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Hydraulic design perspectives of bioswale vegetation layers: a meta-research theory

Joshua Lelemia Irvine, Albert S. Kim*

Department of Civil and Environmental Engineering, University of Hawaii at Manoa, 2540 Dole Street, Holmes Hall 383, Honolulu, Hawaii 96822, USA, Tel. +1 808 956 3718; Fax: +1 808 956 5014; emails: albertsk@hawaii.edu (A.S. Kim), joshuair@hawaii.edu (J.L. Irvine)

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ABSTRACT

Optimized bioswale-design requires a fundamental understanding of mass and momentum transfer through a bioswale vegetation layer (BVL) on top of the porous soil zone. Conventional theories of canopy flows are applicable to structuring BVL in a planning phase. Plants in the BVL can be modeled as an embedded collection of cylindrical rods characterized by using (mean) diameter and height. The number density and spatial periodicity of the plants determine the structural and hydraulic characteristics of the BVL. The current paper stands as what we are calling meta-research or "research of research" consisting of an in-depth literature review followed by our own theoretical development and its application. A design equation for an emergent BVL is developed, which suggests the minimum length-to-width ratio of a bioswale as a function of runoff hydraulic characteristics. We calculate a proper bioswale length near which the viscous force fully supersedes the inertial force along the BVL. Moreover, a supplementary graphical method is developed within this study as a simple tool with which to design bioswale dimensions.

Keywords: Bioswale vegetation layer (BVL); Bioswale design equations; Canopy-flow theory; Runoff Reynolds number; Stormwater management; Plant density

* Corresponding author.