METHODS

This map was produced for the purposes of landscape hazard assessment and climate change adaptation planning for the community of Old Crow. An accompanying report provides additional detail on local surficial geology, stratigraphy, glacial history and landscape hazards (Benkert *et al.*, 2016). The report is published by Yukon College's Northern Climate ExChange and is available for download at yukoncollege.yk.ca/research.

Landscape hazards for the community of Old Crow are modelled using a Geographic Information System (GIS) to generate an integrated risk ranking for each landscape 'unit' (defined by 30 m x 30 m pixels). Input data for the model include the following datasets: slope angle (steepness); slope aspect (directionality and exposure to sunlight); and surface materials (derived from geological map) (see Benkert *et al.*, 2016 for additional details).

Attributes of the individual datasets are classified on a 0-9 scale of potential risk, where zero represents low hazard risk and nine represents high hazard risk. High-risk areas include steep or unstable slopes, low-lying areas subject to flooding or inundation by water, and landscape units with a high likelihood of being affected by ice-rich or thaw-unstable permafrost. Low-risk areas are predicted to have favourable conditions for community development and include well-drained soils, gentle or moderate slopes, and a low likelihood of containing ice-rich or thaw-unstable permafrost.

Each of the input datasets is assigned a unique weighting value in the model that reflects the degree to which they control cumulative hazard risk. For this model, slope angle was given a weighting of 25%. Slope aspect was given a weighting of 15%. Surface materials have a significant impact on landscape stability, and this input dataset was given a weighting of 60%.

Cumulative Ranking = 0.25(slope angle) + 0.15(slope aspect) + 0.6(materials)

By combining the individual rankings of each input raster according to their unique weighting, a cumulative risk ranking for each pixel in the map area is generated. Risk rankings range from 1 (low) to 8 (high). The cumulative rankings are reclassified into four categories (Low, Moderate, Moderately High and High) that represent potential hazard risk due to permafrost, slope stability, and flooding in the map area. The model represents current conditions, and does not integrate any potential changes to landscape stability associated with a changing climate.

LIMITATIONS TO THE MAP

The Old Crow hazards map is meant to be used as a preliminary assessment of potential ground conditions in the study area, and does not replace detailed on-site investigations. Cumulative hazard rankings are dependent on rankings assigned to surface material units, and both the boundaries of the units and the materials assigned to those units are subjective and based on field checking conducted during surficial geological mapping studies (see map by Kennedy (2016) in Benkert *et al.*, 2016 for more detail). Addtional on-site observations of permafrost for sites 1-17 (on map) can be found in Benkert *et al.*, 2016.

Flood risk for the Old Crow region was developed using a digital elevation model based on LIDAR imagery captured along the Porcupine River in the vicinity of the community. Potential modelled flood extents associated with increases in water level of the Porcupine River were created using this data. Here, spatial extent of flooding at 244 m is depicted. This elevation represents a moderate flood wherein the river is still primarily confined to the stream channel, but some low-lying areas along the river's edge experience moderate water incursion. See section "Flooding" on page 43 of the accompanying report (Benkert *et al.*, 2016) for more details and limitations.

Finally, the resolution of this map is limited by the 30 m x 30 m pixel size used to calculate slope, aspect, and permafrost probability, and the 1:10 000-scale mapping used to identify surficial materials and landforms. Local variations in all model inputs should be expected, and will be more pronounced for surface materials and permafrost probability.

It is important to note that cumulative hazard rankings are based on general observations of surface materials, drainage, slope angle, vegetation and the presence of permafrost landforms, as well as subsurface information provided by ERT and GPR profiles, drilling and probing of permafrost, and textural analyses of surficial and borehole samples. This has resulted in a

RECOMMENDED CITATION

Benkert, B.E., Kennedy, K., Fortier, D., Lewkowicz, A., Roy, L.-P., de Grandpré, I.,Grandmont, K., Drukis, S., Colpron, M., Light, E., Williams, T. 2016. Old Crow landscape hazards: Geoscience mapping for climate change adaptation planning. Northern Climate ExChange, Yukon Research Centre, Yukon College. 136 p. and 2 maps.

Digital cartography and risk modeling by K. Kennedy and B. Elliot, Yukon Geological Survey.

A digital PDF (Portable Document Format) file of this map may be downloaded free of charge from the Yukon Geological Survey by visiting geology.gov.yk.ca or from the Yukon Research Centre by visiting yukoncollege.yk.ca/research.

HAZARD CLASSIFICATIONS

Low-Risk terrain in the Old Crow area is characterized by flat to gently sloped terrain comprised of well-drained gravel or coarse weathered bedrock surface materials. Low-risk terrain contains permafrost that may be ice-rich, but it is less likely to be affected by flooding and mass movement than more hazardous terrain in the map area. Development is recommended in low-risk terrain.

Moderate-Risk terrain in the Old Crow area is characterized by gentle to moderate slopes with moderate to poor drainage. Moderate-risk terrain is found on the pediment slopes of Berry Hill, as well as on poorly drained parts of the fluvial terrace near the North Road (*i.e.* Site 9) and school (*i.e.* Site 11) subdivisions. Moderate-risk terrain contains finer-grained material compared to material found in low-risk terrain, and is almost always affected by permafrost with high potential for thaw settlement. Development in moderate-risk terrain should proceed with special attention to minimizing impacts on permafrost and existing surface water drainage networks.

Moderately High-Risk terrain in the Old Crow area is characterized by moderate to steep slopes with all slope aspects. Moderately high-risk terrain is found on the steep escarpment above town, and in areas subject to regular flooding. Moderately high-risk terrain contains permafrost and is subject to landslides related to poor slope drainage and permafrost thaw. The difference between moderate and moderately high-risk terrain in the study area is largely related to landslide susceptibility. Development should be minimized as much as possible in moderate high-risk terrain.

High-Risk terrain in the Old Crow area is characterized by steep slopes and warm aspects (*i.e.*, west and south facing) with an increased risk of landslides. High-risk terrain in the study area occurs in areas with documented landslide debris, paths, or features of slow mass movement such as tension cracks. High-risk terrain contains both permafrost and fine-grained surficial materials on steep to very steep slopes that can easily generate landslides with significant run-out distances. Development is not recommended in areas with high-risk terrain.

LEGEND

GROUND OBSERVATION SITES

- geological field station
- permafrost borehole
- electrical resistivity tomography (ERT) profile line
- ground penetrating radar (GPR) profile line

GEOLOGICAL FEATURES

- T — cryoplanation terrace
- landslide headscarp
- direction and path of visible landslide
- lineament
- potential innundation area at water levels of 244 m above sea level on the Porcupine River

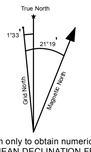
TOPOGRAPHIC FEATURES

- contours
- streams

1:50 000 scale topographic base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION, NATURAL RESOURCES CANADA

ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection
North American Datum 1983
Zone 7

CONTOUR INTERVAL 50 METRES
Elevations in metres above Mean Sea Level



Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION FEBRUARY 2016
FOR CENTRE OF MAP

LANDSCAPE HAZARD RISK

OLD CROW, YUKON TERRITORY

PARTS OF NTS 116O/12

SCALE 1:10 000

0 0.5 1
kilometres

Landscape Hazards Risk
Old Crow, Yukon
Parts of NTS 116O/12
1:10 000 scale

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

and

Northern Climate ExChange
Yukon Research Centre
Yukon College