### 4.2.3 Stormwater

Modelling of stormwater benefits requires a consistent approach to all watersheds in the City of Toronto. In 2004, the Toronto and Regions Conservation Authority (TRCA) commissioned Marshall Macklin and Monaghan Ltd. and Aquafor Beech Ltd. to analyze runoff reduction due to green roofs in the Highland Creek watershed. The modeling of runoff using the HSPF model was based on a unit response function (URF) approach, previously used in the Toronto Wet Weather Study in 2003. The URF of a certain land use category is the annual runoff from one hectare of drainage area. Assuming the runoff process is linear, total runoff can be calculated by multiplying the area by its corresponding unit response function. As unit response functions for other watersheds in Toronto must be determined separately using HSPF, it is assumed in this study that the Highland Creek's unit response function can be used to represent the whole city. Table C1 in appendix C shows the land use categories used in the current study and the annual runoff with and without green roofs. These unit response functions are estimated by

- adopting the unit response function generated in the Highland Creek case study if there is a corresponding land use category; or
- averaging the unit response functions generated in the Highland Creek case study if there are a few similar land use categories.

Using Table C1, annual runoff volumes from different land use categories in a watershed are estimated and aggregated. The percentage change of annual runoff due to green roofs is then calculated.

Three types of the stormwater benefits are estimated

- stormwater best management practice savings due to the application of green roofs;
- pollutant reduction;
- reduction of receiving stream erosion.

After reviewing the best management practice bundles used in the Toronto Wet Weather Study, we find three types of best management practices, which have high cost, may be replaced by green roofs in a generic manner. They are pervious pavements in residential highrise and commercial areas and underground storage in commercial areas. Table C2 in appendix C shows the unit costs of best management practices, which may be replaced by green roofs. This table was derived from the unit costs of best management practices including maintenance in the Toronto Wet Weather Study, while the cost saving is the difference in unit cost between green roofs and other best management practices. The total area of green roofs and the unit cost savings of best management practices in Table C2 determine the best management practice benefit of green roofs.

The City of Waterloo's green roof study allows the pollutant reduction benefit (P) and erosion benefit (E) to be estimated as follows:

$$P = 0.5 * \$5{,}460 / ha\_of\_greenroof$$
$$E = \$5{,}055 * ha\_of\_greenroof$$

Based on a 4,984 ha of potential green roof implementation, the following stormwater benefits are estimated:

- A BMP infrastructure saving from $2.8 to $79 million.
- A pollutant reduction benefit of $14 million
- Savings from erosion control measures of $25 million

The total stormwater benefit is estimated to range from $41.8 to $118 million.