



# Research & Development Highlights

## Stormwater Control to Prevent Basement Flooding

93-208

Technical Series

### Introduction

Many Canadian cities have experienced varying degrees of basement flooding over the past 10 to 20 years, despite increasing knowledge made available to designers of urban drainage systems. Efforts have been made to understand why the methods used to convey stormwater away from a property continue to fail. This report presents an overview of stormwater management practices across Canada and evaluates these practices in relation to the problem of basement flooding. A particular assessment has been made of some aspects of the National Building Code and municipal drainage ordinances. The document is intended as a reference for technical personnel involved in the design or redevelopment of sewer systems in urban communities and uses data obtained from previous studies along with results of a questionnaire sent to municipalities across the country.

### Research Program

Current Canadian design practices were reviewed, in an attempt to identify areas where they may be inadequate. Stormwater management trends, developed by some municipalities, were identified. These may help other municipalities and agencies with their design criteria. Problems with basement flooding in Canada were identified together with causes of basement flooding. Appropriate, implemented, cost-effective planning and engineering solutions were identified. Minimum criteria for municipal designs to allow improved handling of stormwater and a review of modern technology with the potential to reduce sanitary flows and permit increased residential densification are discussed. Some of the major jurisdictional factors that inhibit a clear understanding and resolution of the problems in the design and operation of urban drainage systems are highlighted.

### Findings

The study found that while basement flooding is common across Canada urban drainage system designers do not always understand how to adapt their systems to wet weather conditions. Deficiencies at different stages in the design of urban stormwater drainage systems have resulted in inadequate sewer systems. These deficiencies have led to some basement flooding.

Short duration, high intensity storm events can cause street flooding and result in high infiltration (VI) to the sanitary sewer systems. Ill to sewer systems occurs through manhole covers, cracked or open barrel joints in manholes, sewer system cross-connections, broken pipes or cleanouts, cracked and open pipe joints, structural failure of pipelines, and defective lateral connections. The quantity of Ill can be serious enough to have a major influence on sewer system performance. Basement flooding occurs when the sewer system is overloaded and residential service connections back up.

Communities that have experienced extreme basement flooding appear to have studied the situation enough to understand stormwater drainage patterns, and to identify all the VI sources. However, even when they develop programs to eliminate the most serious causes of their flooding problems they seldom share successful methodologies with other municipalities.

Jurisdictional issues can lead to or exacerbate the problem of basement flooding. The on-lot parties (builder, owner) generally do not realize that deficient drainage designs and practices can cause significant stress on the sewer systems and result in basement flooding in their own and adjacent properties.

Conflicts can develop over the maintenance of stormwater control facilities, from the homeowners' responsibilities, to the municipal versus regional responsibilities for sewer system design and maintenance. The age of the sewer infrastructure and its drainage patterns can contribute to the problems.

Municipal systems that operate within the confines of a regional drainage system must fit into the capacity of that regional system. Basement flooding could result from inadequate drainage practices outside of the municipality. Regional facilities may be inadequate and poorly planned, resulting from a merging of municipal plans rather than the use of a master plan that incorporates, to the fullest extent, the regional drainage area impacts.

A greater understanding of the roles of developer, owner, and municipal authority is evolving, and the development process in many municipalities (such as Edmonton and Vancouver) is beginning to reflect more equitably the responsibilities of all the affected parties. This will undoubtedly lead to more effective urban drainage systems, particularly in newly developed areas.

#### Implications for the Housing Industry

The division of responsibilities for the design, construction, and ongoing operation of on-lot and sewer system drainage contributes significantly to the problem of basement flooding. The construction and maintenance of house service connections appear to be difficult to control due to the large number of parties involved, from the land development stage to the final house completion. Codes and standards for work carried out on the lot (including the National Building Code) need to include and emphasize on-lot drainage considerations. Those responsible for design and operation of the sewer systems should have a clearer understanding of how on-lot stormwater contributions can cause systems to surcharge and overload. The key to public involvement in improving drainage and reducing basement flooding is better coordination between urban planners, developers, and municipal officials.

There is a need for municipalities to develop master drainage plans that incorporate all their drainage components into one plan.

In this way the limitations of that system will be clearly

identified following the results of a thorough investigation of all local conditions, including: local soil types, climate, topography, historical system development, and future planning data.

Maintenance of sewer systems is a necessity in stormwater management control and a municipality should establish a program that will ensure proper operating conditions for the municipality and for the homeowner. This is supported through studies in the U.S. that identify the need for maintenance responsibilities to be clearly defined.

There is a need to educate homeowners about the effects of poor lot grading and roof leader extensions on urban stormwater drainage systems, as local surface drainage due to poor lot grading and roof leader extensions can be significant.

Code approved backflow valves and sump pumps have failed in some instances, but the failure often is due to improper installation, lack of maintenance, or poor sump pump sizing or selection. These problems could be reduced by establishing installation procedures and standards for plumbers, by training building inspectors, and by educating homeowners.

In planning and designing residential redevelopment in existing urban areas, particularly those involving densification, the impact on the stormwater drainage system should be analyzed by the developer and reported to the municipality. The report should consider local surface drainage, sewer system flow, and overland flow implications. The above analyses will provide a basis for determining the risks associated with providing below-grade accommodation in a redevelopment project.

Solving the problem of basement flooding will take a great deal of cooperation among homeowners, developers, builders, and policy makers, to clarify the responsibilities of each.

The report concludes that the long-term consequences of basement flooding are significant, and that the, inspection requirements for on-lot drainage, including roof leader extensions, lot grading, and foundation drain discharges, should be required by building codes and standards, as are those for electricity and plumbing.

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Research Report: Storm water Control to Prevent  
Basement Flooding (1992)  
Research Consultant: CH2M Hill Engineering Ltd.*

*A full report on this research project is available from the  
Canadian Housing Information Centre at the address below.*

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