4.2 Methodology and results

4.2.1 Use of geographic information system (GIS)

Working in a GIS environment made it possible to produce a methodology that examined the characteristics and distributions of actual rooftops across Toronto. GIS is a technology that represents landscape features, such as buildings, streets, stormwater infrastructure, and watersheds in terms of their geographic positions. This enables digital representations of features and their attributes to be related to one another as they are on the ground. This project therefore was able to exploit GIS modelling functions for data management, for numerical analysis (in conjunction with spreadsheets) and for developing presentation materials regarding stormwater and combined sewer systems, air quality, the urban heat island, building-energy use and monetization of benefits.

The City of Toronto's Works and Emergency Services Department provided GIS data. Their records represented the buildings, sewer networks (stormwater and combined sewer overflow) with recent aerial photographs, as well as data sets submitted by consultants as part of the Toronto Wet Weather Flow Management Master Plan Study (TWWFMMP, 2003). Data sets were compiled in a format consistent with City records (MTM NAD 27 projection), but standardized in ArcMap 9.0 format for ease in processing. Quality assurance entailed detailed positional accuracy checks, using digital orthophotographs supplied by the City, and monitoring of feature counts.

Records for the actual rooftops of interest across the city were derived from the buildings data. The City provided geographic records for all buildings whose roof areas were over 350 square metres, and included age, height, and building-use attributes. Many of the buildings' roofs were very intricately represented and had to be simplified so that a single flat roof area was defined for each building. The GIS then linked these with their encompassing subwatershed and watershed, for stormwater and other evaluations.

The Unit-Response Functions (URF) used to assess the ability of green roofs to divert stormwater from sewers were based on calculations in the TWWFMMP. In this report, each consulting team determined the amount of stormwater runoff from measurements of the extent of identified land uses and from permeable and impermeable areas per subwatershed. Aquafor Beech Ltd (2003) calibrated their model for runoff under current and projected green roof scenarios in the Highland Creek Watershed. The calibration values from their model were applied across the city in this study, by using the GIS to assign predicted runoff, based on records of usable roof areas, for each land use in each subwatershed. GIS then enabled aggregation of the stormwater diversions for watersheds and for the whole City of Toronto to demonstrate the reduced hydrological demands on the stormwater drainage network. These were then mapped using the GIS.

Air quality, urban-heat-island reduction and building energy assessments were addressed in a like manner. The work by Currie (2005) used the UFORE model to link vegetated areas to expected ambient air pollutant reductions and economic benefits. By mapping the extent of vegetation added by green roofs across the City, these results were extrapolated to show where air contaminant abatement could be expected and by how much. The distribution of air-quality, urban-heat-island reduction and building-energy benefits, as well as their sum for the City, were also mapped using the GIS.

The total area available for installation of green roofs was calculated as shown in Table 4.1

Table 4.1
Available areas for green roof implementation

Category	Area in hectares (percentage in paranthesis is of the total land area)
Total estimated land area of Toronto	63,175
Total building roof area	13, 478 (21%)
Total building roof area available for greening - flat roofs greater than 350 sq. m. and 75% green roof coverage	4,984 (8%)