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Case Study

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HYBRID ABSORBABLE LANDSCAPES: TREATMENT TRAINS FOR URBAN STORMWATER MANAGEMENT – MONITORING, MODELLING, DESIGN AND IMPLEMENTATION

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Low-Impact Development (LID) is a form of urban infrastructure that provides sustainable management of urban stormwater. LIDs treat stormwater, both from a water quality and quantity perspective, at the source by imitating the absorptive capacity of the natural landscape in pre-developed form. Examples of popular LIDs include bioretention cells (including bioswales and rain gardens), green roofs, and permeable pavements (including porous asphalt, porous concrete, pavers, grass and concrete grids and innovative, highly permeable materials). Practitioners often place various forms of LIDs in the same development with parking lots consisting of permeable asphalt surfaces, for example, interrupted with bioswales between adjacent parking stalls. Interestingly, most research on the efficacy, design and maintenance of these LIDs is conducted on only one type of LID at a time. Treatment trains is a term that refers to two or more LIDs (of the same type or of multiple types) used in combination to treat the stormwater flow over its total flow path (either to a receiving body, as evapotranspired water or as recharge). Not surprisingly, little research has been conducted on the optimum technical configuration for complete stormwater treatment (Brown et al. 2012) for LIDs implemented in combination.

Permeable pavements and bioretention technology (LIDs that use vegetation whether in a rain garden or a green roof) can be considered two distinct categories of LID with the obvious distinguishing feature of living vegetation as an integral part of the LID's function. Each type of LID has different advantages and disadvantages in terms of water quality treatment, initial and developing absorptive capacity over the intended life of the LID, and maintenance and cost. Both types can be designed to provide large amounts of water quantity attenuation at very small sizes in comparison to the drainage area, and as well, each has the capacity varying degrees of physical, chemical and biological water treatment processes. While a wealth of knowledge exists for each category of LID, currently the critical questions to wide scale implementation for both types continues to be the reduction in absorptive capacity over time and maintenance requirements; and for vegetated LIDs, additional questions involve vegetation (both type and extent) requirements given local conditions as well as soil mix designs. While critical gaps remain, treatment trains are a more sustainable method of stormwater management and current knowledge can provide insight into how to best configure a treatment train for any Canadian climate. In addition, given the continued development of highly absorptive materials for permeable pavements, soil mix designs and admixtures, research is necessary to test the optimum treatment train given local requirements.

To this end, the authors have created the Hybrid Absorbable Landscape (HAL) Project at the University of Victoria. HAL is a field scale development to test LIDs alone or in treatment trains as suitable options for stormwater mitigation and sustainable urban landscape design. The user (municipalities, etc.) defined objectives steering development of the site involve providing maintenance schedules, recommendation of vegetation, optimum configuration and suitability of new innovative materials coming onto the market. The research objectives include developing scaling tools, determining clogging and bio-clogging rates, and changes in hydraulic conductivity for all LID types. The site is supported by both the Biofilm Research Laboratory (BRL) and the Facility for Innovative Materials and Infrastructure Monitoring (FIMM), both at the University of Victoria. The facility consists of four bio-retention cells and five types of permeable pavement as seen in Figure 1. Three of the bio-retention cells, A, B, and D, are individually connected to the porous asphalt, Porous Pave®, and grass grid pavers, respectively, via a pipe system (shown as short, thick black lines in Figure 1). The retention cells are individually lined with an impermeable rubber liner. Cell C was maintained as a control with no pavement system connection. All four bioretention cells can be tested individually or in tandem, with or without the permeable surfaces. Surfaces, vegetation and soil media can be replaced at any time and the site is monitored by meteorological, hydrological and ecological equipment and an autosampler that can sample at any sampling point including the sediment trap (ST) which is the final drainage point. FIMM and BRL also contain lab equipment for testing water quality and material parameters. Testing at the site thus far has spawned numerous issue related to scale and test methods for determining site performance (Jernslet et al, 2016).

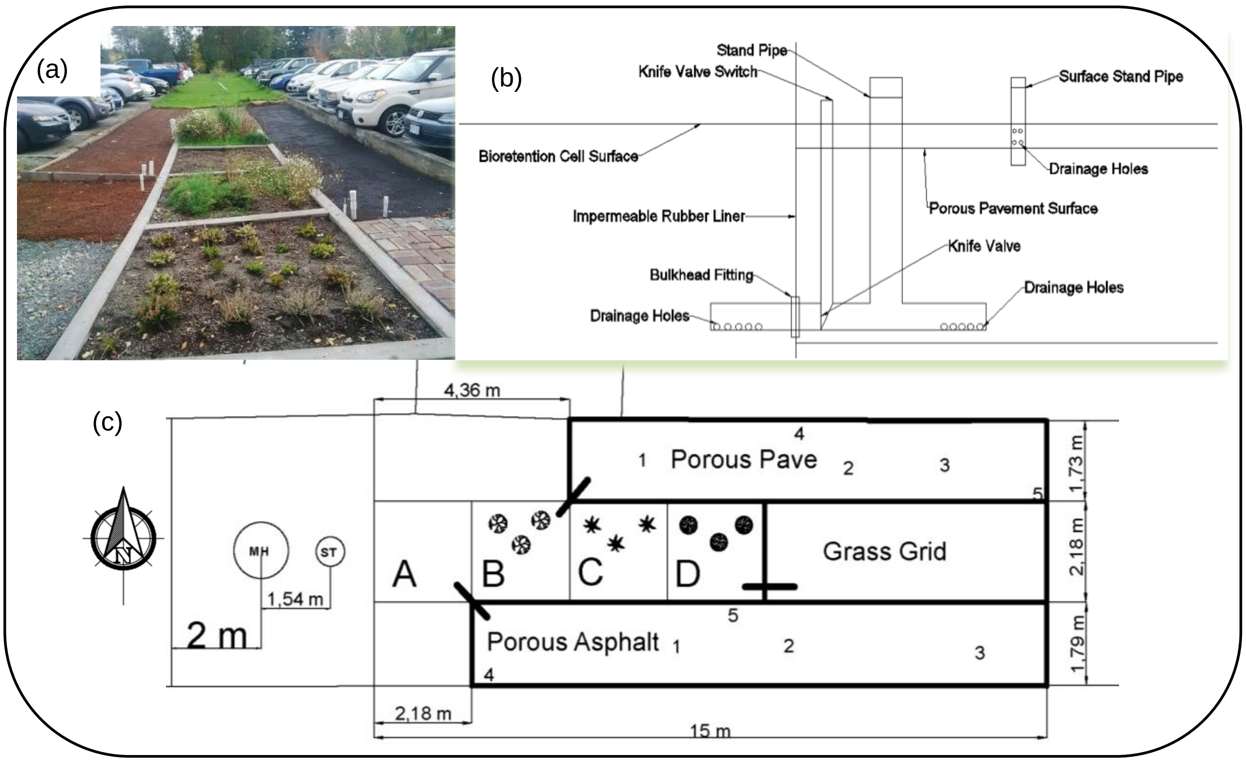

Figure 1: (a) View of site from manhole looking east; (b) schematic of sampling points placed at solid hatch marks of each permeable surface; (c) bird's eye view of the site.

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