigated for possible countermeasures for improvement which are later designed and constructed. A new supplemental approach is the Systemic Safety approach. Rather than managing risk at certain locations, a systemic approach takes a broader view and evaluates risk across an entire roadway system. A system-based approach acknowledges collisions alone are not always sufficient to determine what countermeasures to implement, particularly on low volume and rural highway where collision densities are lower. The systemic approach identifies risk factors and focus collision types, then reviews the network and prioritizes locations for appropriate and affordable for widespread countermeasure implementation. It is critical for the ministry to have a thorough understanding of this approach along with the efforts and limitations for possible adoption of a new approach. The US DOT Federal Highways Administration (FHWA) provides guidance on introducing Systemic Safety for agencies and which has recently been adopted by Illinois, Kansas, Kentucky, Louisiana, Minnesota, Missouri, Nebraska, New York, Ohio. The MTO has traffic volumes, collision data, road safety software, GIS, and some infrastructure attribute data to be used for this assignment.
Challenge:	Introduction of this new systemic approach poses a challenge in understanding the optimal way to begin and use of knowledge and resources to carry it out. Providing an understanding, developing a framework, and conducting first run of this approach will support the ministry in decisions regarding carrying it forward. This will help supplement the current traditional approach with the goal to improve road safety by reducing collision frequency and reduce fatal and serious injuries.

Anticipated Outcome:	A technical written report addressing: - Literature review - Jurisdictional scan - Suggested risk factors specific to MTO highways - Suggested target collision types specific to MTO - Data requirements and limitations - Suggested locations - Suggested countermeasures for wide spread implementation Possible use of GIS and PowerBi for deliverables.
Benefits to MTO	By using the systemic approach MTO can better identify highway safety improvement projects on the basis of both collision experience and collision potential to reduce fatal and serious injury crashes on all highways supporting ministry commitment to CCMTA's Towards Zero. The systemic approach provides new benefits such as: - Identifies a "problem" based on a system-wide analysis of the data, e.g., rural lane departure collisions - Looks for roadway characteristics that are frequently present in severe collisions, i.e., risk factors. - Focuses on one or more low cost countermeasures that can be deployed widely across the system - Identifies and prioritizes locations across the network for implementation. The ministry will have a better understanding and framework on the systemic approach to be used in developing future policy, if desired.
Contact:	Justin White Traffic Operations Engineer, Traffic Office Transportation Infrastructure Management Ministry of Transportation justin.white@ontario.ca 905-321-5103

Subject Area:	Intelligent Transportation Systems
12. Idea Title:	Investigating applications of the autonomous vehicle (AV) technology stack to enhance highway operations.
Background:	Thus far, considerable effort has been put towards building reliable vision and sensing capabilities for autonomous vehicles. Approaches vary in the application and combination of vehicular sensors; however, the three primary sensing technologies are camera, radar and lidar. The plethora of generated data points are processed through the overall AV technology stack to drive perception, decision, and control within the vehicle's operational design domain (ODD), which includes all conceivable conditions, restrictions, and scenarios that an AV may encounter. While work is still underway to perfect each layer of the AV technology stack to ensure safe and reliable standalone operations across all ODDs, many accurate and low latency sensing, computing and networking capabilities of AVs may already be shedding useful insights for cities and road authorities. Some conditions that an AV may need to navigate within its ODD, include road hazards, construction closures, varying road conditions (ie. wet, icy, bumpy, etc), spot weather impacts, presence of emergency vehicles and of course, situational awareness of objects (ie. pedestrians and other vehicles) around it. Many of these data points are just as important to road authorities to support operational needs and improve safety and efficiency for the traveling public. Traditionally, prior to the advent of probe vehicles, such data points could only be obtained through static means from embedded or non-intrusive roadway sensors and communicated via static or dynamic messaging signs. In line with industry advancements, the ministry is currently exploring opportunities in vehicle-to-infrastructure (V2I) and infrastructure-to-vehicle (I2V) applications to enable a wider array of input and output sources which can be communicated via DRSC and/or C-V2X protocols.
Challenge:	Current detection and communication technologies are constrained by static and/or localized means of implementation. The advent and future adoption of connected and autonomous vehicles (CAVs) will produce a dynamic and mobile source of operational data that may enhance safety and highway operations. The challenge is to identify applicable AV data sources and

	supporting communication methodologies to enable V2I and I2V applications/use cases in the interest of improved highway operations. Applicable data points may also support operational enhancements and traditional data dissemination via COMPASS and ON511.
Anticipated Outcome:	Technical report Presentation and/or demonstration to technical committee Available and/or applicable data sources
Benefits to MTO:	MTO could be expected to learn and/or be demonstrated any applicable AV sensory data along with supporting compute and communication methodologies that would enable future development of V2I and I2V applications to enhance highway operations. May support consideration for future partnerships and/or pilot opportunities. Timeline – 1 year.
Contact:	Rey Shen ITS-Innovation & Planning Transportation User Services Branch Rey.shen@ontaro.ca 437-488-3874

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2021

ATTACHMENT B – APPLICATION FORM

For Ministry use only	
Application Number:	

Principal Researcher (Name & Business Address):	Location of Research (address):
Institution:	Applicant's Business Telephone No.
	Applicant's Email Address

Co-Applicants (name, institutional affiliation, city):

1	
2	
3	

Title of Research including Ministry Topic Number:	

Brief Purpose of Research

FINANCIAL SUMMARY:

Funds Requested From MTO	Funds Requested from Other Sources	Starting Date:	Estimated Completion Date:

Total Budget (MTO and other sources):	

Have you applied to any other funding agencies for support of part of this Research?

YES ☐ **NO** ☐ If YES, please provide details below:

Signatures: It is understood that the provisions of the Ontario Ministry of Transportation HIIFP as outlined in the 2017 HIIFP Guidelines are hereby accepted and agreed to.

Principal Researcher	Head of Department	Dean/Director of Research or Authorized Signing Officer of Sponsoring Institution
Name and Title:	Name and Title:	Name and Title:

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2021
ATTACHMENT C – RESEARCH PROPOSAL SUMMARY

Short Title of Research including Ministry Topic Number:	
Principal Researcher	

SUMMARY OF RESEARCH PROPOSAL
(Non-technical language; 300 words maximum)

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2021/22
ATTACHMENT D – BUDGET SUMMARY

Note:
For multi-year applications, complete one form for each Ministry Fiscal Year ending March 31.

FISCAL YEAR ENDING: March 31, _____ (INSERT YEAR)

Principal Researcher:				
Short Title of Research including Ministry Topic Number:				
RESEARCH ITEMS	**Direct Costs of Research**	**Percent Overhead (%) (not to exceed 25%)**	**Net Funds Requested from MTO**	**Amount from other sources**
SALARIES AND BENEFITS				
a) Students				
b) Postdoctoral fellows				
c) Technical/professional assistants				
d)				
SUBTOTAL:				
EQUIPMENT OR FACILITY				
a) Purchase or rental				
b) Operation and maintenance costs				
c) User fees				
d)				
SUBTOTAL:				
MATERIALS AND SUPPLIES				
a)				
b)				
c)				
d)				
SUBTOTAL:				
TRAVEL				
a) Technical presentation				
b) Field work				
c)				
SUBTOTAL:				
DISSEMINATION COSTS				
a) Publication costs				
b)				
SUBTOTAL:				
OTHER (specify)				
a)				
b)				
c)				
SUBTOTAL:				
	Direct Costs of Research	**Net Overhead**	**Net Funds Requested from MTO**	**Amount from other sources**
COLUMN TOTAL:				
TOTAL:				

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2021/22
ATTACHMENT E – PROGRESS REPORT TEMPLATE

	For Ministry use only
Application Number:	

HIIFP Funding Year:	Date:
Principal Researcher (Name & Business Address):	Business Telephone No.
Institution:	Email Address:

Title of Research including Ministry Topic Number:	
Start Date of Research:	
Estimated Completion Date of Research:	

Brief Description of Progress completed to date including 1) status of major tasks, 2) status of outcomes/report, and if applicable, 3) changes and or issues:

Signatures:		
Principal Researcher	Head of Department	Dean/Director of Research or Authorized Signing Officer of Sponsoring Institution
Name and Title:	Name and Title:	Name and Title: