Appendix A: Additional Figures

Figure 1: Detailed comparison of RL controlled and passive system performance for the first two storms of August, 2019.
Figure 2: Total flood volumes in RL controlled and passive systems. Two values of rainfall threshold for the RL reward function (0 and 1.3mm) are shown to illustrate the impact of this parameter on the RL agent’s performance.
Figure 3: Comparison of RL and RBC system performance for the month of July, 2010.
Figure 4: Comparison of RBC and passive system performance for the month of March, 2014.

Appendix B: Classification of Flood Events for Roadway Intersections in Norfolk, Virginia

Using a 1m LiDAR-derived digital elevation model (DEM) and flood event information (Sadler et al., 2018) provided by the City of Norfolk, Virginia, three intersections were identified as potential locations impacted by stormwater system flooding (Fig. 1). As these intersections are in depressions in the land surface, the Whitebox GIS sink tool was used to find the area of each depression. The difference between the minimum and maximum elevation in a sink was assumed to
be its depth and the volume was approximated as the depth times the area. It should be noted that this is a rough calculation of the depth adequate for the purposes of this study, but is most likely an over estimate. The sink depths and volumes were plotted and a linear relationship was assumed (Fig. 2). Using the equation for this line, volumes for 0.2, 0.3, and 0.4m depths of roadway flooding were calculated.

Figure 1: Locations of intersections in the Hague area of Norfolk, Virginia where sinks where identified and elevation data were extracted.
Appendix C: Calculation of Groundwater Contribution to Pond Volume

A depth-volume relationship for the Elmwood Cemetery stormwater retention pond was estimated from design plans provided by the City of Norfolk. The pond’s volume was estimated to be 11612.09m$^3$ and the surface area over which seepage can occur (pond sides and bottom) was 28340.30m$^2$. The normal pond water surface elevation given in these plans was assumed to also correspond to the groundwater table at the pond. Hydraulic conductivity of the soil surrounding the pond was accessed from the NRCS Web Soil Survey and is approximately evenly split between two soil complexes, resulting in a mean hydraulic conductivity of 0.60m/day. The seepage rate $Q$ of groundwater into the pond was calculated as:

$$Q = KIA$$

where $K$ is the hydraulic conductivity, $I$ is the gradient between the pond surface and groundwater table elevation, and $A$ is the surface area over which seepage can occur. This relationship is shown in Figure 1.
Figure 1: Relationship between Elmwood Pond depth and assumed groundwater (GW) contribution.

\[ y = -0.168x + 1.8809 \]