Principles of Urban Flood Hydrology

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Flood hydrology is the study of the quantity and timing of water delivered to a stream. It involves understanding the relationships between water delivered by rainfall and the pathways that water takes on the landscape, which include infiltration into the soil and surface runoff.

Urban Development, Impervious Surfaces, and Flooding. Floods are generated when substantial proportions of precipitation run off on the surface rather than infiltrating (seeping) into the soil. Surface runoff is relatively rapid and generates floods down slope. Under natural conditions (left side of Figure 1), forested surfaces promote high infiltration rates so little runoff occurs and flooding only occurs during rare intense storms. Devegetation, soil compaction, pavement, storm sewers, buildings, rain gutters, and other urban changes reduce infiltration greatly, however, generating large amounts of surface runoff and flooding, even during moderate rainfall events (right side of Figure 2).

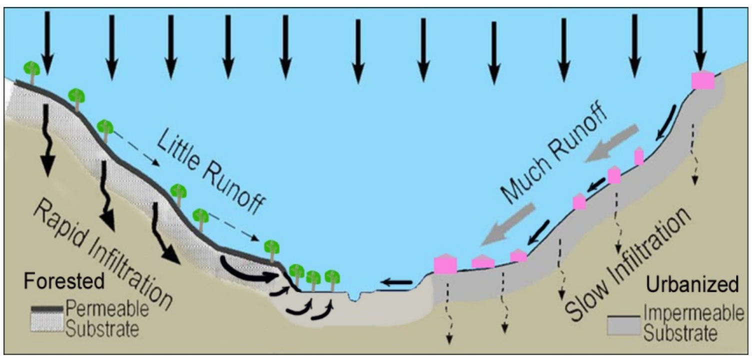

Figure 1. Schematic diagram contrasting infiltration and surface runoff from natural surfaces at left with urbanized surfaces at right. (James, 2012).

Percent impervious area is a common measure of the degree of urbanization effects that has gone on in a watershed. Impervious (impermeable) surfaces include pavement and buildings that can be mapped from aerial photographs. Storm sewers also deliver rainwater downstream very rapidly and generate flooding. Percent area under impervious surface and percent area with storm sewer have been linked to increased flooding (Figure 2).

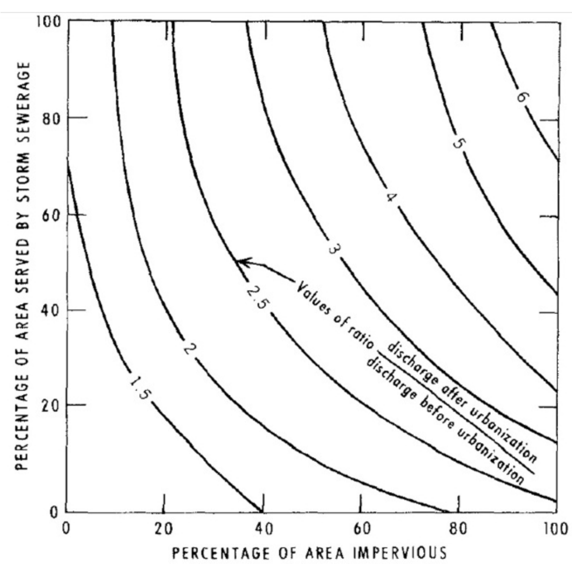

Figure 2. Relationship between percent areas impervious and storm sewered and increase in flooding. (Leopold, 1968).

Floodplain Mgt & Hydraulics in Lower RB Creek. The sale of land near Assembly Ave. and Dreyfus St. for a development in lower RBC was approved by the Columbia City Council, ca. 2011. This was a contentious issue that led to the original formation of the RBW Alliance. Building structures in floodways is generally not wise policy and often violates floodplain regulations. Unfortunately, the site slated for development was already highly prone to flooding due to a railroad culvert downstream that impedes flows. Thus, the development – which is pending – could take place in a floodplain that is deeply inundated during large floods and behaves like a lake, so the normal floodway regulations do not apply.

The hydraulics of a channel system; that is, the fluid mechanics and dynamics of flow, become much more important in the lower basin and are key to understanding flood problems there. Accurate hydraulic models require knowledge of the size of channel cross sections, roughness elements that resist flow, water surface slopes, and other factors that control flow energy. They also require accurate hydrologic information (how much water) to apply as inputs to the hydraulic model. Flow hydraulics in the lower RBW are severely constricted at present by railroad crossings. Removal of embankments would alleviate flooding in the Assembly Street area but would pass a larger flood wave downstream, so it would require enlarging bridge openings downstream. However, flood reductions in the lower RBC would not reduce flooding in Five Points which is driven by upper basin hydrology and local hydraulics in that area.

A Watershed Approach to Flooding in RBC. The best solution for reducing flood risks and improving water quality throughout the RBW is to combine watershed and floodplain management in such a way as to reduce the generation of storm-water runoff in the upper tributaries and to facilitate flood-flow conveyance in the lower basin. Upper basin management methods include low-impact development (LID) and green infrastructure; e.g., rain gardens, rain barrels, permeable pavement materials, storm-water detention and retention structures, green rooftops, etc. For these methods to be effective they must be deployed very widely across the watershed. This calls for participation by a large number of people and is best accomplished by voluntary programs with incentives and community education coupled with disincentives for large conventional pavement projects. LID is cheaper than conventional methods, so education and incentive programs for developers can be highly successful. Floodplain and channel management is needed to improve flood conveyance downstream. This involves structural changes to enlarge culverts as well as maintenance to remove debris and shrubs from channels.

References Cited

James, L.Allan, 2012. Watersheds and Water Resources. Unpublished textbook.

Leopold, L. 1968. Hydrology for urban land planning – A guidebook on the hydrologic effects of urban land use. US Geological Survey Circ. 554.