**Master's Thesis Title**

"Examining the effects of Low Impact Development (LID) technologies development on Storm Water Management in Arid and Semi-Arid Areas: A Case Study of Riyadh City in Saudi Arabia".

**Abstract**

Increasing urbanization and climate change have increased the risks of extreme flash floods in urban areas that cannot fully utilize conventional stormwater drainage systems during heavy rainfall events, such as in Riyadh City.

Low Impact Development (LID) is a sustainable stormwater management technique that aims to control runoff as close as possible to the restored predevelopment condition of a site's hydrology. The LID approach reduces peak runoff flow and volume using natural processes like infiltration and stormwater attenuation.

In this study, the US Environmental Protection Agency guidelines are used to examine the impacts of Low Impact Development on the city of Riyadh in densely populated areas in consideration of the existing stormwater drainage system, which is affected by flash flood events.

To analyse the various scenario's effectiveness of LID Technologies. This study considered LID controls such as Permeable Pavement, Green Roof, Bioswales, Rain Barrel, Rain Garden, Planter Boxes, and OSD. Each LID control was selected according to its applicability depending on the master plan and land-use classification of Riyadh City. For this study, five different LID scenarios were analysed; two different LID scenarios were analysed based on land ownership, such as private and public places (Scenario#2) and only public places (Scenario#1). Furthermore, three sub-sub-scenarios of a combination of LID control were developed using its functionality - Scenario#3 (Green Roofs, Scenario#4 (OSD and Rain Barrel), and Scenario#5 (Bioswales, Rain Gardens, and Planter Boxes) for analysis. The simulations were done for design storm events for a longer design storm duration (24 h) and shorter design storm duration (4 h) for various return periods of 5-years,10-years,25-years,50- years, and 100-years using Bentley OpenFlow's SewerGems using EPA SWMM Solver.

The study area showed the most effective reduction rates for peak runoff flows and runoff volumes for Scenario#2 (LIDs such as Permeable Pavement, Green Roof, Bioswales, Rain Barrel, Rain Garden, Planter Boxes, and OSD). Among which the designed storm events for longer storm duration (24 h) and shorter storm duration (4 h), it is considered that a shorter storm duration (4 h) showed significant effective results. Among Sub-Scenarios, the most effective reduction rates were observed for Scenario#3 (Green Roofs and Permeable Pavements) in longer and shorter storm durations. Similarly, a short storm duration showed the result more effectively. In considering all the six scenarios for two designed storm events, it was observed effectiveness of reduction rates decreased as the return period increased. The analysis of results suggested that the LIDs are effective in short storm duration and shorter return periods.

Keywords: Low Impact Development, Sustainable Stormwater Management, U.S. EPA, Bentley Open

Flows SewerGems, Semi-Arid & Arid Region