

# Urbanization of Highland Creek: Morphological response, Predictability, and Natural Channel Design

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Highland Creek drains about 100 km<sup>2</sup> of an intensively urbanized area in Scarborough, Ontario. Urban land use expanded rapidly into the headwaters of the catchment in the 1970s and 1980s resulting in almost 100% urban land use and 53% impervious surfaces. Peak flows after the onset of extensive development were several times larger than under mainly agricultural land use in the 1950s and early 60s. Headwater streams were channelized but the main branches further downstream remained partially natural. Channel width increases and changes in sinuosity were mapped from aerial photographs over several epochs between 1954 and 2016. Adjustment in sinuosity is dominated by engineering of the channel although some natural bend cut-offs occurred. Channel width adjustment varied in its magnitude mainly because widening was limited by bank protection work in many reaches, and constraint by channel confinement. Channel incision has also been prevalent in some reaches.

The photo-record not only captures the pre- and post-urban settings, but also the shift in approach to river management and design, from hard engineering and the prioritization of flood conveyance towards a more holistic, process-based approach, utilizing natural channel design principles.

Channel width predictions from several regime equations (hydraulic geometry) varied in their reliability over time, and show that the un-engineered reaches adjusted to flow increases quickly, while many engineered reaches remained 'too narrow' for the prevailing flows up until 2005. Large flood events have had a significant effect on channel adjustment and the river morphology is now dominated by various phases of engineering and channel design intended to maintain natural form while minimizing threats to infrastructure. Highland Creek has undergone several designs over the past decade or so which can be evaluated in terms of hydraulic geometry and the predicted channel form. Design specifics of the recently completed Valley Segment H4a natural channel design will be evaluated and presented as an example.

## Biography

**John McDonald** is an environmental consultant at Matrix Solutions Inc. specializing in fluvial geomorphology. In 2011, he completed his M.Sc. in Geography at the University of Western Ontario, focusing on the morphological response of Highland Creek in Scarborough, Ontario to urbanization. Over the past 6 years as a consultant, John has

applied his knowledge of fluvial geomorphology in practice, and gained experience in natural channel design, hazard assessments, subwatershed studies, and public and agency consultation, primarily in Southern Ontario.

**Peter Ashmore** is a fluvial geomorphologist and Professor at Western University with research and consulting experience in fluvial processes and morphology of gravel-bed rivers, experimental geomorphology, and river channel design and restoration.