UTC Project Information	
Project Title	Measuring the Impact of Landslide on Transportation Infrastructure to Improve Mobility and Safety
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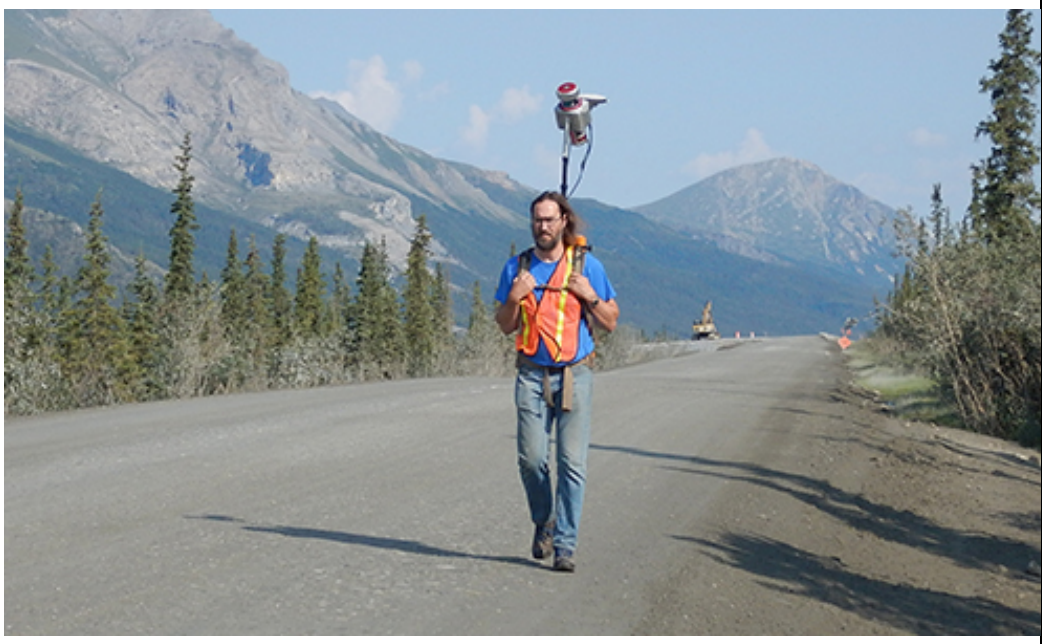
Funding Source(s) and Amounts Provided (by each agency or organization)	University of Washington PacTrans $60,000 Alaska Division of Geological and Geophysical Surveys-(DGGS) $60,000
Total Project Cost	$120,000
Agency ID or Contract Number	69A3551747110
Start and End Dates	September 1, 2017 – August 30, 2019 (extended to November 30, 2019)
Brief Description of Research Project	The project goals are to measure the subsurface changes ahead of a landslide collision with Dalton Highway embankment, in order to collect needed information that can be used to develop appropriate mitigation techniques; and to develop a back-pack LiDAR system technique for quick and inexpensive assessment of surface deformation. The results of this phase and future phases of this research will provide necessary data to make intelligent decisions about how to mitigate slow-moving landslides, to maintain mobility, and to improve safety along the Dalton Highway adjacent to these features.

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	This project produced baseline data on subsurface temperatures and water pressure between the toe of FDL-A and the toe of the old Dalton Highway embankment. The instruments producing this data will continue to be monitored beyond the length of this project to provide insight into changes of the subsurface. This project also allowed for continued monitoring of FDL movement rates. In 2019, the annualized movement rate of FDL-A was 9.3 m/yr. At the 2019 rate, FDL-A will impact the new Dalton highway embankment by 2032, although time to impact will decrease within increasing FDL velocity. This information has been delivered to the Alaska Department of Transportation and Public Facilities Northern Region Materials Section. The backpack-mounted LiDAR technique produced a high resolution (i.e., 0.1 m) digital elevation model for small areas. This technique allowed for change detection and analysis of the FDL-A toe area, including volume change calculations and identification of areas of sedimentation and subsequent settlement. As part of the research project, we produced a short video describing the method, which is linked to the project web page.  Collaborator Dr. Ronald Daanen walking with the backpack-mounted LiDAR along the old Dalton Highway embankment, July 2018 (photography by M. Darrow).

Impacts/Benefits of Implementation (actual, or anticipated)	Continued monitoring of the subsurface instrumentation will provide information on how FDL-A transforms the subsurface, which may be used in mitigation. The success of the backpack-mounted LiDAR technique indicates that it could be used in a myriad of other applications, such as assessing unstable slopes, thermokarsts affecting embankment stability, or structures such as bridges or retaining walls. The Alaska Department of Transportation and Public Facilities has been informed of the increase in movement rate, which will aid in future planning along this section of the Dalton Highway. The imminent collision of FDL-A with the old Dalton Highway embankment represents a unique opportunity to observe a landslide impacting a roadway in a safe and controlled way and on a predictable schedule. Instrumenting the embankment will provide data on how much earth pressure a landslide applies to an engineered structure, and how the landslide deforms the embankment and changes the underlying permafrost. Thus, we recommend a Phase II portion of this research where we will 1) measure the deformation of the embankment and subsurface; 2) measure earth pressure as FDL-A collides with the embankment; and 3) document the collision through geomechanical instrumentation, repeat LiDAR scans, and repeat photography. The results from Phase II research may inform long-term mitigation efforts, and may identify an alternative solution to the FDL problem rather than repeated highway realignments.
Web Links • Reports • Project Website	A link to the video produced for this research, “LiDAR in a Backpack,” and more information about the research can be found on the project website: http://fdlalaska.org/research.html